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THE EFFECTS OF HOUSEHOLD AGRICULTURAL INCOME ON THE ADOPTION OF ELECTRICAL APPLIANCES AND ENERGY SECURITY AMONG RURAL HOUSEHOLDS IN MNQUMA LOCAL MUNICIPALITY.

BY

NTONJANE, P. 201202099

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IN AGRICULTURAL ECONOMICS

SUPERVISOR: MR S.T.C MDLETSHE

CO-SUPERVISOR: DR B.E. AKINYEMI

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Dedication

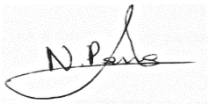
I dedicate this dissertation to Grandma (Tolokazi) and my whole household (Odlamini oJama kasJadu oFakade).

Declaration

I, Pangomsa Ntonjane, 201202099 hereby declare that I am aware of the University of Fort Hare's policy on plagiarism, research ethics and I have taken every precaution ton comply with the research regulations and this dissertation is my original work.

I have obtained an ethical clearance certificate from University of Fort Hare Research Ethics Committee and my ethical clearance certificate reference number is AKI021SNTO01.

This thesis" the effects of household agricultural income on the adoption of electrical appliances and energy security among rural households in Mnquma Local Municipality." has never been submitted for any degree or examination at any other university or institution of higher learning. Words have been re-written, but the general information attributed to them has been referenced, and the source details mentioned in the reference section.

Signed:  **Date: 29/09/2021**

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As candidate's main supervisor, I, Mr Mdletshe Sifiso Themba Clement, agree to the submission of this thesis:

Signed **Date**

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As candidate's co-supervisor, I, Dr Babatope Ebenezer Akinyemi, agree to the submission of this thesis:

Signed **Date**

…….. ……

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List of Abbreviations

BLR -Binary Logistic Regression Model

DoE - Department of Energy

EBSST - Electricity Basic Services Support Tariff

ESS - Energy security status

FBE - Free Basic Electricity

HRP-Head Representative Person

IEA - International Energy Agency

ICT- Information and Communication Technology

IDP - Integrated Development Plan

INEP- Integrated National Electrification Programme

LPG - Liquefied Petroleum Gas

LR- Likelihood Ratio

MLM - Mnquma Local Municipality

NEP- National Electrification Programme

NERSA- National Energy Regulator of South Africa

RE- Rural Electrification

SDGs -Sustainable Development Goals

SMEs - Small Medium Enterprises

SA - South Africa

SPSS- Statistical Package for the Social Sciences

UN- United Nation

VIF -Variance inflation factor

WHO -World Health Organisation

Abstract

Energy security is critical to global economic development and agricultural activities. Electricity is one of the most beneficial types of energy for rural household livelihoods and smallholder producers in South Africa. This study aims to examine the effects of household agricultural income on the adoption of electrical appliances and energy security among agricultural households in Mnquma Local Municipality. The study employed primary data obtained from 224 households using simple random sampling technique across three electrification stages. Descriptive statistics, and binary logistic regression was used to determine the relationship between socio-economic and demographic characteristics of the household and the household agricultural income on the adoption of new electrical appliances and energy security across the three electrification stages.

Descriptive statistics results indicated that non-electrified (67.1%) and recently electrified (54.3%) villages are dominated by female-headed households, while in electrified households there are more male head households (58.3%). The results also show that among the households that have the highest total monthly income (greater than R15000), 34.5% were electrified, 17.1 % were recently electrified, and 4.3% were non-electrified. The Binary logistic regression model's findings for the second objective revealed that household head factors such as age, monthly total household income, household size, and household agricultural income have significant effects on energy security. The study's findings revealed that household agricultural income has a significant impact at a 5 % significant level on the adoption of electrical appliances. Binary logistic regression findings for the third objective revealed that on new electrical appliance adoption there was a significant effect of gender (at 5% level), household size, energy security, and household agricultural income at a 1% significance level. Binary logistic regression revealed that the coefficient of household size variable is positive and significant at a 1% significant level on energy security and electrical appliance adoption.

In this study, household agricultural income on the adoption of electrical appliances has been found to be the most critical factor influencing the energy security status of households among the selected rural households in Mnquma Local Municipality. As a result, policies must be put in place to facilitate access to electrical appliances through electrification programs, invention of affordable electric appliances, encourage participation in agricultural production and agricultural market access, that will provide households with social benefits. To improve energy security, electrical appliances should be simple to use and aid in the transition from biomass to electricity.

Key words: *Energy security, electrical appliance adoption, agricultural income, Binary logistic regression.*

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

This study looks at the effects of household agricultural income on the adoption of electrical appliances and energy security after the electrification in marginalised areas of the Mnquma Local Municipality (MLM). Rural electrification (RE) is the process of installing electricity in marginalised outskirts (Bose *et al.*, 2013). According to Stats SA (2011), the percentage of households connected to an electricity supply from the mains has increased from 76, 7% in 2002 to 84, 4% in 2017. Mnquma Local Municipality rural smallholders with electricity have more demand for utilization of electric appliances to improve their livelihood.

According to the International Energy Agency (2016) globally, about 1.2 billion people have no access to electricity, and 80 per cent of them are from rural areas. The International Energy Agency defined energy security as "the nonstop physical availability of energy at an affordable price, while in respect of environmental concerns" (IEA, 2016). Eskom had already embarked on a programme in 1991 called 'Electricity for All' (Winkler, 2006). The National Electrification Programme (NEP) was implemented between 1994 and 1999 to provide electricity to rural and urban low-income households that had been deprived of access to electricity during the apartheid period (Winkler, 2006). After 1994, the South African government promised to provide basic services such as electricity to rural areas and low-income urban areas (Arthur, 2009). Davis (1998) noted that the programme expected that newly electrified households would switch from using wood, candles, and batteries to using electricity for their household needs.

According to Doll and Pachaur (2010), for the most impoverished, the lack of access to energy is a most important hindrance to poverty reduction, economic development quality of life, as well as on adoption of new technologies in various sectors such as agriculture. Other than the basic use of electricity in agricultural households for lighting, communications and home appliances, the use of electricity to other activities as entrepreneurship bring economic development through productive enterprises and agricultural development bring an important engine of growth. These benefits of electrification have been identified as fulfilling Sustainable Development Goals (SDGs), that were adopted in 2015 Agenda for sustainable development by 2030 the United Nation (United Nation, 2015). Thus, access to electricity, in particular, is a crucial component of poverty reduction, because electricity light lengthens the day to assists economic development and educational opportunities. While agricultural production helps the countries to achieve SDG 1 (No poverty) and SDG 2 (Zero hunger) by improving the livelihoods of poor and extreme poor rural people, including smallholders and household agricultural producers. Electricity can also provide vital

households and community services such as preservation, food processing, entertainment and communications, as well as to electrified buildings such as health centres and schools, (Doll & Pachaur, 2010). When households lack refrigeration, they cannot preserve fresh produce and leftovers rot in kitchen cupboards (Arthur, 2009).

The literature shows that the use of household electrical appliances such as washing machines, fans, radios, and television sets depends, to some extent on the electricity availability (Tezuka & Wijaya, 2013). It was noted that the use of electricity and the adoption of electrical appliances increase year after a year in Vietnam (Khandker *et al.,* 2009). A study conducted in Ethiopia by Aragaw (2012) noted that household income generation activities and Small Medium Enterprises (SMEs) are facilitated and expanded through the availability of electricity. Although income levels of the rural population are another determining factor in purchasing the electrical appliances. Lack of purchasing power to own appliances is a major hindering factor in rural households' equity (Kaygusuz, 2011). Therefore, electric freezers allow people to buy food in bulk and eat it at their free time to save money.

According to Hirmer and Guthrie (2017), noted agriculture as a primary source of food for man., employment opportunities and source of income. Agricultural income refers to income earned, or revenue derived from sources that include farming land, buildings on or identified with an agricultural land and commercial produce from a horticultural land. The major economic activities, the livelihood systems engaged by the local community include agriculture and livestock production (Mbaka, 2012). Although a case study conducted by (Mbatha & Masuku, 2018) reveal that rural areas in South Africa regard small-scale agriculture as a source of income generation and enhancing food security. According to Boshoff and Fourie (2020), agriculture is the pillar of South Africa's economy contributor Gross Domestic Product (GDP), Small-scale agriculture contribution is hindered by poor access to markets and inadequate financial support services were identified to the Gross Domestic Product (GDP) and rural economic development (Mbatha & Masuku 2018). Approximately 80% percent of the populations live in the rural areas mainly rely on agriculture for their livelihood (Majova,2018). The lack of electricity affects livelihoods for rural people and increases poverty where they will not be able to increase their productivity. Kaygusuz (2011) argued that RE has a major impact on agricultural production, health, and the economy at large. Kaygusuz (2011) also said that for rural areas to contribute to the economy, they must be provided with good quality, reliable and inexpensive electricity. Energy security refers to the secured supply of energy devoid of any interruption. According to Torero (2014), electricity is essential for basic human needs and economic activities. Electrification reduces the amount of urban migration, streetlights to improve security, increased

comfort in rural settlements at night particularly for women (Hirmer & Guthrie, 2017). According to Paulo *et al.* (2017), electrification can reduce crime, because it improves the security technology that is used by the police and individuals (cameras and surveillance technologies, alarms, etc.). This reduces individuals' exposure to violent crime (e.g., individuals stay home and use more electric devices, including watching TV, listening to the radio, etc). In addition, increased visibility makes it easier to identify a criminal offense and the offender, which increases the detection of crime (Paulo *et al.,* 2017).

After the electrification process, retail sales increase, because households purchase electrical appliances. Winkler (2006) noted that electricity is the second highest ranking energy in demand after diesel fuel on the part of the agricultural sector in South Africa. Winkler (2006) further said that although the NEP provided electricity to the rural households, they continued to use their non-electric energies (Thom, 2000). Lahimer *et al.* (2013) discovered that RE is affected by several factors such as politics, insufficient funds and beliefs and when the councillor is not distributing services to the communities. Old people from rural areas they do not accept the introduction of electricity as some still believe that this will chase away their ancestors by bringing bright light.

Madubansi and Shackleton (2007) argued that the introduction of electricity decreased the need for fuel wood in their longitudinal study at Bushbuckridge Lowveld. Several factors influence the adoption of electrical appliances in the wake of electrification of a rural area such as Mnquma local municipality. Cost of electricity, belief and politics are factors which cause agricultural households to carry on using old energies even after electricity has been installed. High price of electricity and expensive appliances may limit the adoption of electrical appliances after rural areas electrification (Arthur, 2009). The retail price for electricity increased by 12.6% by 2015 financial year. Through the implementation of Eskom electrification programme, there was about 70% increase of electrified households (Department of Energy, 2017). According to Rogers (2003), households' perceptions which lead to the decision of whether to adopt or not, lack of knowledge about electricity and awareness of new technology (electricity) and its benefits are the factors affecting electricity adoption for those households that are electrified while those who are not electrified only noted income as their reason for not adopting. Unreliable service such as load shedding that reduces the relative advantages and could slow the adoption of electricity (Rogers, 2003).

Bose *et al.* (2013) noted that when households obtain access to electricity, new preferences and expectations appear. Households agricultural producers go through a number of steps, including the adoption of new financing channels for electricity and electric appliances adoption; they start to have more preferences to choose from and begin to budget for the newly installed electricity because of its benefits. Women in rural

areas are now developing businesses (like agriculture, hatchery, and retail shops etc.) inside and nearby their homes (Bose, 2013). This process can even mitigate migration, as rural people will remain in their areas when they can utilize electricity to improve agricultural activities (Lahimer *et al.*, 2013). In South Africa, the process of installing electricity emerged as a reformatory measure to attempt to equalize the standard of living of its citizens. According to Lahimer *et al.* (2013), the NEP was put into place as a catalyst to achieve the broader goal of electrifying rural settlements, to alleviate poverty. Eskom is responsible for the installation of electricity in most of the rural areas of South Africa (Thom, 2000).

1.2 Problem statement

A few studies (Khandker *et al,* 2013; Jobela, 2011; Khandker *et al*, 2009) have investigated the socioeconomic factors that have an impact on rural electrification as well as the impact of RE on the welfare of its recipients. Jones *et al*. (2015) noted that implementation of effective energy policy, prediction, and plan for the future electricity consumption of the domestic sector can be supported by understating the effects of factors to the electricity. Khandker *et al*. (2013) and Khandker *et al*, 2009 provided an analysis of the effects of RE on the welfare of people. Davis (1998), Dinkelman (2011) and Torero (2014) argue that the escalating rate of electrification in South Africa provides an opportunity to determine its impact on households. Electricity is one of the most beneficial types of energy that affect the agricultural households. Several studies have been carried out to identify its impact and evaluate the changes in patterns of energy consumption (Madubanisi & Shackleton, 2007). Energy for mechanisation and productivity is one concern among a range of concerns and drivers including food security, livelihoods, sustainable resource management and climate change The issue of electrification is indeed an international concern as previous studies evaluated the effects of rural electrification which pave a way for this study to examine the effects of household agricultural income on the adoption or use of electrical appliances and energy security among selected agricultural households. Load-shedding and expensive electricity in South Africa is becoming worse. Current literature (Tezuka & Wijaya, 2013; Huebner *et al,* 2016; Hirmer & Guthrie, 2017) shows that limited studies have been conducted regarding adoption of electrical appliances in rural households. The three villages in the Mnquma Local Municipality chosen for this study are all rural (which are low-income earner and far from town) and thus are facing challenges of electricity affordability. In the meantime, National Energy Regulator of South Africa (NERSA) has approved a 2.2 % average price increase of tariffs and charges (DoE, 2017). Electricity price increase is likely to have a negative effect on the low-income households of the Mnquma Local Municipality, although electricity seems unimportant when compared to the pressing issues of poverty reduction and economic development. The concern is that most rural household agricultural producers cannot afford the electricity tariffs, and this can lead to energy

insecurity where the usage of dirty and unsafe energies become high. Purchase of electrical appliances is a problem in rural areas which is affected by different factors including cost of electrical appliances. According to Hirmer and Guthrie (2017), households still struggle to finance expensive electrical appliances such as refrigerator. Kaygusuz (2011) noted that ownership of electrical appliances will depend on the income of the household. The purpose of this study is to provide an understanding of agricultural income effect on the adoption or use of electrical appliances among rural households agricultural producers in the Mnquma Local Municipality after an increasing rate of access to electricity is established. Thus, high access to electricity can reduce energy security and deforestation, as it is the major factor that is caused by wood collection because of lack of access to electricity. An affordable electricity is needed to meet the adopters' budget in the rural areas to promote electricity adoption and regulation. Lack of Access to electricity alone is a problem.

1.3 Objectives of the study

The overarching goal of this study is to examine the effects of household agricultural income on the adoption of electrical appliances and energy security among selected households in Mnquma Local Municipality.

Specific objectives of the study are:

1.3.1 To describe the socio-economic characteristics, energy security status and agricultural income of households in Mnquma Local Municipality.

1.3.2 To examine the relationship between agricultural household socio-economic characteristics and energy security.

1.3.3 To determine the effect of household agricultural income on the adoption of new electrical appliances in Mnquma Local Municipality.

1.4. Hypotheses of the study

The null hypotheses to be tested in respect to the objectives two and three are:

1.4.1 H_0: There is no significant relationship between agricultural household socio-economic characteristics and energy security in Mnquma Local Municipality.

1.4.2 H_0: Household agricultural income does not have significant effect on the adoption of electrical appliances in Mnquma Local Municipality.

Table 1.1: Objectives summary

Objectives	Type of data variable required		Analytical tool
	Dependent variable	Independent variable	
1. To describe the socio-economic characteristics, energy security status and agricultural income of households' livelihood in Mnquma Local Municipality.		Age, gender, marital status, education level, income sources, household size, monthly income, electrification stage, and use of electric appliances	Descriptive statistics. Percentages, Frequencies.
2. To examine the relationship between agricultural household socio-economic characteristics, and energy security.	Energy security	Age, Gender, marital status, monthly income and household size agricultural income	BLR model will allow one to predict the effect of several independent variables on a dependent variable
3. To determine the effect of household agricultural income on the adoption of new electrical appliances in Mnquma Local Municipality.	Adoption of electrical appliances	Age, Gender, marital status, education level, monthly income, Household size, Energy security and Agricultural income etc	BLR model

Source: Authors own computation (2018)

1.5 Justification for the study

Davis (1998), Dinkelman (2011) and Torero (2014) argues that the escalating rate of electrification in South Africa provides an opportunity to determine their impact on households. Bose *et al.* (2013) also noted that RE is an essential process to offer the access of up-to-date energy in Bangladesh. This shows that only similar studies have been conducted in other countries. There is a paucity of research studies on the household agricultural income effect on the electrical appliances adoption and energy security among agricultural households has not been conducted previously in South Africa to my knowledge. This study aims to provide more insight into the dimension of electrification by examining the effects of household agricultural income on the adoption of electrical appliances and energy security among selected agricultural households. The findings of the study may inform policy-makers in the Mquma Local Municipality to form a strong relationship with the rural areas and the service providers in order to create policies that enhance the adoption of electrical appliances and energy security. It will also assist the government in seeing whether households still prefer electricity as their primary source of energy and fast-track the electrification process to those who are not electrified. United Nations Sustainable Development Goals number seven is to ensure

affordability, reliable, sustainable, and modern energy for all (United Nations, 2015). According to Winkler (2006), electricity has played a crucial role in the South African economy, as is one of the inputs to industries like agriculture. Access to electricity was included mostly as the aim of national development strategies; hence, this study is about RE. According to Sikrweqe (2002), RE was aimed to act as a catalyst for stimulating and encourage diversity of agricultural, industrial, and commercial development in rural areas. Therefore, this study may bring significance to local government and communities at Mnquma Local Municipality areas as this study will also be published so that it will be easy for electrification decision-makers to access this information. This study may also be academically significant to other researchers who will undergo a similar study as these electrical appliances are important in households and are used in differently for instance cooking, entertainment, communication, food preservation (storage) and Agro-processing.

1.6 Delimitations of the Study

This study determined the effect of household agricultural income on the adoption of electrical appliances and energy security and was limited to the three selected villages [electrified, non-electrified and recently electrified (>5 years) village] in Mnquma Local Municipality only. The focus was on the effect of household agricultural income on the adoption of electrical appliances and energy security among the selected agricultural households because of time as it is a cross-sectional research. Energy security was measured by the expenditure approach due to limited data. The changes of consumption effect of RE was not included in this study because it is broad, that means it cannot be accommodated in a short period of time as it can use a longitudinal survey. In terms of methodological implications, the analysis model was tested for multicollinearity using a VIF to make sure findings are correct and check whether it was an appropriate analysis model. Huebner *et al.* (2016) concluded that the way variables are coded such as income and household size as categorical or continuous variables, needs careful attention given that outcomes might vary depending on this decision.

1.7 Outline of the study

This study is composed of five chapters. Where Chapter One will be the background of this study, problem statement, objectives, hypotheses of the study and importance of the study. Chapter Two will be the literature review, conceptual framework, and theoretical framework of this study. Chapter Three describe the study area, population and the socio-demographics of the area and presentation of the methodology of this study. Chapter Three explains the sampling method, data collection method and the variables collected.

It further clarifies on the method of data analysis. Chapter Four are the results and chapter Five will be the discussions and conclusions of this study.

CHAPTER TWO: LITERATURE REVIEW

2.0 Chapter introduction

This chapter focuses on the relevant literature that assisted in conducting this study, looking at South Africa and other countries. The purpose of this chapter is to provide information of the effect of rural electrification on the socio-economic characteristics of the households, adoption of electrical appliances, energy security and the benefits of electricity. The progress of RE is there to convince researchers that there is more investigation needed such as a follow up on the effect of rural electricity availability, adoption and electrical appliance's adoption after electrification process. Rural development requires assessing the contribution of electricity at the household level. The ability to predict future demand accurately, will facilitate the adoption of policies that promote the development and will ensure good planning of energy availability and the economic health of the sector. Additional research is needed to entirely map out the progress of this electrification and understand the changes and relationship between possible factors and the rural energy security. However, this research will determine the effect of household agricultural on the adoption of new electrical appliances and energy security in agricultural household's livelihood and explore the relationships between uses of electrical appliances and changes that occur in the process of getting electricity on socio-economic and demographic factors, such, as household agricultural income. Agricultural income which will be investigated in agricultural household is when at least one member of the household is economically active in agriculture. Energy security is measured as a vital powerful factor for sustainable socio-economic development in the world. To end the analytical models used in the study are also assessed in this chapter.

2.1 Availability effect of electricity

According to Lenz *et al.* (2017) noted that the availability of electricity in the communities has a significant effect on the daily routine of rural dwellers and for many households; television becomes an important source of information. Regarding the supply of electricity in rural areas, there is a significant impact on economic growth and development as well as poverty reduction by the major international development agencies (IEA, 2016). However, electricity cannot contribute to economic growth alone (Torero, 2014). A study in developing countries also concluded that electrification alone cannot take care of all improvement issues in the meantime, disadvantaged individuals cannot take other different fuel types of improvement help without access to electricity supply and (Barnes, 2011). Poor people in rural areas tend to struggle

more to afford other types of energies as they are multiple issues such as dirty and expensive and it is preferred to use expensive energy like electricity because is cleaner than other energies. In addition, determining the socio-economic issues is essential to the development of electrification in rural areas, drawing on the experience with grid applications in developing countries such as South Africa (Barnes, 2011). In a village called Tsilitwa in the rural Eastern Cape, South Africa where chain supermarkets provide most goods and services but employ few people in places where they are located, income generation opportunities from electrification are even more limited (Matinga & Annegarn,2013). Schwerhoff & Sy (2017) have demonstrated that RE has an extra-ordinary potential to all, while accomplishing financial, social, and environmental goals as figured in the Sustainable Development Goals. Kaygusuz (2011) stated that the crux of the RE problem is that electricity is costly, a high-quality energy source that practically wants to be bought but not all can afford. These studies emphasise the importance and benefits of the RE which implemented and brought in rural households' livelihood. In contrast, Skrweqe (2002) noted electricity as the cheapest and safest energy. In contrast Thom (2000) further noted that electricity is expensive in terms of cooking by rural homes in South Africa, there are many services that electricity provides at household level. Cabraal *et al.* (2005) noted that access to electricity has a significant impact on rural development only when it is used efficiently and on income-generating activities. Access to electricity has a substantial positive impact on rural growth and livelihoods. The access to the electricity brings wealth to the agricultural households when it is used resourcefully to generate income to improve their livelihoods. In terms of economic development, it provides the basis for improving productivity by facilitating income-generating activities and improving the business standard (Kooijman-van Dijk, 2008; Cabraal *et al.* 2005). Rao (2013) observed that electricity access in India increases the expected income. Even if agricultural households are working you can still use available resources to generate more income. Matinga and Annegarn (2013) also observed that the availability of electricity increases income generation by community shops.

2.1.1 Uses of electricity for different services

According to Thom (2000), most households that own an electric stove or hot plate do not use these frequently for cooking purposes. Thom (2000) further said that most households procure electrical appliances just after they are electrified. This is illustrating the utilisation of electricity for different purposes where electricity is used for connecting radios, refrigerator, electric stove and "power farm machinery, such as water pumps, fodder choppers, threshers, grinders, and dryers (Cabraal, 2005). Winkler (2006) noted that the average energy burden of about 18% in rural areas although the energy burden was reduced by 12% after the introduction of free basic electricity. According to DoE (2012), electricity

consumption in poor households is small despite these households stating their preference for its convenience, cleanliness, and better lighting quality. According to Khandker *et al.* (2009) electricity consumption goes up as households acquire more electrical appliances. Lewis and Pattanayak (2012) claim that women might have stronger preference for using modern energy stoves given their involvement in cooking.

Several studies revealed that electric lighting devices (e.g bulbs) were used by 100% of all electrified households and it is the priority after being connected (Thom, 2000; Khandker *et al*., 2009; Mbaka, 2015) and they were used as security. According to Winkler (2006) revealed electricity was mainly used for lighting. The household that does not have much income save electricity by only consume electricity for lighting only. Electric lightning is advancing health benefits from the reduced use of kerosene, labour-saving for women through a reduced need to collect fuel, reduced operational expenditure, extending the working day, providing extra hours for study. According to Arthur (2009), some appliance serves different uses per appliance such as a two-plate stove and four plates with oven stove which can cook, bake and boil water. Most of the appliances are multi-functioning. Furthermore, the electric stoves help labour-saving for women through a reduced need to collect fuel. Television is used to improve entertainment, access to information, access to modern communication networks and awareness creation (Hirmer & Guthrie, 2017). While communication, access to information and entertainment appliances can be also served by cell phones and radios. Radio was mostly used as a source of access to information in Kenya at 96.3% by electricity adopters while the radio was also used for entertainment by 7.6% (Mbaka, 2015). Even non-electrified households do access radio operation using the battery (Thom, 2000). The number of mobile phones per household and the usage intensity also increased due to electricity. According to (Matinga & Annegarn, 2013) mobile phones were already used widely before electrification (more than 60%). While usage rates increased in both treatment and control areas to more than 70%, the positive and borderline significant suggested that the increase among the connected households is above the general trend. Furthermore, households do not need a grid connection to use a mobile phone, but it is the facilitation of phone battery charging that induces the increase in usage rates (Lenz *et a,l* 2011). According to Hirmer and Guthrie (2017) phone charging is reducing communication costs, mitigation of transport costs connected with mobile phone charging, banking access and improved literacy. Access to information related to agricultural best practices through television and mobile phones. Moreover, a phone was owned by 98.1% of adopters as they were using it for different purposes to ease the communication for families in a far place, internet, social networks and money transfers (Mbaka, 2015; Hirmer & Guthrie, 2017). The

refrigerator, which is for beverages and preservation of food, reduces the chances of food poisoning, increased variety, and quality of the diet through enriched micronutrient intake (Hirmer & Guthrie, 2017).

2.1.2 Use of electricity with other energies or multiple uses of energies

According to Thom (2000), the electrified households still use other energies in combination with electricity, especially the low-income groups and among recently electrified households because they cannot afford electrical appliances or electricity bills. This is not only affected by economics but also traditional factors. Furthermore, the persistent use of paraffin, mainly for cooking and water heating, is one of the most services in energy use among low-income electrified households in South Africa. Moreover, the South African rural areas perceived paraffin as the cheapest energy to use than electricity for these thermal purposes and paraffin use was found to be much more strongly correlated to variables such as gender, generation, and diet than it was to income (Thom, 2000). Madubansi and Shackleton (2007) argued that most of the households in the villages of Bushbuckridge region in South Africa still depend greatly on fuelwood for cooking and use more than three energies for one use. Madubansi (2007) noted that a large portion of electrified households used mixtures of three or more energies, particularly low-income households. Only 1% of households were using electricity alone as their source of energy (Madubansi, 2007). Lenz *et al*. (2017) opined that batteries, candles and kerosene are used when there is an electricity blackout.

2.1.3 Household energy Consumption patterns (preferences and changes)

Rural households depend on fuelwood as their major source of energy (Madubansi, 2007). In contrast, Madubansi (2007) further says fuel choice and substitution are strongly driven by desires for greater conveniences, quality service and cleanliness in rural areas. People desire modern energies that do not consider labour intensity for collection and use. Where low- income electrified households have fuel choice patterns similar to those that are not electrified. In addition, Davis (1998); Madubansi and Shackelton; 2007) noted changes in energy consumption of rural households.

Mazibuko (2015) argues that in areas grid electricity is supplied firstly by Eskom and indirectly by municipalities, whose right of supply have almost been taken by Eskom. While having cooking appliances and the number of electric stoves has been linked to higher electricity consumption. Winkler (2006) noted that the number of households cooking with electricity increased by only 4.3% from 1996 to 2001.Winkler (2006) also noted that after the electrification programme there is a reliance on electricity consumption although there is still an issue for its cost. Rao (2013) noted that electricity consumption significantly affects the GDP. Electricity consumption is affected by the adoption of an electrical appliance. The energy carriers

chosen by low-income households depend on budget, need, availability, and preferences (DoE, 2012). DoE (2012) also noted multiple energy use as an enduring feature of the energy consumption patterns of both electrified and non-electrified households in South Africa.

From Figure 2.1, it is evident that significant patterns of differences exist among electrified and non-electrified households in the range of energy sources that they utilize to meet their basic needs. Those with electricity all reported that they used electricity either for lighting, cooking or heating, although they still use other sources such as candles, paraffin, firewood and gas continue to be relied upon in at least a fifth of cases. Conversely, in the absence of a domestic connection, non-electrified households rely primarily on transitions and primitive energies.

For electrified households, the relatively widespread use of candles (42% of cases) is probably part of an energy substitution strategy in which homes depends on candles in instances of electricity service interruptions or if the household finishes its budgeted expenditure in the case of prepaid electricity meters. Furthermore, a third (31%) of electrified households indicates that they use paraffin and slightly more than a quarter (27%) use firewood and paraffin, most likely for cooking and for lighting. These statistics point starkly to the existence of barriers to energy-switching. In non-electrified households, the use of candles (87%), paraffin (83%) and firewood (65%) stays articulated, for lighting, cooking and space heating.

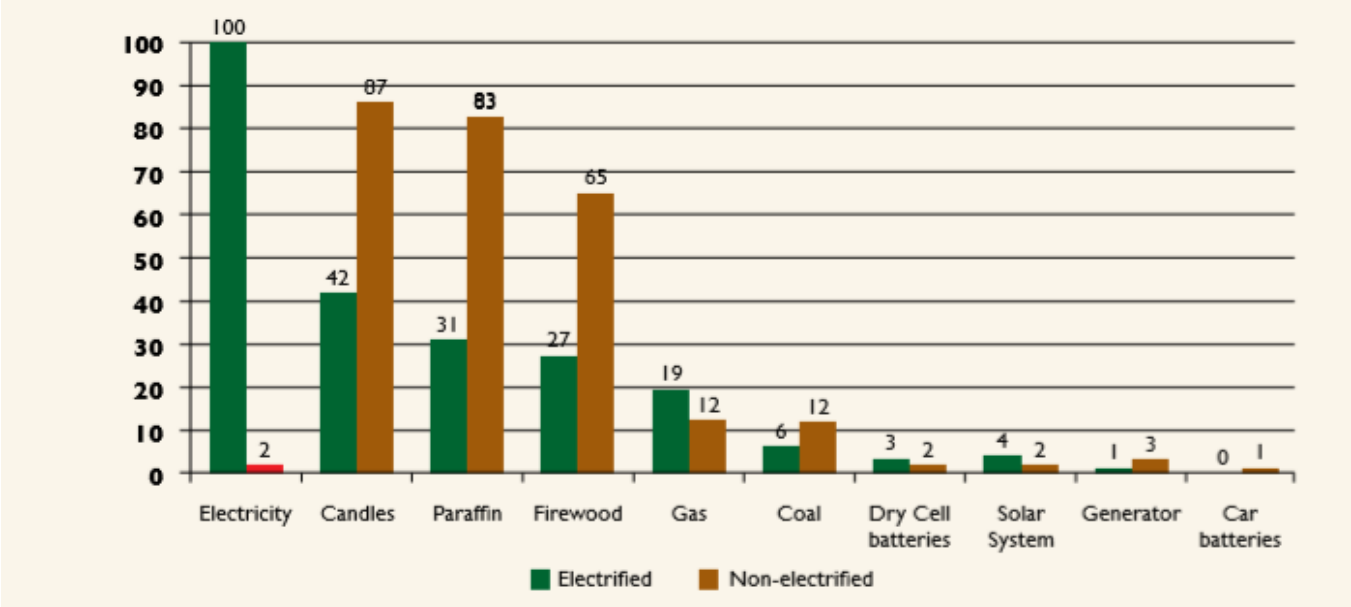

Figure 2.1: South African consumption of multiple energies by rural households (%)

Source: DoE (2012)

2.2 Adoption of electrical appliances

According to Rogers (2003), adoption is a choice of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation". Jones (2015) argued that electrical appliances make a very significant contribution to a household's electricity consumption. According to Mbaka (2015), price and availability of electrical appliances has often been a hindering factor in the electricity consumption. Adoption is restricted by high cost in most households (Davis, 1998). Sikrweqe (2002) revealed that illiterate people from non-electrified areas do not adopt electricity because of various reasons. Sikrweqe (2002), a study from Mount Ayliff mentioned that rural people cannot afford the appliances and cannot operate them effectively as literate people do. Sikrweqe (2002) further identified illiterate people believe that their domestic animals cannot sleep at night because of the electric bright light with the superstition that ancestor cannot visit them under the bright light of electricity. Eder *et al*. (2015) noted that the adoption must occur under the condition that the innovation is affordable and economically viable. Risseeuw (2012) found that stoves should be produced locally, affordable to buyers and designed to be compatible with cultural preferences.

2.2.1 The effect of electrification on the adoption of new electrical appliances

Matinga and Annegarn (2013) argued that television sets were the second most owned household electrical appliance after electric stoves, while the study of Mbaka (2015) further argued that radio (96.3%) was the second most owned appliance followed by television (94.4%). Lenz *et al*. (2017) noted that the first appliance to purchase was electric lamps and propensity score matching was used to match not electrified and electrified households using kernel matching logarithm. Louw *et al.* (2008) also noted that in newly electrified low-income households in South Africa, electrical appliances were shared simultaneously between occupants (e.g. cooking or watching TV). The refrigerator allows the household to eat fresh produce and leftovers that do not rotten in the kitchen counter. Candles continue to be an important source of light even after electrification, particularly those in low-income households (Davis, 1998). In contrast Lenz *et al.* (2017) households use candles as a substitute for electricity when there is a blackout.

2.2.2 Factors influencing the purchase of appliances

According to Arthur (2009), these choices are based on various preference factors such as source and appliance costs, availability, safety and cleanness, facility of use, security of use, a multiplicity of uses, social desirability, and other factors. The choice of energy sources often depends on their prices and on the capability of the household agricultural producer to invest in energy-consuming appliances, required to

consume those sources. According to Louw *et al.* (2008), the continued cost of electricity consumption is one of the constraints (the everyday cost of using electricity) and also the costs of new appliance purchases, repairs and maintenance.

Tezuka and Wajaya (2013) studied characteristics that affect appliances as the price, quality (this term refers to the appearance of an appliance), energy consumption, warranty, user-friendliness, technology, safety, accessories, type, brand, and country of origin. In addition to that, price and quality are the most frequent type of information required prior to purchasing an appliance. Tom (2000) mentioned that availability of space; cost and usefulness are the major factors to purchase an appliance. Rural household agricultural producer's perception of the benefits of electricity is also a factor that determines electricity adoption. Information related to energy consumption and the technology of the appliance was not a prioritized. According to Risseeuw (2012) noted cultural and behavioral factors for cooking, stove adoption is mostly determined by the desperation of poverty which they are the product of active decision-making in households' individuals according to their preferences. Participating in the agricultural activities is vital to eliminating poverty, hunger, and malnutrition in rural areas. This could be achieved by increase small-scale producers' productivity and income; diversify farmers' income through value chain development; and create more and better jobs for the rural poor.

Adoption decision making tributes are the relative advantage, compatibility, complexity, trialability and observability (Roger, 2003). There are many factors that affect adoption decision and intensity of adoption. Various studies (Mangivzo, 2014; Jones *et al*, 2015; Huebner *et al,* 2016; & Baldini *et al*, 2018) looked at socioeconomic factors, institutional factors and technological factors. This research looks at socio-economic factors. Pine *et al.* (2011)'s study conducted in rural Mexico find that education and household income are the most significant factors that determine a household's willingness to adopt improved biomass stoves. Pine *et al.* (2011) found that the opinion of leaders within a community also influences the adoption of improved cooking stoves.

2.2.3 Relationship between appliances ownership and income

Davis (1998) noted that the ownership of electric stoves (and other electrical appliances) are also related to income levels. Sikrweqe, (2002), also noted a close relationship of electrical appliances ownership with income exclusion of radio. A significant percentage of low-income electrified households in rural areas own electrical appliances such as stoves/hotplates, kettles, irons, refrigerators, televisions and radios/hifis (Thom, 2000; Thom & Mohlakoana 2001). Generally, ownership of these appliances appears to increase as

household income increases. Nevertheless, anthropological studies have shown that household income is not the main determinant of household appliance purchases. Concerning the ownership of an iron and its effect on energy consumption Louw *et al.* (2008) found an important and positive relationship in newly electrified low-income African households. Kaygusuz (2011), the use of household appliances, such as rice cookers, fans, radios, and television set, depends first on the availability of electricity and second on the income levels of the rural population same as the costs of acquisition of such appliances. In fact, the poor's lack of purchasing power to own appliances is a major inhibiting factor in rural areas (IEA, 2016). Fisher (2008) argued that at times the uses to which such household appliances are put are not necessary to meet their basic needs. Isolation from the rest of the society is more often than not a central characteristic of rural communities in general and those in remote areas in particular. The ability to own and use a television set is a basic need to acquire a sense of belonging to the mainstream of development. Matinga and Annegarn (2013) figured that 86 of the 89 interviewed households had television sets, of which only one was a black and white set. Some households had DVD players as well, while a few had more than one television set. Appliance ownership was as an explanatory variable included in several studies, with a general finding that owning more appliances and/or using them for longer is associated with greater electricity consumption (Huebner *et al*., 2016). Electrification affects farm households both through the intensive and extensive margins. Khandker, *et al*., (2013), shows that electrification can increase yields and consequently farm incomes mainly through adoption of electric farm Appliances.

2.2.4. Rural electrification and livelihoods dynamics in agricultural income

There are two types of direct energy requirements for increasing productivity: first, energy for transportation to transport goods to markets and supply other key services required by farmers. This includes, for example, fuel transportation (diesel or biofuels), as well as vehicles, roads, and other transportation infrastructure (Winkler,2006). Second, energy for product production, processing, and commercialisation. This includes a wide range of activities such as pumping water to irrigate crops, drying vegetables, and charging mobile phones in order to obtain market price information. According to a study conducted in India by Khandker *et al*. (2012), rural households rely primarily on agriculture-based seasonal income, making it difficult to save enough for the connection cost. The sale of agricultural commodities supports the use of electricity to connect electrical appliances and machines. Terero (2014) claims that rural areas have agricultural production potential and, as a result, could benefit more from being connected to the electric grid. Assisting smallholder producers in increasing agricultural productivity and income, as well as providing access to land, will improve rural livelihoods

(Majova,2018). Agriculture is the primary source of income for many people in most developing countries (Hirmer & Guthrie, 2017), where it also provides job opportunities, increases rural productivity, and ensures food security. Electricity has a positive impact on agricultural produce post-harvest sorting, storing, processing, and packaging. Value-added processing and direct marketing are frequently advocated strategies for increasing income and improving the economic viability of small farms. SMEs that engage in labour-intensive activities such as milling, or fruit and vegetable processing (value addition) can benefit greatly from increased productivity. Furthermore, smallholder farming and animal rearing are the primary sources of income in the five villages studied.

2.3 Socio-economic effects on rural electrification

2.3.1 Electrification effect on the age of responsible person

According to Mbaka (2015), electricity adoption is high among the middle age brackets (36-55) compared to their counterpart in the younger (25-35) and the older (above 65) categories. Jones *et al.* (2015) concluded that the effect of the presence of children in a household, the presence of any number of adults, the presence of elderly people (over 65 years old) and the age of the household head (HH) does have a significant effect on the electricity consumption in rural households. According to Mangizvo (2014) there is a link between the age of the household head and the type of energy used and this was tested in the cross tabulation. Although younger household heads prefer modern energy (electricity) as they knew about the benefits of modern energy sources. In contrast, they still use fuel wood because of financial constraints (Mangizvo, 2014).

2.3.2 Electrification effect on income of the household

According to Rao (2013), a cross-sectional national sample, shows the positive impact on income is found as a return on education, through the effect of improved lighting which was analysed by propensity score matching where electricity access was treated as binary. Khandker *et al*. (2009) found that electrified households for 15 years had high income as compared with the non-electrified household. Jones *et al*. (2015) argued that income is one of the studied variables, with several studies finding that households with higher income were more likely to be in the category of high consumers of electricity. Khandker et al. (2009) also found that income gains increase with time after electrification. Baldini *et al.* (2018) shows that income is not one of the strongest predictors to energy efficient appliance purchases when compared to other variables considered in Denmark. While Mbaka (2015) noticed the negative correlation in income and electricity adoption, some studies find a positive link between electrification and other development measures such as employment (Dinkelman, 2011). It is found that increases in income generation accrued to existing businesses who already had resources to take

advantage of electrification echoes findings by Kooijman-vanDijk (2008) in India, Khandker *et al.* (2009) in Bangladesh and Dinkelman (2008) in South Africa. A variety of literature on electricity provision comes from (World Bank, 2002; 2004; 2008). Dinkelman (2011) noted that RE by estimating the impacts of employment by using the quasi-experimental technique. These studies found that income increases through businesses or employment favour rich and middle-income households. The access to electricity has contributed to the establishment of SMEs such as poultry farming and goat keeping etc.

2.3.3 Electrification effect on health quality of the household

According to Bose *et al*. (2013) RE improves the quality of health services and lowers costs by extending opening hours. RE is significantly strengthening the cold chain for vaccines though it does not increase the extent to which such services are offered. Guo *et al*. (2016) established that the marginal effect of a health condition on rural dweller's well-being is high with the increase of its grade. Through media access to increased health knowledge and improved health and fertility outcomes. Electrification was also found to reduce worker absenteeism in both health clinics and schools by improving livelihood and morals (Tegene, 2015). Improved community health services include improvement in child mortality rate, improvement in maternal health, and a decrease in the prevalence of killer diseases. It is believed that child mortality is substantially reduced by the presence of electricity services. Tegene, (2015) and Risseuw (2012) noted that the possibility of delivering clean water nearer to homes as a result of access to electricity further reduces waterborne diseases for children. Alleviating workloads through access to electricity means that mothers have enough time to cook nutritious food for infants improve child sanitation and better attend to their children (Risseuw, 2012). According to several studies (WHO,2006; Modi *et al*., 2005; Hirmer & Guthrie, 2017), the presence of electricity services improves the provision of health services such as availability of preserved vaccines, mother and childcare services, and access to proper treatment at all times, including laboratory test facilities and safe child delivery, which substantially contributes to reducing child mortality. Thiam (2011) noted that parents are able to learn more about childcare through electronic media, improving the health and well-being of children, and substantially minimizing child mortality.

Electricity services can contribute to maternal health by improving women's quality of life through providing better health services, including prenatal care, which is one of the main factors for reducing maternal deaths (WHO, 2006). Health centres can be better equipped with lighting, refrigeration and use of other equipment for performing operations, including caesarean section. It is also easier to retain qualified health workers in remote towns if electricity services, media and communications facilities are available.

Lenz *et al*. (2017) noted that the availability of electricity services enables the delivery of more effective health services, which in turn can help combat HIV/AIDS, malaria and other killer diseases. According to Hirmer & Guthrie (2017), electricity allows the use of refrigerators for the storage of vaccines and medicines and use of sterilisation/ incineration facilities to stop the spread of HIV viruses. Bose *et al*. (2013) noted that the refrigerator improves nutrition as a good storage facility. Adequate awareness campaigns are conducted using media services facilitated by the presence of electricity for radio and television transmissions. Health education, training and counselling services are provided easily if electricity services are made available. Increased sanitation together with access to potable water through the use of electricity services substantially cuts water-borne diseases and epidemics such as cholera. According to Hirmer and Guthrie (2017), rural households benefit from switching from traditional to modern stoves, they avoid the smoke that causes respiratory illnesses which are one of health risk in the developing countries. Lenz *et al*. (2017) noted a considerable reduction in dry-cell battery consumption with potential environmental benefits.

2.3.4 Electrification effect on education level

According to Tegene *et al.* (2015), electricity enables the school-going children to study in a more productive way due to the extended study hours in the evening as well as due to the comfort offered by electrical appliances such as electric light. Thus, electricity facilitates literacy, enrolment and attainment (Hirmer & Guthrie, 2017). According to Tegene *et al.* (2015), the impact of electrification, if any, on the propensity of a child to stay in school indicates that Rural Electrification (RE) indirectly improves the propensity of a child to stay in school via an increase in the mother's knowledge and education. Along with their affordability, the enlightened outlook towards education due to media exposure contributes to their willingness in pursuing higher studies for their children, especially girls. Mbaka (2015) noted that the operation of night schools in the electrified villages and an increase in reading/studying hours due to illumination after dawn can also contribute to rejuvenating the thirst for education for adult and female members as well.

Guo *et al.* (2016) concluded that educational level has the greatest marginal effect on rural occupants' well-being with the decline of its grade. Electricity in education services provides a direct means of enhancing primary education through lighting and the use of media/ ICT (Information and Communication Technology). Distance learning opportunities and the use of equipment in remote locations are facilitated through the use of electricity services in villages where school enrolment rates have remained low (Modi

et al., 2005). Lighting enables evening classes to take place when youth and adults, especially women who are busy during the day, can attend (Hirmer & Guthrie, 2017). Distance learning using ICT is one of the inexpensive and effective means of expanding education in rural areas. Its use can enhance and standardize the quality of teaching, narrow the disparity in quality of education at both primary and high school levels while decreasing school dropout rates (Modi *et al.,* 2005). Such benefits can only be achieved if there is access to electricity services. In locations where grid extension is not possible, stand-alone mini and micro-hydro generators and photovoltaic sets such as Solar Home Systems (SHS) have proved effective in Kenya (Aragaw, 2012). A number of indirect benefits arising from access to electricity in the form of retention of motivated teachers who otherwise choose to transfer to main towns where electricity services are available (Modi *et al.,* 2005). Electricity services contribute to reducing household chores such as grinding, water and energy collection that compete with school attendance for children, especially girls (UN, 2005). RE also contributes to improving health, sanitation, and income, thereby motivating parents and children to attend schools. Modi.et.al. (2005) noted that access to the radio; television and digital technology are enhanced following the delivery of electricity, which both, directly and indirectly, contributes to the promotion of universal education and exposure to learning. Bose *et al*. (2013) pointed out that children in electrified areas have a higher literacy rate than those in non-electrified areas in Bangladesh (Aragaw, 2012). Increasing levels of education are associated with a higher probability of using modern energies and a lower incidence of solid fuel use.

2.3.5 The effect on household size on electricity consumption

According to Huebner *et al*. (2013), household size is the important predictor in electricity consumption as a larger household size is generally correlated with higher electricity use; however, the effect is not necessarily shown to be linear and depends on how the variable is coded. Using household size as continuous predictor showed that a larger household was associated with greater electricity consumption. Huebner *et al,* (2016), also noted that households with teenagers were more likely to be high consumers of electricity. Lewis *et al*. (2012) identified household size variable as variable having positive significant associations with Improved Cook stoves adoption at analyses considered (67%). Rehfuess *et al.* (2014) noted that the bigger the household size the lower the adoption because of low value time and labour assigned to collect fire-woods and the need to cook for many people.

2.3.6 Electrification effect on gender equality and women empowerment

According to Matinga and Annergan (2013) both women and men cited that they perceived television to be beneficial because it provides entertainment and information. Televisions and DVD players is the most

preferred to have rather than radios because the former have added visual value, making television the dominant news and entertainment medium. Thiam (2011) noted that the best way to which access to modern energy could impact on equity issues is by reducing time spent for collecting biomass. Winkler (2006) noted that in rural areas of developing nations, this activity is mainly carried out by women and children. There is no doubt that the affordability of modern energy will empower these people (Lewis & Pattanayak 2012). The critical hours used to collect biomass could be used in other income generating activities such as commercial foods vending, which is facilitated by improved heating and lighting, agricultural processing using mechanical power, beer brewing, and many trading activities (Thiam, 2011). Gender findings have mainly focused on the labour situation of women (Lewis & Pattanayak 2012). Electricity facilitates the reduction of workloads for women and children by freeing the time needed to collect wood and water (Bose, 2013). This, in turn, contributes to increased attendance at schools, which eventually can improve a woman's position in both the households and in society (Modi *et al,* 2005). The use of electricity for cooking substantially reduces indoor air pollution, which is the main cause of respiratory diseases for women and children in the form of indoor carbon monoxide and particulate matter emissions (WHO, 2006). According to Mbaku (2015) Gender roles influence the decision making on energy at household level. Although women are the end users are not always the one who decide the energy to be used. Furthermore, according to Mbaku (2015) noted that male-headed household are more likely to be connected to electricity than female-headed households. Rural electrification is amongst the supply alternatives in energy security for the delivery of electricity in marginalized areas (Sikrweqe, 2002).

2.4 Energy security and unreliable provision of electricity

Access to modern clean energy help in achieving goal 7 in the sustainable development goals (United Nation, 2015). For instance, households can generate income through electricity by reducing the burden of time-saving, reducing poverty where they will cook food quickly and bring community safety and security. The electric lighting of the street reduces the crime rate such as robbery, assault, burglary, and vandalism (Arvate *et al.,* 2015). This electricity also improves security technologies like a camera which makes easy to identify criminal offence. As it is shown that electricity improves the livelihood of households by enabling the use of electric appliances. At household level there are numeral threats for energy security (DoE, 2017) most rural households do not afford to pay for energy the rise of crude oil which increase the price of paraffin, a fuel used by a large number of rural households for both cooking and heating. Households still use dirty energy because of high cost of clean energies and lack of access to electricity. Now the unreliable electricity or blackouts negatively influences livelihood the of households as they are

already depending on electric appliances. Access to reliable electricity influences the quality of social services (DoE, 2017). The government should not only increase access to electricity, but the quality of the electricity supplied is also important as this defeats the drive of electrification. Madubansi and Shackleton (2007) investigated the impact of access to electricity in South Africa.

Blimpo & Cosgrove-Davies (2019) noted that unreliability is a symptom of technical inefficiencies which results in low revenue and production. Load shedding is a planned outage by electric utilities when the electricity demand is more than available electricity supply. When the electricity is cut off most electric appliances such as electric stoves, electric kettle, meat cutting machine and television cannot be operated. In the case of an electric stove for cooking, people tend to eat unhealthy food. The load shedding is mostly caused by insufficient electricity generation and by scheduled maintenance or requirements. Industrial operations, digital technologies, Agro-processing, and communication depend on a reliable and efficient supply of electricity. Households faced severe disruptions because of the high incidence of electricity blackouts. Effects of load shedding are that food goes bad, damage to electric appliances, increase in crime rates and disruption of night studies (Barnes, 2011). The primary reason for load shedding was due to a lack of maintenance and neglect over the preceding twelve years resulting in an unpredictable and unreliable system (Retief, (2019). Reliable electricity access is an important catalyst in the agribusiness value chain.

2.5 Policies or regulation on rural electrification

2.5.1. Free Basic Electricity (FBE) Policy

According to Mvondo (2010), electricity, in particular, is critical in the fight against poverty at household level. Mvondo (2010) also noted the Free Basic Electricity (FBE) policy as a state-driven policy and implemented by specific government institutions, with the aim of improving the livelihood of the poor. FBE is one of the policies implemented by South African government with the aim of reducing poverty (Mvondo, 2010). According to Winkler (2006), government adopted the Electricity Basic Services Support Tariff (EBSST) or otherwise known as the FBE policy. This policy emanates from the decision taken by the government in 2001 to provide free basic services to poor households and identified these priority services as water, sanitation and energy. The government policy for the provision of FBE compels municipalities and state-owned enterprises, involved in the electricity sector, to provide a certain amount of electricity free of charge, to poor households throughout the country. For grid-connected households, FBE means that these households qualify for free 50 kWh monthly. While off-grid electricity users are subsidised with R40 per month towards the R58 monthly service fee. The R40 subsidy for off-grid users is

paid directly to the service providers, meaning that households only have to make a cash-payment of R18 per month (Mvundo, 2010). According to Mazibuko (2015), tariff policy objectives are to ensure availability of electricity to consumers at reasonable and competitive rates and ensure the financial viability of the sector and attract investments.

2.5.2. Rural electrification policy

Integrated national electrification programme contributed to the livelihood of the South African communities by enabling improved health care in clinics and evening adult education classes in schools (Winkler, 2006). Winkler (2006) also noted that most households were only able to cover the costs of electricity for lighting and media. Authorities care about peoples' needs when they want them to vote (Sikrweqe, 2002). The ineffectiveness of authorities hinders the development progress, especially in rural areas. In 1994, after the first free and fair election, there were roughly 6 million households that did not have electricity and this build-up in electricity was mostly determined by race (Niez, 2010). Almost all these households were black and were situated in the rural areas. For example, in 1993 only around 30% of the nation was electrified (DoE, 2012). This was essentially in towns which were predominantly white places. The government organized to change the inequalities in energy access that were caused by the former government. Rural electrification became part and parcel of the government's transformation with the main objective being to eradicate the historical inequalities and energy security. The South African government has therefore committed itself to provide access to electricity for all by 2012 (Niez, 2010).

The government was guided by a number of factors. Government had a moral obligation to electrify households as a way of elevating the lives of poorer individuals in the nation. At the same time, it was a way of rectifying the past injustices. The issue of health and safety of households utilizing candles, paraffin and wood was crucial in the planning procedure as they exposed people to fire dangers and illnesses related to indoor pollution (Terero, 2014). It is important to note that grid electrification has been utilised as the general approach to the electrification process. It is not surprising therefore that by 2008, electrification levels had risen to 73%, which means a surplus of 4.5 million households were electrified to the grid (Department of Minerals and Energy, 2008; Terero, 2014). The programme concentrated on expanding the grid to new communities such as rural areas and communities that were not electrified although they were in already electrified areas.

In 1994, the National Energy Regulator South Africa (NERSA) was therefore tasked to develop and oversee the implementation of the Integrated National Electrification Programme (INEP) (Niez, 2010 & Mazibuko, 2015). Between 1994 and 1999 the INEP was implemented to boost energy security. The objective of the

INEP was to provide electricity to rural and urban low-income households which did not have access to electricity during the apartheid period. These households were expected to switch from using fuel wood, candles and batteries to using electricity for their household needs such as cooking, lighting and heating. In 2000, the Government of South Africa made an assertion that everyone should have access to basic services and these included electricity and water (DoE, 2012). Access to energy became a social right and this was supposed to be addressed at national, provincial and municipality level. In 2001 the Department of Energy (DoE) the command was given to implement and oversee the electrification programme in the country. Despite Eskom produces 97% of the electricity it distributes 55% while the rest is sold to municipalities which then distribute it to the consumers (Niez, 2010). Municipalities have been capacitated to roll out the national electrification programme. It is important to observe that the electrification programme benefits from a special allocation from the National Treasury.

The South African government supports the principle that basic services should be accessible and affordable to all. The government has therefore put in place mechanisms that enable the poor to benefit directly from the electrification programme. The government has allocated a 20 amph connection free of charge and there is also a 50kWh free monthly alleviation that is implemented by municipalities (Louw *et al.*, 2008; DoE, 2012 & Department of Minerals and Energy, 2008). An international comparison with other countries revealed South Africa as one nation with the lowest tariffs in the world (Niez, 2010).

The focus of government is grid connection, and the non-grid connection is only used if there are no other feasible options to extend the grid within a foreseeable future (DoE, 2012). In actual fact, South Africa has a large off-grid electrification programme which is driven by the government's interest in renewable energy which it considers essential for sustainable development. The renewable energy which is indigenous and naturally available in South Africa is considered central to the strengthening of the country's energy security as it is not subject to disruption by international crises. The country published a White paper on renewable energy in 2003 to show its seriousness with regards to the adoption of renewable energy (Mbaka, 2015).

The government has therefore embarked on a non-grid electrification programme through solar home systems in remote areas where the lowest capacity grid system cannot be provided. This programme is fully funded by government and rural end consumers purchase non-grid electricity from the service provider who has the responsibility of providing maintenance for the solar home systems (Mbaka, 2015). The Department of Energy guarantees that the providers of non-grid technologies augment their services by selling thermal energies such as paraffin and liquefied petroleum gas. The service provider who has a monopoly for serving an area must ensure that widespread access is completed in a village identified as a non-grid area. It is

therefore realised that by 2009, 96% of the households electrified used electricity for lighting and television, whilst 63% used it for cooking and 34% used it for heating (Niez, 2010). Households that have not been connected as yet use candles for lighting, wood and paraffin for cooking and wood for space heating. All these policies may in the long run support the government to meet the energy security issues at one end and move towards the future of clean energy in South Africa.

2.6 Conceptual framework

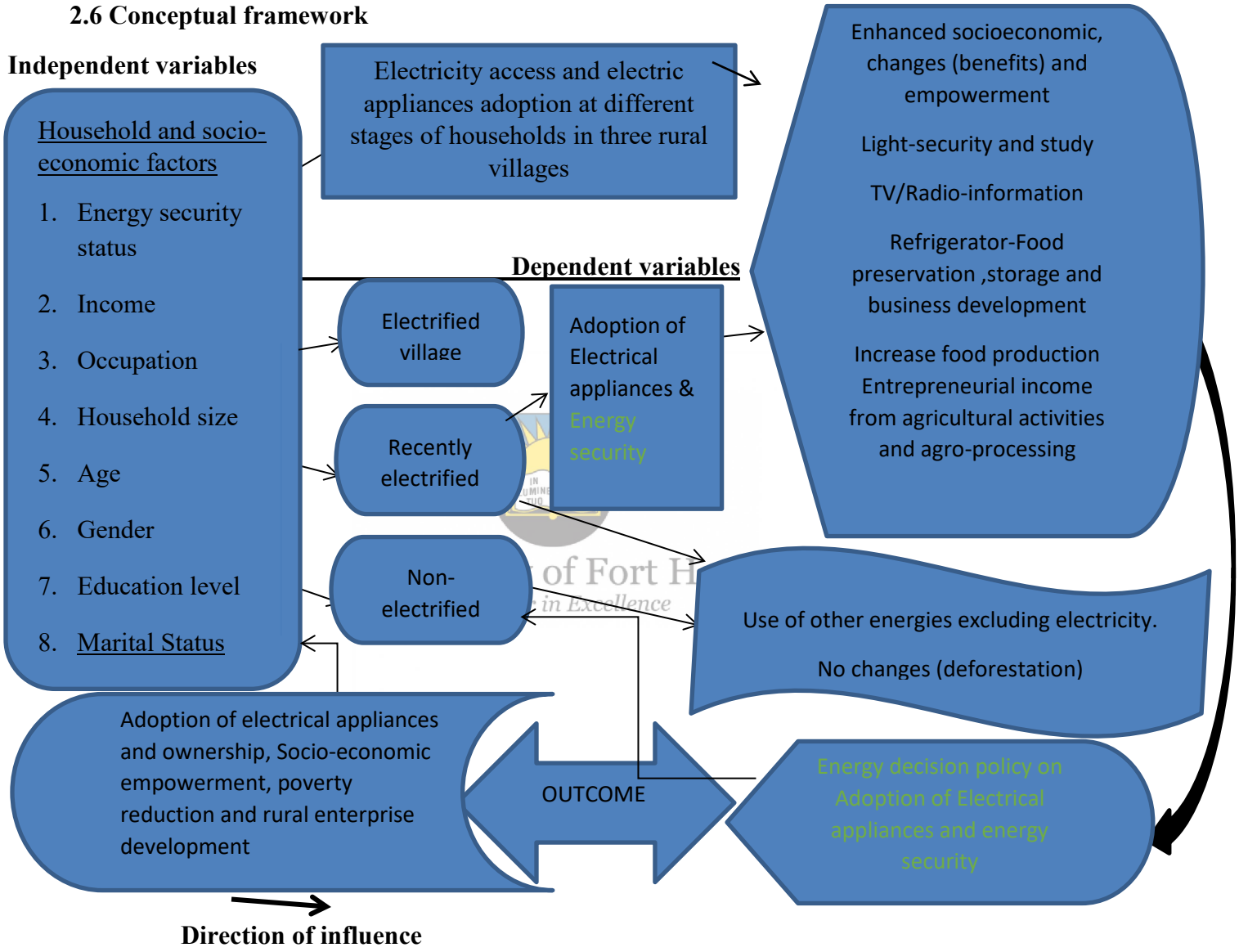

Figure 2.2 Diagrammatic representation of the conceptual framework for this study

Source: Adapted from Kawsari & Zerriff (2011)

According to McGaghie (2001), research reports a conceptual framework as it identifies research variables and clarifies relationships between the variables. A conceptual framework acts as an analytical mechanism

to structure a review with numerous variations and context. It explains graphically or in narrative format the steps that are taken in achieving the problem and objectives of a study by explaining factors that are going to be studied such as main concepts, research questions, variables, data collection, analysis methods, and the relationship between them (Kumar & Antonenko, 2014).

This study will be guided by a conceptual framework adapted from (Kawsari & Zerriff, 2011) and from reviewing empirical literature on the impact of rural electrification to answer the question of this study. The researcher adopted from Kawsari & Zerriff, (2011) conceptual framework by reviewing the empirical literature and extracting the most useful literature and electrification policies in addressing the research problem or objectives (Ravitch & Riggan, 2016). Thus, Figure 2.2 shows the conceptual framework that will be followed in this study.

2.7 Theoretical framework

2.7.1 Household Energy adoption theories

There are so many theories, but this study adopted the four following theories:

a) Household decision making theory

Eder *et al.* (2015) noted that the rural households' perceptions in Uganda influenced the adoption which led to the decision of whether to adopt the provision of electricity by a mini-grid. This study will look at the unitary model, which is under traditional and neoclassical economics, which are based on consumer choice. Males head are the ones who decide which energy to use for the households. Lewis and Pattanayak, (2012) noted that households working in agricultural signalling their socioeconomic status, were less likely to use cleaner energy. Farming households and their decision-making are influential in alleviating rural poverty. Mangivzo (2014) noted that the socio-cultural and the traditional power hierarchy prevailing in the rural areas give this authority to the husband. Furthermore, women are basically subservient to their husbands as they do not have the space to make decisions.

b) Diffusion theory

Rogers's theoretical model states that the potential adopters go through a number of steps before accepting or rejecting an innovation (Rogers, 2003). This model helps that potential adopter to make the final decision whether to adopt or not. The Roger's diffusion of innovation in a household is a process by which new technology adoption is communicated over time by utilizing various channels (Rogers, 2003). This

diffusion process has been modelled and theorized over time. It assumes that potential adopters get interested in new innovation only when they start collecting knowledge of innovation. Socioeconomic factors are there in the process of acceptance or rejection of an innovation. According to Shalamzari, (2016) diffusion of innovations is a theory that seeks to explain how, why, and at what rate new ideas and technologies spread through cultures.

c) Neoclassical theory

Louw *et al.* (2008) noted the neoclassical theory suggested that the primary economic variables in determining the demand for any good or service are individual and/or household tastes and demands; further, the prices of these goods and services, as well as available income, also influence the demand for consumer goods and services. Neoclassical theory looks at the unitary model. This theory assumes that the head of the household's marginal utility is similar to the marginal utility of every member of the household. Household head actions are therefore determined not by his personal income but rather by the household income. The unitary model assumes that decisions within the household are made jointly and that the household maximizes a single set of objectives for all its members. Soon after lighting, television and radio are the first appliances to be purchased and these are associated with men's preferences. Those appliances that are preferred by women are bought later (Mangivzo, 2014).

d) Utility maximizing theory

According to Arthur (2009), presented a theoretical model as a utility maximization of a deprived household, obtained from consuming leisure and non-energy commodities, and from owning energy that are consuming appliances. Utility-maximizing theory is the most demanded when household consumption and production decisions are reliant such as in rural areas (Mangivzo, 2014). Utility maximization approaches include the dual character of peasant households as both families and enterprises and thereby take account of the consumption side of peasant decision making (Eder *et al*. (2015). The household maximizes utility through the utilization of all available commodities, subject to full income limitations. A farming household as a customer influences its behavior as a producer, and the other way around (Arthur 2009).

2.7.2 The Energy ladder model

According to Winkler (2006), changing patterns of energy consumption where the energy transition has been described by some as a 'universal trend' whereby households move from traditional fuel, consisting of wood and dung through transitional energy sources (coal and paraffin) to 'modern energy services' (electricity)**.** According to (Risseeuw, 2012), the ladder of cooking energies and household energy transition is often explained using the 'energy ladder' model (Mangivzo, 2014 & Davis, 1998). This model which resembles a ladder (Figure 2.3 below) contains three rungs that represent three categories of energies i.e., primitive, transition and advanced energies. These energies are also ordered in increasing order of importance, starting with 'primitive fuels' such as animal dung and firewood at the bottom; continuing with 'transition energies' like charcoal and paraffin in the middle, and ending with 'advanced fuels' such as gas and electricity on top. The assumption behind this model is that as a household's socioeconomic status increases, they will rationally choose for an energy carrier that is more advanced and therefore able to better fits their energy service needs (Mangivzo, 2014).

In other words, as a household's income increases, dirtier energies such as firewood will completely be abandoned and substituted first for transition energies such as charcoal and paraffin and ultimately with cleaner energies namely, liquefied petroleum gas (LPG) and electricity. This transition in which one enrgy is completely replaced by another is often referred to as fuel switching (Risseeuw 2012). As previously mentioned, these energies are placed in a sort of order, meaning that some energies are considered to have more disadvantages than others and therefore some energies are considered superior to others. Therefore, it assumes that as households climb up the energy ladder, a full switch is done to an energy that has more advantages while still taking into consideration the household's economy. Risseeuw (2012) noted that income is an important determinant for the type of fuel used in a household. The authors claim that consumers will choose the most advanced fuel accessible with their socioeconomic profile, replacing lower quality energieswith higher quality ones. The energy ladder model shows that income rises, households switch to a fuel better suited for their socioeconomic status. Additionally, although the transition to cleaner energies is depicted as an "evolutionary process", in the energy ladder model, the authors present that a more rapid progression towards cleaner energies can be achieved through "active policy".

According to Davis (1998) and Masera *et al.* (2000), the "energy ladder" model has been extensively used to describe household fuel choice and energy transition to modern energies. Arthur (2009) revealed that household wealth determines the transition from biomass to electricity in Mozambique and it was analyzed

by logistic model and asset ownership is regarded as a requirement to go high on the energy ladder. The energy ladder by Arthur is a criterion for ranking preferences for domestic energy sources based on the households' incomes, with biomass sources at the bottom and electricity at the top. Conventionally, the energy ladder places the cheapest sources at the bottom (preferred by the low-income families) and the more expensive at the top, also called 'modern energies' (Kowsari and Zerriffi, 2011) in recognition of their superiority inconvenience, cleanness, safety (Masera, Saatkamp *et al.*, 2000) and on the variety of end uses (Arthur, 2009).

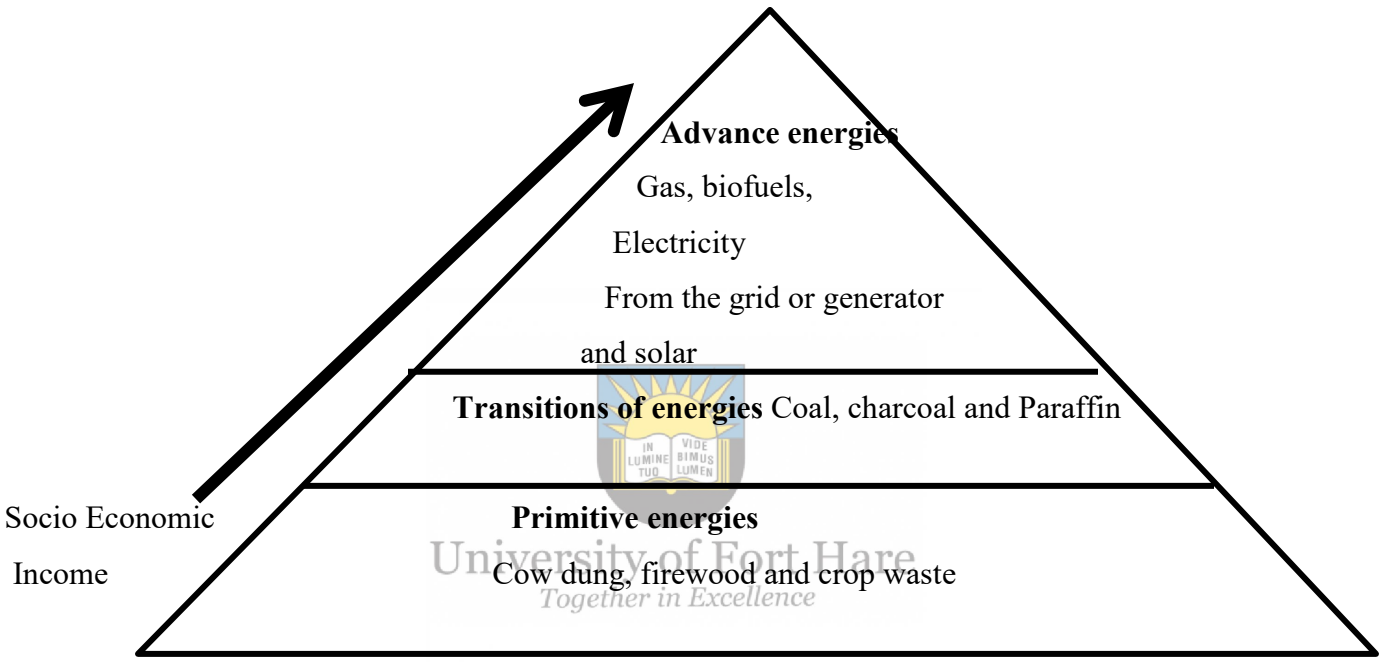

Figure 2.3: Energy ladder model

Source: Arthur (2009)

Jones *et al*. (2015) revealed that access to rural electrification is influenced by different factors such as income, occupation, education level, age of household responsible person and household size etc. The researcher reviewed the literature about the adoption of electrical appliances after electrification process on those electrified villages, which later on, they benefit from electrification where the quality of life is enhanced because they start to use the electric refrigerator for food perseverations. However, there are still those villages that are still not electrified which show that those areas do not experience electricity benefits. In addition, those areas that are recently electrified get low socioeconomic empowerment and low rural development (Jones *et al.,* 2015). The better intervention of policies can increase access to electricity, socio-economic empowerment and rural development**.** Kowsari and Zerriff, (2011) hypothesized that electrification of households relies upon household characteristics. At the point when electricity is

accessible. Connection utilization of electricity by household units improves personal satisfaction at the rural household unit level and empowers the economy at the group level (Khandker *et al.,* 2009).

Arthur (2009) noted that changes in the household units associated with and strengthens each other, at last turning into a self-maintaining process. Picking up a superior comprehension of household electricity adoption determinants upgrades understanding in making a quality of policy that should be utilized to enhance acceptance where electricity is reachable. The applications of particular policies add to rural improvement and social monetary empowerment among rustic households. Thus, this study adopts this conceptual framework by examining household's characteristics influencing electricity connections, and socio-economic benefits of rural electrification.

Ismail and Khembo (2015) measured energy poverty as a vital powerful factor for sustainable socioeconomic development around the world. Energy poverty was measured using various approaches, including the expenditure-based approach used in this study, the subjective approach, and the thermal inefficiency approach (DOE,2012).

1. Expenditure-based approach: If a household spends more than 10% of its total household income on energy, it is considered energy poor, or energy insecure.

2. Subjective approach: a household is considered energy inefficient if it possesses one or more of the following characteristics:

- the amount of energy the household uses is reported to be insufficient for its needs;
- the amount of energy the household uses for lighting is reported to be insufficient for its needs;
- the amount of energy the household uses for cooking is reported to be insufficient for its needs;
- the amount of energy the household uses for heating rooms and keeping warm is reported to be insufficient for its needs.

3. The thermal inefficiency approach is based on assessments of the state of one's household, with a particular emphasis on thermal comfort levels in relation to social demands. In essence, this entails rating a household's thermal efficiency, as this has an effect on the amount of energy required to heat the household to an acceptable standard and is commonly represented as a significant determinant of domestic energy costs. This is where energy poverty comes into play, focusing on the proportion of total household income or expenditure that is devoted to energy. Households that spend more than 10% of their income on energy are considered to be energy insecure, and as a result, they are likely to face difficult choices between meeting energy requirements on the one hand and sacrificing other important competing spending priorities

on the other. As a result, the indicator is frequently conceptually linked to the measurement of affordability (WHO, 2006).

2.8 Assessment of the analytical models used in the study

According to empirical evidence on energy and poverty issues, reality is far more complex than the simple transitional theory would appear to imply. It has been discovered that at any given time, households rely on a variety of energies that typically include at least two steps on the 'energy ladder' empirical review on Binary Logistic Regression (BLR). Mbaka (2015) used binary logistic regression to evaluate electrification adoption in a study conducted in Kenya and concluded that socioeconomic characteristics of households are important factors in determining grid extended electricity adoption. In a study conducted by Ismail and Khembo (2015), a logistic regression model was used to estimate the determinants of energy poverty of these households. They concluded that households connected to the national electrical grid were more energy poor/insecure. In an Arthur (2009) study, logistic regression was used to assess the likelihood of poor households shifting from biomass to electricity usage based on a variety of factors. She went on to say that while income is not a determining factor in the shift, wealth and the degree of primary energy consumption share are just as important as the nature of the energy mix in Mozambican households. Because electricity is only available to two-thirds of households in this study, the Binary Logistic Regression model is used to investigate factors that influence the adoption of electrical appliances (adopt or not adopt electrical appliances). Because of the nature of the dependent variables, which are dichotomous, the logistic regression model was used with data from relevant independent variables. The binary logistic regression model's coefficients were estimated using the maximum likelihood method in STATA 14. As a result, both models are used in this study.

2.9 Chapter summary

This chapter reviewed relevant literature on the adoption of electrical appliances at three different electrification stages. Firstly, availability of electricity in rural households of South Africa and its effects on adoption of electrical appliances. The socio-economic factors affecting household electrification was reviewed with security and unreliable provision of electricity. Policies or regulation on rural electrification with household energy transition theories and energy ladder model.

CHAPTER THREE: METHODOLOGY

3.0 Chapter introduction

This chapter covers the description of the study area and the research design or framework of how the research was conducted. Socio-demographics of the study area are described. This chapter also illustrates the selected villages, sample size, sampling procedure, and data collection method of the project as well as the statistical analysis of the data.

Figure 3.1: Map of the study area

3.1 Description of the study area

The study was conducted in three villages under Mnquma Local Municipality (MLM) in the Eastern Cape Province of South Africa between July and August 2018. The municipality is located in the former Transkei of South Africa. The Mnquma local municipality is one of the municipalities that have a huge backlog demand for electricity (Mazibuko, 2015). According to the Stats SA (2011), Mnquma Local Municipality is located at 32° 19′ 0″ S and 28° 8′ 0″ E with 252390 population of approximately 69732 households. Unit analysis of this study is the households in villages. Mnquma Local Municipality has these villages which are electrified (Electrified = 313 households), non-electrified (non-electrified village = 281 households) and recently electrified (recently electrified = 260 households) which make the total of 854 households (Stats SA, 2011).

Temperature and climate conditions: According to (IDP,2016), the climate within MLM of jurisdiction varies from mild temperature conditions 14 to 23 degrees Celsius along the coast to slightly more extreme conditions in the inland of about 5 to 35 degrees Celsius. The summer rains give conducive environment to farming. In winter, frost is dominant, and snow rarely falls. This gives a reason to the households to use energy more for heating their homes in winter season.

Agricultural potential: Arable land is one of the resources exist in MLM and the area is regarded as a maize belt area. Maize is a staple food which is converted to mealie-meal, samp and other tech products. IDP (2016) noted that there are more than 50 existing Agriculture Co-operatives within MLM, and the municipality supports them through supply of inputs and implements, capacity building and business plan development. According to Stats SA, (2011) MLM population practice livestock raising especially cattle, goats, chicken, and sheep. According to the South African Department of Agriculture, MLM has 33.5 % livestock, 32.4 % poultry, 24.0 % vegetables, 6.0 % other crops and 4.1 %other. Crop farming is also at subsistence level within the villages, characterised by gardens and medium sized plots where landscape allows.

Unemployment Levels: As part of the Eastern Cape, MLM is one of the municipalities with the highest levels of poverty, illiteracy and unemployment. Approximately 13.3% of the population is unemployed, only 16.7% is employed while 70% of the municipal population is considered economically inactive (IDP, 2016). The municipality has limited employment opportunities, and this has huge implications on the increased need for welfare, livelihood and indigent support in the municipality.

Household's monthly income: According to IDP (2016) about 15 % of the households in the municipality have no income and approximately 4% with income less than R1600 per month. This means that approximately 15% of households in the local community need subsidy arrangements for survival and thus are unable to pay for services. This therefore has huge implications on the municipality's financial status in that they cannot rely on residential cross subsidisation for revenue.

Education Levels: About 7% of the Mnquma population has no schooling and 31% completed primary while 52% completed grade 12 and just above 9. % of the population got a higher education in 2011(IDP, 2016).

Access to electricity as a basic service: According to IDP (2016) the Table 3.1 below shows that the government has made remarkable improvement in terms of ensuring that households have access to electricity, especially in previously disadvantaged areas. In Mnquma Local Municipality approximately

26000 households still use paraffin and candles for lighting and that shows that government still needs to address this issue.

Table 3.1: Types of energies used by households at Mnquma Local Municipality

Energy types	**Number of Households**
Electricity	42795.1
Paraffin	19960.5
Solar	118.9
Gas	341.2
Candles	6382.7
Other	133.6
TOTAL	67032

Source: IDP (2016)

Infrastructure: Rural villages in Mnquma Local Municipality are serviced mainly by gravel roads and very little by tar road to the nearby towns (Centane, Ngqamakhwe and Butterworth). Due to the steep terrain and high erosion levels, the gravel roads in the area require regular maintenance due to erosion of which that is rare to find. Even when there is an electricity problem that requires maintenance Eskom takes time to come and fix the wires. Eder *et al.* (2015), noted lack of infrastructure as a barrier physical facility of transmission and distribution networks and there is no after scale support after the installations.

3.2 Research Design

A quantitative cross-sectional research design was employed in this study because data collection was collected at one point in time on several variables such as demographics and household's socio-demographic influencing the adoption of electrical appliances after rural electrification. This design is chosen because masters is a two-year degree programme and it is not feasible to track one village over a long period of time. Hall and Lavrakas (2008) noted this design can only measure differences among a variety of people, subjects, or phenomena rather than a process of change. As such, researchers using this design can only employ a relatively passive approach to make causal inferences based on findings because of this study duration (Hall and Lavrakas, 2008). Quantitative data was gathered through the administration of questionnaires to respondents in the study area. Planning for the research is essential for the researcher not only to choose variable research problem but also to consider the types of data required to address the research problem, as well realistic means of collecting and interpreting the data (Leedy & Ormrod, 2010). Hence, the researcher should know where the data can be established, how the data can be collected, when to collect and how to interpret the collected data

3.2.1 Unit of Analysis

According to Bless *et al.* (2016), unit of analysis is the person or object from whom the social researcher collects data. The units of analysis for this study are the rural agricultural households from the three electrification stages in the three villages purposively selected for the study. Household representative in Mnquma Local Municipality constituted unit of analysis for this study. The respondents were selected from electrified, recently electrified and non-electrified villages, in which a sampling frame was developed from village list that was shared during data collection. Household representative were surveyed on behalf of all the people who usually ate and slept under the same roof and who shared the same budget of incomes to support their electricity consumption. Considering household head as unit of analysis minimized costs and time, because instead of questioning every member of the household, only one member was questioned.

3.2.2 Sampling Procedure

Sampling is the process of selecting a portion of the population to represent the entire population. Bless *et al*. (2016) define a sampling frame as a list of all units from which a sample is to be drawn. The population of interests is the household of three villages in Mnquma local municipality, these villages are at different stages of electrification: an electrified, recently electrified (less than 10 years) and non-electrified. The study used a simple random sampling to select households from the three stages of electrification villages (three villages because each one is at a different stage of electrification). Chiefs of the villages share the village lists of the household during the data collection with the enumerators. The three villages in terms of several variables such as age, gender, marital status, household size, location of the household, education, and energy use, source of income to but electrical appliances, income and energy expenditure of the household. Mnquma Local Municipality has these villages which are electrified village (Mgomanzi = 313 households), non-electrified village (Qina= 281 households) and recently electrified village (Qobo-qobo= 260 households) which make the total of 854 households (Stats SA, 2011). Yamane (1967) provided a simplified formula to calculate sample size:

$n = \frac{N}{1+Ne^2}$ [Yamane's formula]

Where n = sample size; N = number of households, 854 (total household of the three selected villages obtained from census 2011) and e = degree of precision (95%)

$= \frac{N}{1+Ne^2}$

$= \frac{854}{1+854\times0.05^2}$

$=272.4$

Therefore, sample size that the researcher managed to get was n= 224 collected from households of the three villages which are Mgomanzi, Qobo-qobo and Qina. A sample of 70 households was collected from non-electrified and recently electrified each village and 84 households from Electrified. The rule of thumb for choosing a sample size is that it should be at least 5% of the population (Bless *et al.*, 2016). Simple random sampling was used from a sample frame list provided by the village chief to select 91 households from each of the three villages, but due to unavailable households, a researcher was only able to get about 70 in each village. The advantage of this method is that everyone in the population has the same probability of being selected as part of the sample as any other individual (Bless *et al.*, 2016). Leedy and Ormrod (2010) also noted that this eliminates the bias inherent in non-probability sampling procedures because the probability sampling process is random; every farmer had an equal opportunity of selection in the population. However, the challenge with this technique is that every person in a population has to be listed before the corresponding random numbers can be read, this method is very cumbersome to use for large populations.

3.2.3 Data collection instrument

Primary data was collected through a quantitative method using face to face survey questionnaires (Appendix 1). Where the presence of the interviewer increases the quality of the responses since the interviewer can probe for more specific answers (Leedy & Ormrod, 2010). This data was collected from the respondents of rural areas of Mnquma Local Municipality. The field work of this study was conducted by the researcher and three enumerators. Each household was visited and identified using socio-demographic characteristics such as household size, age, gender and income for rural electrification and on the effect of energy security on adoption of new electrical appliances in the three villages of the Mnquma Local Municipality was collected. It was separated into the following sections: Household demographic characteristics, electricity availability status, electrical appliances adoption and electricity benefits. The targeted respondents were the household head, and in their absence a close and mature relative or next of kin was interviewed. A structured questionnaire was administered with both open-ended questions that required written responses and closed-ended questions providing pre-determined options. Data collected using the survey questionnaire was analysed using Statistical Package for Social Sciences (SPSS 24) and Stata version 14. According to Bless *et al.* (2016) open-ended questions leave the participants free to express their answers as they wish in as detailed or complex, as long or as short a form as they feel is appropriate. Pictures below show how data was collected from the three villages.

3.2.4 Energy security status measurement

The dependent variable was measured using the method developed by Ismail and Khembo (2015), in which energy poverty was assessed using an expenditure approach. The household expenditure approach was used in this study to assess energy security in relation to household income,

$$Energy\ budget\ share\ of\ total\ household\ budget\ = \frac{Expenditure\ on\ all\ energy\ sources}{Household\ Total\ monthly\ income} 100\%$$

Households with an energy expenditure budget greater than 10% were considered to be energy-insecure, and thus coded 0 (zero). Those who spent less than 10% of their income on energy received a code of 1(one) and considered energy secured. As shown in Table 3.2, this allows for the creation of a dummy variable for energy security.

3.2.5 Household agricultural income measurement

In the questionnaire used for this study, respondents were specifically asked to explain how some selected appliances were purchased (please see question number B.6 in section B "How was the purchase of selected appliances financed?"). The question was used to calculate household agricultural income. Some responses included dummy measures of agricultural and non-agricultural income. When the household head, reference person, or main income earner is economically active in agriculture, the household is considered to be an agricultural household (Guthrie and Hirmer, 2017). The household was determined to be activeness in agriculture when household owners were able to use the income from selling the vegetables and livestock/livestock products to purchase the electrical appliances. Agricultural household is a household involved in agricultural activities.

3.2.6 Adoption of electrical appliances measurement

Adoption of electrical appliances was assessed based on the extent to which new appliances were purchased and old non-electric appliances were replaced by electrical appliances, electricity access, household preferences, household income, and ownership of electrical appliances (Huebner et al., 2016). In this study the questionnaire respondents were asked if the household adopted the electrical appliances.B.5 in section

3.3 Data Analysis

According to Bless *et al.* (2016), data analysis allows the researcher to generalise the results from the sample used in the study by the researcher to the entire population. Descriptive statistics was used to interpret, to describe the sample and determine the electrification effect and benefits to the respondents. This was done using descriptive statistics such as frequencies and percentages which were used to present the demographic

information and other analysed data in graphs and tables. This analysis was performed using Statistical Package for Social Sciences (SPSS) version 24 to enable descriptive graphical representation for the collected data and STATA version 14 for the regression analyses. Objective one used descriptive statistics which was employed in the three villages and objective two and three employed BLR to reveal the relationship between the respondents' socioeconomic and demographic effect in their use of new electric appliance and households energy security status.

3.3.1 Model specification: Binary Logistic Regression Model

In the literature, it has been noted that a binary choice model (logit or probit) is most appropriate in analysing models with binary response-dependent variables. Binary choice models assume both deterministic utility and probabilistic decision process (Greene, 2012), and have been used extensively in the literature to model adoption decision studies involving binary or dichotomous choices. A strong linkage between binary choice models and the theory of utility has been established in the previous literature. The study utilized a binary logistic model to analyse factors that influence household new electrical appliances adoption on the availability of electricity because it was found to perform superior to the multinomial logit model by (Cakmakypana and Goktas, 2013). Binary logistic regression is a type of regression analysis where the dependent variable is a dummy variable coded 0 or 1(Greene, 2012). Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables. The probability distribution and constrains of the estimated probabilities should lie between 0 and 1 (Hosmer & Lemeshow, 2000). The dependent variable was coded 1 if the household is energy secured and 0 Otherwise.

According to Greene (2012), the logistic model takes the form:

$$\log(P_i \; /(1 - P_i) \; = logP_i = \beta_0 + \beta_1 X_1 \ldots \ldots \ldots . . \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (1)$$

Where P_i is the probability of energy security and X_1 is a predictor variable? Therefore, the parameter β_0 gives the coefficient Exp (β) of the dependent variable.

The probability of the occurrence of an event relative to non-occurrence is called the odds ratio and given by the following equation:

$$P_i \; /(1 - P_i) \; = \exp(\beta_0 + \beta_1 X_1) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (2)$$

Or in terms of probability outcomes

$$P_i = \exp(\beta_0 + \beta_1 X_1)/(1 + exp(\beta_0 + \beta_1 X_1)) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3)$$

The model is set as follows

$$P_I = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots B_n + \mu_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where: β_0=intercept term

$\beta_1, \beta_2, \beta_3 \ldots B_n$= slope of the parameters or regression coefficients of the model which measures a unit change in explanatory variables using marginal effects of binary model.

$X_1, X_2 \ldots Xn$ = the marginal effect of eight explanatory variables for objective two were investigated to examined the relationship between socio-economic and demographic factors of the household agricultural income on energy security among selected agricultural households with the probability that a household is knowledgeable about the energy security and affordability of the household. These include, gender, age, marital status, household size, occupation, Total household monthly Income and agricultural income. Table 3.2 summarizes variables specified in the binary logistic model with energy security as the dependent variable and their expected signs.

U_i = Error or disturbance term

In objective two, the dependent variable (energy security status) was determined by assigning a value of 1 for a household that was shown to be energy secured. A value of 0 was assigned for households who shown being energy insecure in response to household socio-economic characteristics and household agricultural income. The model was utilised to estimates the relationships of socio-economic characteristics and household agricultural income on energy security.

Table 3.2: A priori expectation of the Binary Logistic Model variables

VARIABLE	UNIT AND DESCRIPTION	TYPE OF VARIABLE	A PRIORI EXPECTATION (+/-)	LITERATURE
Energy security status (E.S.S)	If the household is energy secured (Yes= 1) or not (No = 0)	Dummy		
INDEPENDENT				
Gender (GENDER1) X_1	0= if household head is female; 1= male	Binary dummy	+/-	Mbaku, 2015. Lewis and Pattanayak, 2012

Age of head (AGE 1) X_2	Actual ages in years	Discrete	+/-	Jones *et al* .2015
Marital status (MARIST1) -X_3	1= if household head is married; 0= otherwise	Dummy	+/-	Kumar & Rauniyar 2018
Household size (TOTALSAMS)-X_4	Total number of people who live in the household Number of household members in the household	Discrete	+	Lewis and Pattanayak, 2012
Occupation (OCCUP1 -X_5	1= Employed 0=unemployed	Dummy	+	Kooijman VaDijk, 2008
Income (Rands) HHMINC- X_5	Total household monthly income	Continuous	+/-	Kooijman VaDijk, 2008 Khandker *et al.* (2009)
Agricultural Income (AGRICI)-X_7	1= agricultural income 0=non Agricultural income	Dummy	+/-	Guthrie and Hirmer, 2017)

Source: Authors own computation (2018)

Where Pi is the probability of adopting new electrical appliances and X1 is a predictor variable? Therefore, the parameter β_0 gives the coefficient Exp (β) of the dependent variable.

X1, X2…. Xn = the marginal effect of eight explanatory variables for objective three were investigated to determine the effect of household agricultural income on the adoption of new electrical appliances.

With the probability that a household is knowledgeable about the adoption of electrical appliances use. These include, gender, age, marital status, education level, household size, Total household monthly Income, occupation, energy security status and agricultural income. Table 3.3 summarizes variables specified in the binary logistic model with adoption of electrical appliances as the dependent variable and their expected signs.

Ui = Error or disturbance term

In objective three, the dependent variable (adoption of electric appliances) was determined by assigning a value of 1 for a household that has adopted electric appliances. A value of 0 was assigned for household

who has not adopted electric appliances in response household agricultural income. The same model was utilised to estimates the relationships of household agricultural income on energy security. In this study, the Binary Logistic Regression model (BLR) was employed to explore factors that affect the adoption of new electrical appliances since the number of availabilities of electricity to households is only two (adopt or not adopt new electrical appliances).

Table 3.3 summarizes description of variables specified in the binary logistic model with adoption of electric appliances as the dependent variable and their expected signs in Table below:

Table 3.3: A priori expectation of the Binary Logistic Model variables

VARIABLE	**UNIT AND DESCRIPTION**	**TYPE OF VARIABLE**	**A PRIORI EXPECTATION (+/-)**	**LITERATURE**
Adoption of electric appliances	Yes= 1 No=0 If the household has adopted electric appliances or not	Dummy		
INDEPENDENT				
Gender (GENDER1)-X	0= if household head is female; 1= male	Binary dummy	+/-	Mbaku, 2015. Lewis and Pattanayak, 2012
Age of head (AGE 1)-X	Actual ages in years	Discrete	+/-	Jones *et al* .2015
Level of education (EDULE1)-X_3	1= formal education, 0 = otherwise	Dummy	+	Tegene *et al.* 2015
Marital status (MARIST1)-X_4	1= if household head is married; 0= otherwise	Dummy	+/-	Kumar & Rauniyar 2018
Household size (TOTALSAMS)-X_5	Total number of people who live in the household Number of household members in the household	Discrete	+	Lewis and Pattanayak, 2012

Income (Rands) HHMINC-X_6	Total household monthly income	Continuous	+/-	Kooijman VaDijk, 2008 Khandker *et al.* (2009)
Occupation (OCCUP1) X_7	1= Employed 0=unemployed	Dummy	+	Kooijman VaDijk, 2008
Energy security status (E.S.S) -X_8	1=energy secured; 0=energy insecure	Dummy	+	Louw *et al.*2008; Ismail And Khembo 2015
Agricultural Income (AGRICI)-X_9	1= agricultural income (Selling livestock and Selling vegetables) 0=non-agricultural income (Loan, Savings, Remittees)	Dummy	+/-	Guthrie and Hirmer, 2017)

Source: Authors own computation (2018)

3.4 Model Fit

As explained by Hosmer and Lemeshow (2000) the logistic regression model is the best fitting model to describe the relationship between an outcome (dependent or response) variable and a set of independent (predictor or explanatory) variables where the dependent variable is dichotomous. The findings for the goodness-of-fit test shown in chapter 4 indicate that the model fits the data well. Thus, the findings for Hosmer & Lemeshow Test show that the binary logistic regression is well suited to predict the influence of the independent variable on the dependent variable.

3.5 Ethical Considerations

To complete research with appropriate research rules research ethics is very significant considering the ethical aspect of research enough time will be given to the respondent of the study so that they can depict their true view on research questions. Primary data is used in this study. The ethical clearance certificate reference number AKI021SNTO01 was obtained at University of Fort hare on the 23 July 2018. Permission to conduct the research in Mnquma Local Municipality was therefore requested from the three villages Councillor

Informed consent and discontinuance participation: Informed Consent by visiting the chiefs of the study villages before collecting data. During the visits, the methodological objectives were explained to the chiefs

which then gave researcher permission to conduct data collection through administering of questionnaires. Informed consent from the participants of the research to ensure the usage of their given data. Participants have the right to know what the research is about, how it will affect them, the risks and benefits of participation (Bless *et al*.2011). The researchers tried to explain the aim of the study and also revealed that participation was strictly voluntarily (Leemy & Ormrod, 2010). They also should know that they have the right to decline or discontinue their participation at any point during the process. In the case of this research, local authorities will be notified beforehand, and permission will be asked for before anything happens. The questionnaire will be short o avoid fatigue that can cause participants to stop before finishing.

Confidentiality and Anonymity: Confidentiality of respondent will be maintained strictly to ensure the privacy of their data by always keeping under the secure condition of the participant personal information when collecting data. The disclosure of respondent identity will be based on their consent where if they are not willing to disclose the identity (such as the name of respondents), their identity will not be exhibited, each questionnaire used will be assigned a number and use correct referencing for secondary data information.

Protection of Vulnerable Participants: Vulnerable participants are those do not have the necessary degree of understanding to give informed consent to participate in the research e.g., children. Other vulnerable people include those that are unemployed, disabled people and mentally ill people. If vulnerable people are encountered during the process, the researcher will be sensitive to their needs and will not be patronising or condescending to the participants.

Respect: Research involving people only is possible if there are a mutual respect and confidence between investigators and participants. All participants will be fully respected regardless of their attitude. Since the research would not happen without the participants, the researcher will make sure the participants do not walk away from the research having regrets or unhappy.

3.6 Chapter Summary

The first part of the chapter has focused on the description of the study which highlighted areas where the study was conducted, temperature, level of education, agricultural potential, total monthly household income and infrastructure of the three villages. The design of the study has described the approach used during the study as well as the method applied in collecting data. The data collection covered the theoretical method in collecting data and how it was analysed to achieve the objectives of the study. The techniques and procedures used, the issue of ethics applied throughout the study has been clearly clarified and lastly model fit was done to check the suitability of the models**.**

CHAPTER FOUR: PRESENTATION OF RESULTS

4.0 Chapter introduction

This chapter presents the descriptive statistical analysis results of the sampled households Mnquma Local Municipality specifically on non-electrified, recently electrified, and electrified. The data was collected in August and September 2018 where a total of 224 respondents were collected from the mentioned three villages. This chapter is divided into four parts. Part one presents and discusses the socio-demographic characteristics of household heads and the effect of electrification in the adoption of electrical appliances to three different stages of electrification. Part two presents' benefits of electricity with electrical appliances and part three presents' uses of adopted electrical appliances. An objective of the study was to examine the effects of household agricultural income on the adoption of electrical appliances and energy security among the selected agricultural households in Mnquma Local Municipality. Table and charts were used to present the information.

4.1 Descriptive statistics of socio-demographic characteristics of the household head

4.1.1 Household head age, gender of the household head and marital status

Presented in the Table 4.1 below are the demographic variables of the household heads. The ages were categorized into four groups, the first one was that of ages less than thirty, the second category goes between thirty and forty, the third category goes from forty-one to fifty, while the fourth category goes from fifty-one to sixty and then the last one aimed at categorizing pensioners was sixty and above. The findings revealed that many households in three villages are pensioners, i.e. persons over the age of sixty. In non-electrified and recently electrified many respondents fall into the (60+ years) age group followed by the middle class which is between the ages of (41-50 years) and then (51-60 years) and also (30-40 years). The remainder, the smallest group, had the age range (less than 30 years) while in Electrified many respondents fall into the (60+ years) age group followed by the middle class which is between the ages of (41-50 years) and then (30-40 years) and also (51-60years). The remainder, the smallest group, had the age range (less than 30years). According to Jones (2015) noted that old household heads consume low electricity.

The mean age for a village electrified for a long time is 51 years, for a recently electrified village is 56 years while a village that is not electrified is 54 years. Since the majority of household heads of the studied villages are in their productive years; then it means that younger household heads are more likely to be adopting electrical appliances than those with older household heads.

From the table 4.1 reveals that in Electrified male head were many (58.3%) and females were few (41.7 %). While in non-electrified 67.1 % are females and 32.9% are males while in recently electrified there are

more female-headed household (54.3%) and males are few (45.7%). In Electrified the highest percentage of the male head of households support the study by Mbaku (2015) which showed males as the one who adopt electricity.

The findings indicated that the marital status of the household heads was divided into four main groups namely single, married, widowed and divorced. Table 4.1 shows that most household heads from electrified (48.8 %) and recently electrified (54.3%) are married, which indicate that such households are relatively stable in Mnquma municipality while in non-electrified are single (15.7%), widowed (24.3%), married (35.7%), divorced household heads (10.0%) were the least class of respondents.

Table 4.1: Household head age, gender of the household head and marital status

Variables		**Electrified**		**Recently electrified**		**Not electrified**		**Total**	
		Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Age	<30	3	3.6	2	2.9	3	4.3	8	3,6
	30-40	18	21.4	11	15.7	8	11.4	37	48,50
	41-50	23	27.4	14	20.0	19	27.1	56	24,83
	51-60	12	14.3	12	17.1	13	18.6	37	16,67
	>60	28	33.3	31	44.3	27	38.6	86	38,73
	Total	84	100.0	70	100.0	70	100.0	224	100
	Mean	51.36		56.2		54.9			
	SD	13.8		13.8		13.4			
	Min.	27		24		27			
	Max.	80		86		86			
Gender	Female	35	41.7	38	54.3	47	67.1	120	54,37
	Male	49	58.3	32	45.7	23	32.9	104	45,63
	Total	84	100.0	70	100.0	70	100.0	224	100
Marital status	Single	15	17.9	10	14.3	11	15.7	36	15,97
	Married	41	48.8	38	54.3	25	35.7	104	46,27
	Widowed	19	22.6	17	24.3	27	38.6	63	28,50
	Divorced	9	10.7	5	7.1	7	10.0	21	9,27
	Total	84	100.0	70	100.0	70	100.0	224	100

Source: Field survey, 2018

4.1.2 Household head's educational level and occupation status and source of income

On the Table 4.2 below Secondary education is the highest level of education amongst these households with 60.7% (electrified), 65.7% (recently electrified) and 52.9% (non-electrified). While tertiary education is in electrified (22.6%), recently electrified (10 %) and in non-electrified (2.9 %). In Electrified there was no household head without formal education while in recently electrified it was1.4% and in non-electrified it was 10 %. In electrified households it's shows that there are more household heads who went to tertiary than other villages. This is supported by Tegene *et al*. (2015), that having access to electricity has a visible effect on the level of schooling.

Employment status is one of the important factors in determining the rate of adoption of any kind of appliances. The employment status presented in Table 4.2 is categorised into five different groups for household heads, i.e. Unemployed, employed, self-employed, Pensioner and part-time, measured as dummy variables, as an electrified or non-electrified. Amongst the recently electrified households, unemployed respondents were about 21.4%, employed respondents 22.9%, self-employed 14.3 %, pensioners 40.0% and part-time farmers were about 1.4 % while in more than ten years electrified households, unemployed respondents were about 25.0 %, employed respondents 31.0 %, self-employed 6.0 %, pensioners 33.3% and part-time farmers were about 4.8 %. Considering the demands of electricity production such as access to fresh food and better studying appliances, these results are reasonable enough. Electrical appliances adoption also encourages self-employment, hence some of the Electrified households are self-employment.

On the other side, when considering the individuals that have not-electrified, unemployed respondents were about 38.6 %, employed respondents 11.4 %, self-employed 1.4%, pensioners 41.4% and part-time farmers being 7.1%. These results are inconclusive because of various factors such as high employment status in rural areas of the Eastern Cape Province, being risk-averse, and being not exposed to knowledge and information. Energy services greatly enhance food security, increase labour productivity, and increases household income.

In many rural areas, the majority of people receive social grants as a source of income. Social grant includes child support, disability, and old age pension grants. The study aimed to determine whether household income levels have an influence in electricity availability information regarding the source of income is presented in Table 4.2. The study indicated that in households electrified more than ten years (34.5%) household rely on old age grant and pension followed by 28.6% participants who generate their income from salary, remittances (19.0%,), wages (7.1%) business (6.0%) those who do not have source of income are 4.8 %.

In recently electrified (recently electrified) shows that (40.0%) household rely on old age grant and pension followed by 22.9% participants who generate their income from salary, remittances (15.7%), business (14.3%), those who do not have source of income are 4.3 % and wages (2.9%). While in non-electrified households (non-electrified) (41.4%) household rely on old age grant and pension followed by remittances 32.9%, followed by wages (10.0%) then by 8.6% participants who generate their income from salary, then those who do not have the source of income are 5.7%. and businesses (1.4%) were the least in non-electrified households.

Furthermore, the findings indicated that from sampled participants the majority of households are not electrified and receive social grant as their main source of income. Based on the results, it is evident that there is a relationship between the source of income and availability of electricity.

Table 4.2: household head's educational level and occupation status and source of income

Categorical Variables		Electrified		Recently electrified		Not electrified		Total	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Education level	None	0	0	1	1.4	7	10.0	8	3,8
	Primary	14	16.7	16	22.9	24	34.3	54	24,63
	Secondary	51	60.7	46	65.7	37	52.9	134	59,77
	Tertiary	19	22.	7	10.0	2	2.9	28	11,63
	Total	84	100.0	70	100.0	70	100.0	224	100
Occup-ation	Unemployed	21	25.0	15	21.4	27	38.6	63	28,33
	Employed	26	31.0	16	22.9	8	11.4	50	21,77
	Self employed	5	6.0	10	14.3	1	1.4	16	7,23
	Pensioner	28	33.3	28	40.0	29	41.4	85	38,23
	Part-time	4	4.8	1	1.4	5	7.1	10	4,43
	Total	84	100.0	70	100.0	70	100.0	224	100
Source of income	Salary	24	28.6	16	22.9	6	8.6	46	20,03
	Wages	6	7.1	2	2.9	7	10.0	15	6.67
	Pension/Old age grant	29	34.5	28	40.0	29	41.4	86	38.63
	Business	5	6.0	10	14.3	1	1.4	16	7.23
	Remittances	16	19.0	11	15.7	23	32.9	50	22.53
	None	4	4.8	3	4.3	4	5.7	11	4.93
	Total	84	100	70	100.0	70	100.0	224	100

Source: Field survey, 2018

4.1.3 Household size and total monthly households' income

Household size refers to all members of the family living under one roof. The household size consists of children and adults. Table 4.3, household size is categorised into four different sizes, that is, less than 3,3-5, 6-8, and greater than 8 members, while the level of response is categorised based on the village, that is, electrified, recently electrified and non-electrified. In electrified, the response was high to households that have the household sizes that have 3-5 (63.1%) members followed by households which are between 6-8 (31%) greater than 8 (4%) and households which are less than 3 (1.2%). In non-electrified the response was high to households that have the household sizes that are between 3-5 members (68.6%), followed by households which are less than 3 members (27%), followed by households which are between 6-8 (4.3%) and the were no members more than 8 members. While in recently electrified the response was high to households that have the household sizes that are between 3-5 members (47.1%), followed by households between 6-8 (44.3%), followed by households which are members that are more than 8 (7.1%) and members that are less than 3 (1.4%). Larger households' size utilises more electricity than lower household size (Huebner *et al.,* 2016).

Income level is the indicator of appliances affordability (Kaygusuz, 2011) hence it is one of the important socio-economic factors in the literature. Table 4.3 has categorised income level into five, i.e., less than R1001, R1001-5000, R5001-10000, R10001-15000 and greater than R15000. Households that have the highest total monthly household income which is greater than R15000 is electrified (34.5%) follow by recently electrified (17.1%) the non-electrified (4.3%)Amongst the recently electrified households, unemployed respondents were about 2.9% (<R1001), 28.6% (R1001-5000), 25.7 % (R5001-10000), 25.7% (R10001-15000) and 17.1% (greater than R15000) while in more than ten years electrified households, 0% (<R1001), 41.7% (R1001-5000), 16.7 % (R5001-10000), 7.1% (R10001-15000) and 34.5% (greater than R15000).Considering the demands of electricity such as access to fresh food and better studying appliances, these results are reasonable enough. Electrical appliances adoption also encourages self-employment, hence some of the Electrified households are self-employment.

On the other side, when considering the individuals that have not-electrified, 5.7% (<R1001), 78.6 % (R1001-5000), 11.4 % (R5001-10000), 0% (R10001-15000) and 4.3% (greater than R15000). These results are because of various factors such as low employment rate in non-electrified households of the rural areas, being at risk of not exposed to knowledge and information. Khandker *et al.* (2009) also found that in Bangladesh the households that have electricity for more than 15 years have 43 percent higher incomes than those without. Household income is naturally an important determinant of livelihood diversification.

Table 4.3: Household size and total monthly households' income

Variables		Electrified		Recently electrified		Not electrified		Total	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Household size	< 3	1	1.2	1	1.4	19	27.1	21	9.90
	3-5	53	63.1	33	47.1	48	68.6	134	59.60
	6-8	26	31.0	31	44.3	3	4.3	57	26.53
	>8	4	4.8	5	7.1	0	0	9	3.97
	Total	84	100.0	70	100.0	70	100.0	224	100
	Mean	4.9		5.6		3.4			
	SD	1.5		1.8		1.3			
	Min.	3		1		1			
	Max.	9		10		6			
Total monthly household income	<1001	0	0	2	2.9	4	5.7	6	2.87
	1001-5000	35	41.7	20	28.6	55	78.6	110	49.63
	5001-10000	14	16.7	18	25.7	8	11.4	40	17.93
	10001-15000	6	7.1	18	25.7	0	0	24	10.93
	>15000	29	34.5	12	17.1	3	4.3	44	18.63
	Total	84	100.0	70	100.0	70	100.0	224	100
	Mean	12296.1		10137.1		4027.9			
	SD	11216.0		7261.8		3919.7			
	Min.	2090		400		450			
	Max.	50100		34600		26000			

Source: Field survey, 2018

4.1.4 Total household energy expenditure

Total household energy expenditure on energy sources is detailed in Table 4.4 For each energy carrier and/or source, expenditure for the users of that particular energy type total monthly expenditure for the three sample villages shows some range, with monthly expenditure amongst the electrified and recently electrified R101-R200 per month, while households in non-electrified spend R101-R200 per month for

gas. The zero expenditure of electricity for non-electrified households is due to the lack of access to electricity connections.

Table 4.4 Energy security status measurement for the three villages

ESS	Energy budget share of total household budget %
Energy secured	55%
Energy insecure	45%
Total	100%

Table 4.5 Total household energy expenditure on energy sources

	Electrified				**Recently electrified**				**Not electrified**			
source	**0-100**	**101-200**	**201-300**	**>300**	**0-100**	**101-200**	**201-300**	**>300**	**0-100**	**101-200**	**201-300**	>300
Electricity	13.1	51.3	13.1	22.7	8.5	61.4	22.8	7.1	0	0	0	0
Gas	0	4.8	1.2	6.0	0	11.4	2.8	7.2	0	34.3	9.9	21.4
Paraffin	28.6	0	0	0	59.9	1.4	0	0	58.6	35.8	1.4	0
Candles	31.0	0	0	0	38.6	0	0	0	34.3	0	0	0
Fire-woods	0	0	0	0	0	0	7.1	15.6	0	0	22.9	2.9
Other energies	0	0	0	0	0	0	0	0	17.1	20	1.4	0

Source: Field survey, 2018

4.2 Benefits of electricity with electric appliances

4.2.1 Benefits of electricity

Electricity has knock-on effects in the lives of electrified village respondents. There are three keys on the graph, not connected on the electricity, no means electricity does not improve education, health, knowledge information and social status while there is yes electricity improve education, health, knowledge information and social status

Figure 4.1 shows that 100% of the respondents in electrified seem to think that electricity improve education and 98,6% of the respondents in recently electrified seem to think that electricity improve

education whilst 1.4% of them seem to think that electricity does not improve education. 100% of the respondents in electrified seem to think that electricity improve knowledge and information and 100% of the respondents in recently electrified seem to think that electricity improve knowledge and information.100% of the respondents in electrified seem to think that electricity improves health and 98,6% of the respondents in recently electrified seem to think that electricity improves health whilst 1,4% of them seem to think that electricity does not improve health.97,6% of the respondents in electrified seem to think that electricity improves social status whilst 2,4% of them seem to think that electricity does not improve social status and 100% of the respondents in recently electrified seem to think that electricity improve social status.

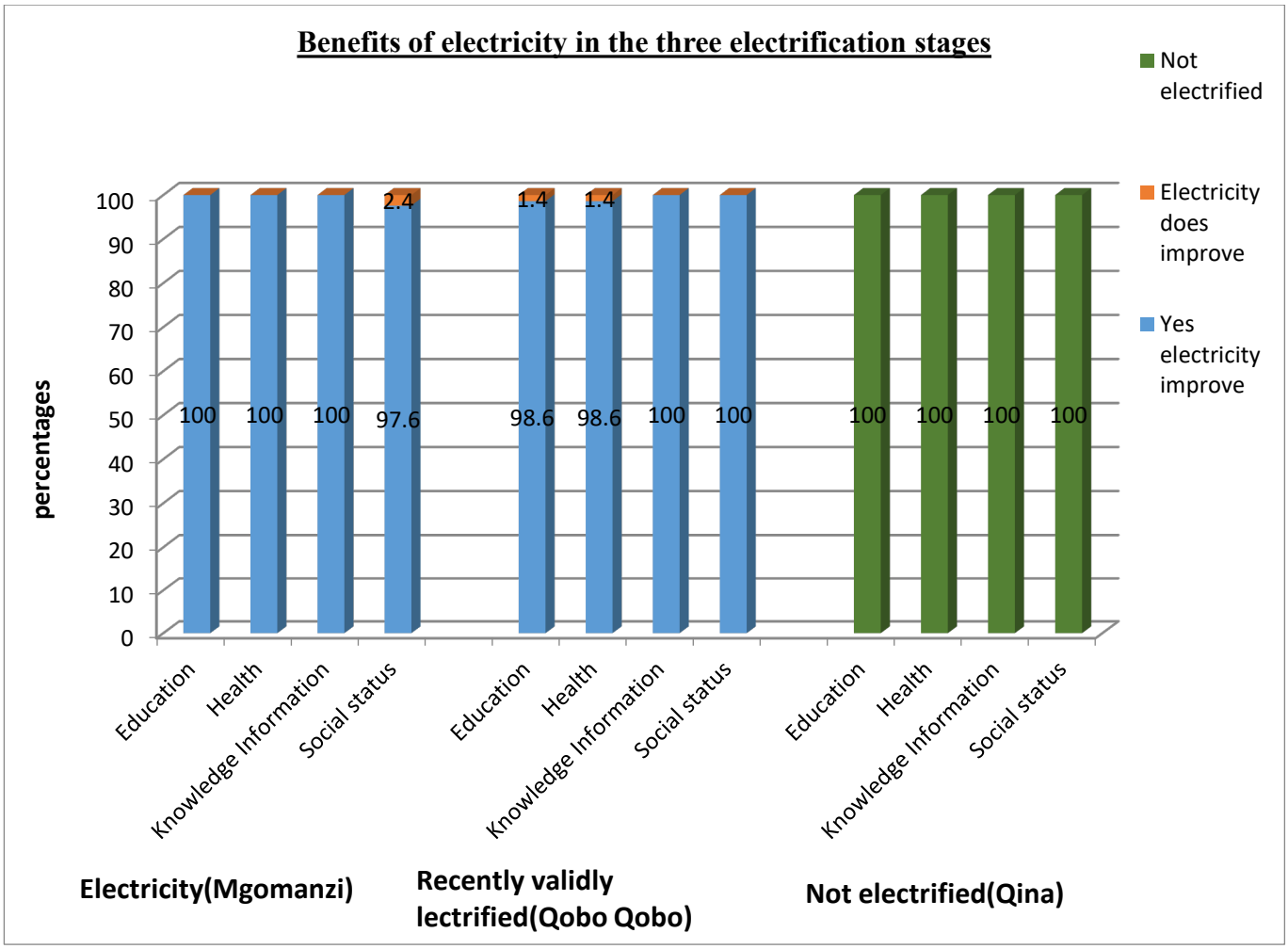

Figure 4.1: Benefits of electricity in the three electrification stages

Figure 4.2 shows that 90% of the respondents in electrified seem to think that electricity improve security whilst 9, 5% of them seem to think that electricity improve business and 9, 5% of them seem to think that electricity improve environment. The 81% respondents in recently electrified seem to think that electricity

improve security, whilst 7,1% of them seem to think that electricity improve business and 2,9% of them seem to think that electricity improve environment. Thirteen respondents from electrified and recently electrified villages emphasised electricity as a boost in their rural businesses. On the non-electrified village there was no benefits identified from electricity. Benefits of electricity in the three electrification stages.

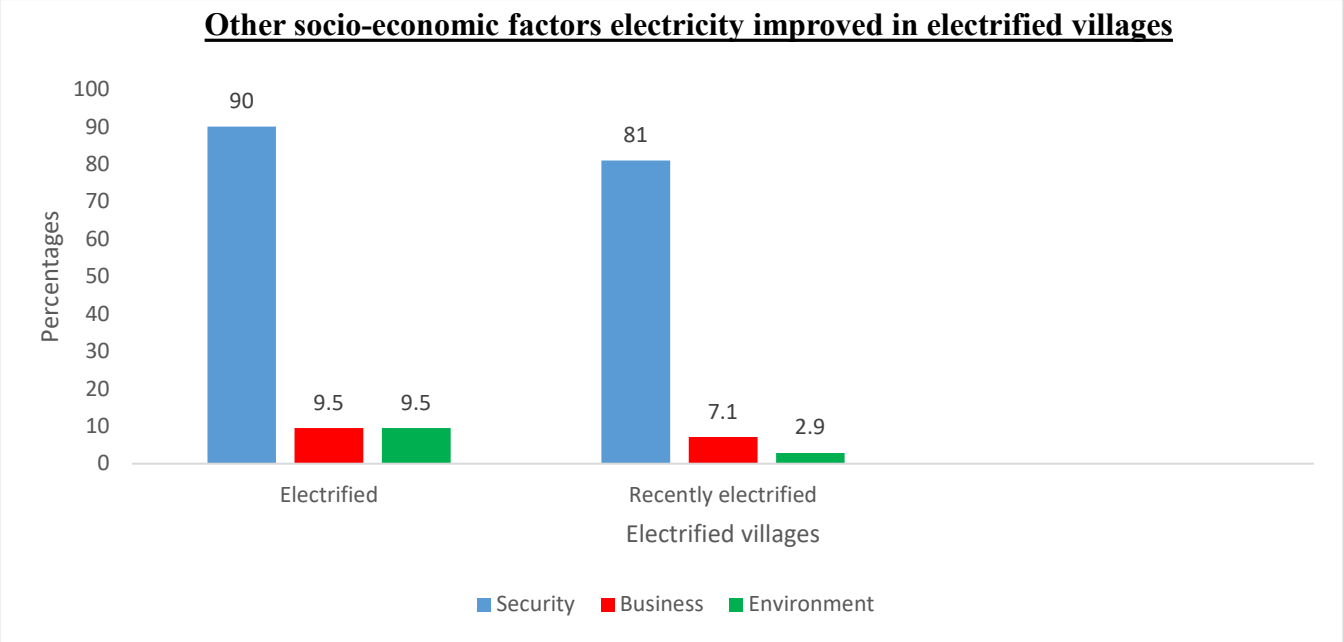

Figure 4.2: Other socio-economic factors electricity improved

4.2.2 Benefits of electrical appliances

Figure 4.3 show that the three household appliances which were adopted after electrification process in both electrified villages are refrigerator (75%), electric bulb (96,4%) and electric stove (64,3%). The adoption of these three appliances depended on their necessities, preferences and the ability to purchase.

Meat cutting machines which the household were purchase for the business (hiring) purpose when the household slaughter cows and sheep etc. This meat cutting machine was recorded under other appliances.

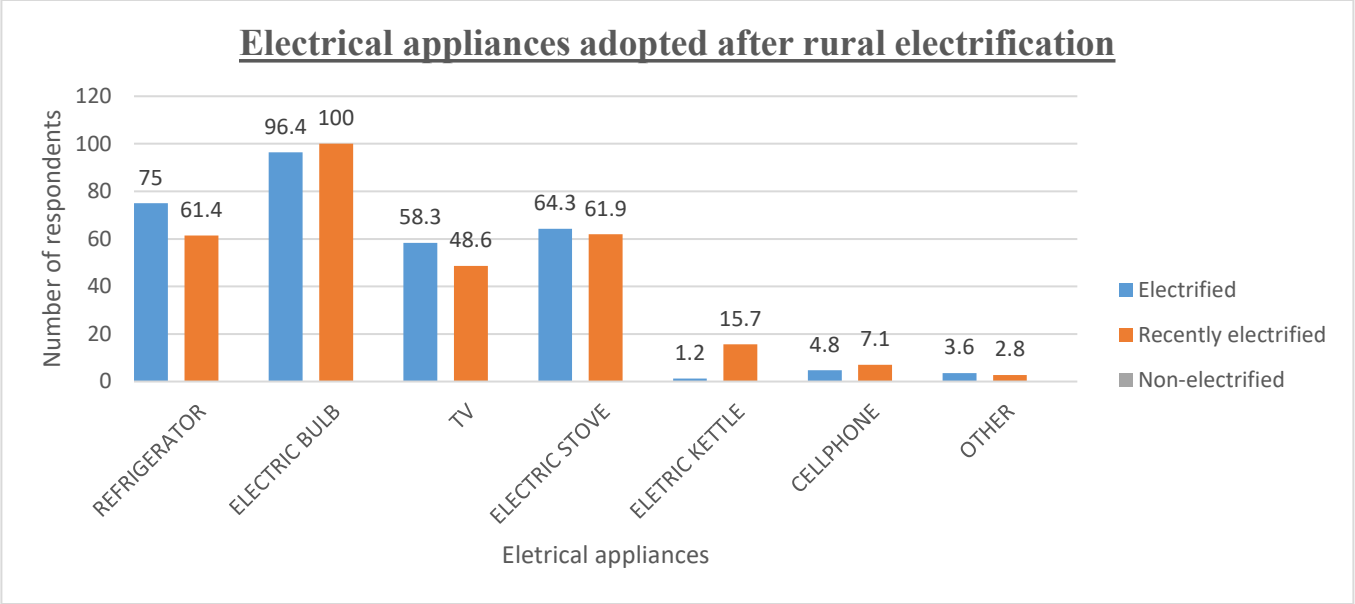

Figure 4.3: Electrical appliances adopted after rural electrification

The electric appliances adopted in Figure 4.3 improve returns on education, time savings for household chores and ability to use electric refrigerator as main benefits of electricity access. Most of these appliances are multifunctional for example mobile phones improve bank access, improve access to information and communication. Table 4.5 shows how respondent perceived benefit of preservation and processing of food by the refrigerator, which 'add value' to home garden produce. In terms of value chain in agriculture Refrigerator assist in storage of the agricultural produce and food. When the households slaughter animals they are no longer afraid of perishing meat. Household agricultural product means can be processed, package stored and kept for long periods Bright light at night protect thieves from breaking in the houses (Hirmer &Guthrie, 2017). The importance benefits of electrical appliances are discussed below.

Table 4.5 Three first appliances with the benefits in electrified households

Village	Electric appliances Benefits	Frequency	Percentage
Electrified	Bright light at night	11	13.1
	Preservation and processing of food	20	23.8
	Increased variety and quality of the diet	14	16.7
	Labour saving for women	15	17.9
	Improved access to information	14	16.7
	Study longer hours	10	11.9
	Total	84	100

Recently electrified			
	Bright light at night	6	8.6
	Preservation and processing of food	30	42.9
	increased variety and quality of the diet	5	7.1
	Banking access	3	4.3
	Labour saving for women	12	17.1
	Improved access to information	6	8.6
	Study longer hours	8	11.4
	Total	70	100.0

Source: Field survey, 2018

4.3 Uses of adopted electrical appliances

4.3.1 Purchasing of the first three appliances after electrification process

In figure 4.4 results from the households that were electrified for a long time, the first three appliance were purchased by 34% agricultural income and by 27 % in the recently electrified households. Non-agricultural income was the most form of income used to purchase the first three appliance in both long time electrified and recently electrified households by 50% and 43% was through loans, savings, and remittances. While in the non-electrified households who did not buy electrical appliances.

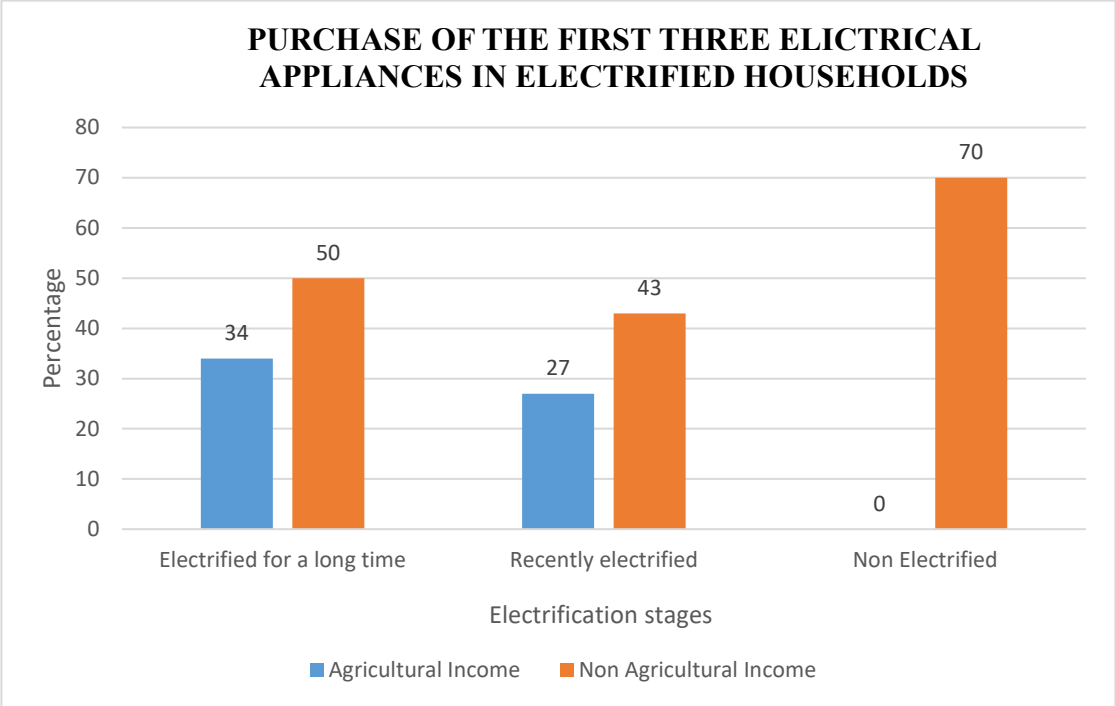

Figure 4.4: Purchasing of the three first appliance in electrified households

4.3.2 Uses of electrical appliances

According to Mbaka (2015), availability of power for charging the cell phones had made it very convenient to households and phone ownership improved communication with household members in distant places, money transfers, social media, and internet.

The findings in figure 4.5 shows that about 68.75% of households use electricity for ironing, followed by paraffin 21.43%, then gas at 8.48% then firewood 0.89% and other about 0.45%. Households have multiple energy uses for different purposes.

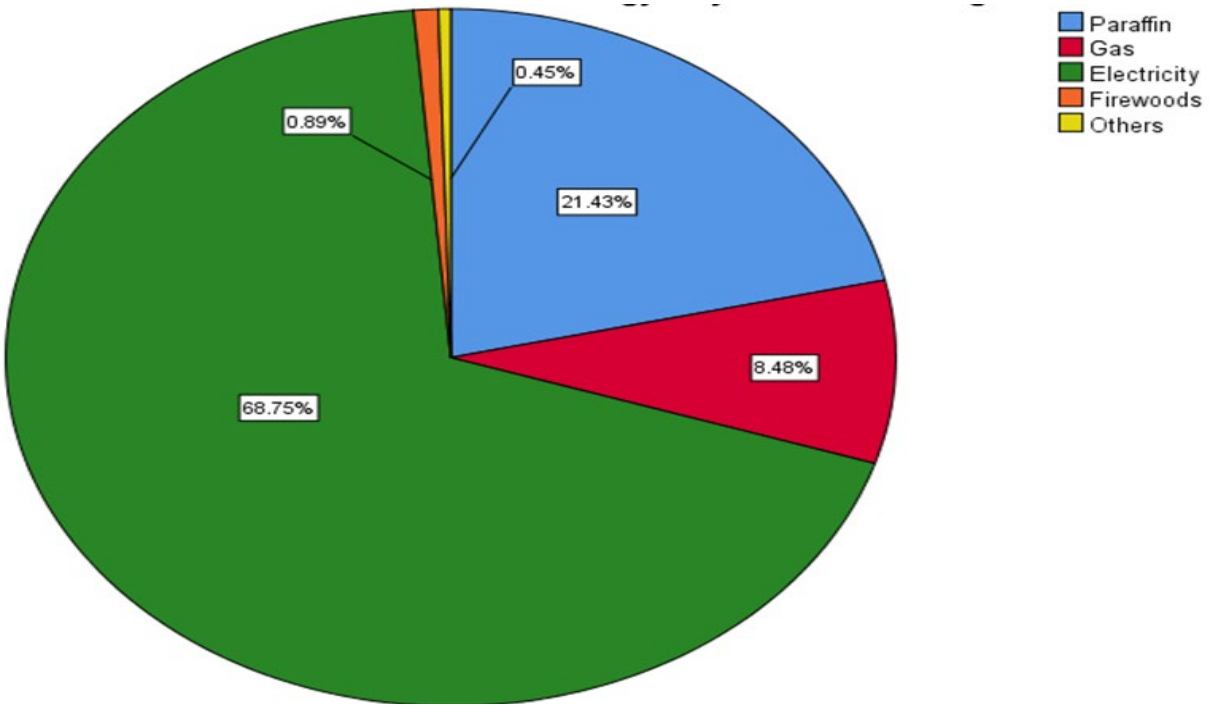

Figure 4.5: Main energies for ironing

The findings from figure 4.7 shows that about 78.57% of households use electricity for charging phones followed by solar 12.24%, and other about 9.18%. Batteries were also used by respondents for charging phones. According to Guthries and Hirmer (2017) phones are improving agricultural and labour market efficiency coordination with suppliers (to know who is selling what)

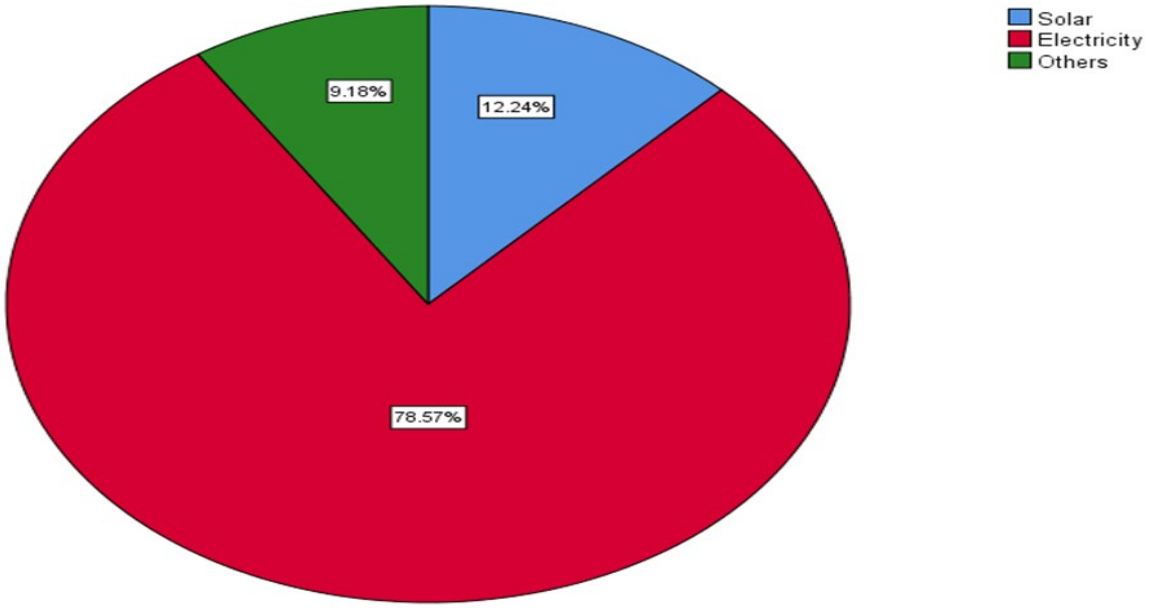

Figure 4.6: Main energies for charging phone

The findings from figure 4.7 shows that about 59.64% of households use electricity for cooking followed by gas at 28.70% then paraffin 8.07% and firewood 3.59%. Therefore, most households use electricity than other energy sources for cooking by 59.64%. This means both food security and energy security are connectedly significant in the production and distribution of food to fight hunger in households (Sikrweqe, 2002).

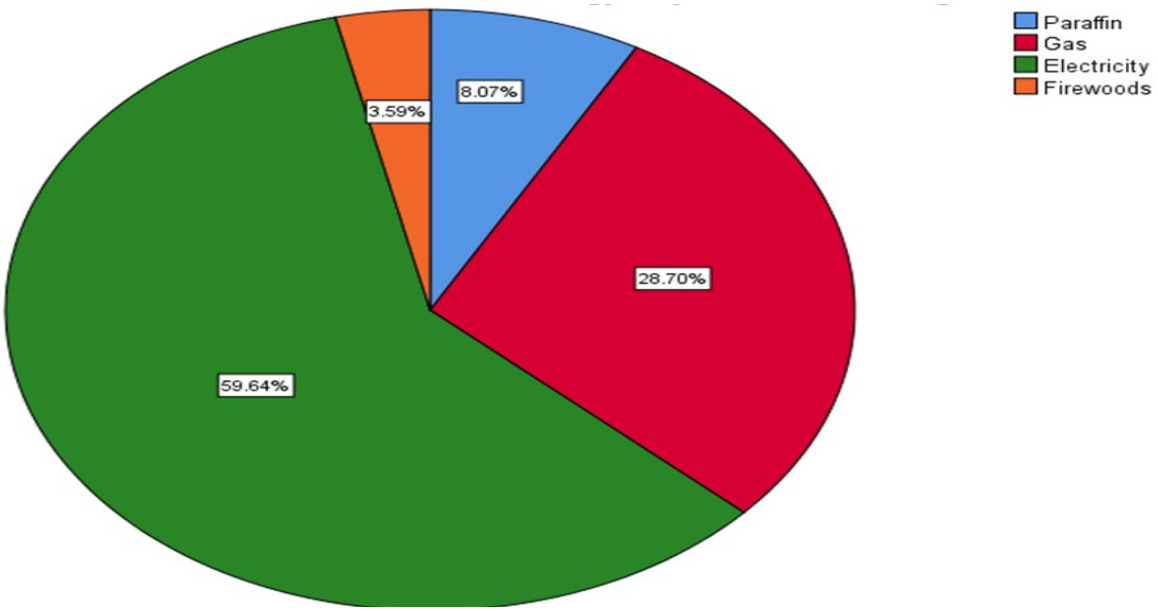

Figure 4.7: Main energies for cooking

The finding from figure 4.8 shows that about 37.22. % of households use electricity for heating followed by firewoods 30.04% then paraffin 24.22% and gas at 8.52%. This space heating for the rooms is usually done in cold season like winter.

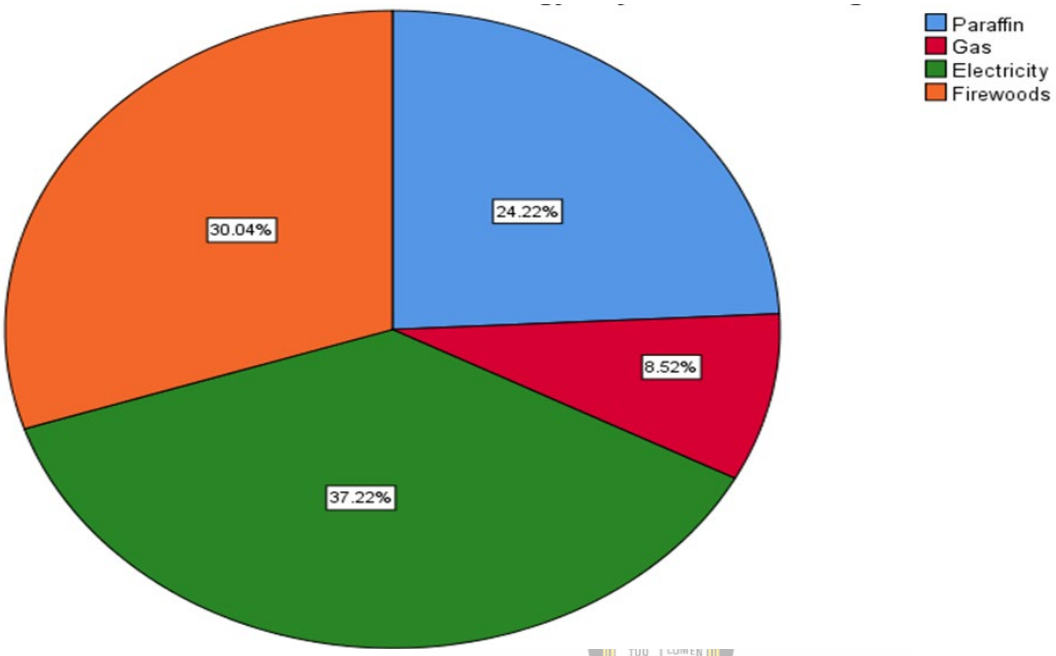

Figure 4.8: Main energies for heating

The findings from figure 4.9 shows that about 68.75% of households use electricity for lighting followed by paraffin 25.45%, then others 4.02 % and solar about 1.79 %. Lighting was the first priority for being connected to the grid electricity. Candles was specified as other energy source for lighting. Even in electrified households, there is still a huge use of candles as they used as a substitution strategy in case of load shedding and short of expenditure budgets.

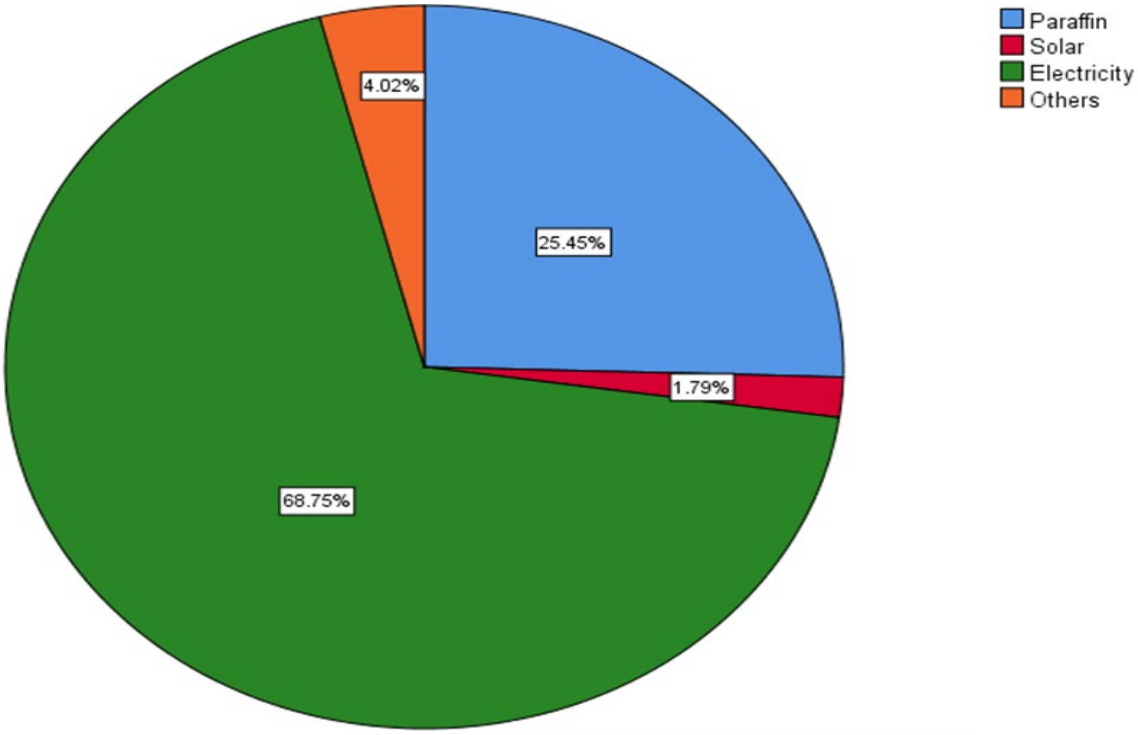

Figure 4.9: Main energies for lighting

4.4 Chapter Summary

This chapter presented and discussed the results of descriptive analysis of the households in three villages in Mnquma Local Municipality that participated in this study. Within this chapter, descriptive statistics such as frequencies, percentages and graphs were used to describe socio-demographic characteristics, including household size, monthly income, education level, source of income, age, gender etc. Household heads in non-electrified and recently electrified was dominated by females unlike in Electrified households' heads were dominated by males. Electrified village has more households receiving <15000 of total monthly household income. Results show that the electrified household used agricultural income to purchase electrical appliance just after the electrification. Most households use electricity than other energy sources for cooking by 59.64% followed by gas at 28.70% then paraffin 8.07% and firewood 3.59%. The results show that most households about 68.75% of households use electricity for lighting followed by paraffin 25.45%, then others 4.02 % and solar about 1.79 %. The top three household appliances which were adopted after electrification process in both electrified villages are electric bulb (81), refrigerator (63) and electric stove (52). Lighting was the first priority for being connected to the grid electricity.

CHAPTER FIVE

EMPIRICAL RESULTS AND DISCUSSIONS

5.0 Chapter introduction

This chapter present empirical results of the effect of household agricultural income on energy security. Binary logistic regression was also estimated with energy security as the dependent variable. These effects have been analysed using logistic regression when the adoption of electrical appliance is a dependent variable. Lastly, chapter is summarised.

5.1 Binary logistic Regression Model

This section presents the results obtained from the binary logistic regression model and these results are based on socio economic factors and household agricultural income influencing energy security. This model used a sample of 224 households in both electrified a non-electrified village and it was analysed with Stata. A number of factors and household agricultural income influencing the energy security were tested using the Binary Logistic Model. Measures of the significance were at 1% and 5%. Variables were selected based on previous studies (Arthur, 2009; Matinga, & Annegarn, 2013). The -57.17752 log-likelihood function also shows that the regression model fit the data appropriately. The Pseudo R Square is 0.61 (refer to Table 5.1) and it lies between 0 and 1, confirming the goodness of fit of the model, the negative coefficient of age implies that the probability is statically significant at 10% level.

Table 5.1 shows a summary of the results showing seven (7) variables which were hypothesized to be the variables influencing energy security. Log likelihood is -57.18. Likelihood Ratio (LR) Chi-Square is 179.87 and its respective P- value (LR) is 0.0000, these indicate lower probabilities of making mistakes in rejecting the null hypothesis because it is less than 0.5. The Variance Inflation Factor (VIF) was used to test the multicollinearity. The results shows that all the variables had VIF a less than 10 VIF and mean VIF 4.11 implying that there was no multicollinearity (Senaviratna1 & Cooray,2019). The low correlation among the variables prove that the multicollinearity is not an issue for binary logistic regression models.

The binary logit model was to indicate the factors and agricultural income that have influence on energy security. The variables which include age, total household sample size, total monthly household income, and agricultural income were identified as significant from the study results. On one hand, household sample size variable is significant at 1% while agricultural income is significant at 5%. On other hand and occupation variables and marital status were insignificant at greater than 10% level. Socio economic factors and

agricultural income are influencing energy security included age, total monthly household income, total household sample size and agricultural income. The results are presented in Table below:

Table 5.1: Factors that are influencing energy security: Binary logistic Model results

Variable	Coefficients	Standard erro	Exp (β)	ME dy/dx	p-value	VIF
Age	-.0409	0.0046	0.9599	-0.008	0.074*	7.19
Gender	-.6491	0.2121	0.5225	-0.132	0.239	2.51
Marital Status	-.3892	0.1183	0.6776	-0.077	0.514	3.02
Household Monthly Income	.0005	0.0000	1.0005	0.000***	0.000***	4.11
Household Size	.4925	0.0393	1.6363	0.099	0.011***	8.11
Occupation	-.0713	0.0888	0.9311	-0.014	0.871	1.60
Agric. Income	.2277	0.0242	1.2557	0.046	0.057**	2.22
Constant	-4.0083	0.08438		-0.08067	0.000***	
Mean VIF						4.11
Log likelihood		-57.17752				
LR chi 2(7)		179.87				
Prob > chi2		0.0000				
Pseudo R^2		0.6113				
Observation		224				

Legends: *, ** and * denote significance at 1%, 5% and 10% respectively**

Standard errors in parentheses t-statistics based on robust standard errors

Source: Field survey, 2018

Marginal effects (ME): is referred as the change in the expected value of a dependent variable associated with a change in an independent variable with other held independent variables constant at specified values.

Marginal effects show the change in probability when the predictor or independent variable increases by one unit.

coefficient Exp (β): is the degree of change in the outcome variable for every 1-unit of change in the predictor variable.

Standard error: A measure of the statistical accuracy of an estimate, equal to the standard deviation of the theoretical distribution of a large population of such estimates.

VIF: is a measure of the amount of multicollinearity in a set of regression model variables.

5.2 Determinants of new electrical appliances in the three villages

Table 5.1 shows that age, level of education, gender, marital status, occupation, household size, total monthly household income. The coefficient of age, gender, marital status and occupation are negatively related to the adoption of new electric appliances.

Age of household heads: The coefficient estimates of the variable age negative statically significant at 10% level, in reference to results presented in descriptive statistics. The marginal effect indicates that a 0.8 % increase in age of the household head increase the probability of energy security with all other independent variables constant. The coefficient is negative in the agreement with a priori expectations. The negative coefficient indicates that energy security decreases as age increases. This implies that younger household heads have high chances of affording energy sources than older household heads. The reason for older household heads to have less chances is that they receive less income (pension) which is not enough to afford all necessary household expenditures including the household source of energies. The results revealed that the majority of households were employed in electrified villages.

Household total monthly income: The results show that household income is statistically significant at 1% level and positively influence. The marginal effect result indicates that if other independent variables are held constant, probability of total monthly income for the household is significantly increase by less than 1% with R1 increase on household energy security. This indicates that the higher the income the more likely to buy other energies as compared with lower-income households.

Household size: The variable was statistically significant at 1% level. The coefficient was positive in the agreement with a priori expectations. The marginal effects indicate that 9.9 % increase in household size increase the probability with all other independent variables held constant This led to an increase in the energy security on household's agricultural income with all other independent variables constant. The positive

coefficient indicates that energy security increases as the household size increases. According to Ismail and Khembo (2015), coincided that households with a high number of household members staying in one house are more likely to be energy poor than households with a low number of people live in the one household.

Occupation of household heads: this variable has a negative effect on the energy security and insignificant at greater than 10% probability level. The marginal effect indicates that a1.4% increase in the household head occupation increase the probability of energy security on household's agricultural income with all other independent variables constant. The negative relationship indicates that working household heads had negative significant influence on probability of the energy security than unemployed household heads. This could be attributed to the fact that the household head's employment status is largely contributing to afford many sources of energies. These results are in line with the study from the national survey conducted in South Africa by (Davis, 1998) which showed that the ownership of electric stoves (and other electrical appliances) are also related to income levels.

Household agricultural income: This variable has a positive effect on the energy security and significant at greater than 5 % significant level. The marginal effect indicates that a 4.6% increase in the agricultural income increase the probability of the household energy security on household's livelihood with all other independent variables constant. The positive relationship indicates that working household heads are more likely to afford many energies than unemployed household heads.

Table 5.1 show the results of marginal effects for the adoption of appliances which are: age of household head (p-value <0.01) and occupation of household head (p-value <0.10) and the gender of household head (p-value <0.10 are negative, while household size (p-value <0.01), household total monthly income age (p-value <0.01), and household agricultural income (p-value <0.10), are positive. Three out of seven variables in the binary model shows that there is a positive effect between the socio-demographic factors, agricultural income and the energy security

5.2 The effect of electrification on the adoption of new electrical appliances

This section presents the results with regards to the effect of household agricultural income on the adoption of new electrical appliances. The logistic regression model was used in this study as stipulated in the methodology chapter and it was fitted using Stata. In this section, the study outlines the probability model for the adoption of electrical appliances.

The factors that influence the decision to buy new electrical appliances are estimated using a logistic regression as summarised in Tables 5.2. The variables included in the model are the energy security, age, gender, marital

status, education, occupation of the household head, total household size, household monthly income, and household agricultural income. The likelihood ratio statistics of -74.547873 indicates that the estimated model is statistically significant at the 1% level. The results for the goodness-of-fit test shown in Table 5.2 indicate that the model fits the data well. Thus, the results for pseudo R^2 show that the logistic regression is well suited to predict the influence of the independent variable on the dependent variable. The estimated logistic regression was statistically significant at 1%, Pseudo R^2 is 0.51 (refer to Table 5.2) and it lies between 0 and 1, confirming the goodness of fit of the model.

Table 5.2 shows a summary of the results showing nine (9) variables which were hypothesized to be the household agricultural income influence the adoption of new electrical appliances. Log likelihood is-74.547873. Likelihood Ratio (LR) Chi-Square is 153.53 and its respective P- value (LR) is 0.0000, these indicate lower probabilities of making mistakes in rejecting the null hypothesis because it is less than 0.5. The Variance Inflation Factor (VIF) was used to test the multicollinearity. The results shows that all the variables had VIF a less than 10 VIF and mean VIF 4.25 implying that there was zero multicollinearity (Senaviratna1 & Cooray,2019).

Table 5.2 Binary logistic regression estimates for the adoption on new electrical appliances

Variable	Coefficients	Standard errors	Exp(β)	M E dy/dx	p-value	VIF
Energy Security status	0.5334	0.9973	0.83960	0.323	0.000***	3.60
Age	-.0195	0.0152	0.9861986	-0.005	0.132*	7.89
Gender	1.0294	0.4850	1.0976965	0.1614	0.033**	2.50
Marital status	-.4460	0.4810	0.6981865	-0.110	0.212	3.15
Education level	.6321	1.11800	1.2291501	0.051	0.527	5.79
Household monthly income	2.06e-02	0.00003	1.0000022	7.01e-06	0.754	5.21
Household size	.3743	0.0158	1.2985807	0.085	0.003***	6.22

Occupation	-.7741	0.5271	0.77940108	-0.081	0.142**	1.62
Agric. Income	.7423	0.5486	1.1133391	0.035	0.044**	2.23
Constant	-1.1803	0.8566692			0.168	
Mean VIF						4.25
Log likelihood		-74.547873				
LR chi 2(9)		153.53				
Prob > chi2		0.0000				
Pseudo R^2		0.5064				
Observation		224				

Legends: *, ** and * denote significance at 1%, 5% and 10% respectively**

Standard errors in parentheses t-statistics based on robust standard errors

Source: Field survey, 2018

From the nine variables used in the logistic model, six variables had a significant effect on influencing the households' new electrical appliances adoption, while four variables were not significant. Out of the nine variables, seven variables had a positive sign, indicating a positive influence on new electrical appliances adoption.

Household energy security status: The findings show that energy security is statistically significant at the 1% level and has a positive effect on the adoption of new electrical appliances. With all other independent variables held constant, the marginal effect results show that households that use a lot of energy are 32% more likely to buy new electrical appliances for their livelihood and increase their agricultural income.

Age of the household head: Age has negatively influenced the probability of participating in new adoption of electrical appliances at greater than 10 % statically insignificant level. The marginal effect indicates that a 0.5 % decrease in age of the household head increase the probability of agricultural income on household's adoption of new electrical appliances with all other independent variables constant. These results show that young household heads have a probability of adopting to new electrical appliances as compared to older household heads. The reason for older household heads to have less

chances is that they receive less income (pension) which is not enough to afford all necessary household expenditures including the electrical appliances. This may be explained by the fact that households gain a better understanding of the importance of electrical appliances at a young age, possibly through experience gained. Baldini *et a.l* (2018) arguing that older consumers are more likely to invest in energy-efficient light bulbs.

Household head gender: Gender of the household head is statistically significant at 5% level and positively influences the likelihood of new electrical appliances adoption. The marginal effect shows that if other variables are held constant, male household heads are 16% more likely to adopt new electrical appliances than female household heads. This is in contrast with the fact that female-headed households have more knowledge about the benefits of electrical appliances and male household heads have limited knowledge about the importance of electrical appliances uses were shared by (Hirmer & Guthrie, 2017) reported that household electrical appliances benefits assisted girls by reducing their daily chores.

Household head education level: education level is statistically significant at greater than 10% level and positively affects the likelihood of electrical appliances adoption. The marginal effect indicates that a 05 % probability in education level of the household head increase the probability of agricultural income on household's adoption of new electrical appliances with all other independent variables constant. This suggests that household heads with a higher level of education were more likely to adopt electrical appliances. This is due to the fact that higher educated heads are employed and able to afford electrical appliances and use of electrical appliances. According to Kumar and Rauniyar (2018), access to electricity at household level increased school enrolments by 9 percentage for girls and 6.3 percentage for boys in Bhutan. While in Mnquma Local Municipality the number of people with less than Grade 12 has decreased by 13 percentage from 2010 to 2011 whilst the number of pupils who did not continue to tertiary level has decreased was 4 percentage over the same period.

Household total monthly income: The results show that household income is statistically insignificant at a 10 % level with influence on the likelihood of new electrical appliances adoption. The marginal effect result indicates that if other independent variables are held constant, probability of total monthly income for the household is significantly increase by greater than 1% with a decrease in the electrical appliances adoption on household's livelihood. This indicates that the higher the income the more likely to buy electrical appliances than lower-income households. This is due to the fact that higher-income households afford to buy electrical appliances. Similar results were also shared by Khandker *et al*. (2013)

evaluated the impacts of electrification in Vietnam using household fixed-effect model. They show that household electrification had positive impacts on total monthly household income. As a result of access to electricity at the household level, total income rose by 2.4 per cent in MLM in 2013(IDP, 2019).

Equalised income was chosen as it is considered to provide a better indication of household disposable income which might turn to be a predictor of expenditure on electricity consuming appliances as well as financial pressure on electricity bills (Huebner *et al.,* 2016). Baldini *et al.* (2018) noted that there is a positive correlation between household income and energy-efficient appliances adoption concurs.

Lenz *et al.* (2017) said that in Rwanda the first electrical appliance to purchase was electric lamps and propensity score matching was used to match not electrified and electrified households using kernel matching logarithm.

Household size is statistically significant at 1% level and positively influences the adoption of electrical appliances. The marginal effects results show that the probability of 8.5 % of household size are more likely to increase household agricultural income and adopt new electrical appliances on household's livelihood with all other independent variables constant. These results imply that a household with more members is less likely to participate in the adoption of electrical appliances. The previous study by Rehfuess *et al*. (2014) noted that the bigger the household size the lower the adoption because of low-value time and labour assigned to collect fire-woods and the need to cook for many people.

Household agricultural income: This variable has a positive effect on energy security and is significant at a probability level greater than 1%. The marginal effect result shows that households with agricultural income are 3.5% more likely to adopt new electrical appliances than non-agricultural income households. The positive relationship indicates that working household heads are more likely than unemployed household heads to afford a variety of energies.

Table 5.2 show the results of marginal effects for the adoption of electrical appliances which are: energy security (p-value 0.01), age of the household (gender of household (p-value< 0.05), head (p-value< 0.05), education level of household head (p-value <0.10), household size (p-value 0.01), total monthly household income (p-value < 0.10), and agricultural income (p-value 0.01). Energy security, gender, education level, household size and agricultural income has a positive effect while age, marital status, household total monthly income and occupation has a negative effect on the adoption of electrical appliances.

5.3 Chapter Summary

This chapter presented the empirical results and discussions of the results. The binary logistic model was used to examine the relationship between socio-economic and demographic factors of the household and the household agricultural income on energy security. Results of the logistic regression model revealed that factors such as household total monthly income and household size have a significant effect on adoption of the new electrical appliances.

The null hypothesis to third objective was that there is no significant relationship between socio-economic characteristics and agricultural income of the households and their adoption of electrical appliances in Mnquma Local Municipality. The hypothesis is therefore rejected since the binary logistic model results for the Prob > chi2 indicated 0.0000. Thus, this hypothesis was rejected. The null hypothesis to fourth objective was that household agricultural income does not have significant effect on the adoption of electrical appliances in Mnquma Local Municipality. The hypothesis is therefore rejected since the logistic regression results for the Prob > chi2 indicated 0.0000. Thus, this hypothesis was rejected.

The results of marginal effects for the adoption of appliances which are: age of household head (p-value 0.10), gender of household head (p-value < 0.10), occupation of household head (p-value < 0.10), household size (p-value 0.01), household total monthly income age (p-value 0.01) and household agricultural income (p-value 0.05). Binary logistic regression was performed to determine the effect of agricultural income on the adoption of new electrical appliances. The results of logistic regression estimated that age, gender, energy security, household size and household agricultural income as statically significant for the adoption on new electrical appliances. The findings show the results of marginal effects for the adoption of electrical appliances which are: energy security (p-value 0.01), age of household head (p-value <0.10), gender of household head (p-value <0.05), marital status of household head (p-value <<0.10) education level of household head (p-value < 0.10), household size (p-value< 0.01), household total monthly income (p-value <0.10) occupation of the household head (p-value <0.10) and household agricultural income (p-value<0.05). These empirical results (for the third objective) of this research shows that electrical appliances adoption has insignificant effect on households' income.

Moreover, the results showed that people are not knowledgeable about the electrical appliances. The next chapter summarises and concludes and provide recommendation for the study results.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the summary and conclusion of the study. It starts by presenting the objectives that were outlined in the first chapter in line with the major results that were drawn from the descriptive and empirical analysis chapters. Lastly, the chapter provides policy recommendations and outlines gaps in research for further study.

6.1 Summary

This section summarizes the major results from the analytical chapters in order to conclude on the major research objectives of the study. The overall objective of this study was to examine the effect of energy security on the adoption and use of electrical appliances among agriculturalhouseholds in the former Transkei. In line with this, the specific objectives were:

The first objective was to describe demographics, energy security status and agricultural income of households' livelihood in the study area. Descriptive analyses revealed a number of variables which include age, source of income, and education were identified as significant from the study results. Household heads in non-electrified and recently electrified households were dominated by females unlike in electrified households' heads were dominated by males. Most unemployed people are from non-electrified households and they do not have expenditure on electricity because they are not connected to electricity. Results show that the electrified household used agricultural income to purchase the first three electrical appliance just after the electrification. The top three household electrical appliances which were adopted after the electrification process in both electrified villages are electric bulb (81), refrigerator (63) and electric stove (52). These electrical appliances have a significant influence on household livelihood.

The second objective was to examine the influence of socio- economic characteristics and energy security status and household agricultural income on energy security. The results from this objective showed that gender, marital status, and education level of the household head were identified as statically insignificant from the study results. On one hand, age variables were significant at 10% on the other hand household total monthly income, household size variables were significant at 1% and agricultural income variable was significant at 5%. In contrast age, marital status and occupation status of the household head has a negative significance on household energy security.

The third objective was to determine the effect of household agricultural income on the adoption of new electrical appliances. The results from this objective showed the energy security and household size were identified as significant at level 1% from the study. On one hand, the gender variable and education level were significant at 10 % level. In contrast age, marital status, household total monthly income and occupation of the household head have a negative effect on household energy security. Agricultural income influences the adoption of electrical appliances. Income is generated from agricultural activities to purchase those electrical appliances and those appliances also benefit the value chain of the agricultural produced by the smallholder producers in different households. This resulted in the households storing their perishable products for a longer period. According to the study electrical appliance that the electrified households buy first after rural electrification is a lighting appliance.

6.2 Conclusion

This study examined the effects of household agricultural income on the adoption of electrical appliances According to the results of this study, it is showed that appliance ownership and usage are the most influential variables in understanding electrical appliance adoption in electrified villages, together with household size. The fact that the level of education, gender, occupation and household size has a significant influence on agricultural households' energy security and in adopting new electrical appliances. It is evident from the results that respondents seem to think electrical appliances improve the preservation and processing of food. A number of factors affecting adoption of electrical appliances in Mnquma Local Municipality areas, with major significant factors identified being age, household size, household total monthly income and education level. A large proportion of households in electrified villages showed maximum adoption or use of electrical appliances are those with high income. It is concluded that longer electrified households have the highest total household monthly income which is greater than R15000 (34.5%) as compared with recently and non-electrified households. Larger households are more likely to adopt electrical appliances. Furthermore, results implied that the higher the income level of households, the more likely the households would adopt electrical appliances. Non-electrified households face increased costs and risks related to basic daily chores like cooking and lighting. As the lighting bulb was the first priority after being connected to the grid electricity in the majority of household agricultural producers. Keeping electricity and electrical appliances costs low will improve the welfare and livelihood of families. Even though electricity access is significant, reliability is critical for magnifying the impact of access. Household agricultural income have a significant effect on the adoption of electrical appliances.

6.3 Recommendations

This study showed that, in Mnquma Local Municipality, electricity is a competitive domestic source and can improve significantly the lives of low-income households, by providing them with efficient and varied services and opportunities. However, policies must be put in place to facilitate access to the electrical through electrification programs, invention of affordable electric appliances, encourage participation in agricultural production, and agricultural market access, that will provide households with social benefits. Electrical appliances should be relatively simple to use and durable can also be a good choice for agricultural households that are technologically illiterate, facilitating the transition from biomass to electricity concerning to improve energy security. Load shedding is caused by a failure to maintain existing generation and transmission infrastructure. This lack of maintaining existing transmission infrastructures will cause this country to not meet future demand for electricity. Therefore, it is recommended that urgent interventions and introducing better planning should be taken to address the situation of maintaining existing infrastructure where more investors are invited to work with Eskom to stop this monopoly.

6.4 Implications for future research

This study provides a sound basis for increasing investments in electrification in order to improve benefits. This study chose three villages only from the municipality. However, the study can be expanded to a bigger area and longitudinal survey for better conclusions. Moreover, the study focused on the adoption of electrical appliances and energy security on the effect of household agricultural income. There is a need to broadening this research to add changes to the consumption of electricity linked to agricultural activities and adoption of electrical appliances for farming activities or agricultural production.

REFERENCES

Aragaw, M.L., 2012. Assessing the Impacts of Rural Electrification in Sub-Saharan Africa*: The Case of Ethiopia* (Doctoral dissertation, University of Victoria).

Arthur, M.D.F.S.R., 2009. On the energy sources of Mozambican households and the demand-supply curves for domestic electricity in the northern electrical grid in Mozambique. Degree of Doctor of Philosophy Dissertation. Colorado State University.

Baldini, M., Trivella, A., Wente, J. W. 2018. The impact of socioeconomic and behavioural factors for purchasing energy efficient household appliances: A case study for Denmark. Energy Policy, [s.l.], v.120, p.503-513, [s.d]. Available online: https://0www.sciencedirect.com.wam.seals.ac.za/science/article/pii/S0301421518303513.Accessed:5 January. 2019.

Barnes, D, F. 2011. Effective solutions for Rural Electrification in Developing countries: Lessons from successful Programs. Current Opinion in Environmental Sustainability 3,4: pp.260-264.

Blimpo, M.P. and Cosgrove-Davies, M., 2019. Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact. World Bank Publications. Published 9 March 2019.Available online https://doi.org/10.1596/978-1-4648-1361-0 Accessed: 22 November 2019.

Bose, T.K., Uddin, M.R. and Mondal, A., 2013. Impacts of electricity access to rural SMEs. *International Journal of Managing Value and Supply Chains (IJMVSC),* vol.4(4), p.17.

Boshoff W.H., Fourie J.2020. The South African Economy in the Twentieth Century. In: Boshoff W. (eds) Business Cycles and Structural Change in South Africa. Advances in African Economic, Social and Political Development. Springer, Cham. Available at <https://doi.org/10.1007/978-3-030-35754-23> Access [10 May 2021].

Bless, C., Higson, S.C. and Kagee, A., 2016. Fundamentals of Social research methods: An African perspective. 5th edition. Cape Town: Juta. ISBN 978-0-70218-683-7.

Cabraal, R. Anil, Douglas F. Barnes, and Sachin G. Agarwal. 2005. Productive Uses of Energy for Rural Development. Annual Review of Environment and Resources 30:pp.117–44.

Cakmakyapan, S. & Goktas, A. 2013. A comparison of binary logit and probit model with a simulation study, Journal of Social and Economic Statistics, 2(1), Summer 2013.

Davis, M, 1998. Rural household energy consumption: the effects of access to electricity-evidence from South Africa, *Energy Policy* 26, pp. 207–217.

Department of Energy (DoE). 2012. A survey of energy-related behaviour and perceptions in South Africa. The Residential Sector. Pretoria. ISBN: 978-1-920435-04-2. Accessed [12 September 2017].

Department of Energy, 2017. South African energy price report 2016. Pretoria. Available online:

< www.energy.gov.za/files/media/explained/Energy-Price-Report-2016.pdf>07 October 2017.

Dinkelman, T., 2011, 'The Effects of Rural Electrification on Employment: New Evidence from South Africa', American Economic Review, vol 101, no. 7, pp. 3078-3108.

Doll C.N. and Pachauri S., 2010. Estimating rural populations without access to electricity in developing countries through night-time light satellite imagery. *Energy Policy*, *38*(10), pp.5661-5670.

Eder, J, M, Mutsaerts, C, F, Sriwannawit, P.2015.Mini-grids and renewable energy in rural Africa: How diffusion theory explains adoption of electricity in Uganda. http://dx.doi.org/10.1016/j.erss.2014.12.014 2214-6296. Energy Research & Social Science 5 (2015) pp.45–54.

Fisher, G., Hizsnyik, E., Pricler, S., Shah, M., velthuizen, H. 2008. Biofuels and food security. OFID and IIASA. Available from www.ofid.org/ [accessed date 02 July.2017].

Hall, J and Paul J. Lavrakas, 2008. "Cross-Sectional Survey Design." In Encyclopedia of Survey Research Methods. Ed. Thousand Oaks, CA: Sage, pp. 173-174.

Gould ER, Weinberg BA, Mustard DB 2002. Crime rates and local labor market opportunities in the United States. Rev Econ Stat 84(1): pp.45–61.

Greene, W.H., 2012.Econometric analysis. 7th edition, Prentice Hall, Upper Saddle River, NJ.

Hosmer, D. W & Lemeshow, S., 2000. Applied logistic Regression 2 nd Edition. John Wiley & Sons, New York.

Hirmer, S and Guthri, P.2017.The benefits of energy appliances in the off-grid energy sector based on seven off-grid initiatives in rural Uganda. Renewable and Sustainable Energy. Reviews. Available online <http://dx.doi.org/10.1016/j.rser.2017.05.152>.79. 924–934[June 2018].

Huebner. G, Shipworth. D, Hamilton I, Chalabi. Z, Oreszczyn.T.2016. Understanding electricity consumption: A comparative contribution of building factors, socio-demographics, appliances, behaviours

and attitudes. Applied energy. Published by Elsevier Ltd. Available online <http://dx.doi.org/10.1016/j.apenergy.2016.04.075. 177. pp.692–702.

IDP .2016. Mnquma Municipality – Draft Reviewed Integrated Development Plan for the period 2015-2017.http://www.mnquma.gov.za/documentrepository/documents/draft-2015-2016-idp.pdf. Accessed 14 May 2017.

IDP .2019. Mnquma Municipality – Final Integrated Development Plan for the period 2018-2019.http://www.mnquma.gov.za/documentrepository/documents/mlm-final-2018-2019-idp.pdf, Accessed 01 September 2019

International Energy Agency-IEA, 2016. Modern Energy for all: Energy access database of the world outlook 2016. International Energy Agency, Paris, Available online at <http://www.worldenergyoutlook.org/resources/energydevelopment/weo2011_energy_for_all.pdf>. [Accessed 18 May 2017].

Ismail, Z. and Khembo, P., 2015. Determinants of energy poverty in South Africa. Journal of energy in southern Africa, 26(3), pp.66-78.

Jobela, S., 2011. Investigating the socio-economic impact of electrification of electrification in Mnquma municipality. Masters. NMMU, South Africa. Thesis. Available at <http://vital.seals.ac.za:8080/vital/access/manager/Repository/vital:9090/SOURCEPDF>[Accessed 11 April 2017].

Jones.R.V., Fuertes. B, Lomas.K.J. 2015.The socio-economic, dwelling and appliance-related factors affecting electricity consumption in domestic buildings. Published by Elsevier Ltd. Renewable and Sustainable Energy Reviews 43 (2015) pp.901–917.

Kaygusuz, K., 2011. Energy services and energy poverty for sustainable rural development. *Renewable and Sustainable Energy Reviews*, *15*(2), pp.936-947.

Kanagawa, M. and Nakata, T., 2007. Analysis of the energy access improvement and its socio-economic impacts in rural areas of developing countries. *Ecological Economics*, *62*(2), pp.319-329.

Khandker, SR, Barnes, DF and Samad, HA, 2009. 'Welfare impacts of rural electrification: a case study from Bangladesh', Policy Research Working Paper Series 4859, The World Bank.

Khandker, SR, Barnes, DF, Samad, HA and Minh, NH, 2009. 'Welfare Impacts of Rural Electrification: Evidence from Vietnam', Policy Research Working Paper Series 5057, the World Bank.

Khandker, S.R., Barnes, D.F. and Samad, H.A., 2013. Welfare impacts of rural electrification: A panel data analysis from Vietnam. *Economic Development and Cultural Change*, *61*(3), pp.659-692.

Kooijman-van Dijk, A.L., 2008. The role of energy in poverty reduction through small-scale enterprises in the Indian Himalayas in India. 13 July 2017.

Kowsari, R. and Zerriffi, H., 2011. Three-dimensional energy profile: A conceptual framework for assessing household energy use. *Energy Policy*, *39*(12), pp.7505-7517.

Kumar, S. and Antonenko, P. 2014.Connecting practice, theory and method: Supporting professional doctoral students in developing conceptual frameworks. *TechTrends*, *58*(4), pp.54-61.

Kumar S, Rauniyar G. 2018.The impact of rural electrification on income and education: Evidence from Bhutan. Rev Dev Econ.00:1–20. https://doi.org/10.1111/rode.12378

Lahimer, A.A., Alghoul, M.A., Yousif, F., Razykov, T.M., Amin, N. and Sopian, K., 2013. Research and development aspects on decentralized electrification options for rural household. *Renewable and Sustainable Energy Reviews*, *24*, pp.314-324.

Leedy. P,D and Ormrod. J.E.2010. Practical Research: Planning and Design, Ninth Edition. Published by Merrill. Copyright © 2010 by Pearson Education, Inc.

Lenz, L. Munyehirwe, A., Peters, J. and Sievert, M. 2017. Does large-scale infrastructure investment alleviate poverty? Impacts of Rwanda's electricity access roll-out program. world development vol. 89, pp. 88–110, 2017 0305-750x/ 2016 Elsevier Ltd. all rights reserved.

Lewis, J.J. and Pattanayak, K. 2012. Who Adopts Improved Fuels and Cook stoves? A Systematic Review. Environmental Health Perspective, 120 (5): pp.637-645.

Louw K, Conradie B, Howells M, Dekenah, M. 2008. Determinants of electricity demand for newly electrified low-income African households. doi: 10.1016/j.enpol.2008.02.032. Energy Policy 36 (2008) 2812– 2818. Elsevier Ltd. all rights reserved.

Madubansi, M. and Shackleton, C.M., 2007. Changes in fuelwood use and selection following electrification in the Bushbuckridge Lowveld, South Africa. *Journal of environmental management*, *83*(4), pp.416-426.

Majova, B.L., 2018. An implementation evaluation of the Eastern Cape rural development strategy: agrarian transformation and food security (Doctoral dissertation, Stellenbosch: Stellenbosch University). Available at <http://scholar.sun.ac.za/handle/10019.1/103530> Accessed [11 May 2021].

Mangizvo R.V., 2014. An assessment of energy use as a rural development strategy: the case of Chiwundura communal area, Zimbabwe. A thesis submitted to the faculty of social sciences and humanities in fulfilment of the requirements for the Doctor of Philosophy degree.

Masera, O. R., B. D. Saatkamp and D. *M.* Kammen 2000. "From Linear Fuel Switching to Multiple Cooking Strategies: A Critique and Alternative to the Energy Ladder Model." World Development 28(12): pp.2083-2103.

Matinga, M.N. Annegarn, H.J. 2013.Paradoxical impacts of electricity on life in a rural South African village /.Energy Policy(58) pp.295–302.

Mazibuko, S, P., 2015. State of electricity Eastern Cape. Eskom General Manager East London. Available online <www.safma.co.za/Portals/0/State_of_Electricity.pdf> [Accessed08May 2017].

Mbaka, C.K 2015. An evaluation of rural electrification adoption dynamics in Meru-south sub-county, Tharaka-nithi country, Kenya. Thesis.

Mbatha, M.W. and Masuku, M.M., 2018. Small-Scale Agriculture as a Panacea in Enhancing South African Rural Economies. Journal of Economics and Behavioral Studies, 10(6 (J)), pp.33-41.

McGaghie, W.C., Bordage, G. and Shea, J.A., 2001. The problem statement, conceptual framework, and research question. *Academic Medicine*, *76*(9), pp.923-924.

Modi, V., S. McDade, D. Lallement, and L. Saghir. 2005. *Energy Services for the Millennium Development Goals*. New York: UNDP and the World Bank. <Accessed online 30 September 2017>.

Mvondo, J.M. 2010**.** Impact of access to free basic electricity on households' poverty in buffalo city municipality in the Eastern Cape. Thesis Submitted to the University of Fort Hare in full fulfilment of the requirement of the Master of Social Science in Development Studies.

Niez, A., 2010. Comparative study on rural electrification policies in emerging economies: Keys to Successful Policies. OECD/IEA Publisher: Ruedela Federation Paris, France, pp-1-114 <https://www.oecdilibrary.org/docserver/5kmh3nj5rzs4en.pdf?expires=1530010497&id=id&accname=guest&checksum=C28BCD07C08BD69D454E593773D20A29>Accessed [08 June 2017].

Paulo. A, Filipe O. F, Felipe G. R, and André P. S. 2017. Lighting and Homicides: Evaluating the Effect of an Electrification Policy in Rural Brazil on Violent Crime Reduction. J Quant Criminol. DOI 10.1007/s10940-017-9365-6. Springer Science+Business Media.

Pine, K., R. Edwards, O. Masera, A. Schilmann, A. Marrón-Mares, and H. Riojas-Rodríguez. 2011. "Adoption and use of improved biomass stoves in Rural Mexico." *Energy for Sustainable Development* 15 (2):pp.176-183.

Rao, N, D, 2013. Does (better) electricity supply increase household enterprise income in India? International Institute for Applied Systems Analysis, Schlossplatz 1, A2361 Laxenburg, Austria. http://dx.doi.org/10.1016/j.enpol.2013.02.025, Energy Policy 57 (2013) pp.532–541.

Ravitch, S.M. and Riggan, M., 2016. Reason & rigor: How conceptual frameworks guide research. Sage Publications.

Rehfuess EA, Puzzolo E, Stanistreet D, Pope D, Bruce NG. 2014. Enablers and barriers to large-scale uptake of improved solid fuel stoves: a systematic review. Environ Health Perspect. 122(2):120–130. [PubMed: 24300100]. https://doi.org/10.1289/chp.1306639 [Accessed 10 August 2018].

Retief, H. 2019. "Eskom is captured': Jan Oberholzer on wet coal, sabotage and stage 6 desperation". CityPress. Retrieved<https://city-press.news24.com/News/eskom-is-captured-jan-oberholzer-on-wet-coal-sabotage-and-stage-6-desperation-20191216> [Accessed 04 February 2020].

Risseeuw, N. 2012. Household Energy in Mozambique: A study on the socio-economic and cultural determinants of stove and fuel transitions. Institute for Environmental Studies. Research project.

Rogers, E.M. 2003. Diffusion of Innovations, 4th Edition: Free Press.

Schwerhoff, G. and Sy, M., 2017. Financing renewable energy in Africa–Key challenge of the sustainable development goals. *Renewable and Sustainable Energy Reviews*, Published by Elsevier Ltd *75*, pp.393-401.

Shalamzari, M.J, Sadoddin, A., Sheikh, V., Abedi Sarvestani, A. 2016. 'Analysis of adaptation determinants of domestic rainwater harvesting systems (DRWHs) in Golestan Province, Iran', *Environmental Resources Research*, 4(1), pp. 27-43. doi: 10.22069/ijerr.2016.3151.

Senaviratna, N.A.M.R. and Cooray, T.M.J.A., 2019. Diagnosing multicollinearity of logistic regression model. Asian Journal of Probability and Statistics, pp.1-9.

Sikrweqe, M.M., 2002.The impact and effectiveness of rural electrification on improving the quality of life of households in rural South Africa: a case study of the Mount Ayliff district in the former Transkei.

Statistics South Africa (Stats SA). 2011. Census 2011. Statistics by place – P11241. Pretoria: Accessed online<http://www.statssa.gov.za/?page_id=993&id=mnquma-municipality>. 08 May 2017.

Tegene,.G,. Berhe,. G, and Teklemariam,.D, 2015. Impact of Rural Electrification on Poverty Reduction. Journal of Business Management & Social Sciences Research (JBM&SSR) ISSN No: 2319-5614.Volume 4, No.1, January 2015.Accessed [14 April 2017]. Evidence from Rural Districts of Tigrai, Northern Ethiopia.

Tezuka, T. Wijaya, M.E.,2013. Measures for improving the adoption of higher efficiency appliances in Indonesian households: An analysis of lifetime use and decision-making in the purchase of electrical appliances. Applied Energy, 112.pp. 981–987.

Thiam, D.R., 2011. Renewable energy, poverty alleviation and developing nations: Evidence from Senegal. Journal of Energy in Southern Africa, 22(3), pp.23-34.

Torero, M., 2014. The Impact of Rural Electrification. Challenges and Ways Forward. 11th Conference AFD PROPARCO/EUDN: Energy for Development. International Food Policy Research Institute.

Thom, C., 2000. Use of grid electricity by rural households in South Africa. *Energy for Sustainable Development*, *4*(4), pp.36-43. Available at https://doi.org/10.1016/S0973-0826(08)60262-8. [Accessed 06 April 2017].

Thom, C., and Mohlakoana, N., 2001. Use and impact of electricity in a rural village in the Northern Province, in Association of Municipal Electricity Undertakings (Southern Africa) Conference, February 2001.

United Nations (UN) 2015. *Transforming our World: the 2030 agenda for sustainable development.*Available.at:https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf [Accessed 05 March 2017].

WHO. 2006. Fuel for life: household energy and health." World Health Organization, Geneva.

Winkler, H., 2006. Energy policies for sustainable development in South Africa: Options for the future.

Winkler, H., 2007. Energy policies for sustainable development in South Africa. *Energy for Sustainable Development*, *11*(1), pp.26-34.

World Bank, 2002.Energy Strategies for Rural India: Evidence from Six States. Energy Sector Management Assistance Program (ESMAP) Report No. 258/02. Washington, DC

World Bank Independent Evaluation Group (IEG).,2008. The welfare impact of rural electrification: are assessment of the costs and benefits. Washington, DC.

Yamane, Taro. 1967. Statistics, An Introductory Analysis, 2nd Ed., New York: Harper and Row.

APPENDIX 1: HOUSEHOLD SURVEY QUESTIONNAIRE

UNIVERSITY OF FORT HARE-MASTERS IN AGRICULTURAL ECONOMICS

THE EFFECTS OF HOUSEHOLD AGRICULTURAL INCOME ON THE ADOPTION OF ELECTRICAL APPLIANCES AND ENERGY SECURITY AMONG RURAL HOUSEHOLDS IN MNQUMA LOCAL MUNICIPALITY.

This household survey is designed to gather information about the adoption and availability of electricity of households in Mnquma Local Municipality areas. It is not meant to implicate anyone but rather, to gather data for academic purpose only. Your response and co-operation will be immensely appreciated.

RESEARCHER NAME: NTONJANE. P

Date of the interview: ……	Respondent No#.....
Municipality……	Village: .....

Please read and answer all the questions carefully. Place —× on only ONE answer for each question unless stated Otherwise. Please choose all that apply as indicated. You may also ask your interviewer if you need any help.

Non-electrified household will answer according to the available alternative energy they consume.

Section A

Part 1: Household head Demographic information of consumer's survey

Gender: 1. male, 2. Female

Marital status: 1. Married. 0.otherwise

Education: 1. None, 2. primary, 3. secondary.4 Tertiary.

Household composition structure and occupation starting with the household head

Members of the household. (HHH first)	Gender	Marital status	Level of education	Age	Occupation	Source of income	Total monthly HH income
Respondent							

A.2 Household size:

1	<3			2	3-5			3	6-8			4	Above 8	

No. of adult above 21	
No. of children	
Total	

A.3 Total Monthly Household income (R): Tick and write the exact value below.

1	<500			2	500-2500			3	2501-10000			4	10000>	

Section B

Part 2: Availability and adoption of electricity

B.1 Is the household connected to the electricity?

Yes	No

B.2 When was electricity first available? ……..

B.3 What were some of the challenges involved in the electrification process?

……

……

……

B.4 Which are the first three electrical appliances did you buy first after electricity installation and explain their benefits of services?

Refrigerator	Lighting devices(bulb)	TV	Electric Stove	Electric Kettle	Mobile phone	Other(specify)

Explain:……

……..

…….……

B.5 Is the household adopted the electrical appliances?

Yes	No

B.6 How was the purchase of the appliances (selected above) financed?

…….....

B.7 How did the purchase of these appliances affected on other expenditure like grocery?

…….....

.....

B.8 Which source of energy does your household use?

Paraffin	Gas	Solar	Electricity	Wood	Other (specify)

Why?

.....

…….

B.9 What is the main use of selected energies above. Tick all those apply and fill in.

Uses	Tick &specify the main use of energy sources for each.

Cooking	
Heating	
Lighting	
Charger cell-phone	
Ironing	
Other(specify)	

B. 10 How much do you pay for your household energy for consumption on a monthly basis?

R10- 50	1	R 55-100	2
R101-200	3	R200>	4

TYPE OF ENERGY	R/monthly consumption
Electricity	
Gas	
Paraffin	
Candle	
Firewood	
Other (specify)……	

B.11Has the availability of electricity improved your livelihood? 0=No 1= Yes

In what way?.....

B.12 Do you consider electricity cheap?

Yes	No

B.13 Have you experience power outage last month (blackout)?

0	No	1	Yes

B.14 How long the outage last?

1=Never	2=once	3=twice	4=three and more times

B.15 What are some of the challenges you faced in electricity adoption?

……

……

……

Section c

Part 3: benefits of electricity

C.1 What are the advantages associated with using electricity?

……..…….……

……..……..

C.2 Does electricity improve the level of

Education	Health	Knowledge and information	Social status	Other

Choose 1=Yes /2=No /3=Not electrified

Explain:

…….....

.....

.....

C.3 Are there some months your household use less electricity than the household usually do as a result of other essential uses of available money?

Explain……

…….

C.4How does electricity Impacted on food purchases patterns?

……

……

C.5 Has the use of electricity changed households time spending patterns? Yes/No

Explain your selected answer

……

……

C.6 Has the use of electricity affected/changed your eating and diet habits? Yes/No (Explain your answer whether its Y/N)

……

……..

C.7 Has the use of electricity changed your knowledge of what is happening in S.A (Politics & sport).

……

……

C. 8 What are the challenges facing those wishing to be connected?

……

……..

C. 9 What should the government and other stakeholders do to support these people?

…….....

C.10 Any other comments you wish to add concerning installation of electricity in a rural area?

……

……

THANK YOU FOR YOUR COOPERATION!

APPENDIX 2: ETHICAL CLEARANCE CERTIFICATE

University of Fort Hare
Together in Excellence

ETHICAL CLEARANCE CERTIFICATE
REC-270710-028-RA Level 01

Certificate Reference Number:	AKI021SNTO01
Project title:	**The impact of adoption and availability of electricity on rural households in the former Transkei: An overview of the Mnquma Local Municipality.**
Nature of Project	Masters in Agricultural Economics & Economics
Principal Researcher:	Pangomsa Ntonjane
Supervisor:	Dr B.E Akinyemi
Co-supervisor:	N/A

On behalf of the University of Fort Hare's Research Ethics Committee (UREC) I hereby give ethical approval in respect of the undertakings contained in the above-mentioned project and research instrument(s). Should any other instruments be used, these require separate authorization. The Researcher may therefore commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the UREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the document;
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research.

The Principal Researcher must report to the UREC in the prescribed format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

Special conditions: *Research that includes children as per the official regulations of the act must take the following into account:*
Note: The UREC is aware of the provisions of s71 of the National Health Act 61 of 2003 and that matters pertaining to obtaining the Minister's consent are under discussion and remain unresolved. Nonetheless, as was decided at a meeting between the National Health Research Ethics Committee and stakeholders on 6 June 2013, university ethics committees may continue to grant ethical clearance for research involving children without the Minister's consent, provided that the prescripts of the previous rules have been met. This certificate is granted in terms of this agreement.

The UREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if
  - Any unethical principal or practices are revealed or suspected;
  - Relevant information has been withheld or misrepresented;
  - Regulatory changes of whatsoever nature so require;
  - The conditions contained in the Certificate have not been adhered to.

- Request access to any information or data at any time during the course or after completion of the project.

- In addition to the need to comply with the highest level of ethical conduct principle investigators must report back annually as an evaluation and monitoring mechanism on the progress being made by the research. Such a report must be sent to the Dean of Research's office.

The Ethics Committee wished you well in your research.

Yours sincerely

11/07/2018

Professor Pumla Dineo Gqola
Dean of Research

05 July 2018

APPENDIX 3: CONSENT LETTERS FROM THREE VILLAGES

Ethics Research Confidentiality and Informed Consent Form

(To be adapted for individual circumstances/needs)

I NTONJANE PANGOMSA, will be is asking people from some of Mnquma Local Municipalities villages to answer some questions, which I hope will benefit your community and possibly other communities in the future.

NTONJANE PANGOMSA is conducting research that will help us understand the effect of availability and adoption of electricity on rural households in the former Transkei: an overview of Mnquma local municipality.

Please understand that you are not being forced to take part in this study and the choice whether to participate or notis yours alone. However, I would really appreciate it if you do share your thoughts with me. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

I will not be recording your name anywhere on the questionnaire and no one will be able to link you to the answers you give. Only the researchers will have access to the unlinked information. The information will remain confidential and there willbe no "come-backs" from the answers you give.

The interview will last around 30 minutes. I will be asking you questions and ask that you are as open and honest as possible in answering these questions. Some questions may be of a personal and/or sensitive nature. I will be asking some questions that you may not have thought about before, and which also involve thinking about the past or the future. We know that you cannot be absolutely certain about the answers to these questions, but we ask that you try to think about these questions. When it comes to answering questions, there are no right and wrong answers. When we ask questions about the futurewe are not interested in what you think the best thing would be to do, but what you think would actually happen.

If possible, I would like to come back to this area once I have completed my study to inform you and your communityof what the results are and discuss our findings and proposals around the research and what this means for people in this area.

INFORMED CONSENT

I hereby agree to participate in research regarding (The effect of availability and adoption of electricity on rural households in the former Transkei: An overview of Mnquma Local Municipality). I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continue,and that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally.

I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to my community on the results of the completed research.

M. [illegible]

Signature of participant

Date: 2018-02-17

Qing

Ethics Research Confidentiality and Informed Consent Form

(To be adapted for individual circumstances/needs)

I NTONJANE PANGOMSA, will be is asking people from some of Mnquma Local Municipalities villages to answer some questions, which I hope will benefit your community and possibly other communities in the future.

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I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to my community on the results of the completed research.

HEADMAN. W.R. KU[illegible]
QOBOQOBO ADMIN/AREA
CENTANE 4950
DATE[illegible]2013. SIGN [illegible]

.....W. Kokolo.....
Signature of participant

Date 2.10.13.....

Qobo9060

Ethics Research Confidentiality and Informed Consent Form

I NTONJANE PANGOMSA, will be is asking people from some of Mnquma Local Municipalities villages to answer some questions, which I hope will benefit your community and possibly other communities in the future.

NTONJANE PANGOMSA is conducting research that will help us understand the effect of availability and adoption of electricity on rural households in the former Transkei: an overview of Mnquma local municipality.

Please understand that you are not being forced to take part in this study and the choice whether to participate or not is yours alone. However, I would really appreciate it if you do share your thoughts with me. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

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If possible, I would like to come back to this area once I have completed my study to inform you and your community of what the results are and discuss our findings and proposals around the research and what this means for people in this area.

INFORMED CONSENT FOR PARTICIPANTS AND VILLAGE CHIEFS

ETHICS REFERENCE NUMBEER: AKI021SNTO01
PRINCIPAL INVESTIGATOR: NTONJANE PANGOMSA
CONTACT NUMBER: 0783905693

I hereby agree to participate in research regarding (The effect of availability and adoption of electricity on rural households in the former Transkei: An overview of Mnquma Local Municipality). I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continue, and that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally. I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to my community on the results of the completed research.

.....

Signature of participant /~~chief~~ headman Date: 2018-09-01

Mgomanzi

APPENDIX 4: ENGLISH EDITOR'S LETTER

TO WHOM IT MAY CONCERN

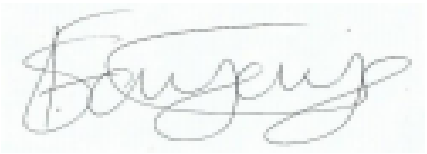
I hereby confirm that I have proof read and edited the following research proposal using Windows 'Tracking' System to reflect my comments and suggested corrections for the author to action: THE EFFECTS OF HOUSEHOLD AGRICULTURAL INCOME ON THE ADOPTION OF ELECTRICAL APPLIANCES AND ENERGY SECURITY AMONG RURAL HOUSEHOLDS IN MNQUMA LOCAL MUNICIPALITY BY NTONJANE, P.

Although the greatest care was taken in the editing of this document, the final responsibility for the work rests with the author.

Sincerely,

Sibhekisipho Fayayo

14/08/2021



Sibhekisipho Fayayo
083 502 2363 | | sibhekisiphofayayo@gmail.com
BA Hons.English and Communication (MSU), MA English and Comparative Literature (UFH)

APPENDIX 5: Road in recently electrified village and Pictures showing how data was collected.

Figure 3.2: Road in recently electrified village

Figure 3.3: Pictures showing how data was collected