Evaluating the factors that influence fuelwood consumption in households at the Thulamela Local Municipality. South Africa

By

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Submitted in accordance with the requirements for
the degree of

MASTER OF SCIENCE

in the subject

ENVIRONMENT MANAGEMENT

at the

UNIVERSITY OF SOUTH AFRICA

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APRIL 2021

DECLARATION

I, Lusani Faith Netshipise hereby declare that this research is authentic and my own original work. All sources used in this research have been accurately acknowledged by proper references. This research has never been submitted by me or any other student to the University of South Africa or to any other university. I agree that I have read and understood the University of South Africa policy regarding plagiarism.

Signature: _____L.F. Netshipise_______________________________________

Date: _________12/04/2021____

DEDICATION

To my family, for the encouragement, prayers, and endless love. I will forever be indebted to all of you.

ACKNOWLEDGEMENTS

The completion of this dissertation could not be possible without the help of many people.

First, I would like to thank the Lord Almighty for giving me the utmost strength and guidance during the completion of this study; it was not an easy journey, but God kept me going.

Secondly, I would like to thank Ms Linda Ntuli for the special work she did in editing the dissertation. Your work is outstanding.

My sincere gratitude goes to thank Mr Matawa Farai, for meticulously designing the Map for the Thulamela Local Municipality.

I would also like to show my utmost appreciation and special thanks to my supervisor Dr Khomotso Semenya for her guidance, tireless support, patience, constant encouragement and for always willing to answer my endless questions.

Furthermore, I would like to extend my sincere appreciation and gratitude to the residents of Khubvi Village for their warm welcome to their homes and for availing themselves to respond to my questionnaires and for their willingness to share their information and time with me.

Last, but not least, I want to acknowledge and give special thanks to my field assistants, Khodani, Zwivhuya, Masana, Tshinamufhi and Dakalo for their enthusiasm, help, energy, passion, and meticulous skills shown during the data collection process. I am extremely grateful, and may god bless you all.

Finally, my biggest appreciation and deepest love goes to my parents, friends and family for being able to step in and help whenever possible. You always encourage me to be the best I can be and also showed me that every challenge has to be tackled head-on. I am grateful for your everlasting support, advice and for just being there for me. Indeed, with God anything is possible.

ABSTRACT

Fuelwood remains a crucial source of energy among the vast majority of rural households because of its availability and affordability in comparison with most energy alternatives. Approximately 17 million people in South Africa live in communal lands where fuelwood can be harvested easily and freely by households, with 80% of the overall fuel consumed for domestic purposes extracted from burning fuelwood. The rapid-excess trends of fuelwood consumption – aggravated by population growth, agricultural and household settlement expansions – pose utmost challenges for community development. Overharvesting of fuelwood can result in fuelwood scarcity, loss of biodiversity, excessive land clearance and soil erosion.

This study evaluated the factors that influence fuelwood consumption in households at the Thulamela Local Municipality. The study utilised mixed research methods, comprising quantitative and qualitative methods. A semi-structured questionnaire consisting of both closed and open-ended questions was used to collect data from the households. The collected data was mainly qualitative data (nominal and categorical data) and the researcher used the frequency menu to summarise the data and cross tabulation menu in the Statistical Package for Social Scientists (SPSS) version 25. For cross tabulation, the researcher used the Chi-square ($\chi2$) test to measure the degree of association between two categorical variables. If the p-value is less than 0.05, there is a significant association between variables – thus, the variables dependent on each other.

The study found that socio-economic characteristics such as monthly income, employment status, gender, educational level of the household head, number of employed household members, energy expenditure and type of occupation play a significant role in the factors that influence fuelwood consumption. As a result of these factors, fuelwood energy is still being used as a primary energy source by most households to meet their domestic needs for cooking and water heating – despite most of them being electrified. Additionally, lack of environmental education, the erratic electricity supply and staggering living conditions which drive widespread poverty in rural areas contribute to the extensive fuelwood consumption among households. The study highlighted the recommendations on mitigation measures that can be used to reduce extensive fuelwood consumption. These recommendations include encouraging the use of renewable energy and modern energy technologies such as biogas and solar energy, together with improved cooking stoves to help reduce overexploitation of natural resources and prevent indoor air pollution which is associated with heart disease and immortality. There is also a need to raise environmental awareness. It is through education that people's perceptions, attitudes and behaviour regarding fuelwood consumption practices can be changed. The promotion of sustainable development through harvest control and afforestation can significantly reduce deforestation, loss of biodiversity, fuelwood scarcity and soil erosion.

Keywords: Fuelwood consumption, energy poverty, low income, South Africa, rural households, socio-economic characteristics, environmental degradation

MANWELEDZO

Khuni dzi kha ḓi shumiswa sa tshiko tshihulwane tsha mafulufulu kha miṱa minzhi ya mahayani ngauri dzi a wanala na u swikelelea musi dzi tshi vhambedzwa na dziṅwe nḓila dza mafulufulu. Vhathu vha swikaho miḽioni dza 17 Afrika Tshipembe vha dzula mahayani hune vha kona u reḓa khuni hu si na vhuleme nahone nga mahala, ngeno zwivhaswa zwi swikaho 80% zwi shumiswaho miḓini zwi tshi bva kha khuni. Maitele maṅwe a tshihaḓu a kushumiselwe kwa khuni – a tshi ṋaṋiswa na nga nyaluwo ya vhathu, u engedzea ha vhulimi na vhupo ha vhudzulo – zwi ḓisa khaedu kha mveledziso ya tshitshavha. U reḓa khuni lwo kalulaho zwi nga vhanga ṱhahelelo ya khuni, u xelelwa nga mutshatshame wa zwi tshilaho, u ṱangula mavu na mukumbululo wa mavu.

Ngudo iyi yo ḓiimisela u ela zwivhumbi zwi ṱuṱuwedzaho u shumiswa ha khuni miḓini ngei kha Masipala Wapo wa Thulamela. Ngudo yo shumisa ngona dza ṱhoḓisiso dzo ṱanganaho dzi re na ngona khwanthethivi na khwaḽithethivi. Mbudzisambekanywa dzo dzudzanywaho dzi re na mbudziso dza phindulo nthihi na dza phindulo ndapfu dzo shumiswa u kuvhanganya data miḓini. Data yo kuvhanganyiwaho kanzhi ndi yo sedzaho ndeme (ya tshivhalo na khethekanyo) ngeno muṱoḓisisi o shumisa menyu wa tshivhalo tsha zwithu u nweledza data na menyu wa thebulu dzi leluwaho kha Statistical Package for Social Scientists (SPSS) vesheni ya vhu 25. U itela thebulu dzi leluwaho, muṱoḓisisi o shumisa ndingo dza Chi-square ($\chi2$) u ela tshikalo tsha nyelelano vhukati ha zwithu zwivhili zwo fhambanaho. Arali ndeme ya p i ṱhukhu kha 0.05, hu na u elana hu hulwane vhukati ha zwithu zwi vhambedzwaho – zwithu izwi zwi dovha zwa ṱalutshedzana.

Ṱhoḓisiso yo wana uri zwiṱaluli zwa ikonomi na matshilisano sa mbuelo ya ṅwedzi, tshiimo mushumoni, mbeu, ḽeveḽe ya pfunzo ya ṱhoho ya muḓi, tshivhalo tsha vhathu vha shumaho muṱani, mbadelo dza fulufulu na mushumo une muthu a u shuma zwi na mushumo muhulwane kha zwithu zwi ṱuṱuwedzaho u shumiswa ha khuni. Nga ṅwambo wa zwithu izwi, khuni dzi kha ḓi shumiswa sa tshiko tshihulwane tsha fulufulu kha miḓi minzhi u swikelela ṱhoḓea dzavho dza hayani dza u bika na u wana u dudedza – naho vhunzhi havho vhe kha muḓagasi. Nṱhani ha izwo, u sa vha na pfunzo ya vhupo, nḓisedzo ya muḓagasi ine ya dzula i tshi shanduka na maga a kutshilele a konḓaho ane a vhanga vhushai ho andaho kha vhupo ha mahayani zwi vhanga u shumiseswa ha khuni miḓini. Ngudo dzo sumbedzisa themendelo kha maga a u lulamisa ane a nga shumiswa u fhungudza u shumiseswa ha khuni. Themendelo idzi dzi katela u ṱuṱuwedza tshumiso ya mafulufulu ḽo vusuludzwaho na thekhinoḽodzhi dza fulufulu dza musalauno sa bayogese na fulufulu ḽa masana a ḓuvha, kathihi na zwiṱofu zwa u bika zwo khwiniswaho u thusa u fhungudza u tambiseswa ha zwiko zwa mupo na u thivhela tshikafhadzo ya muya nga ngomu zwine zwa vhanga vhulwadze ha mbilu na dzimpfu. Hu na ṱhoḓea ya u ita mafulo a zwa vhupo. Ndi nga kha pfunzo hune kuvhonele kwa vhathu, kusedzele kwa zwithu na vhuḓifari havho maelana na kushumiselwe kwa khuni zwa nga shandukiswa. U bveledzwa ha mveledziso i sa nyeṱhi nga kha ndango ya khaṋo na u ṱavhiwa ha miri zwi nga fhungudza vhukuma u fhela ha maḓaka, u lozwiwa ha mutshatshame wa zwi tshilaho, u konḓa ha khuni na mukumbululo wa mavu.

Maipfi a ndeme: khuni, tshumiso, mafulufulu, vhushai, mbuelo ya fhasi, Afrika Tshipembe, miṱa ya mahayani, zwiṱaluli zwa ikonomi na matshilisano, u wisa vhupo.

SETSOPOLWA

Dikgong tša go bešwa di tšwela pele go ba methopo o bohlokwa wa enetši gareng ga bontši bja malapa a dinagamagaeng ka lebaka la ge di hwetšagala le go se ture ga tšona ge di bapetšwa le mekgwa ye mengwe ya enetši. Tekano ye e ka bago batho ba dimilione tše 17 ka Afrika Borwa ba dula mafelong a magaeng fao dikgong di ka kgonago go rengwa gabonolo le ka tokologo ke malapa a, fao e lego gore 80% ya palomoka ya dibešwa tšeo di šomišwago ka gae di hwetšwago go dikgong. Lebelo leo ka lona dikgong di hwetšago ka lona gore di tle di bešwe – leo le mpefatšwago ke go gola ga setšhaba, temo le go oketšega ga madulo a batho – le tliša ditlhohlo tše kgolo tlhabollong ya setšhaba. Go rema dikgong go fetišiša go ka feletša ka go hlaelela ga tšona, tahlegelo ya phedišano ya diphedi tša mehutahuta, go rema mehlare ka fao go fetišišago le kgogolego ya mobu.

Dinyakišišo tše di ikemišeditše go sekaseka mabaka ao a huetšago go šomišwa ga dikgong ka malapeng ka Masepaleng wa Selegae wa Thulamela. Dinyakišišo tše di šomišitše mekgwa ya dinyakišišo ye e hlakantšwego, ye e lego wa dinyakišišo tša bontši le wa dinyakišišo tša boleng. Dipotšišonyakišišo tšeo di beakantšwego ka seripa tše di nago le bobedi dipotšišo tša di nago le dikgetho le dipotšišo tšeo di nyakago gore motho a fe maikutlo a gagwe di šomišitšwe go kgoboketša tshedimošo ka malapeng. Tshedimošo ye e kgobokeditšwego e bile kudu tshedimošo ya boleng (ya dipalo le ya go hlophiwa) gomme monyakišiši o šomišitše menyu wa bokgafetšakgafetša go dira kakaretšo ya tshedimošo le go menyu wa go bea dilo ka dintlha ka Sehlopheng sa Dipalopalo sa Bašomi ba tša Mahlale a Leago (SPSS) bešene ya 25. Go bea dilo ka dintlha, monyakišiši o šomišitše teko ya *Chi-square* ($\chi 2$) go ela bogolo bja kamano magareng ga diphapano tše pedi tša magoro. Ge *p-value* e le ye nnyane go 0.05, go na le kamano ye bohlokwa magareng ga diphapano – ke gore, diphapano di a hlalošana.

Dinyakišišo di hweditše gore dipharologantši tša ekonomi ya setšhaba tša go swana le letseno la kgwedi ka kgwedi, maemo a mošomo, bong, maemo a thuto a hlogo ya lapa, palao ya maloko a ka lapeng ao a šomago, tšhomišo ya tšhelete go enetši le mohuta wa mošomo di raloka tema ye bohlokwa ka mabakeng ao a huetšago go šomišwa ga dikgong. Ka lebaka la mabaka a, enetši ya dikgong e sa šomišwa bjalo ka methopo o bohlokwa wa enetši ke malapa a mantši ka nepo ya go fihlelela dinyakwa tša bona tša ka gae tša go apea le go ruthufatša dintlo – go sa kgathale gore bontši bja tšona ke tša mohlagase. Godimo ga fao, tlhokego ya thuto ya mabapi le tikologo, kabo ya mohlagase ye e sa tshepišego le maemo a bophelo ao a hlobaetšago ao a hlohleletšago bohloki ka dinagamagaeng di tsenya letsogo go tšhomišo ya dikgong go fetišiša ka malapeng. Dinyakišišo di hlagiša ditšhišinyo tša mabapi le go fokotša tšhomišo ya dikgong go fetišiša. Ditšhišinyo tše di akaretšwa go hlohleletša tšhomišo ya mohlagase wa go dirišwa leswa le ditheknolotši tša enetši tša sebjalebjale tša go swana le gase ya tlhago le mohlagse wa sola, gotee le ditofo tša go apea tšeo di kaonafaditšwego ka nepo ya go fokotša go šomiša kudu methopo ya tlhago le go thibela tšhilafatšo ya moya ya ka dintlong e lego seo se amantšhwago le bolwetši bja pelo le mahu. Gape go na le tlhokego ya go tliša temošo ya tša tikologo. Ke ka go diriša thuto fao e lego gore maikutlo a batho, ditebelelo le maitshwaro a bona mabapi le ditiro tša tšhomišo ya dikgong a tlago fetošwa. Tšwetšopele ya tlhabollo ya go ya go iule ka taolo ya go rema dikgong le go bjala mehlare fao go ka fokotšago go rengwa ga mehlare, tahlegelo ya mehutahuta ya diphedi, tlhaelelo ya dikgong le kgogolego ya mobu.

Mantšu a bohlokwa: tšhomišo ya dikgong, enetši, bohloki, letseno la fase, Afrika Borwa, malapa a dinagamagaeng, dipharologantšhi tša ekonomi ya setšhaba, tshenyo ya tikologo

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ABBREVIATIONS AND ACRONYMS

% - Percentage

CO_2 - Carbon dioxide

CO - Carbon Monoxide

DAFF - Department of Agriculture, Forestry and Fisheries

DMRE - Department of Minerals Resource and Energy

DoE - Department of Energy

FAO - Food and Agriculture Organisation of the United Nations

FBE - Free Basic Electricity

GHGs - Green House Gases

HAP - Household Air Pollution

IEA - International Energy Agency

IOM - International Organisation for Migration

km^2 - Square Kilometer

KWh - Kilo Watt per hour

LEMA - Limpopo Environmental Management Act

LPG - Liquid Petroleum Gas

m^3 - Cubic Metre

NEMA: Protected Areas Act, 57 of 2003

NEP - National Electrification Programme

NO - Nitrogen Oxide

SA - South Africa

SADC - Southern Africa Development Communities

SO_2 - Sulfur Oxides

SSA - Sub Saharan Africa

StatsSA – Statistics South Africa

UNHCR – United Nations High Commissioner for Refugees

UNISA – University of South Africa

WFP - World Food Programme

CHAPTER 1: BACKGROUND OF THE STUDY

1.1. Introduction

Energy plays a significant role in the development of any country as it enhances socio-economic development of a region as well as drives industrial competitiveness (Ateba *et al.,* 2018; Msibi, 2015). Fuelwood remains a crucial source of energy among most rural households because it is readily available and cheaper than most energy alternatives (Uhunamure *et al.,* 2017; Matsika *et al.,* 2012; Preston 2012). Furthermore, fuelwood continues to be the most preferred source of energy for meeting domestic requirements for cooking, lighting and heating in majority of rural communities in Sub-Saharan African countries such as Angola, Congo, Ethiopia, Kenya, Malawi, Mozambique, Namibia, Nigeria, Tanzania, Zambia and Zimbabwe (Semenya & Machete, 2019; Scheid *et al.,* 2018; Urge & Feyisa, 2018; IEA, 2014; Gatama, 2014; Truneh, 2014; Wambua, 2011). In the southern Africa Development Communities (SADC), fewer countries have achieved 66% electrification rate, which promote the heavy reliance of fuelwood utilisation (Masekameni *et al.,* 2017). Urge and Feyisa (2018) emphasized that in the majority of Sub-Saharan African states wood fuel accounts for 90-98% of the energy consumed domestically. Fuelwood alone accounts for 91% of the overall energy consumed in the African countries, hence its consumption in comparison with other energy alternatives has reached as far as 33% of the total energy used in developing countries (Urge & Feyisa, 2018; Magembe *et al.,* 2015).

In 2016, the World Health Organisation (WHO) estimated that a staggering 2.9 billion people worldwide are still dependent on solid fuels which include fuelwood, charcoal, coal, animal dung and agricultural residues as their predominated source of energy for cooking and water heating. Consequently, the current trends of solid fuels consumption are anticipated to increase unchanged with roughly 2.3 billion people within the next decades remaining dependent on fuelwood as an energy fount for cooking and water heating (Scheid *et al.,* 2018). This indicates the significant role of solid fuels on household energy use.

Solid fuels are often regarded as dirty and incompetent and usually burned using inefficient technologies in confined environment, which contribute to household air pollution (HAP) (Mgwambani *et al.,* 2018; Kasangana *et al.,* 2017). The poor combustion of fuelwood emits toxic (e.g. carbon monoxide, nitrogen oxides and Sulphur dioxides) which has the potential of being harmful to the environment and human health (Semenya & Machete, 2020; Kasangana *et al.,* 2017). Annually, respiratory diseases which are both chronic and acute are reported, with over 4.3 million deaths being linked to poor combustion of solid fuels (Kasangana *et al.,* 2017; Masekameni *et a.l*, 2017). Moreover, the tenacious utilisation of fuelwood can further lead to fuelwood crisis, loss of biodiversity, increase chance of accidental fires were there is excessive fuelwood clearances and a decline in social and economic capital due to overexploitation of these natural resource (Makonese *et al.,* 2016; Kimemia, 2014; Wessels *et al.,* 2013; Shackleton *et al.,* 2007; Sandra Vasa-Sideris, n.d)

Nevertheless, fuelwood remains the most preferred energy source due to several reasons such as the fact that it is a renewable and infinite energy source which can be repeatedly used over time (IEA, 2014). Other significant advantages are that it is cheaper, efficient, free and saves electricity especially in rural areas because it is easily accessible, cost effective and provides more heat that last for a longer period (Uhunamure *et al.*, 2017; Kimemia, 2014; Sandra Vasa-Sideris, n.d). In countries such as Sudan where fuel is imported, the utilisation of local biomass such as fuelwood can significantly contribute to the reduction of foreign exchange (Saeed, 2009). On a social side fuelwood can be used to generate income for low-income households as it can be used to generate income in fuelwood market businesses (Guild & Shackleton, 2018; Makhado *et al.*, 2009; Saeed, 2009). Fuelwood can also be incorporated into the domiciliary energy mix as it can be used with other energy alternatives and can effectively reduce the vulnerability of households to market fluctuations, electricity blackouts, high electricity tariffs and the cost of purchasing electrical appliances (Uhunamure *et al.,* 2017; Wessels *et al.,* 2013; Saeed, 2009).

The extent in which people utilises and consumes fuelwood as an energy source is influenced by several factors such as energy poverty, limited financial resources, accessibility and availability of energy sources, cultural preferences, climate change, the cost for electric appliances such as stoves, high energy tariffs, household size etc. (Muller & Yan, 2018; Uhunamure *et al.,* 2017; Wessels *et al.*, 2013). Different households are faced with the decision on how they can best acquire their domestic fuel for cooking, lighting and water heating, hence the erratic nature of poor modern energy provision and distribution in South Africa combined with the aforementioned factors are some of the major drivers that promote high levels of dependence on traditional biomass energy (Ateba *et al.,* 2018; Lloyd, 2014). Vulnerable households are burdened by the prohibitive high energy cost which is further aggravated by the high unemployment rate standing at 30.1% in South Africa (StasSA, 2020; Stiftung, 2016; Matsika *et al.*, 2012). As a result, many households would rather invest their limited financial resources into fuelwood which does not require much effort to collect (Uhunamure *et al.,* 2017). Supporting this notion is Kimemia (2014), who indicated that 50% of South Africans are deemed "energy poor" because they spend more than 10% of their income on energy resources to sustain themselves. This has subsequently led to many poor households opting to incorporate the multiple fuel use to counterbalance their domestic needs (Uhunamure *et al.,* 2017). Furthermore, many people in South Africa are living in peri-urban and rural areas with limited financial resources (Kasangana *et al.,* 2017). These people struggle to make an exclusive switch to electricity despite some of them being connected to the national electricity grid (Uhunamure *et al.,* 2017). As a result, they incorporate the multiple fuel use into their domestic energy mix whereby electricity is exclusively used for lighting, whilst biomass is used for cooking and water heating despite the shortcomings (Uhunamure *et al.,* 2017; Wessels *et al.,* 2013, Kimemia, 2010). Nevertheless, the spectra of large-scale use of traditional biomass fuel for meeting domestic needs exacerbates household's susceptibility for other poverty dimensions such as that of social and economic deprivations (Truneh, 2014).

Likewise, South Africa as with other developing states is confronted with the erratic and pivotal energy related predicaments. These predicaments lead to the widespread use of fuelwood and other highly unreliable energy alternatives such as kerosene, candle and coal which could pose cumulative impacts on both economic, environmental and health sectors (Wessels *et al.,* 2013; Saeed, 2009). It is for this reasons that in 1994 the government-initiated interventions for the electrification programme that could help in poverty alleviation (Lourens, 2018). The electrification programme is aimed to address energy inequality within the residential sector and widen household accessibility to electricity (Israel-Akinbo, 2018). Apart from the electrification programme, several policies have been introduced to encourage households to switch from the heavy reliance of solid fuels to modern energy sources such as renewable energy and electricity (Winkler, 2006). The underlying rationale for the intervention of promoting these energy alternatives is to ensure households energy security for the long-term purposes and to reduce extensive fuelwood consumption through the adoption of cleaner energy fuel (Hainduwa, 2013).

Although literature exists on the factors that influence fuelwood consumption among households especially in developing countries, there appears to be inconsistence on the findings and conclusions of different researchers. For example, the influence of socio-economic factors as the main determinant of fuelwood consumption and fuel substitution are still debated in the literature. A study conducted by Semenya and Machete (2019) in Senwabarwana Villages, South Africa indicated that socio-economic factors plays a significant role in the factors that influence fuelwood usage and several studies such as Ismail and Khembo (2015); Knight and Rosa (2011); Ogwuche and Asobo (2013); Danlami (2019); Muller and Yan (2018) supports this statement. However, the study that was conducted by Song *et al.* (2012), indicated that socio-economic factors has a negative relationship with the factors that influence fuelwood consumption. Additionally, some studies (Semenya & Machete, 2019; Ateba *et al.,* 2018; Uhunamure *et al.*, 2017), established that income has a positive relationship with household fuelwood use whereas other studies by Song *et al.* (2012); Jingchao and Kotani (2011) and Masera *et al.* (2000), disapprove this as they concluded that there is a negative relationship between income and household fuelwood consumption. As such the divergences among these studies indicate that findings and conclusions of a particular study in a certain area should not be used to generalise another area due to the differences in socio-economic and household dynamics of fuel consumption. None of the studies that have been conducted previously has ever taken Khubvi Village as a case study. For this reason, this study seeks to evaluate the factors that influence fuelwood consumption in households within the Thulamela Local Municipality in South Africa and with exclusive target being Khubvi Village.

1.2. Statement of the problem

Notwithstanding its great wealth and considerable endowment of financial resources and promptly improvements in rural accessibility to electricity, South Africa is similarly dependent on fuelwood as an energy source especially among rural households (Wessel *et al.,* 2013; Mokwena, 2009). Approximately 17 million people in South Africa lives in communal lands where fuelwood can be harvested easily and freely by households, with 80% of the overall fuel consumed for domestic purposes extracted from burning fuelwood (Rasimphi, 2020; Clark & Luwaya, 2017; Jimena, 2014). Moreover, Nott and Thondhlana (2017), reported that in South Africa an estimate of 9.8 million tons of fuelwood is used every year, irrespective of the attempts initiated by the current regime for alleviation of energy poverty through the addressment of energy inequality and the provision of free basic electricity to indigent households. Given the high rate of fuelwood consumption in South Africa, it is easy to foretell that fuelwood demand and supply is likely to increase in future, especially among rural areas (Variawa, 2012). Even more than that, there are increasing concerns that fuelwood harvested in and around the communal areas show unsustainable trends which could lead to fuelwood crisis (Nott & Thondhlana, 2017).

The Limpopo Province which is regarded as the poorest province in South African other than the Eastern Cape Province is a hotspot for the widespread fuelwood usage among households and this is made evident by the high rate of fuelwood consumption for cooking, lighting and water heating which remains at 40% (Guild & Shackleton, 2018; Nott & Thondhlana, 2017; Uhunamure *et al.*, 2017). Over the years villages in the Limpopo province have experience challenges in sourcing their domestic energy source for cooking and heating due to fuelwood scarcity (Chikava & Annegarn, 2013; Masekoameng *et al.,* 2005). Worth noting, is that the challenges of domiciliary energy consumption are nowhere more exhausting than in Khubvi Village where the majority of homes are still heavily reliant on fuelwood despite most households being electrified. The Village of Khubvi has been experiencing a high rate of fuelwood consumption and this is aggravated by the erratic electricity supply combined with various socio-economic factors which has resulted in many households remaining vulnerable to the high cost of electricity. Hence, most households would rather take refuge in the use of fuelwood for domiciliary needs as it available in abundance (Thulamela municipality final IDP, 2018).

Whilst the provision of electricity has many benefits for Khubvi Village, fuelwood consumption for domiciliary needs rank high in-terms of usage and preferences. This is easily noticeable since fuelwood used for cooking and water heating outpaces other rival energy alternatives such as LPG, electricity, solar, kerosene, and candles (Thulamela municipality final IDP, 2018; Orimoogunje & Asifat, 2015). Approximately 96.6% of electricity within the Thulamela Municipality is used exclusively for lighting, while 42.9% of households use electricity for cooking purposes (Statistics South Africa, 2018; Uhunamure *et al.,* 2017). The frequent commitments of monthly electrical purchases and the high cost of electrical appliances are the paramount constraint for vulnerable households. These commitments have attributed to many hindrances such as impelling many households within the community to survive with limited resources (Masekoameng *et al.,* 2005). Additionally, fuelwood acquisition and uses are often regarded as the women's responsibility, which frequently leads to detrimental poor health. Hence, the constant use of inefficient energy sources such as fuelwood attributes to cumulative impacts which could endanger the lives of women and children who are directly involved in cooking and heating through exposure to indoor air pollution (Uhunamure *et al.,* 2017; Stiftung, 2016; Scheepers, 2013; Wessels *et al.,* 2013). Fuelwood is used daily in poorly ventilated kitchen (Semenya & Machete, 2020). These leads to emission of toxic gases which are harmful to human beings, especially vulnerable women and children who inhales these toxic gases (Semenya & Machete, 2020; Mgwambani *et al.*, 2018). Continuous inhalation of toxic gases leads to coughing, lung cancer, chest pains, eye irritation, shortness of breath, asthma attacks etc (Kasangana *et al.,* 2018).

Fuelwood in the Khubvi Village is usually collected from friends' farms, communal lands and nearby mountains and villages; or bought from the fuelwood markets. The acquisition of fuelwood as previously mentioned is mostly done by women and children, and an outmost expense for many poor-resourced households as most poor households must collect their fuelwood using head load methods or wheelbarrow, unlike the middle-class households who usually buy their fuelwood from suppliers or hire a truck-load of fuelwood (Shackleton *et al.,* 2007; Masekoameng *et al.,* 2005). In addition, fuelwood gathering is time-consuming and deprives women and children from undertaking income-generating initiatives that could alleviate poverty (Masekoameng *et al.,* 2005). Extensive fuelwood harvesting has resulted in environmental impacts which include but not limited to, fuelwood scarcity, loss of biodiversity, excessive land clearance and soil erosion which is further aggravated by population growth, agricultural and household settlement expansions (Chikava & Annegarn, 2013; Matsika *et al.,* 2013). The fuelwood scarcity has also attributed to many households encountering challenges in sourcing their domestic energy, which have led to women and children spending more than three hours weekly in search of fuelwood (Chikava & Annegarn, 2013). Moreover, women and children face risk of being assaulted during long walks to the mountains, friend's farms and neighbouring villages. They also face risks of being attacked by wild animals or being kidnapped by strangers (FAO & UNHCR, 2017). The continuous dependence on fuelwood despite its shortage, impact on humanity and electrification in majority of households signifies the importance of fuelwood as an integral part of household energy use. As such fuelwood use will still be a dominant and preferred energy source for meeting domestic needs among the low-income households in the foreseeable future due to its secure supply and affordability. It is therefore reasonable to believe that the current over-exploitation of fuelwood is beyond the productivity of the wood vegetation.

1.3. Motivation/ rationale

Fuelwood consumption is an on-going poverty-related challenge for rural areas because the majority of people are still heavily reliant on fuelwood for cooking and water heating, Whist electricity is used exclusively for lighting (Uhunamure *et al.*, 2017; Mijitaba, 2013). On average, fuelwood dependency for cooking and water heating in rural households in South Africa varies from 75% to 100% (Nott & Thondhlana, 2017). The use of fuelwood for meeting domiciliary needs is seen as a measure to significantly save electricity which is far beyond reach for predominance of households within Khubvi Village (Nott & Thondhlana, 2017; StatsSA, 2018).

Fuelwood utilisation grants a much-needed help from the precursor of energy poverty, as it is centered around affordability and accessibility (Kasangana *et al.*, 2018). As such, despite the progress made in South Africa for the promotion of modern energy accessibility and usage for domestic purposes, literature indicates that fuelwood remains the main survival commodity as 95% of households are economically poor claiming they cannot afford the modern energy technologies (Mgwambani *et al.*, 2018; Lourens, 2018; Makonese *et al.*, 2012). It is important to note that regardless of the above-mentioned the risks that are associated with fuelwood consumption and harvesting, poor households have limited options for switching to modern energy and dependency on fuelwood is likely to increase as the population increase (Lloyd, 2014; Wessels *et al.*, 2013). Hence, fuelwood remain a stronghold energy source for the poor, vulnerable and marginalised households who have the limited opportunities to fully transition to modern energy sources (Lourens, 2018; Matsika *et al.*, 2013; Variwa, 2012). Furthermore, the accessibility to modern energy such as electricity is still a challenge for low-income households, as the provision of electricity to rural homes is a great challenge (Isma'il *et al.*, 2014; Prasad & Visagie, 2006). As a result, many Villages in Limpopo remain inferiorly deprived in terms of social services and contemporary energy services among rural areas (Masekoameng *et al.*, 2005).

Accordingly, this study intends to evaluate and present the factors that influence fuelwood consumption in households at the Thulamela Local Municipality and seek to enhance knowledge about the driving factors that promote fuelwood consumption. It is equally vital to consider the role of fuelwood for rural livelihoods and household consumptions patterns of fuelwoods. There is a need for intervention by the government and policy makers to make informed-decisions and strive to improve on energy alternatives that are accessible and affordable by everyone.

Furthermore, the research intends to contribute to the current academic knowledge that is associated with fuelwood consumption by addressing its challenge as it outlines the factors that influence fuelwood consumption in households.

1.4. Aim and objectives

The main aim of this study is to evaluate the factors that influence fuelwood consumption in households at the Thulamela Local Municipality. To achieve this research aim, the following objectives form the basis of this study:

1. To assess fuelwood utilisation in comparison with other energy source use within the Thulamela Local Municipality in the case study of Khubvi village,
2. To assess the socio-economic dynamics of households in Khubvi village in relation to fuelwood utilisation and,
3. To evaluate the different energy resources accessibility in rural households of the Khubvi village.

1.5. Chapter outline/ Research outline

The dissertation is organized and presented in five chapter as follows:

Chapter 1 consist of the background of the study, statement of the problem, motivation/rationale, and the study ‘aim and objectives.

Chapter 2 examines the reviewed literature, which comprises of the energy sources used in South African household, energy poverty and accessibility of locally and internationally, the importance of fuelwood, the implication of fuelwood use, the debates about the factors that influence fuelwood consumption and lastly, the current fuelwood consumption trends worldwide.

Chapter 3 describes the study area and explains the methodology used in the study, which include data collection methods, sampling method and size, data analysis, ethical consideration, and project limitations.

Chapter 4 focuses on data presentation and discussion, which is divided in three sections. The first section is the socio-economic characteristics of the population, characterizing the community energy mix and lastly the evaluation of the factors influencing the community energy mix through analysis.

Chapter 5 Summarises the conclusion and recommendation. Recommendation include encouragement of renewable energy use, encouragement of environmental education and public participation, promote sustainable development through harvest control and afforestation and lastly recommendation to policy makers.

CHAPTER 2: LITERATURE REVIEW

This chapter examines previous studies that have been conducted on household energy consumption to provide the reader with relevant information on the present study. The first section of this chapter introduces the energy sources used by South African households. The second section reviews energy poverty and accessibility locally and internationally. The third section examines the importance of fuelwood, and the fourth section reviews the implication of fuelwood use. The fifth section traces the debates about the factors that influence fuelwood consumption. The last section of this chapter further examines the current fuelwood consumption trends worldwide.

2.1. Energy sources used by South African households

2.1.1. What is energy?

The term "energy" has many definitions and it is mainly defined based on the physical levels of its abilities such as the ability to do work (Valenti, 2015). Energy occurs in various forms such as heat, light, chemical and electrical energy. For a household, energy is defined as a basic need which is vital for performing domestic tasks such as cooking, water heating and lighting (Truneh, 2014; Ntobeng, 2007). For example, electricity is required to produce heat for cooking, lighting, space water heating and other wide range of benefits that are associated with electricity (Truneh, 2014). According to Ntobeng (2007), energy cannot be perceived in isolation as it forms an integral part in sustainable development.

2.1.2. Different source of energy

There are different types of energy that are used in South African households. These energy source includes traditional biomass, electricity, coal, solar and paraffin amongst others.

2.1.2.1. Traditional biomass

In South Africa, biomass is a substantial contributor of renewable energy as it is utilised by an immense number of households in both rural and peri-urban areas to meet their domestic needs (Msibi, 2015; Petrie, 2014). The South African economy is an industrialised, energy-intensive sector which consumes the highest energy per capita consumption in Africa (Petrie, 2014). Traditional biomasses which include fuelwood, agricultural residues, animal dung and charcoal are usually regarded as outdated energy sources for meeting domestic needs because of the current trends of modern energy use (Danlami, 2019; Petrie, 2014). However, due to its availability, accessibility and affordability, biomass is still widely preferred by most households as a source of domestic energy. Among these traditional biomasses, fuelwood is the most prominent source of energy that is mostly used for domestic purposes by households in South Africa (Semenya & Machete, 2019; Matsika *et al.*, 2013). It is usually collected from the agricultural fields, forest or the surrounding of the communal land, especially in marginalised and poor areas (Matsika *et al.*, 2013). The significant role that fuelwood plays as a predominant energy source for meeting domiciliary needs among households is still evident in South Africa's energy use statistics on the government's White Paper on Renewable Energy, November 2003 (DoE, 2018; Petrie, 2014). Thus, even in a coal-rich country such as South Africa, fuelwood usage continues as woodland resources serves as a safety net against the broad grip of energy poverty (Variawa, 2012). With the savanna biome covering approximately one-third of land in South Africa, the harvesting of wood for meeting domestic needs and income generation is likely to increase as it is influenced by various factors including accessibility and availability of energy fount (Jimena, 2014). Currently, an estimate of 9.8 million tons of fuelwood is consumed annually (Nott & Thondhlana, 2017). Moreover, it is important to acknowledge that woodland resources such as fuelwood are available in abundance and most easily accessible, which attributes to the high rate of consumption (FAO, 2017; Variawa, 2012). While 95% of South African households are connected to the national electricity-grid, majority of these people are still hinged on fuelwood as a primary fuel source for meeting domestic needs (Lourens, 2018; Kimemia & Annegarn, 2011). Fuelwood remains a stronghold for low-income and affluent households as a means for income generation, saving and livelihood security against the erratic energy supply of alternative energy (Ateba *et al.*, 2018; Variawa, 2012).

2.1.2.2. Electricity

South Africa supplies about 40% of Africa's overall electricity demand and has been one of the four cheapest suppliers in Africa (DoE, 2018; Stiftung, 2014). The electricity sector in South Africa plays a tremendous role in both industries and domestic purposes. Electricity is produced from various sources which range from coal, nuclear, hydro, wind, gas-fired and pumped storage with a total capacity of 44 134MW (DoE, 2018; Moller, 2018; Mncube, 2006). The power stations consist of 36 441MW of coal-fired stations, 1 860MW of nuclear power, 2 409MW of gas-fired stations, 600MW of hydro and 2 724MW of pumped storage stations and 100MW wind farm (DoE, 2018). Coal is the primary electricity producer in South Africa and in terms of power generation, capacity it has 83% of the maximum generating capacity mix followed by pumped storage 6%, gas 6%, nuclear 4%, hydro 1% and wind 0% respectively (Rasimphi, 2020; DoE, 2018). The electricity generation in South Africa is dominated by the national utility Eskom, which is the prime electricity generator for approximately 90% of the overall electricity used in South Africa including the residential areas (DoE, 2018; Mzini & Lukamba-Muhiy, 2014). The key driver that influences the continuous use of coal-based power stations for electricity generation in South Africa is the availability of coal in abundance, the reliable output, increased security supply and high cost for purchasing other alternative technologies (DoE, 2018; Moller, 2018).

Moller (2018) argued that electricity supply profile of the consumer should complement the demand profile of consumers. Electricity is usually the most preferred energy fount for meeting domestics need due to its dependability, competency, accuracy, and cleanliness (Kimemia, 2012). Over the years since the introduction of electrification programme in1992, South Africa has seen a high increase in electricity consumption and demand patterns (Mzini & Lukamba-Muhiy, 2014). The ongoing funding of electricity among indigent households is aimed at decreasing the demands of dirty solid fuel (Variawa, 2012). The increase in the demand of electricity in South Africa could be linked to the introduction of Free Basic Electricity (FBE) by the Department of Mineral Resource and Energy (DMRE) which is aimed to help the indigent and Vulnerable households through the provision of 50 kWh per households of electricity (Lourens, 2018; Kimemia, 2012). Almost 80% of urban households and 50% of rural households in South Africa are connected to the national electricity grid which is a rapid improvement in comparison with other developing countries (Lourens, 2018; Ismail & Khembo, 2015; Wessels *et al.*, 2013). While the electrification programme in South Africa is exceptional among indigent households and farms as shown by electrification statistics in table 2.1, the majority of low-income households are still struggling to afford electricity rates and rely on heavily on alternative energy sources (DoE, 2018; Francioli, 2018). As a result, much of the supplied electricity in South African households is used for lighting (86 %) (DoE, 2018).

Table 2. 1: Electrification statistics until 2017

Province	**Electrified Houses: Municipalities and Eskom**
Eastern Cape	1 473 355

Province	Electrified Houses: Municipalities and Eskom
Free State	780 832
Gauteng	3 527 003
KwaZulu-Natal	2 247 498
Limpopo	1 484 310
Mpumalanga	1 065 610
Northern Cape	285 179
North West	997 484
Western Cape	1 608 147
Total	13 469 418

(*Source: DoE, 2018*)

2.1.2.3. Coal

South Africa's energy resources structure is dominated by coal energy in the industrial, commercial and transportation sector, accounting for 77% of the country's energy needs (Rasimphi, 2020; DoE, 2018; Balmer, 2007). The economy in South Africa is mainly distinguished by exceedingly high levels of inequality and poverty which is why a considerable use of coal within the residential sector is noticeable as over 200 households are utilising coal for water heating, while over 100 households are using coal for cooking (Burton *et al.*, 2018). Approximately 30% of the total coal that is mined in South Africa is exported worldwide, mostly through Richard's bay coal terminal (DoE, 2018). The use of coal as the majority energy source in the South African economy is due to several reasons such as the availability of coal in abundance, the government support of low-cost electricity production and the low cost of resources (Burton *et al.*, 2018). While Eskom uses a vast amount of coal for electricity generations, households also use coal for domiciliary functions which include water heating and cooking, especially during the winter seasons (Burton *et al.*, 2018; Balmer, 2007). In the last decade, South Africa has seen a significant reduction of households that relied on coal to meet their domestic needs, especially among poor households mainly attributed to the high rate of modern energy connections among these households (Kimemia, 2012).

Household coal usage was approximately 3% of the overall coal use with an estimation of 950 000 households using coal for winter seasons because of its availability and cheapness (Balmer, 2007). In contrast, since a majority of households are adopting the multiple fuel use due to various reasons, the reduction of coal usage among households went from 3% to 0.8% in 2002 and 5% to 1.8% in 2012 (Uhunamure *et al.,* 2017; Msibi, 2015).

In residential sectors the use of coal energy is mostly dominated in poor households in informal settlements where electricity is not available or is limited and coal plays a role as a substitution fuel for other energy alternatives (Msibi, 2015; Kimemia, 2012). The extensive coal consumption is exacerbated by fact that nearly 50% of people stay next to the mine fields where coal is mined and due to it cheapness and availability to them, people use coal despite some of them being connected to the electricity grid for domestic purposes (Lourens, 2018). Furthermore, coal is an inexpensive fuel source that grants households with dual utility benefits as it allows the same appliance to be used for both cooking and water heating (Balmer, 2007).

2.1.2.4. Solar Energy

Solar energy is the energy that is acquired directly from the sun (Uhunamure, 2015). Solar energy has a leading potential when compared to other energy resources due to its utmost capacity to produce raw energy power that is required to meeting both industrial and domestic needs, and also for being less destructive (Jain & Jain, 2017; Uhunamure, 2015). Worldwide, South Africa stands out for having the highest level of solar radiation which varies between 4.5 and 6.5 kWh/m^2 in comparison with its counterparts 3.6 kWh/m2 for the United States, and 2.5 kWh/m2 for Europe and the United Kingdom (Uhunamure, 2015; Masekoameng *et al.,* 2005). The vast majority of regions can gather an average of 8-10 hours of sunshine per day, 2,500 hours annually nationwide and 4.5 to 6.6 kWh/m^2 of radiation level (Jain & Jain, 2017). The use of solar energy for domestic purposes is proposed to ensure household energy security and to address climate change (Mncube, 2006). Solar technologies have many benefits as they can be used for domiciliary functions and for generation of electricity (Masekoameng *et al.,* 2005). For domestic purposes, solar (PV) accounts for less than 2% which is attributed to the many challenges and limited growth that was faced by the government in their initiation of the off-grid initiative (Msibi, 2015; Kimemia, 2012).

2.1.2.5. Paraffin

Paraffin is another energy source that is used by Vulnerable and marginalised South African households (Masekoameng *et al.*, 2005). It is a leading source for cooking energy in urban indigent households because it is readily available and affordable in most townships and informal settlements as compared to other energy alternatives (Kimemia, 2012; Masekoameng *et al.,* 2005). Paraffin is mostly utilised in rainy seasons when the use of fuelwood cannot be achieved or when wood is not available (Masekoameng *et al.*, 2005). In rural regions and informal settlements, paraffin also known as kerosene is utilised for domestic functions such as cooking, lighting, and water heating (Lloyd, 2014). Paraffin lanterns are used interchangeably with candles for lighting, depending on which energy fuel is available (Masekoameng *et al.*, 2005). Paraffin is mostly favoured by numerous households in South Africa, especially in Eastern Cape and North West provinces because it reduces cooking time (Aitken, 2007). The cooking devices can be monitored, which allows the intensity of heat to be regulated (Aitken, 2007). Furthermore, paraffin is sold in litres and cupful's, which helps poor household meet their domestic needs for broad aspects of domestic applications (Aitken, 2007; Lloyd, 2014). Regardless of the exceedingly high levels of electrification in South Africa, paraffin usage among both electrified and un-electrified households continue to play a significant role in the everyday energy consumption (Tait, 2013).

2.1.3. Advantages and disadvantages of the diverse energy sources used in households.

Table 2. 2: shows the advantages and disadvantage of the diverse energy sources used in households.

Energy sources	Advantages	Disadvantages
Traditional biomass	• Renewable energy sources • Cheap and costless among rural regions • Saves electricity • Effortless and available in abundance where forest, communal	• Overexploitation of natural resources • Loss of biodiversity • Deforestation • Acceleration of soil erosion • Destruction of habitats • Air pollution

Energy sources	Advantages	Disadvantages
	lands, crops and animals exist • Provides good heat that lasts • Ash can be utilised as fertiliser • Multiple-functional/ purpose energy sources	• Increase chances of accidental fires • Decline in social and economic capital
Electricity	• Independent of cost rates for oil, uranium and other alternative energy fuel • Rarely causes pollution • Reduce greenhouse emission • High-transition efficiency • Easy to control • It is more reliable than other energy alternatives such as solar and wind	• Electric appliances require frequent maintenance • Costly as electric tariffs increase all the time • Electric appliances cannot be used when there is no electricity
Coal	• Abundant coal reserves • It can supply the society with endless power • By-product of burned ash can be used for the construction of roadways	• It is not a renewable resource e.g. if over used can result in depletion • Coal has the potential to emit extremely high levels of carbon

Energy sources	Advantages	Disadvantages
	• Coal has great benefits of offering low investments in the economic market • Benefits of carbon capture and storage machinery/ technologies which can be used to decrease potential emission by lowering the complete greenhouse gases (Liquefaction and gasification) • Low cost in comparison with other energy resources • Flexible as it can be scalded directly and changed completely to liquid or gas, or used in its natural state • It is a renewable fuel • It is an all-time energy resource as it can be burned 24/7 to generate energy	dioxide which contribute to global warming • Creates too much waste through the emission on SO_2, Nitrogen Oxide, and ashes • Coal power might produce the utmost levels of radiation • Coal radiation is linked to environmental and health impacts • Even high quality coal has great levels of methane • Liquefaction and gasification require large amounts of water
Solar	• Reduces electricity bill • Diverse application • Low maintenance • Technology development	• Costly (initial purchase of solar system) • Weather dependent • Solar energy storage is expensive

Energy sources	Advantages	Disadvantages
	• It is a renewable energy meaning that it can be used repeatedly • Readily available from the sun • Environmentally friendly	• Requires a lot of space for solar PV panels • Lack of manufacturers around the Villages
Paraffin	• Durable and fast cooking primarily when utilised in stable and suitable stoves • Manageable fuel storage • It can be purchased in small quantities which is cost-effective among Vulnerable homes • It is an alternative fuel especially when there are power cuts and limited funds to purchase electricity • It is also used as an alternative energy source where accessibility to traditional biomass is limited or unavailable	• It is a limited resource • When utilised in stoves that are not suitable, it can release high levels of pollutants and automatically promote indoor air pollution • It has an undesirable odour and often adds distasteful taste to food cooked or prepared • It is extremely flammable • It has a high chance of depletion since it is not a renewable energy source

Energy sources	Advantages	Disadvantages
		• Although unlikely poisonous, when accidentally swallowed it can lead to short-term lung deterioration

(*Source: DoE, 2019; Kimemia, 2014; Wessels et al., 2013; Saeed, 2009; Shackleton et al., 2007; Sandra Vasa-Sideris, n.d)*

2.2. Energy poverty and accessibility

2.2.1. What is energy poverty?

Energy poverty refers to the inadequate access to contemporary energy services in which households have no access to electricity and clean cooking technologies or facilities (Stiftung, 2016; Kimemia, 2014; Truneh, 2014). Energy poverty outstrips most, if not all elements of poverty and is a major hindrance that threatens human development and enhances social problems globally, particularly in developing countries (Israel-Akinbo *et al.,* 2018; Lourens, 2018). It has been widely reported that energy poverty is a growing concern for most households especially among poor and underdeveloped countries like the Sub-Saharan Africa and Asia, where approximately 80-85% of people are deemed energy-poor and an estimate of 90% households rely on traditional biomass (Israel-Akinbo *et al.,* 2018; Lourens, 2018; Ismail & Khembo, 2015; Wessels *et al.,* 2013). In addition, rural areas in Sub-Saharan Africa are most affected, and energy-deprived as over 139 million people are still living without access to electricity (Lourens, 2018). For those that are linked to the electricity grid, they hardly use electricity due to the high energy tariffs and its unreliability (Lourens, 2018; Ismail & Khembo). The provision of access to modern energy sources such as electricity and solar among households for cooking and water heating is of the utmost importance for the improvement of human health and a crucial foundation for eradicating energy poverty (Israel-Akinbo *et al.,* 2018; Makonese *et al.,* 2016).

2.2.2. Energy poverty and accessibility from a South African context

From a South African context, energy poverty remains an ongoing challenge (Israel-Akinbo *et al.,* 2018). The Department of Energy (DoE) has conceded that energy is the lifeblood for modern energy life and significantly affect our very own existence; hence accessibility to clean and efficient energy is a prerequisite for sustainable development as well as socio-economic growth. Apart from playing a crucial function in poverty alleviation, energy also represents a status as well as the stage of economic and social growth of a country (Uhunamure *et al.*, 2017; Valenti, 2015). However, despite the crucial role that energy plays in the livelihoods of all people, its provision to everyone at an affordable price remains a challenge (Uhunamure *et al.,* 2017; Valenti, 2015; Nkomo, 2007).

While South Africa has considerable low rates of energy poverty in-comparison with other developing countries, it continues to set an example of a country that is struggling to fully develop its energy resources and remove its citizens from the stronghold of energy poverty (Israel-Akinbo *et al.,* 2018). This is supported by Masekoameng *et al.* (2005), who emphasised that a large number of households in rural regions struggle with the accessibility of competent and cost-effective energy sources. The inadequacy in the accessibility of clean energy such as electricity impede greatly on household's development, infrastructural development, service delivery and economic growth especially for rural areas where such developments are essential for income generation and for meeting the domestic needs of a household (Johnson, 2012).

Energy poverty has resulted in multifaceted issues such as accidental fires and, respiratory diseases resulting from indoor air pollution (Stiftung, 2016). In some cases, people have died due to gasping incidents (inhalation of CO_2) especially in winter as a result of using *mbaula* or fuelwood for water heating and emission of carbon dioxide which contribute to climate change (Francioli, 2018; Stiftung, 2016; Kimemia, 2014). Energy poverty still manifests itself through the inadequate supply of clean, efficient and competent energy which is exacerbated by income burden and high costs that are associated with efficient and modern technology utilisation, resulting in the use of alternative fuel sources such as traditional biomass (Hainduwa, 2013; Wolpe & Reddy, 2010). Makonese *et al.* (2012) argued that the magnitude of energy poverty has resulted in slow social growth and development in South Africa.

Lack of energy in South Africa has led to the advancement of poverty and further contributed to the erosion of health and educational outcomes (Ismail & Khembo, 2015). This is supported by Stiftung (2016), who emphasised that poverty has compelled Vulnerable households to live in a state of absolute destitution beyond the accessibility of basic services such as that of energy, water, and sanitation. Compared to other developing countries, the rural areas in South Africa are more prone to energy poverty as they are substandard and impoverished in terms of communal services and infrastructure development (Valenti, 2015; Masekoameng *et al.*, 2005). This has resulted in unavailability of service, provision of poor quality and limited services and increased use of less sustainable energy resources.

South Africa was previously ruled by an apartheid government which forcibly moved black people to settle in socially and economically marginalised areas with limited or no provision of clean energy (Kimemia, 2011). Consequently, the energy policies in South Africa were strategically implemented based on the energy inequality that was practised by the apartheid government; (Kimemia, 2011; Lourens, 2018). Moreover, due to the aftermath of apartheid, South Africa remains an economically and socially divided society as the legacy and tradition of poverty and inequality are deeply entrenched in its socio-political history (Tait, 2013). However, as part of the rehabilitation process, the new democratic government has set goals to address energy inequalities by launching the National Electrification Programme (NEP) in 1994 and the introduction of FBE by the Department of Minerals Resource and Energy (DMRE) in 2003 (Israel-Akinbo, 2018; Lourens, 2018). The main focus of NEP was to provide electricity to both poor and disadvantaged urban and rural areas (Lourens, 2018; Makonese *et al.*, 2012). At the same time, FBE aimed to provide a free monthly electricity tariff of 50 kWh per indigent household, thus fighting the heavy reliance on inefficient energy fuel (Lourens, 2018; Moshoeu, 2017; Makonese *et al.,* 2012).

Despite the current interventions made by the present democratic government on both national and local level for the progression of affordable modern energy, destitution, energy inequalities and energy poverty still persist (Makonese *et al.,* 2018). As a result, South Africa continues to face a tenacious grip of energy inequality burdens. The establishment of FBE policy for the indigent households has delivered basic services to previously marginalised communities (Makonese *et al.*, 2018). However, it is evident that the system for effectual implementation of NPE policy and provision of affordable energy for all is still far from meeting the sustainable development goals as service backlogs continue to pile up and further delays energy poverty alleviation (Makonese *et al.,* 2018; Stiftung,2016; Makonese *et al.*, 2012). This is also an indication that South Africa still requires a significant amount of effort in the implementation of mitigation measures and polices that can entirely reduce energy poverty (Mgwambani *et al.*, 2018).

2.3. Importance of fuelwood

Sub-Saharan Africa is particularly a host of countries with the least rates of electricity connections among households (Mgwambani *et al.,* 2018). A greater number of these households are exclusively based in rural regions where there is lack of access to modern and efficient energy sources, which yields in households remaining dependent on traditional fuel to sustain themselves (Mgwambani *et al.,* 2018; Kasangana *et al.,* 2017). Fuelwood as a fount fuel continues to outpace other energy alternatives through its dominance within the fuel sector especially in Sub-Saharan Africa and other developing countries (Mislimshoeva *et al.,* 2014). This is attributed to the limited accessibility of other energy alternatives. The significance of fuelwood is evident worldwide but more particularly among indigent households where fuelwood utilisation outpaces other rival energy alternatives such as LPG, electricity, kerosene, and charcoal (Orimoogunje & Asifat, 2015). Fuelwood is an essential energy source for approximately 2.7 billion people worldwide, notably among those who are Vulnerable (Scheid *et al.,* 2018). Financial constraints exacerbate the high dependency of fuelwood and limited social progression which is associated with socio-economic characteristics and the struggle to make an effective commitment to electricity use due to the prohibitively high cost of monthly tariffs (Uhunamure *et al.,* 2017; Matsika *et al.,* 2012; Preston 2012). Poor households will try to cope with the little that they have by incorporating natural resources such as fuelwood which is readily available and cheap into their domestic energy mix to supplement for the lack of modern energy sources which is a luxury for them (Jimena, 2014).

Currently, the fuelwood consumption nationally within the rural regions is between 4.5 to 6.7 million tons annually and these consumption rates are not only unsustainable but are also a major driver of environmental degradation (Amoah *et al.,* 2015; Wessel *et al.,* 2013). Traditional biomass mainly obtained from the forest or communal lands remains an important source of fuel for many rural households; thus, it is critical to manage the biomass resources in a sustainable (Wessels *et al.,* 2013). Fuelwood plays an essential role in the integration of sustainable development process, as sustainable consumption and harvesting of fuelwood could ensure that the present forest and communal lands can meet the present generation without compromising the future generation's needs as stated in the Brundtland Commission report of 1987 (Ntobeng, 2007; Pope *et al.,* 2004). Sustainable development according to the Brundtland Commission report of 1987 is "Development that meets the needs of the present without compromising the ability of the future generations to meet their own needs" (Pope *et al.,* 2004).

2.4. Implications of fuelwood use

The over-exploitation of natural resources such as fuelwood has negative impacts on the environmental, socio-economic as well as health sectors. The following sections discuss some of the major environmental, socio-economic and health implications.

2.4.1. Environmental impacts

Heavy reliance on traditional biomass has raised worldwide environmental concerns in developing countries (Démurger & Fournier, 2011). It has been asserted that over half of all wood harvested is used for domestic purposes as opposed to industrial and commercial use (Knight & Rosa, 2011). Over-harvesting of fuelwood can lead to significant imbalances of natural resources as it deprives the ecosystem of its essential nutrients that are necessary for fertility and growth (Feyisa *et al.*, 2017).These imbalances of the ecosystem constitute a substantial risk to the environment because it contributes to the diminishing and degradation of the existing forest, communal savanna woodlands, and promotes soil erosion, habitat fragmentation and climate change (She, 2014; Akther, 2010).

Firstly, overexploitation of natural resources, mostly clearing of wood, imperils soil to the harshness of the tropical sun and torrential rains, which will eventually alter water resources and agricultural yields and pose significant threats on food security, the economy as well as social development (Feyisa *et al.*, 2017; Akther, 2010). Secondly, cutting down trees also has severe implications on biodiversity since trees provide animals with food and habitat (Hainduwa, 2013). Therefore, if trees are cleared, this can lead to a severe loss of biodiversity, loss of forest cover like fauna and flora, habitat fragmentation and extinction of wildlife which often result in forested land being degraded to wasteland (Hussain *et al.,* 2017; Hainduwa, 2013). Thirdly, unsustainable harvesting of fuelwood can lead to an escalation of global warming from clearing and burning of forest and vegetation covers, resulting in decomposition that can cause large scale emission of carbon dioxide and other greenhouse gases into the atmosphere, thereby increasing the anthropocentric greenhouse effect (Strydom & King 2009). These impacts can leave multiple shocks and stresses that can increase the vulnerability of almost every household (Strydom & King. 2009).

Woodlands products are being consumed and eradicated at an alarming rate, particularly among rural areas and this is further exasperated by household's vulnerability to poverty, energy poverty and socio-economic characteristics such a lack of income sources (Makhado *et al.,* 2009). Additionally, fuelwood is being consumed without replantation and these can further escalate the disruption of the ecosystem (Semenya & Machete, 2019). Such high levels of dependency of fuelwood and subsequent extraction and over-exploitation of the forest and communal lands have unnerved concerns regarding the looming "fuelwood crisis" (Wessels *et al.,* 2013). By exploiting the forests and communal lands, people risk their quality of life, jeopardise the stability of the climate and local weather and also endanger the existence of vulnerable species which undermines the important services that are provided by biological diversity and ecotourism. Jimena (2014) argued that overharvesting of fuelwood should not be ignored on the basis that small-scale deforestation does not have an impact on larger effects (Wessels *et al.,* 2013). Marginalized households could be rendered vulnerable to livelihood insecurity and global warming as their dependency on natural resources such as traditional biomass is placed at risk. If fuelwood is harvested and consumed at a sustainable rate, then it could continue to supplement rural energy needs as well as meet the industrial and domestic needs of those who are dependent on it (Wessels *et al.,* 2013).

2.4.2. Socio-economic impacts

Unsustainable fuelwood harvesting results in several adverse effects in the economic development. Tropical rainforest destroyed annually amounts to the loss in forest capital valued at US $45 billion and by destroying the forest, every possibility of current and future revenues and employment that could be derived from sustainable management of these natural resources is decreased (Okia, 2012). Moreover, fuelwood scarcity adds extra expenses like the incurred direct and indirect financial cost related to fuelwood price or alternative energy sources (Démurger & Fournier, 2011). A good example is that fuelwood scarcity can increase fuelwood collection time and deprive households of spending quality time with their loved ones (Hainduwa, 2013). Poor households may incorporate a wide variety of livelihoods strategies that can improve their lives such as fuelwood trading which can increase the demand for fuelwood harvesting and supply (Makhado *et al.,* 2009).

2.4.3. Health impacts

Unsustainable fuelwood harvesting has detrimental social implications for many households with most of them having pernicious residual long-term consequences. Amidst of them is the emission of greenhouse gas (GHG) that is released into the air when fuelwood is burned (Semenya &

Machete, 2019; Makonese *et al.*, 2016). Household Air Pollution (HAP) could result in a number of diseases such as chronic respiratory disorder, cancer, tuberculosis, perinatal mortality, low birth weights, eye irritation and cataract, pulmonary and systemic diseases (Mgwambani *et al.*, 2018; Makonese *et al.*, 2016). Mwaura *et al.* (2014) reported that approximately 1.3 million household air-pollution related deaths are recorded worldwide annually, and this is associated with traditional biomass usage. Indoor air pollution continues to be a serious health hazard for Vulnerable households as on many occasions their cooking space and living space are combined in one place (Feyisa *et al.*, 2017). Therefore, they are more prone to acute respiratory infections.

The inaccessible contemporary energy has spurred the utilisation of incompetent and unclean fuel such as fuelwood, candles, agricultural residues, coals, and kerosene. The use of these fuel is associated with serious health and safety risks particularly among women and children who remain exposed to incidences during the gathering and use of perilous fuel in cooking, water heating and cleaning (Stiftung, 2016). Furthermore, due to prolonged fuelwood harvesting time women and children are deprived of continuous improvements, especially in the academic sector as they have to endure exhausting long walks for fuelwood harvesting as wood becomes scare (FAO & UNHCR, 2017). They also face the risk of being assaulted during these long walks (FAO & UNHCR, 2017; Preston 2012). Thus, the overexploitation of traditional fuel is an expression of social injustice.

2.5. The legal framework in south Africa and the role of local government and traditional authorities in forest management.

In South Africa as with other developing states, the local government and traditional leaders plays a significant role in the conservation of natural resources, including forest management (Lenfers *et al.*, 2018; Mwalukomo, 2008). These roles include but not limited to social regulation of fuelwood collection, controlling access to land, allocation of land and natural resources (Lenfers *et al.*, 2018; Mwalukomo, 2008). Given the high rate in which natural resources are exploited, it is important to note that conservation of resources be emphasised and laws be implemented to ensure sustainable use (Mphephu, 2017). Additionally, policies and regulatory legislations alone cannot prevent exploitation of natural resource since they are limited to economic potential. As such, inter-government and the general public, particularly the traditional authorities should be consulted and co-operated with in the matters that concern protected areas and species as stated in the NEMA: Protected Areas Act, 2003. Various legislation has been established in south Africa for the conservation of natural resources, which limits people from harvesting and informal trading of plants. For example, the Limpopo Environmental Management Act (LEMA) prohibits any person without a permit to pick, sell, purchase, donate, receive as gift, be in possession of, import into, export or remove protected plants, more especially the protected plants in the province (Mphephu, 2017). Yet people are still cutting down these trees for various uses (e.g. fuelwood use and medicinal plants trading). Similarity, Section 15(1) of the National Forests Act, 1998, indicated that no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any product derived from a protected tree, except under a licence or exemption granted by the Minister to an applicant and subject to such period and conditions as may be stipulated (DAFF,2018). This is a clear indication that local government and traditional authorities have an active role in the conservation of natural resources. The main reason for involving the local people in the conservation of natural resources is attributed mainly to the active roles that that can play in taking ownership of the resources in their own areas. Moreover, the underlying success of community bases wildlife conservation initiative will depend highly on ensuring that individuals acquired benefits from conservation and sustainable management of the resources (Mphephu, 2017).

2.6. Factors that influence fuelwood consumption

Several factors influence fuelwood consumption within households such as the poor living conditions which drive widespread poverty. Rural areas struggle with challenges such as limited financial resources, limited accessibility and availability of contemporary energy sources, unemployment status, the cost for electric appliances such as stoves, high energy tariffs, and household size (Muller & Yan, 2018; Uhunamure *et al.,* 2017; Wessels *et al.,* 2013). Household fuel choice is not solely driven by monetary aspects, but also by multitudinous socio-demographic determinants which include gender, employment status, academic level of household head, household size, marital status and age (Ateba *et al.,* 2018; Uhunamure *et al.,* 2017). The choice of fuel type for domiciliary purposes among poor households in developing countries is also influenced by cultural and taste preferences (Muller & Yan, 2018; Uhunamure *et al.,* 2017). The energy consumption patterns in households are an indication of the status and stage of economic development in a country (Uhunamure *et al.,* 2017). As the South African economy continues to improve, it is expected that more and more energy will be consumed. Below are some of the factors that influence fuelwood consumption in households.

2.6.1. Employment status

Employment status plays a significant role in the wellbeing of society. When economic development is marginalised, employment opportunities often decline due to scarcity and the little momentary income often saved up dwindles, resulting in households soliciting traditional fuel to meet their domestic needs (Matsika *et al.,* 2012). However, since employment status is usually attributed to education, it is often concluded that employment status plays a role in household energy use (Semenya & Machete, 2019). Hence, as the household attains a higher employment status, they tend to associate themselves with efficient, modern, and reliable energy sources (Uhunamure *et al.,* 2017).

2.6.2. Household income

According to StatsSA (2015, 66), household income alludes to all revenues obtained by all associated households members in cash; in a variety of exchange employment or in returns for capital investments or revenues acquired from other sources such as social grants and pension. Household income is a predominant factor which influences the type of fuel that is used by households and prominently affects the utilisation of other supplementary forms of energy sources within a home (Semenya & Machete, 2019). Household income is also an indication of status welfare as well as the economic development of a country (Uhunamure *et al.,* 2017; Ogwuche & Asobo, 2013). Literature review indicates that the income of the household head can remarkably intensify the monetary position and welfare of a household (Semenya & Machete, 2019; Uhunamure *et al.,* 2017; Ogwuche & Asobo, 2013). Thus, an increase of income of household head can significantly influence a household to a shift to more appropriate energy fuel (Ogwuche & Asobo, 2013).

In a study conducted by Uhunamure *et al.* (2017), the authors demonstrated that people who have low-income are compelled to harvest fuelwood as a regular energy source for meeting domiciliary needs. In most cases, the low-income households spend a lot of time gathering fuelwood for cooking and water heating, with the little available electricity being served for lighting purpose only. Similarly, a study done by Danlami (2019), found that an increase in income for people who are living in urban areas can reduce the likelihood of fuelwood utilisation in developing areas.

Additionally, Makonese *et al.* (2018), showed that income plays a substantial role in determining the type of energy that a household considers for meeting domestic needs such as cooking and water heating. Nevertheless, data in Sub-Saharan Africa indicates that an unambiguous link exists between income level and the fuel type used at households. The rise of income in a household reduces fuelwood consumption and promotes the conversion from traditional biomass use to more contemporary fuel such as electricity and LPG (Malla & Timilsina, 2014).

The matter of household income and fuel choice is mostly conceptualised and analysed through the energy ladder model (Ateba *et al.*, 2018; Lourens, 2018; Gatama, 2014). Figure 2.1 below depicts the Energy Ladder Model, which is a principal concept within the energy transition process as it portrays the order of fuel switching, from one fuel to another (Gatama, 2014; van der Kroom *et al.*, 2011). It is based on household preferences with regards to energy efficiency, cleanliness and ease of use (van der Kroom *et al.*, 2011).

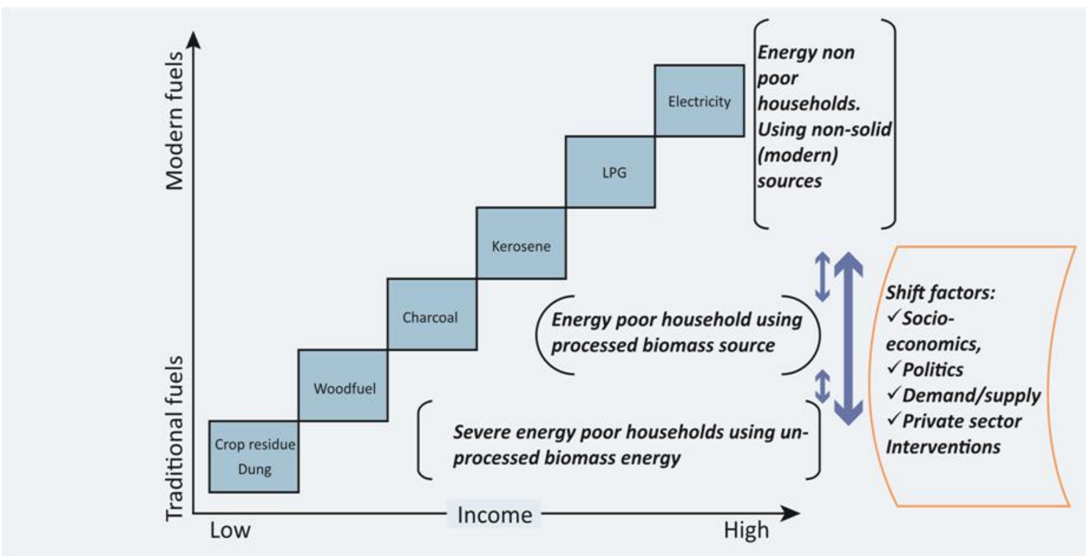

Figure 2. 1: Energy Ladder Model

(Source: Mwaura et al., 2014)

The model emphasises the importance of income as a factor that influences the fuel choice within a household and its utilisation in developing countries (Muller & Yan, 2018; Gatama, 2014). Furthermore, the model suggests that when a household's income increases, families tend to drift away from the use of traditional biomasses (dung and wood) to average fuel (charcoal and kerosene) and then to a more clean, sophisticated and modern source of energy (gas and electricity)

(Semenya & Machete, 2019; Muller & Yan, 2018; Uhunamure *et al.*, 2017). Higher ranked energy fuel is considered to be more efficient, sophisticated and costly, yet they require less work to perform a task and emit less pollution into the air (van der Kroom *et al.,* 2011). The energy ladder model provides a clear illustration of how an ordinary household income plays a role in fuel switching as shown in Figure 2.1 (Muller & Yan, 2018). Nevertheless, the significance of household income as a driver that influences energy decision-making has been scrutinised by those who support the multiple fuel use model (Lourens, 2018).

Masera *et al.* (2000) has castigated the energy ladder model based on the argument that the model cannot adequately describe the dynamics of a household energy use. The authors further indicated that multiple fuel stacking is frequently used in both rural and urban regions regardless of the household income increase (Muller & Yan, 2018; Masera *et al.,* 2000). Numerous authors support this statement. According to Uhunamure *et al.* (2017), in most households, the fuel substitution or energy transition does not apply as most households prefer the use of different kinds of fuel (fuel stacking) ranging from the traditional biomass to modern energy fuel. Similarly, a study done by Waweru (2014), shows that a household cannot fully shift to modern energy fuel; instead, they utilise a combination of a variety of energy sources. Therefore, rather than moving up the energy ladder with income increase, they prefer the incorporation of multiple fuel use. This also indicates that economic development alone should not be regarded as a primary and sole factor for households to transition their energy consumption practices as other significant factors exist in decision making when selecting domiciliary energy (Uhunamure *et al.,* 2017; Masera *et al.,* 2000).

Furthermore, literature indicates that several cultural, social, and economic factors influence households to use multiple fuel (Makonese *et al.,* 2018; Lourens, 2018; Uhunamure *et al.,* 2017). For example, certain households believe that some food tastes better or cooks faster with fuelwood (Uhunamure *et al.,* 2017). Economic factors can include high energy tariffs, accessibility and availability of fuel. Social factors can be the development and insurance of a family income; and cultural factors can be taste preferences and religious beliefs (Lourens, 2018). Consequently, fuelwood will continue to be a prestigious source of energy for cooking and water heating, hence fuel stacking remains significant in households regardless of income increase (Uhunamure *et al.,* 2017).

2.6.3. Education level

The level of education plays a substantial aspect in the factors that influence fuelwood consumption because education enhances the knowledge about proper fuelwood harvesting and promotes sustainable development. When the community is knowledgeable about the impacts of mismanagement of fuel, they tend to have the right attitude about fuel management. Education is regarded as the key to the establishment of consciousness and conservation of natural resources (Naidoo, 2009).

Most literature review shows that education or environmental awareness is a significant factor that does influence the choice of energy used in households (Semenya & Machete, 2019; Ateba *et al.*, 2018; Uhunamure *et al.*, 2017; Malla & Timilsina, 2014). Education further act as a prominent aspect in decision-making process of fuel use and is also an essential component that can be used for poverty alleviation (Muller & Yan, 2018; Ismail & Khembo, 2015). According to Uhunamure *et al.* (2017), people have different outlooks regarding the choice of energy to be utilised within a household, and their level of education influences this. The authors argued that people who have elevated educational standards are more likely to embrace the use of cleaner energy forms which enhance the conservation of natural resources. Likewise, the level of education is assumed to have an unfavourable relationship with fuelwood consumption and demand for less clean energy fuel (Gatama, 2014). Thus, most educated people are associated with higher income levels which prominently contribute to poverty alleviation.

Semenya and Machete (2018), indicated that highly educated people favour the use of more reputable fuel sources, unlike their counterparts who are less educated. Furthermore, a study by Ismail and Khembo (2015), also showed that a negative relationship exists between educational level and energy poverty. The authors asserted that people who have obtained their matric certificate could alleviate poverty because higher educational stratum correlates with the acquisition of higher-income, resulting in expenditure sharing in a household's energy usage. In contrast lower levels of education promote energy poverty. Based on the study in selected South African homes, Ateba *et al.* (2018), investigated the impact of fuel energy choice determinants on sustainable energy consumption and the authors found that educational level corresponds with the choice of household fuel. Ateba *et al.* (2018), went on to explain that household participants with postgraduate and degree qualifications are presumably willing to support the use of cleaner energy like electricity for both cooking and water heating. Households with lower educational levels such as diploma and matric certificate are likely to use paraffin. The level of education prominently influences how a household is informed, thus the more the household members are educated and empowered, the more open-minded and enlightened they are to cleaner energy fuel (Ateba *et al.*, 2018; Ogwuche & Asobo, 2013).

In a multinomial logit evaluation of household cooking fuel in the rural areas of Kenya, Pundo and Fraser (2006) found that the level of education of a wife propels the use of less dirty fuel. This is because an educated wife will have a hard time collecting fuelwood due to her involvement in other commitments such as work. As a result, she will prefer the use of other fuelwood alternatives such as charcoal or kerosene. A similar finding is reported by a Nigerian study done by Onyeneke *et al.* (2015), who showed that education has a negative relationship that moderately correlates to fuelwood consumption. This is a clear indication that indeed less educated people will harvest more fuelwood, unlike their counterparts who have higher educational levels (Onyeneke *et al.*, 2015).

2.6.4. Gender

Gender concept refers to the social system that is characterised by the formulation of task, privileges, roles and attributes between men and women in society (Troncoso *et al.*, 2007). These social characteristics are not physiologically motivated but somewhat influenced by social customs (Ateba *et al.*, 2018; Troncoso *et al.*, 2007). Gender is yet another debated factor on whether it affects the choice of household fuel use (Muller & Yan, 2018). According to Ismail and Khembo (2015), a positive relationship exists between gender and energy poverty. Troncoso *et al.* (2007) and Ateba *et al.* (2018), confirmed that gender is indeed a key factor in the analysis of the fuelwood usage and also influences the fuel choice in households. Equally important is that women and men make different decisions regarding the choice of household fuel (Ogwuche & Asobo, 2013). A home that is headed by a male who is a primary provider and decision-maker might differ distinctively from a household that is led by females (Ismail & Khembo, 2015). Male-headed household might disregard the significance of cost and the usage of clean energy sources (Ateba *et al.*, 2018; Ismail & Khembo, 2015). Moreover, a female- run home usually prefers the use of more contemporary energy fuel that are decent, clean and sophisticated than traditional biomasses that are dirty and unhealthy (Muller & Yan, 2018; Malla & Timilsina, 2014).

Generally, the society regards women as people who should be accountable for cooking, fuelwood harvesting and performing various domestic chores around the house (Ateba *et al.,* 2018; Onyeneke *et al.,* 2015). As a result, women are liable for a majority of the decision-making processes of energy fuel choice around the house that affect cooking and other domestic chores (Ismail & Khembo, 2015; Malla & Timilsina, 2014). A study conducted in Nigeria found that 23.9% of fuelwood is consumed by households that are headed by males as opposed to their counterparts who consume less (Danlami, 2019). Women who are employed, find it difficult to find time to harvest fuelwood; as a result, they favour meals that do not require a long-time to prepare and cook (Lourens, 2018). Nevertheless, most households are headed by men who oversee cash flow and are also the primary decision-makers. This compels women to use traditional biomass as they are hardly in control of financial expenditures such as purchasing energy resources (Semenya & Machete, 2019; Ismail & Khembo, 2015). Annecke (2002) cited by Ismail and Khembo (2015) argued that women who have limited control of financial resources are more remaining absolutely energy poor. Furthermore, a study conducted in Giyani indicates that women conduct 80% of energy-related chores as men's involvement in energy decision is only to consider which fuel type is more suitable, what kind of cooking device and which energy fuel should be purchased for cooking (Masekoameng *et al.,* 2005). Worldwide it is highly recognised that women are more disadvantaged when it comes to gender inequality and this has conclusively resulted in poverty imbalances (Stiftung, 2016).

2.6.5. Age

The age of the household head is a significant factor that influences the choice of household fuel (Ogwuche & Asobo, 2013). Households that are headed by the older generation are said to favour the use of fuelwood, unlike their counterparts who are young and embrace the use of new technologies such as electricity (Semenya & Machete, 2019; Gatama, 2014; Ogwuche & Asobo, 2013; Nyembe, 2011). The age of a household corresponds to the type of food that is cooked, the amount of time it takes to cook such food, taste preference and the household size (Ogwuche & Asobo, 2013). Gatama (2014) asserted that in the Ethiopian cities, consumption, and demand for wood increases with age. The author further explains that older people are resistant to change and prefer the use of traditional biomass as the source of energy for meeting domiciliary needs. Pundo and Fraser (2006), concurred that age was indeed an anticipated factor that significantly influences the choice of household fuel. As the women's age increase it is unlikely that they will agree to switch to modern fuel. Adoption of modern energy sources such as electricity is often discouraged by older members of the household as they would rather cling to traditional biomass out of habit (Semenya & Machete, 2019; Gatama, 2014).

2.6.6. Household size

Household size is yet another influential factor that determines the fuel choice within a household (Ateba *et al.*, 2018; Muller & Yan, 2018; Uhunamure *et al.*, 2017). According to Ismail and Khembo (2015), a large household has a higher possibility of being energy-poor because they do not perceive fuelwood as being difficult to gather and harvest. Only when there is an increase in household income, a family is likely to switch to more sophisticated and modern energy fuel. Ateba *et al.* (2018) cited Ado (2016), who pointed out that the size of a household prominently influences a home to practice fuel stacking as opposed to smaller households. Furthermore, the size of a family is an inversely proportional factor that influences households to incite the incorporation of various energy sources in fuel switching and energy stacking behaviours (Ateba *et al.*, 2018). Therefore, household size necessitates its members to adopt the energy transition model because of social-economic changes that occur in a household (Ismail & Khembo, 2015). It further allows a family to incorporate alternative energy fuel.

Waweru (2014) highlighted that a household size negatively affects the choice of fuelwood alternatives because big households tend to have sufficient members to conduct labour of fuelwood gathering and preparation. The family size is a factor that necessitates the consumption of extensively large quantities of fuelwood for food preparation as fuelwood is easy to harvest and gathered at no added cost. Link *et al.* (2012), supports that large households increase fuelwood consumption due to large homes having a great chance to increase the demand of energy for meeting domestic needs. Large households prefer the utilisation of fuelwood for meeting domiciliary tasks such as cooking and water heating, while electricity is used exclusively used for lighting purposes.

According to Semenya and Machete (2018), larger homes are likely to consume far greater energy than smaller households in cooking and water heating. Furthermore, large families are faced with a great burden resulting from household spending and income burden, which then results in their minimum income being far less than their needs. This financial burden compels them to favour cheap and dirty energy fuel that are easy to collect and readily available (Semenya & Machete, 2019; Lourens, 2018). Thus, remains a challenge for large households to fight energy poverty. Although large families usually have enough members to perform fuelwood harvesting tasks, they are more prone to energy poverty, poverty in general and the ineffective use of unreliable cooking technologies which is unlikely in smaller households (Ismail & Khembo, 2015). Furthermore, fuelwood is free and usually collected around communal lands or forests whereas electricity is expensive and requires a household to have sufficient income to purchase it (Asik & Masakazu, 2017; Uhunamure *et al.*, 2017).

2.6.7. Cultural and taste preferences

Cultural and taste preferences are believed to be the favourable priorities when choosing a variety of energy to be used for domiciliary needs. According to Uhunamure *et al.* (2017), the selection of fuel type is mainly influenced by cultural norms and taste preferences. Uhunamure *et al.* (2017) further cited Masera *et al.* (2000) who discovered that taste preferences and cultural norms are the reason why in the rural areas of Mexico, people favour the use of fuelwood and traditionally made stoves for the cooking of tortillas. Masera *et al.* (2000) also pointed out that that in Jaracuaro, Mexico, tortillas that are cooked with traditionally made stoves or with fuelwood tastes better and cooks faster. In contrast tortillas that are prepared over gas stoves are distasteful. Muller and Yan (2018), articulates that lifestyle factors such as cultural norms, taste preferences and type of food are closely linked to the choice of household fuel. Fuelwood is seen as a convenient way of cooking because it does not hamper the taste of the food prepared nor consumes a lot of time; these are some of the reasons why people prefer to use fuelwood or charcoal. In a study done by Lourens (2018), the author concurred that most people prefer the use of traditional biomass for preparation of their food out of habit, even though they have electricity, or because they are used to how their food tastes when prepared with fuelwood. The author further explained that people prefer the use of traditional energy fuel because modern technologies cannot duplicate the traditional recipes. It is believed that the taste differs for electricity prepared meals from those that are prepared by traditional fuels.

2.6.8. Marital status

Marital status is explained as the distinct case that represents whether a household head is married or not. Marital status is another factor that is believed to play a significant role in factors that influence fuelwood consumption. This statement is supported by Onyeneke, (2015), who agreed that indeed marital status has a positive relationship to energy use within a household. Studies by Danlami (2019) and Ismail and Khembo (2015) disapprove of this statement. They concluded that marital status does not have an impact on the factors that influence fuelwood consumption because households led by married partner or couples living together are likely to combine their income and share the expenditure among themselves.

2.6.9. Expenditure of electrical appliances and high energy traffic rates

The high cost associated with buying electrical appliances is one of the reasons why low-income households are failing to make an effective transition to modern energy fuel such as electricity (Shackleton *et al.,* 2007). Vulnerable and marginalised households favour the use of fuelwood because it is traditional, readily available, and easy to harvest. According to Uhunamure *et al.* (2017), household appliances require frequent maintenance or replacement, which is a major challenge because poor household are faced with the constraints of income burden. These constrained low-income families from transitioning to appropriate modern energy like electricity. Poor households will continue to depend on the use of fuelwood because it does not require much effort and maintenance (Semenya & Machete, 2019).

Wessels *et al.* (2013), emphasised that the situation of fuelwood dependence for disadvantaged households is exacerbated by the cost of electrical appliances and high electricity tariffs. The author further explained that although an immense number of households are connected to the nationwide electrical grid in South Africa, they are still confronted with enormous challenges of purchasing electricity. This is the reason why electricity is being used exclusively for lighting and fuelwood for cooking and water heating (Uhunamure *et al.*, 2017; Wessels *et al.*, 2013). Saeed (2009), also pointed out that the rise in electrical appliance price limits such families to use electricity exclusively. Thus, most households remain reliant on charcoal and wood for meeting domiciliary needs to save cost. Waweru (2014), highlighted that the cost of stoves needed for cooking is a serious hindrance influencing the choice of household fuel. The development of low-cost technologies such as stoves which are affordable by poor households could certainly be a way to alleviate fuelwood consumption (Onyeneke *et al.,* 2015).

South Africa has faced significant growth levels in the consumption and demand for electricity, especially in urban areas. However, fuelwood consumption still plays a predominant role in many households particularly in rural regions where people are constrained by limited financial resources

(Uhunamure *et al.,* 2017; Matsika *et al.,* 2012; Preston 2012). The high energy tariffs hamper the exclusive transition of households to switch to electricity fully. Ogwuche and Asobo (2013), stated the high cost of electricity as the main culprit that prevented low-income homes to seek other energy alternatives, and as a result, they favour charcoal.

Makonese *et al.* (2018), postulated that high electric tariffs have compelled poor households to rely on other cheap and readily available energy alternatives such as fuelwood for cooking even though they have electricity. The authors also explained that the government should subsidise rural areas for them to be given better options in choosing household fuel. The cost of fuel can prominently encourage or discourage the factors that influence households to shift towards other supplementary fuel (Semenya & Machete, 2019). In comparison the sad reality is that electricity can be afforded by more privileged households unlike their counterparts who are struggling to make ends meet. Vulnerable families are faced with too much debt, constraints of income burden and high cost of energy which derails them from fully experiencing the beneficial opportunities that come with the usage of electricity (Moshoeu, 2017; Stiftung, 2016). As a last resort, Vulnerable households are obliged to seek cheap alternatives energy fuel like coal, wood and kerosene which remain hazardous to human health and are also required to be consumed in large quantities (Stiftung, 2016). The availability and accessibility of electricity continue to play a predominant role in the factors that promote the incorporation of fuel stacking (Lourens, 2018).

2.6.10. Availability of energy source

The availability of an energy source is an influential factor that determines the choice of household fuel to be utilised (Semenya & Machete, 2019). According to Ismail and Khembo (2015), many households prominently use traditional and unreliable energy source for domiciliary purposes because of the high cost of electricity which is beyond their reach. The author also cited Ferriel (2010), who pointed out that an estimated 2.5 million households within the rural and urban regions in South Africa are connected to the nationwide electricity grid. Sadly, out of the million who are connected to the grid, many households are unable to pay electricity bills. Likewise, in support of the statement above, Wessels *et al.* (2013), indicated that about 55% of the 2.4 million households in rural regions in South Africa are connected to the national electricity grid; however, 54% of rural households are still dependent on fuelwood as a fundamental energy source. This is because electricity requires frequent commitments such as monthly purchase of electricity, which is a constraint for vulnerable households with low revenues.

A study by Masekoameng *et al.* (2005) in Giyani rural communities, highlighted that more than 72% of the household's participants indicated the scarcity of energy resources, this compelled people to resort to other measures such as gathering dirty crop stalks. In some instances, the availability of energy sources is limited, and as a result, households use whatever they can find (Semenya & Machete, 2019). Energy is an essential basic component of human life, which drives social development (Ateba *et al.*, 2018; Masekoameng *et al.*, 2005). Nevertheless, a predominant number of households among rural regions struggle with the accessibility of adequate and economical energy source, hence there is a constant constraint of energy burden and inequality (Masekoameng *et al.*, 2005). Lourens (2018), pointed out that Vulnerable household in developing countries will attempt to meet their domestic needs by looking readily available alternative energy.

2.7. Fuelwood consumption trends with special focus on selected African countries

2.7.1. Nigeria

Fuelwood is an important energy source in Nigeria. Hence 95% of the total wood that is harvested in Nigeria is used as fuelwood to meet domestic needs such as cooking (Danlami, 2019; Ebe, 2014). Fuelwood consumption trends in Nigeria have over the years increased while in other developing states like South Africa has virtually decreased (Orimoogunje & Asifat, 2015). According to Gatama (2015), in 1994, Nigeria had the highest fuelwood consumption rates in the West African sub-region. It has been stated that daily fuelwood consumption in Nigeria by rural homes is approximately 27.5 million kg/day (Zaku, 2013). This makes fuelwood consumption a grueling task with devastating consequences for both social wellbeing of collectors and the environment in general as both are endangered (Danlami, 2019; Zaku, 2013). According to Orimoogunje and Asifat (2015), the high increase in fuelwood dependency is the result of high price tariffs of other energy alternatives such as paraffin, electricity, and LPG (Orimoogunje & Asifat, 2015). Another reason that has greatly exacerbated fuelwood consumption is the rapid growth rate of population in Nigeria which has contributed to severe deforestation and subsequently the conversion of forestry lands into agricultural lands (Orimoogunje & Asifat, 2015; Gatama, 2014). This has promoted extensive fuelwood consumption in this country has resulted in fuelwood scarcity, desertification, and economic burden for low-income households. They must either purchase fuelwood at certain price or endure long distance to the forest in search of fuelwood (Danlami, 2019; Gatama, 2014).

2.7.2. Ethiopia

Ethiopia is another country that is distinguished by its high dependency on biomass energy as over 92% of the population remain massively reliant on traditional biomass as a primary source of energy for meeting domiciliary needs such as cooking and other energy-related chores (Urge & Feyisa, 2018; Truneh, 2014). Although households also depend on other substitutional energy sources like charcoal, agricultural residues, dung, paraffin, electricity, and LPG, they are not as dominant as fuelwood (Feyisa *et al.*, 2017). Fuelwood consumption accounts for approximately 99% of all energy demand in rural areas, whereas manure and agricultural debris accounts for 12% and 9% respectively (Urge & Feyisa, 2018; Feyisa *et al.,* 2017). Furthermore, the Ethiopian biomass energy consumption is estimated to be 105,172,465 tons per year (Feyisa *et al.*, 2017). This is a clear indication of Ethiopia's poor socio-economic status (Truneh, 2014). Like in many developing countries, fuelwood in Ethiopia is mainly used for cooking, water heating and lighting (Urge & Feyisa, 2018). Fuelwood is highly significant in Ethiopia, and most people source it from different places such as non-private forest, private plantation and fuelwood market sellers (She, 2014). Substantial dependence on fuelwood has resulted in negative environmental impacts such as deforestation, forest degradation, loss of biodiversity and promotion of climate change (Urge & Feyisa, 2018).

2.7.3. Kenya

Kenya is a country that is forest poor as its forest only accounts for 5.9% of the total area and of this forest, 41% is the closed canopy indigenous and plantation or mangrove forests (Wambua, 2011). Over the years, Kenya lost an estimate of 8% of its indigenous forest to overexploitation by local residents (Wambua, 2011). Traditional biomass which is a primary energy source in Kenya plays an important role in meeting the domestic needs of the majority of households as it accounts for 80% of total energy consumption (Gatama, 2014; Wambua, 2011). Just like other developing countries, biomass dependency is high especially in rural areas where poverty pose significant impediments such as increasing pressure on the current forest to sustain almost 700 persons per square kilometer of the population density within its vicinity (Wambua, 2011). Kenya also uses other energy alternatives such as electricity and petroleum products; however, traditional biomass remains a dominant source of energy among households (Gatama, 2014).

2.7.4. Tanzania

Tanzania had a population of 54.2 million people in 2018, yet only a small fraction of that population (about 2%) has access to clean energy, and the rest is energy-deprived (National Bureau of Statistics Dodoma, 2019; Scheid *et al.,* 2018). Energy poverty among poor households in Tanzania has resulted in high levels of fuelwood consumption; this has aggravated deforestation, fuelwood scarcity and land degradation as the country has lost a staggering estimation of 370000 ha per year (Scheid *et al.,* 2018). Furthermore, it is estimated that the annual wood fuel consumed in Tanzania is 44.8 million m^3 (Magembe *et al.*, 2015). This is emanating from high reliance on traditional biomass. Traditional biomass accounts for 91.6% whereas petroleum products and electricity accounts for 6.8% and 1.6% respectively (Gatama, 2014). Fuelwood dependency alone in Tanzania is 89% and given the fact that 75% of the Tanzanian population resides in rural areas, fuelwood consumption for domestic purposes is more than 25,832,702 m^3/year (Magembe *et al.*, 2015; Scheid *et al.,* 2018). Additionally, 96.6% of harvested fuelwood is used for cooking purposes while 3.4% is used for lighting purposes, especially in rural households (Magembe *et al.,* 2015). All these actions of overexploitation of natural resources by the local community have resulted in Tanzania losing a significant vast amount of forest between 2010 and 2015 (Scheid *et al.,* 2018).

2.7.5. Uganda

Uganda is a country that is characterised by richness in renewable energy sources, however due to the high dependency on biomass the country is contradictorily regarded as an energy-poor country (Egeru, 2014). Over 90% of the household's energy source is derived from biomass (FAO & UNHCR, 2017). Fuelwood, which is the most dominant and primary energy source, accounts for over 95% of all domestic energy used in homes and diminutive business like that of brick-making, food processing and rubber production (Abigaba *et al.*, 2016; Egeru, 2014). It has also been reported that due to the lack of government and private sector's initiatives in raising awareness of sustainable fuelwood harvesting and promoting the use of clean energy and efficient stoves, fuelwood consumption and supply in 2015 was more than 75% of the total energy consumed in Uganda (FAO & UNHCR, 2017; Egeru, 2014). Furthermore, in the same year (2015), the consumption and production of wood fuel were approximately 42.4 million m^3 and 1.06 million tons for fuelwood and charcoal respectively, which indicates that 95% of the wood fuel that is consumed in Uganda is in a state of fuelwood (FAO & UNHCR, 2017).

Uganda also uses fuelwood in combination with alternative energy sources such as electricity, charcoal, LPG (Bizzarri, 2009). Charcoal is widely used in urban areas, whereas fuelwood is mostly used in rural households. Equally important is the fact that due to increasing population growth, which is estimated to be 130 million by 2025, the availability of wood will be reduced significantly and poses serious challenges to those who are primarily dependent of it to sustain themselves (Egeru, 2014). This will also exacerbate the annual forest cover loss, which has been significantly reduced over the years as 2.6 million hectares of forest cover has been lost between 1990 and 2015 (FAO & UNHCR, 2017).

2.8. Fuelwood consumption trends from outside south Africa

2.8.1. Bangladesh

Bangladesh is one of the poorest and most densely populated countries worldwide with a population of about 144 million and the population growth density of 1.54% per annum (Jinia, 2014; Foysal *et al.*, 2012). Over 19 million people in Bangladesh directly depend on trees and forest to meet their domestic needs and to support their livelihoods (IOM & FAO, 2017). With the combination of high population growth densities, decreased land and high dependency on wood as a primary source of energy, sustainable forest management remains a challenging burden that derails economic and social growth and further exacerbates the decline of traditional biomasses (IOM & FAO, 2017; Foysal *et al.*, 2012). Energy resources in Bangladesh consist of commercial and traditional biomass. Traditional biomass includes fuelwood, charcoal, dung, and agricultural residues which are used mainly for cooking (Jinia, 2014; Foysal *et al.*, 2012). An estimate of over 92% of rural households relies on traditional biomass for cooking, and fuelwood consumption for cooking in rural areas accounts for 72% (Toufique *et al.*, 2018). Furthermore, 98% of the population in rural areas of Bangladesh continues to utilise traditional biomass-burning stove for cooking despite the availability of natural gas, kerosene, electricity, and promotion of LPG (Toufique *et al.*, 2018; Foysal *et al.*, 2012).

2.8.2. Brazil

Brazil is an industrialised and diverse country that is characterised by the Amazon River basin which includes vast tropical forests and a continental area of 8.5 million km^2 (Gils *et al.*, 2017; Pereira *et al.*, 2011). It is also one of the largest countries in South America and Latin America, ranking at fifth place globally in a territorial area with a considerable large population of 190 million people in 2010 (Gioda, 2019). The energy demand and supply in Brazil is obtained from hydropower and biomass, which accounts for 60% and 10% respectively (Gils *et al.*, 2017). Other dominant energy supplies include fossil fuel, mainly oil and gas which accounts for 36% and 14% respectively (Gils *et al.*, 2017). Nevertheless, traditional biomass remains a principal source of energy among the majority of rural households in the residential energy sector due to lack of access to electricity and limited supply of other energy sources (Pereira *et al.*, 2011). Almost 10 million people in Brazil are dependent on traditional biomass for cooking which correlates to an estimate of 5% of the total country's population (Coelho *et al.*, 2018). Although the government of Brazil is promoting and subsiding LPG among rural households, fuelwood alone accounts for 49% for the energy supply in homes (Gonçalves & Rodrigues, 2019; Coelho *et al.*, 2018). In 2017, an increase of 17.6% of fuelwood was consumed for cooking in comparison with the 16.1% of fuelwood consumed in 2016 (Gioda, 2019). Such dependency on traditional biomass threatens Brazil's sustainable development as extensive burning of biomass contribute to climate change through the emission of greenhouse gases generated in the residential sector (Gioda, 2019).

2.8.3. China

China is distinguished by the clear geographical patterns of its mountains, which accounts for over 70% of its national territory (Wei *et al.*, 2012). The large forestry and extreme agricultural areas which enhance remoteness of most rural households, make it difficult for rural households to access modern energy, resulting in biomass being an essential component of the rural household framework (Chen, 2017). China has a high number of people who reside in rural areas, and in 2016; China had a rural population of 589.7 million people (He, 2018; An *et al.*, 2014). Currently, traditional biomass represents a crucial source of fuel for the residential sector in China and forms an important aspect of China's energy consumption structure and development (Chen, 2017; An *et al.*, 2014). Despite its rapid wealth and extreme economic growth of over 30 years, the Chinese government is still faced with a serious challenge in their plight to alleviate poverty and energy poverty in rural households, which has been experiencing heavy reliance of traditional biomass for domestic needs (Démurger & Fournier, 2011; Pereira *et al.*, 2011). Factors such as geographical difference, vast territory, economic, social, and environmental conditions play a significant role in the type of energy that is utilised by rural households of China (He, 2018; Wei *et al.*, 2012). About 60% of rural households in China are dependent on traditional biomass for cooking and water heating (He, 2018). Furthermore, an estimated 89.4% of traditional biomass which includes agricultural residue, animal dung, and woody biomass is consumed for domestic purposes such as cooking, water heating and lighting (Chen, 2017). Fuelwood or straw remains the primary energy source for the majority of households in China because of factors such as simplicity and sufficient availability (He, 2018). Fuelwood alone in rural household accounts for 55.22% of the total energy consumed in China (Zou & Lou, 2019). The fuelwood consumption in rural households of Southwest and Central China accounts for 76% and 70% respectively (Zou & Lou, 2019). Such dependency on fuelwood threatens China's sustainable development and can result in fragmentation of natural resource such as forest and biomass utilisation (Chen, 2017).

2.8.4. India

India is home to over 240 million households, and is a country concentrated by a high number of people who are dependent on traditional biomass for meeting their domestic needs such as cooking and water heating (Sharma, 2018). Hussain *et al.* (2017), reported that approximately 92% of the rural households in India depend on biomass for cooking. In addition, an estimate of over 100 million people are deprived of LPG as a source of domestic energy which results in biomass, especially fuelwood being a survival commodity among poor and indigent households (Sharma, 2018; Hussain *et al.,* 2017). In rural households in India, LPG is seen as a luxury that most homes only use when guests are visiting (Dhanai *et al.,* 2015). Fuelwood predominates these rural households accounting for over 77% of household energy used for cooking, because of its affordability, availability, accessibility, and simple usage (Hussain *et al.,* 2017; Dhanai *et al.*, 2015).

Annually fuelwood consumption in India is 216.4 million tonnes per year, which is consumed by approximately 854 million people (Sharma, 2018). In the mountains of Himalaya, commercial energy including kerosene and electricity is rarely used and only accounts for 1.41% of the total energy due to it being out of reach for many households. Inaccessibility, restriction of resources and poor socio-economic conditions also restrict the usage of commercial energy (Dhanai *et al.*, 2015). Fuelwood is locally harvested from the forest, and around communal lands by mostly women (Sharma, 2018; Onyeneke *et al.,* 2015). Society generally regards women as people who should be responsible for cooking, hence fuelwood is harvested by women who spend over 374 hours collecting fuelwood for domestic chores around the house (Ateba *et al.*, 2018; Sharma, 2018; Onyeneke *et al.,* 2015). The extensive fuelwood consumption for cooking and water heating as a result of limited options especially in the mountains of Himalaya has resulted in overexploitation and encroachment of the forest, which has increased loss of forest cover and further promoted fuelwood scarcity (Hussain *et al.,* 2017; Dhanai *et al.,* 2015; Tahir *et al.,* 2014). The loss of forest and fuelwood scarcity has devastating impacts on rural households as they must walk long distances in search of wood (Uhunamure *et al.*, 2017). They also must invest the little money that they have on obtaining the fuelwood for domestic needs (Tahir *et al.,* 2014; Uhunamure *et al.,* 2017).

2.8.5. Mexico

Mexico is another country where traditional biomass still plays a significant role in the residential fuel sector, despite the Mexican government's effort in subsidising and promoting the use of LPG and other modern energy sources (Serrano-Medrano *et al.,* 2013). While there is a variety of biomass fuel that a household can use, fuelwood remain a primary source of traditional energy for cooking and water heating especially in rural households and semi-urban areas (Manning & Taylor, 2014). Fuelwood in rural household's accounts for almost 40% of the total residential energy consumption due to its availability, zero momentary cost and easy use (Serrano-Medrano *et al.,* 2019). As a result of its affordability, fuelwood has been extensively harvested, and fuelwood consumption has reached 19.4 million tons of dry matter in 2010 (Serrano-Medrano *et al.,* 2019).

CHAPTER 3: METHODOLOGY

This chapter describes and explains the research methods and instruments that were used to conduct this research. The chapter first introduces the study area and gives a full description of the Thulamela Local Municipality.

3.1. Study area

The Thulamela Local Municipality is situated within the Vhembe District and is located on the northern region of Limpopo, in South Africa (Figure 3.1) (Thulamela Municipality IDP, 2018).

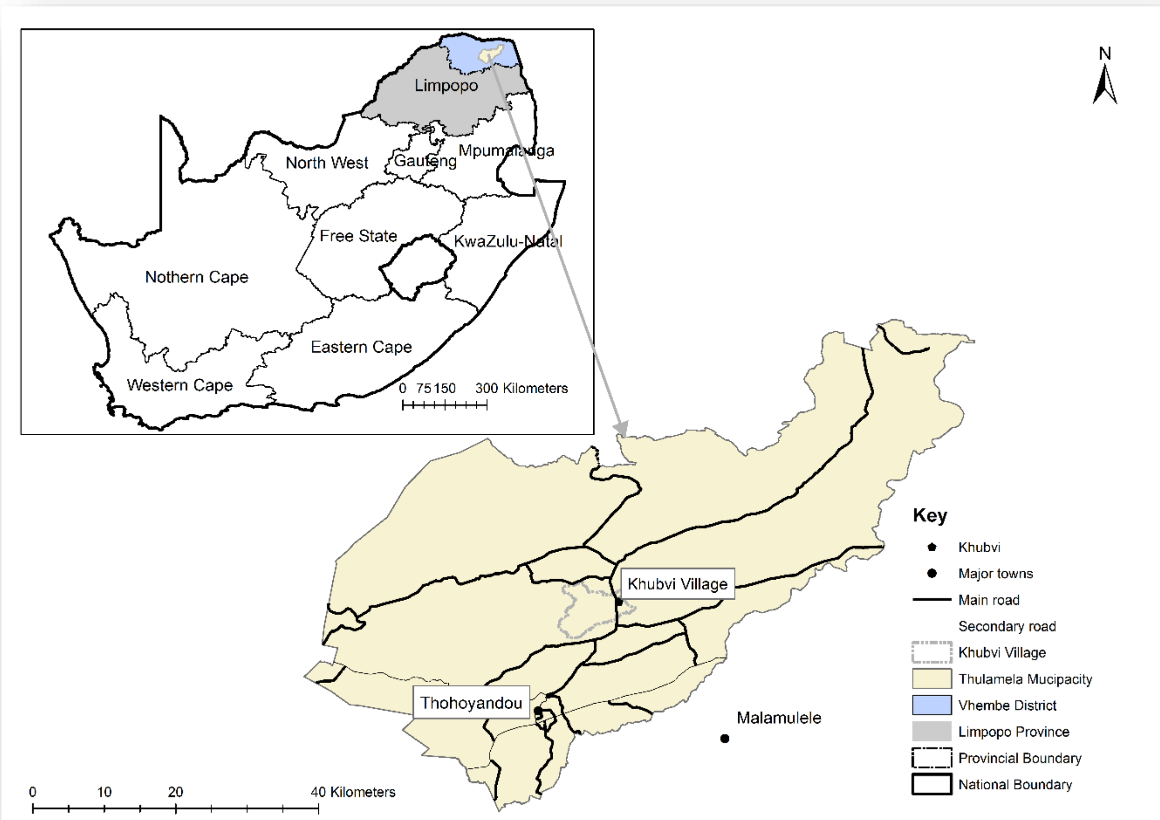

Figure 3. 1: Depicts the map of the study

(Source: Thulamela municipality final IDP, 2018)

3.1.1. Location and population of the study area

Limpopo is one of the nine provinces in South Africa that is located on the northern region of the country and shares borders with Botswana, Zimbabwe, and Mozambique (StatsSA, 2018). The province is divided into five district municipalities, namely Mopani, Vhembe, Capricorn, Sekhukhune, and Waterberg (StatsSA, 2018). Limpopo has 22 local municipalities and a population of approximately 5.8 million in 2016 (StatsSA, 2018). Within the Vhembe district municipality, there are four local municipalities, namely Musina, Thulamela, Makhado and Collins Chabane municipalities (Vhembe District Municipality 2019 IDP, Review).

The Thulamela Local Municipality which is the focus of this study is a Category B municipality that is situated in the eastern part of the Vhembe District and is further located on the northern region of Limpopo Province, in South Africa (Thulamela Municipality IDP, 2018). Thulamela Local Municipality lies approximately between longitudes 22° 57' S and latitudes 30° 29' E (Thulamela Municipality IDP, 2018). In terms of the population, the Thulamela local municipality is the second largest of all the municipalities in Limpopo, with the population size of 497 237 and 130 320 number of households (StatsSA, 2018; Thulamela Municipality IDP, 2018). The total land mass coverage is 2 893.936 km^2 (Vhembe District Municipality 2019 IDP, Review). The research was conducted in Khubvi Village, which forms part of the municipality. Khubvi Village has an appropriate population size of 10271, and the number of households is 2,519, with an area coverage of 11.50 km^2 and GPS coordinates are 22.8302S, 30.56' 13"E (StatsSA, 2018). Most of the people from the Khubvi Village speak the *Tshivenda* language.

3.1.2. Climate

The Thulamela Local Municipality’s climate is usually subtropical and distinguished by its climate variability (Thulamela Municipality IDP, 2017). The average rainfall in the Thulamela municipality ranges from 300-1000 mm per year of which 87.1% falls between summer months (October and March) (Thulamela Municipality IDP, 2017; Uhunamure, 2015). The municipality’s complex topography influences annual rainfall patterns with effects from the Soutpansberg Mountains, which has a great impact on the weather conditions within the municipality (Thulamela Municipality IDP, 2017). The temperature in Thulamela municipality varies with the seasons. During summer, the temperature ranges from 17° and 27^{o}C and can reach as high as 45^{o}C in some areas, and in winter seasons the average temperature is between 4° to 20°C (Uhunamure, 2015).

3.1.3. Topography and Drainage

The complex topography of the Thulamela municipality influences the climatic conditions within the region (Thulamela Municipality IDP, 2017). The topography flows with distinguishable and prominent mountains such as the Soutpansberg Mountains which forms the majority part of the northern border of Thulamela local municipality (Louw & Flandorp, 2017; Uhunamure, 2015). The municipality is composed of the granite gneiss of the Precambrian age, which is a metaphoric rock that is formed by high temperature and pressure, and not easily eroded (Mulugisi, 2017; Uhunamure, 2015). Because of this complex topography, the municipality is more prone to high rainfall (Mulugisi, 2017).

The Thulamela Local Municipality is distinguished by its well-drained perennial rivers which include the Mutale, Mutshundudi, Mutangwi, Tshinanne and Luvuvhu rivers (Uhunamure, 2015). The area also consists of several catchment areas such as the Limpopo River, Luvuvhu and Mutale catchments which supply water for agriculture, human consumption, and mining activities. (Thulamela Municipality IDP, 2017). All the rivers mentioned above flow into the Limpopo River, which is the largest catchment in the Vhembe district followed by the Luvuvhu catchment (Thulamela Municipality IDP, 2017; Uhunamure, 2015). The Limpopo River serves a crucial task of supplying water to nearby residents within the Vhembe District and the river also provides sustenance within the hot and drylands through its gently meandered shape (Thulamela Municipality IDP, 2017).

3.1.4. Geology, soil and vegetation

The municipality area is covered by quarzitic sandstone, shale and sandy shale which are usually shallow, gravelly, and well-drained of the Fundudzi formation. (Louw & Flandorp, 2017; Uhunamure, 2015). The municipal area is further characterised by the desperation of different types of soil such as clay soil, loamy soil, sandy soil, and silty soil which are mostly dispersed with in the river valley (Uhunamure, 2015).

The Thulamela Municipality is rich in biological diversity of both flora and fauna (Thulamela Municipality IDP, 2017). Among the municipality, various vegetations include different kinds of biomes such as the grassland, savanna, and forest biomes (Thulamela Municipality IDP, 2017). Furthermore, among the vegetation covers, there are also trees and the most noticeable are the acacia species which include acacia Siberian, Acacia Tortilis, Acacia Caffra, and Mopani (Mulugisi, 2017). Other trees species are Dichrostachyscineria, Selerocaryabirrea and Annona senegalensis, etc. (Mulugisi, 2017; Uhunamure, 2015). Another distinct feature is the sacred forest and lake such as the Thathe Vondo and Lake Fundudzi which are not open to tourism development (Anyumba & Nkuna, 2017). Lastly the municipality has naturally protected areas that include the

Kruger National Park (Thulamela Municipality IDP, 2017). The vegetation cover helps with the protection of the soil and preventing excessive surface water run-off (Mulugisi, 2017).

3.1.5. Economic Activities

The people in the Thulamela Municipality are highly dependent on agriculture, livestock, mining, and manufacturing activities (Uhunamure, 2015). The agricultural sector in the municipality is characterised by profitable commercial farming as well as small scale and subsistence farming (Louw & Flandorp, 2017). The municipal area has numerous agricultural schemes such as the projects to produce products like bananas, mango, avocados, maize, cotton tea, coffee, and macadamia nuts (Thulamela Municipality IDP, 2018). The irrigation schemes produce a significant share of income for Vulnerable households within the municipality, which helps with the eradication of poverty (Louw & Flandorp, 2017). There is also livestock farming within the municipality which include cattle, chicken, and goat farming (Uhunamure, 2015).

3.1.6. Energy supply

The electricity in South Africa is distributed to residential sectors by the state-owned utility provider Eskom, which is responsible for 96% of the overall electricity produced and supplied in South Africa (Thulamela Municipality IDP, 2017). Within the Thulamela Local Municipality, approximately 156594 households are connected to the electricity grid, 10400 households have no access to electricity whereas 1158 households are supplied through solar energy systems (Thulamela Municipality IDP, 2019). According to StatsSA (2018), approximately 91.5% of households in Limpopo are connected to the national electricity grid, however only 42.9% of households within the Thulamela Local Municipality use electricity for cooking. Hence, 57.1% of households are dependent on other energy alternatives such as solar, gas, fuelwood, kerosene, coal, agricultural residues, and animal dung (Thulamela municipality final IDP, 2018). Consequently, 96.6% of households within the municipality uses electricity exclusively for lighting and fuelwood is used for cooking and water heating (StatsSA, 2018; Uhunamure *et al.,* 2017). Furthermore, in the majority of Villages within the Thulamela Municipality such as Khubvi, electricity and fuelwood are predominant, yet fuelwood is the most preferred energy source used to meet domestic needs such as cooking and water heating because it is readily available and easy to access.

3.2. Design of the study

A research design is a master plan or a blueprint which includes the steps of how the researcher intends to carry out their research (Mbulayi, 2014). This study used a mixed research approach comprising of both quantitative and qualitative information through survey and participant observation (Leedy & Ormrod, 2015). Survey research encompasses gathering knowledge from one or more groups regarding their characteristics, attitude, beliefs, experiences, and perspective by asking them questions and enumerating their answers (Leedy & Ormrod, 2015; Creswell, 2014). The generated data was summarised through statistical analysis. The main goal in survey research is to learn more information about the current sample of the population investigated, hence this method was the most preferred because it allowed data gathering through a questionnaire used in data collection (Leedy & Ormrod, 2015). Participant observation is a classical qualitative approach where the main focus is on the everyday natural experiences of the respondents (de Vos *et al.,* 2005). The researcher also used this tool for data collection because it allows the researcher to gather real-life information from participants that could not be gathered from the literature review or administered questionnaires (Leedy & Ormrod, 2015; Uhunamure, 2015).

3.2.1. Mixed-Methods approach

The mixed-methods approach entails the involvement of both quantitative and qualitative research approach in different aspects of the research process in either a single study or multi-phased study, which can answer different kinds of questions (Leedy & Ormrod, 2015; Creswell, 2014; de Vos *et al.,* 2005). Majority of these studies enlist the use of triangulation as a way of linking both quantitative and qualitative approaches (de Vos *et al.,* 2005). In triangulation, different sources of data are utilised for data collection to build a coherent justification that will support the theory (Leedy & Ormrod, 2015; Creswell, 2014). According to Kimemia and Annegarn (2011), "triangulation is not aimed merely at validation but at deepening and widening a researcher's understanding". The approach is mainly used in qualitative research design, where the researcher uses fieldwork and in-depth interviews from participants to look for consistencies or inconsistencies that will appear in the data collection (Leedy & Ormrod, 2015). A good advantage of using both quantitative and qualitative research methods is that the data collection methods augment each other, which results in a powerful argument producing valid and accurate conclusions (Leedy & Ormrod, 2015). Triangulation helps in the validation of the research as it enhances reliability, as bias inherent in data collection by the researcher is nullified (de Vos *et al.,* 2005). The use of a mixed-method approach in this research helped to mitigate the risk of internal validity as the approach addressed the main strength and limitation of each research approach (Mncube, 2006).

3.2.2. Quantitative research approach

The quantitative research approach entails the process of counting, describing, analysing and interpreting and summarising results of the study (Masekela, 2019; Creswell, 2014). The approach tests the objectives theories by evaluating the relationship among variables and then uses the results to validate or revise the current theories (Creswell, 2014). This study adopted the quantitative research approach because the researcher seeks to evaluate the factors that influence fuelwood consumption within households with the overall aim of answering the research objectives and validating the current literature. Fundamentally, the research method determined the factors that influence fuelwood consumption within households in Khubvi Village using the statistical method. Data was gathered through questionnaires and the obtained data was measured and analysed using statistical procedures and in this case, SPSS version 25. The main strength of using a quantitative research approach is that it enables the researcher to reach a large sample size with accuracy, precision, control, and credible outcomes through statistical analysis (Mncube, 2006). The control was acquired through sampling and design whereas precision was obtained through credibility and validity obtained through quantitative measurement. However, the quantitative research approach has several limitations, and one of this limitation is that it fails to consider the meaning behind the social phenomenon. It does not take into consideration the feelings, choices, human endeavors, attitudes, and perceptions behind an action; rather it is interested in the measurement of a variation (Kumar, 2011; Mncube, 2006). To minimise and address this limitation the researcher incorporated the qualitative research approach, which is concerned with people's perception and, attitudes regarding the factors that influence fuelwood consumption (Mncube, 2006).

3.2.3. Qualitative research approach

The qualitative research approach entails sampling of people whom the information will be gathered from, the participant viewpoint on action to be investigated in real-life setting (Masekela, 2019; Kumar, 2011). The approach is highly focused on learning about the phenomenon to be explored instead of the numeric measurement and depends on participant observation, focus groups and in-depth interviews of participants to conclude a situation (Adejimi, Oyediran & Ogunsanmi, 2010; Mncube, 2006). The main strength of using qualitative research approach is that the researcher can immerse themselves in a complex situation to directly observe, explore, discover and clarify the trends, situations, characteristics, attitudes, and perceptions regarding the sample to be investigated (Leedy & Ormrod, 2015; Kumar, 2011). This study opted to incorporate the qualitative research approach in the research design because the researcher seeks better understanding regarding the factors that influence fuelwood consumption in households through a personal view which cannot be achieved through quantitative research approach (Leedy & Ormrod, 2015). Two of the limitations of using a qualitative research approach is that the process tends to select a smaller sample of participants whom the information will be gathered from, which does not generally represent a large population (Kumar, 2011; Mncube, 2006). Due to the adaptability and inadequacy of control during data collection, it is difficult to verify if the researcher was biased with participants.

3.2.4. Research tools

Research tools refer to the procedures which the research will utilise to carry out the study (Mbulayi, 2014). Data collection tools that were used in this research were semi-structured closed and open-ended questionnaires (comprising of both quantitative and qualitative questions). The tools also consisted of participant observation and secondary data which included published and unpublished government articles, statistics, academic books, and journals related to household energy consumption and factors that influence fuelwood consumption.

3.2.4.1. Primary research methods

3.2.4.1.1. Participant Observation

Participant observation is a classical qualitative approach where the main focus is on everyday natural experiences of the respondents and the data that is collected using participant observation cannot be reduced to figures (de Vos *et al.,* 2005). A participant observation tool was used for the researcher to engage with participants and observe their daily patterns. The researcher used various observations techniques which included (1) the researcher as a participant- the researcher took notes, observed, and participated in the interviews and questionnaires filling during the household survey process. (2) Total researcher – the researcher silently observed the harvesting process by the residents. The researcher observed the group patterns and dynamics through transect walks. The researcher would accompany the household heads to collect fuelwood in the case where fuelwood was self-harvested in the mountains or communal lands. The researcher also observed the trends of those who went to collect fuelwood, how long it takes, the time they wake up to go and harvest fuelwood, where do they collect fuelwood, what do they do once they arrive at their estimation, how do they choose their fuelwood and which type of trees they prefer for fuelwood use.

The researcher observed that people usually harvest fuelwood in the morning around communal lands or mountains. It usually takes between 1-2 hours to go to the area where fuelwood is harvested and to, choose the preferred trees to be harvested. Also, the researcher observed that some of the households do not go to the mountains or forest to harvest fuelwood, but instead, they hire a truck to deliver fuelwood for them monthly. Each load for fuelwood costs less than R500 depending on the distance from where the fuelwood is harvested to where it is delivered. Furthermore, other households chop trees in their yards and wait for them to dry. Once dry, they use them for cooking and water heating.

Five households were available for transitional walks. These transact walks were based on the availability or willingness of the household to be accompanied by the researcher to the place where fuelwood was harvested. The transact walks were arranged on time and mostly done with household heads, and in this case, all the participants accompanied were women. During the transact walks the researcher observed that people usually harvest fuelwood in the morning around the communal lands or mountains. The fuelwood collection sites were recorded and identified.

3.2.4.1.2. Semi-Structured Questionnaires

Questionnaires are research tools that consist of a set of questions on a form used for gathering information and must be completed by the participant (de Vos *et al.*, 2005). A semi-structured interview is a strategised interview where the interviewer asks slightly predefined questions which gives allows the researcher to regulate the structure of the questions and for the participants to have an option to broaden their interpretation about a certain phenomenon rather than depend on concepts planned (Grimsholm & Poblete, 2010). The research made use of a semi-structured questionnaire consisting of both closed and open-ended questions (Appendix B). Both closed and open-ended questions were used because they permit an unlimited number of questions to be asked with possible adequate answers. These questions also allow the participants a chance to supply additional information not included in the structured questions (Hainduwa, 2013; de Vos *et al.*, 2005).

A household survey was conducted in Khubvi Village on 173 households for one week from the 18th of March 2020 to the 26th of March 2020 to generate data regarding the factors that influence fuelwood consumption. The researcher explained the purpose of the study before the data collection process could commence. Preliminary pilot questionnaires were handed out to the residents using six questionnaires to see if the method chosen will work and if there is a need for additional information that needs to be added or modified on the questionnaires to ensure that errors are immediately rectified. This pilot also helped to check if the questions asked were too long for the respondents to answer. After the piloting process, some sections of the questionnaires were changed. Thereafter, questionnaires were distributed among residents for them to fill. The interview lasted for approximately 20 minutes. The questionnaires were divided into three sections, namely:

- Demographics (age, gender, race, marital status, level of education, employment and occupation);
- The type of energy used by the households for cooking, lighting and water heating (electricity, fuelwood, solar, paraffin, coal and liquefied petroleum gas);
- Factors that influence household energy use (age, gender, number of cooking times, level of education, household size, cost of energy, taste, and preferences).

3.2.4.2. Secondary data

The secondary data refers to information that already exists and has been collected already by someone else (Leedy & Ormrod, 2015; Mncube, 2006). This data includes information from documents such as government gazettes, annual government statistics reports, magazines, academic books, journals, newspaper, and media reports. The secondary data that was used in this study included government articles, government statistics reports, academic books and journals related to household energy consumption and factors that influence fuelwood consumption. The information was integrated with data obtained from questionnaires, in an attempt to add any other nuances that might reside in these sources.

3.2.5. Sampling method and sample size.

A sampling method is predetermined before data collection. Sampling refers to the process of selecting a representative sample of the population to be studied (de Vos *et al.*, 2005). This study made use of the probability sampling method. In probability sampling, a representative sample is chosen from the overall population by random selection (Leedy & Ormrod, 2015). This ensures that every member of a population is given a chance to be selected. A probabilistic sampling technique called systematic sampling was used. In the systematic sampling technique, the individuals are assigned according to a sequence such as an interval, e.g. each fourth or fifth case (de Vos *et al.,* 2005). In this study, the household was systematically sampled in numerical order of one in every fifth household until the enumerator's allocation was complete, thus 50% proportional of the total households. Khubvi Village has a population size of 10 271, and the number of households is 2 519.

The sample population was obtained as follow:

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

Where; n =sample size, N= population size, e= Level of precision

At 95% level of precision :. p= 0.05

Thus;

$$n = \frac{2519}{1 + 2519\ (0.05)^2}$$

$$= \frac{2519}{1 + 6{,}2975}$$

$$= 345\ households$$

Since households were systematically sampled in the interval of 1 in every fifth household, then:

$$\frac{345}{100} \times 50$$

$$= 173\ households$$

A systematic sample of every 1 in 5th of the 345 households = 173. The total questionnaires that were distributed to the household heads were 173.

3.2.6. Data analysis

Data analysis is a process of systematically bringing order, structure and meaning in data to evaluate or recap the collected data (de Vos *et al.,* 2005. A household survey was used for data collection. A total of 173 questionnaires were administered by the researcher and research assistants to the selected households, the researcher ensured that they were correctly filled. The questionnaires were checked for gaps and incomplete information, and in cases were questionnaires were not filled, relevant participants were called to provide more information. The data from the open and closed-ended questionnaires were captured in Microsoft Excel then later transferred to SPSS. The data was mainly qualitative (nominal and categorical data). Therefore, the researcher used the frequency menu to summarise the data and cross-tabulation menu in SPSS version 25. For cross-tabulation, the researcher used the Chi-square (χ^2) test to measure the degree of association between two categorical variables. If the p-value is less than 0.05, there is a significant association between variables, i.e. the variables explaining each other.

Chi-square (χ^2) is formulated as follows:

$$x^2 = \varepsilon \frac{(o-e)^2}{e}$$

We take the square of the difference between the observed (o) and expected (e) values and divide it by the expected value.

This software was chosen for data analysis because of the many benefits it has such as the fact that the software is user friendly, it is mainly used for analysing survey data and grant relevant and detailed information. The software can also import data from other sources such as Microsoft Excel, cross-section, cross-tabulation and can analyse relationships between two or more variables (Gatama, 2014; Paura & Arhipova, 2012).

3.2.7. Data reliability and validity

Reliability refers to the stability and consistency in the data measured between two measures (de Vos *et al.,* 2005). Validity refers to the extent to which findings or conclusions measure accurately and corresponds with the concept or phenomenon it is intended measure (de Vos *et al.*, 2005). In this research, the researcher made use of a triangulation method. In triangulation method, different sources of data are utilised for data collection to build a coherent justification that will support the theory and check for the consistency and inconsistency on the data collected (Leedy & Ormrod, 2015; Creswell, 2014). According to Kimemia and Annegarn (2011), "Triangulation is not aimed merely at validation but at deepening and widening a researcher's understanding". To ensure that trustworthiness and authenticity are established through objectivity, the researcher followed four indicators used in the qualitative study as suggested by Guba and Lincoln (1985) in a framework which made a considerable contribution towards reliability and validity in qualitative paradigm (Kumar, 2011).

Table 3. 1: The proposed criteria and the "analogus" quantitative and qualitative criteria.

Traditional criteria for judging quantitative research	**Alternative criteria for judging qualitative research**
Internal validity	Credibility
External validity	Transferability
Reliability	Dependability
Objectivity	Confirmability

(*Source: Kumar, 2011*)

3.2.7.1. Credibility/ Internal Validity

Credibility/ internal validity refers to the extent to which the researchers can agree in the study findings and come to the same conclusions (Grimsholm & Poblete, 2010). A good example is whether a perfect match lies within their observations of a social setting (Kumar, 2011; Grimsholm & Poblete, 2010). This research was designed in a manner that seeks to achieve the aims and objectives of this study accurately and validating the current literature.

3.2.7.2. Transferability/ External Validity

Transferability refers to the extent to which findings can be generalised to other contexts (Leedy & Ormrod, 2015). For example, a selected representative sample concludes the population to be investigated. This research was only conducted in Khubvi Villge and could not spread out to neighbouring Villages due to budgetary constraints. The research was generalised based on the study findings, which showed the same trends and patterns from the sampled households. As a result, the study findings from Khubvi Village could be generalised to a broader range of social settings of other population groups.

3.2.7.3. Dependability/ Reliability

Dependability refers to the probability and consistency to which the phenomenon that has been investigated could yield the same results if observed or measured twice (Grimsholm & Poblete, 2010). This research used the same questionnaire in selected households throughout the whole process of data collection, which resulted in similar trends during data analysis. This ensured dependability/reliability.

3.2.7.4. Confirmability/ Objectivity

Confirmability refers to the extent to which results could be confirmed or corroborated by other (Grimsholm & Poblete, 2010). The captured was presented to the allocated supervisor who can confirm or corroborate the legitimacy of the collected data.

3.2.8. Ethical considerations

Ethics refers to the sets of standards or codes that govern the moral principles of professionals where certain conduct is considered acceptable (Kumar, 2011). This study followed the research ethics principles as outlined by the Ethics Committee of the University of South Africa (UNISA). The researcher sought and obtained approval to conduct the study from UNISA's research ethics committee (Appendix D). The researcher followed the necessary steps with regards to gaining permission from the Traditional Authority Council of Khubvi Village. Firstly, a meeting was set to meet the traditional authority council at the community hall to present a formal letter seeking permission to conduct research within Khubvi Village. After thoroughly reading the formal letter by the traditional council, a signed permission letter was granted to the researcher, as indicated in Appendix C. Secondly, before the administration of the questionnaires to the sampled households, an informed consent form was read out to participants to make sure they were aware of the voluntary nature of their participation. The participants had the choice to withdraw at any time or refuse to participate in the study. Both the participants and researcher signed a consent form which indicates that they have read and understood the nature of what was expected from them (Appendix A). Throughout the data collection process, the participant's information was kept confidential. The research was conducted in the vernacular language which made it easy for respondents to understand. The participants were made aware that the information obtained from the questionnaires will be kept for the duration of the research. Also, the information will be made available only to the researcher, supervisor, and people from the UNISA Ethics Committee should it be requested.

3.2.9. Project limitations

The researcher identified the following limitations, mainly related to data collection techniques that were used in this study. However, the acknowledgement of these limitations does not render in any way that the findings of this study are inaccurate.

- The study was limited to the factors that influence fuelwood consumption by households, as such, air pollution due to the emission of toxic gases such as carbon dioxide (CO_2) carbon monoxide (CO), sulfur oxides (SO_2) and nitrogen oxides (NO) was not investigated.
- The study was only conducted in Khubvi Village and could not spread out to neighbouring Villages due to limitations of the budget.
- Time and resources were the main constraints; as such, the research did not cover the variation of fuelwood consumption in different seasons.

CHAPTER 4: DATA PRESENTATION AND DISCUSSION

This chapter presents the main findings of the study. Data is presented in charts in accordance with their relevance in the study. The findings in this chapter form an important aspect of the research analysis on the socio-economic characteristics of people living within Khubvi Village. The information on factors that influence fuelwood consumption which includes amongst others, the socio-economic characteristics of households helped to facilitate the understanding of extensive fuelwood consumption, despite most households being electrified.

4.1. Socio-economic characteristics of the population

The sample comprised people of the 20-29, 30-39, 40-49, 50-59 and > 60 age groups. 62% of the respondents were females, while 32% were males. From Figure 4.3 the results indicated that 52.0% of the respondents were single, and the respondents had an education level ranging from some secondary to tertiary education. The socio-economic characteristics of the population are discussed later in detail in the following subsections:

4.1.1. Age of the household head

Findings on Figure 4.1 indicated that households are headed by the age group of people who are between 50-59 years (29.5%) followed by 40-49 years (28.9%), then by over 60 years and 30-39 years with both having 1(6.2%) and (16.2%) respectively.

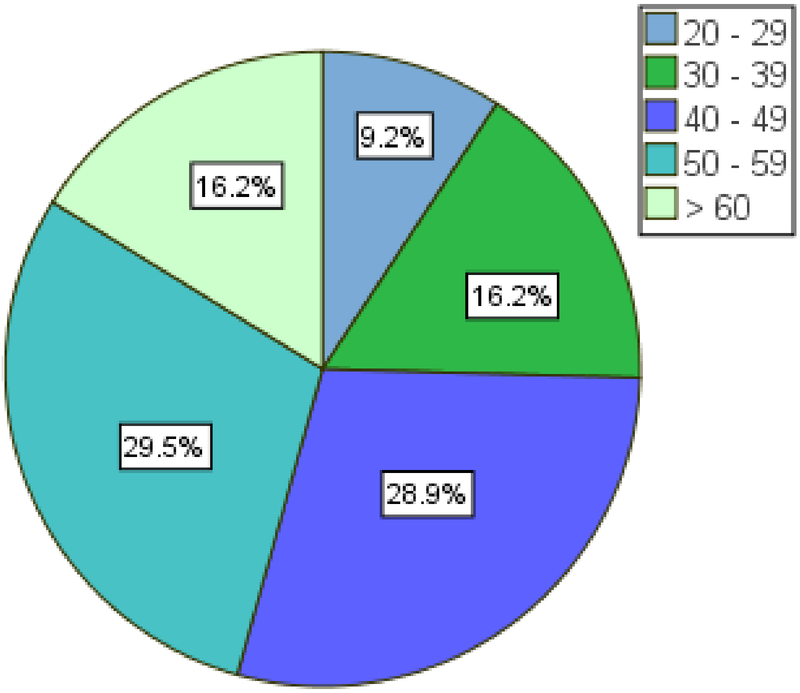

Figure 4. 1: Age of the household head

The least age group is that of 20-29 years which comprises of (9.2%) who prefer the use of fuelwood for meeting domestic needs. It was established that as the household head ages, especially the older members of the family prefer to use traditional biomass such as fuelwood, which also according to them gives better taste to food than food that has been cooked by electricity or other energy alternatives.

4.1.2. Gender of the household

Figure 4.2 showed that most people who were interviewed were females (61,85%) while males were in minority (38.15%). These results might be because females are entrusted with cooking responsibilities more than their male counterparts.

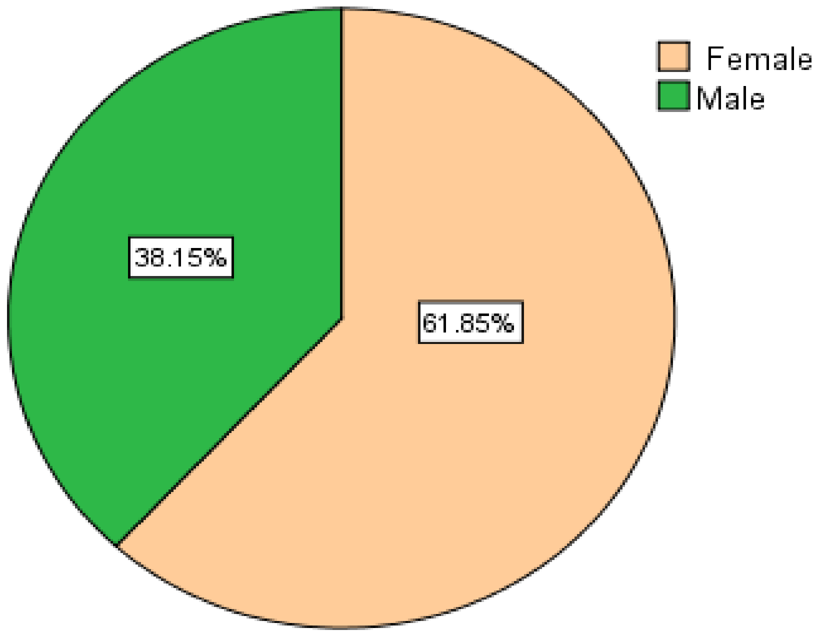

Figure 4. 2: Gender of the household

These results indicated that female respondents are more involved in deciding and sourcing fuel required to meet domestic needs. The findings of the current study are consistent with the conclusions of the results of literature review. For example, a study by Ateba *et al.* (2018) revealed that society perceives women as people who should be accountable for cooking, harvesting fuelwood and performing various domestic chores around the house. Hence, these women are liable for the decision-making process of energy choices within the household and are involved in sourcing and collection of fuelwoods.

4.1.3. Marital status

As indicated in Figure 4.3, the majority (52.0%) of participants were single, followed by married (39.3%), then widowed (8.1%) with the least number of people indicating that they were divorced (0.6%). This figure demonstrate that Khubvi Village is dominated by single-headed households, who are mainly dependant on fuelwood as a major source for meeting domestic needs.

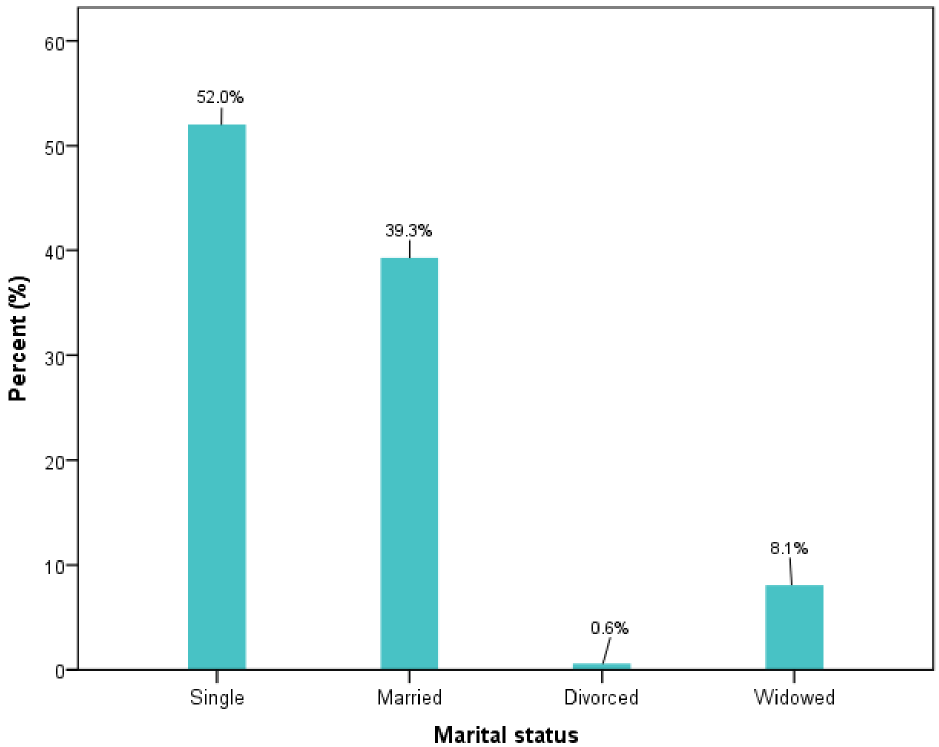

Figure 4. 3: Marital status

Most of these households can be regarded as being energy poor because even though they are connected to the electricity grid, they cannot afford to use electricity exclusively for meeting all their domestic needs. Families with one breadwinner are likely to endure more socio-economic challenges than families where two or more people are working because their combined salary can make a huge difference in sustaining the home.

4.1.4. Education of the household head

The study sought to understand if education plays a role in household energy use since literature review shows that education or environmental awareness is a significant factor that does influence the choice of energy used in households (Semenya & Machete, 2019; Ateba *et al.*, 2018; Uhunamure *et al.*, 2017; Malla & Timilsina, 2014). To achieve this, the study classified the level of education in categories, which range from no schooling to tertiary qualification.

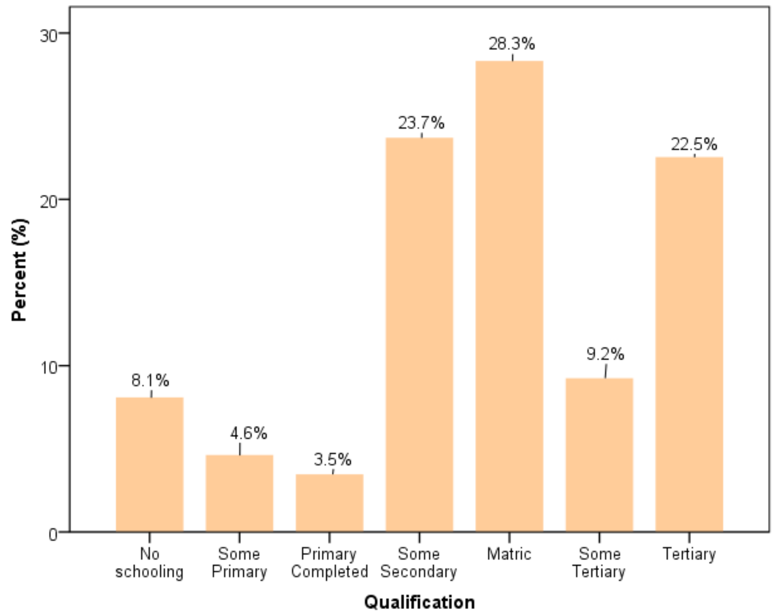

Figure 4. 4: Education of the household head

The results in Figure 4.4, indicates that (28.3%) of the respondents had National senior certificate (matric), followed by some secondary education (23.7%), then tertiary education (22.5%), then some tertiary education (9.2%) and finally no schooling, some primary and primary completed with both having (8.1%), (4.6%) and (3.5%) respectively. Although (28.3%) of respondents have matric certificates, this is not enough to get better employment opportunities. In the first quarter of 2020 south Africa had an unemployment rate of 7.1 million people (StatsSA, 2020). The high rate of unemployment results in decreased chances of employment for people with low educational attainment. Post-matric qualifications are a necessity for better employment opportunities with tangible benefits. The level of education doesn't not only yields in better employment opportunities but also influence the choice of household energy use as the level of literacy of the household head affects how a household is informed (Ateba *et al.*, 2018; Gatama, 2014; Ogwuche & Asobo, 2013).

While it does not require a person to be educated to realise that extensive fuelwood consumption results in environmental degradation and promote soil erosion, findings revealed that most people who use fuelwood for domestic needs could read and write. However, participants have different perceptions and attitudes regarding the kind of fuel to be used by the household. Findings of the study revealed that participants with low educational attainment perceived fuelwood as a natural resource that is readily available at no cost for anyone to use, which is why sometimes they tend to misuse it. While people with higher education attainment perceive trees as useful and valuable natural resources with tangible benefits. Hence, educated participants indicated that they favoured the use of modern energy technologies and preferred to conserve and protect the natural resources for future generations. However, due to the limited employment opportunities, they are forced to use fuelwood. Moreover, the level of education does not necessarily mean that educated people do not use fuelwood. The study found that educated and employed people still uses fuelwood to save money for other priorities such as education and health. Most people who use fuelwood for domestic purposes are fully aware of the consequences that can occur from the continued use of fuelwood such as accidental fires, indoor air pollution and environmental degradation from excessive clearance of fuelwood. It is evident that the educational background of a household head and limitation of financial incentives strongly impact on the choice of fuel to be used for domestic purposes. It can be argued that a combination of educational backgrounds and a decent income could mitigate excessive fuelwood harvesting.

4.1.5. Employment status

The study sought to evaluate whether employment status has an impact on the factors that influence fuelwood consumption. Figure 4.5 depicts the overall employment status of the participants. 59.5% of the overall participants were employed, followed by (39.9%) of unemployed participants and (0.6%) of those who could not specify which category they fall in since the rely on temporal jobs.

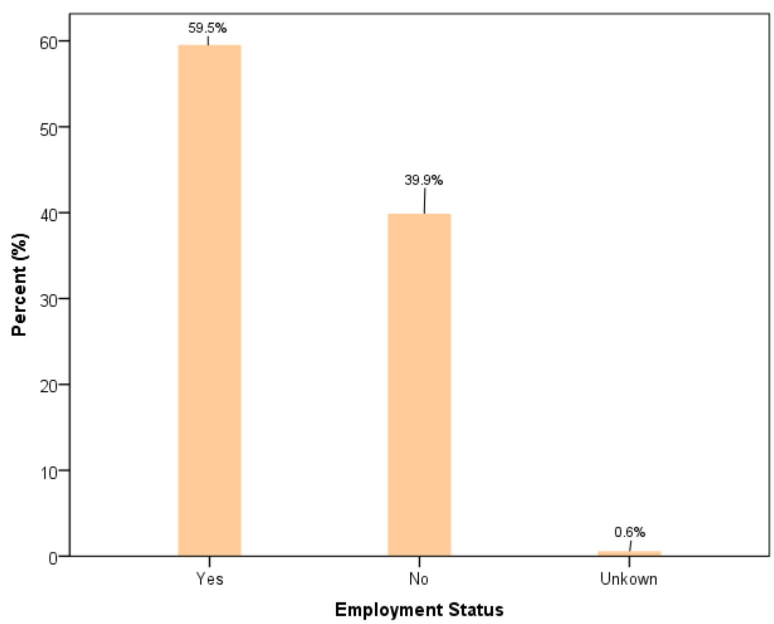

Figure 4. 5: Employment status

However, for those who are employed, (31,3%) of them were employed in primary and (28.2%) in secondary sectors that hardly pay them enough money to sustain themselves mainly due low educational attainment (Figure 4.7). Supporting this notion is Semenya & Machete (2019) who indicated that employment status is usually attributed to the level of education, and it is often concluded that employment status plays a role in household energy use. Educated and skilled people are usually employed in better job prospects that comes with benefit, while uneducated people struggle to find employment as aforementioned. As such, unemployed people spend most of their time collecting fuelwood (Uhunamure *et al.,* 2017). Results also indicated that several households only have one member of the family working (Figure 4.6). Participants who have no formal employment further indicated that they rely on single or multiple grants to support themselves, whilst others rely on family members who does not stay with them for financial support. To meet all the energy needs of a home, most households have opted to incorporate fuelwood in the domestic energy mix. Fuelwood is the main energy source used by majority of households.

4.1.6. Number of employed household members

From Figure 4.6, results have indicated that in most households only one member (38.7%) of the family is employed. Followed by those who are not working (31.8%), then households with two members working (21.4%).

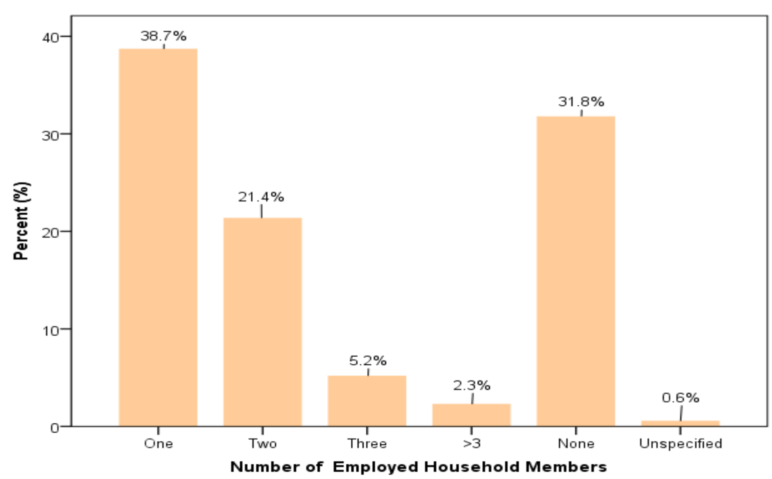

Figure 4. 6: Number of employed household members

The aforementioned percentage was followed by households with three members and more than three members, with both having (5.2%) and (2.3%) respectively. The least number of participants

(0.6%) claim that they could not specify whether they are employed or not because they do odd jobs whenever they get a chance.

4.1.7. Monthly income

To evaluate if income plays a role in the factors that influence fuelwood consumption, participants were asked personal income questions. As shown in Figure 4.7, 19.7% of the participants earned less than R1000; 28.9% earned between R1001 and R3000; and 9.8% earned between R3001 and R6000. The study also found that 9.2% of the participants earned between R6001 and R10 000; 7.5% earned between R10 001 and R12 000; 6.4% earned between R12 001 and R15 000; 12.1% earned between R15 001 and R20 000 and lastly, 6.4% of the participants earned above R20 000 per month.

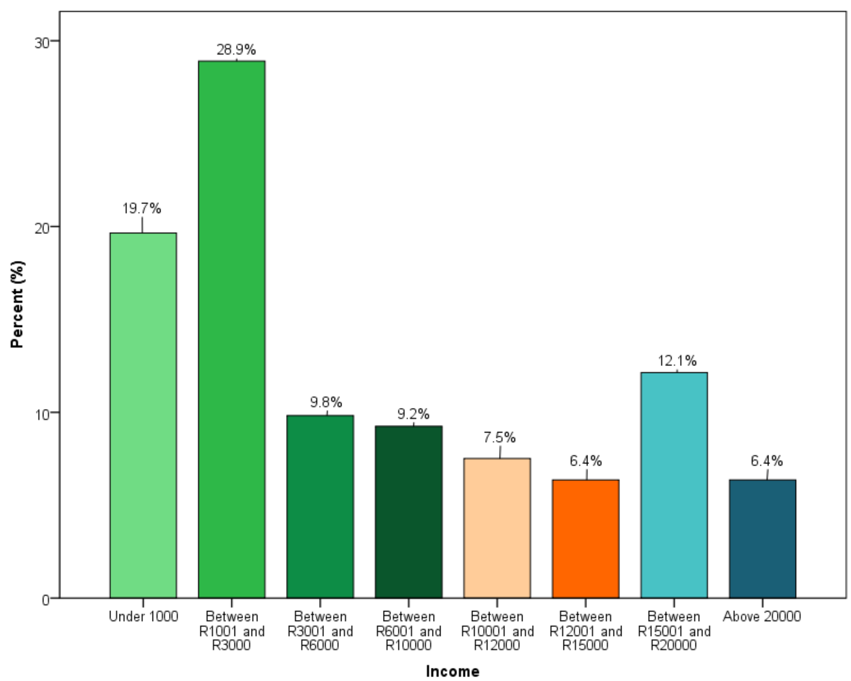

Figure 4. 7: Income levels of the sampled population

Of the participants, (48.6%) earned less than R3000 per month, this include government grant holders and pensioners who have limited options to use other energy alternatives to meet their domestic needs. The findings of the current study are consistent with the findings from the literature review. For instance, a study by Uhunamure *et al*. (2017) revealed that fuelwood is generally consumed by low-income households as they have limited options and resources to switch to modern technologies fully. These limited options hinder the progress of a household from practicing sustainable measures which could save them from the looming fuelwood crisis. Fuelwood is cheap, easily accessible and can be used to generate income by selling fuelwood bundles to other households at a specific price. From the results, it can be observed that there was a decline in the use of fuelwood in households with an income of more than R3000. Thus, it can be argued that as the household starts to earn more money, they tend to use less fuelwood and prefer to incorporate other energy alternatives in their domestic mix. Similarly, the literature study found that household income is an indication of status welfare as well as the economic development of a household (Uhunamure *et al.*, 2017).

4.2. Characterising the community energy matrix

The following sub-sections discusses the findings related to the energy matrix of households within Khubvi Village.

4.2.1. Source of energy and frequency of use for cooking and water heating

The study showed that majority (59.3%) of the participants used fuelwood, followed by electricity (37.2%) and LPG (3.5%) as a source of energy for meeting daily domestic needs for cooking and water heating.

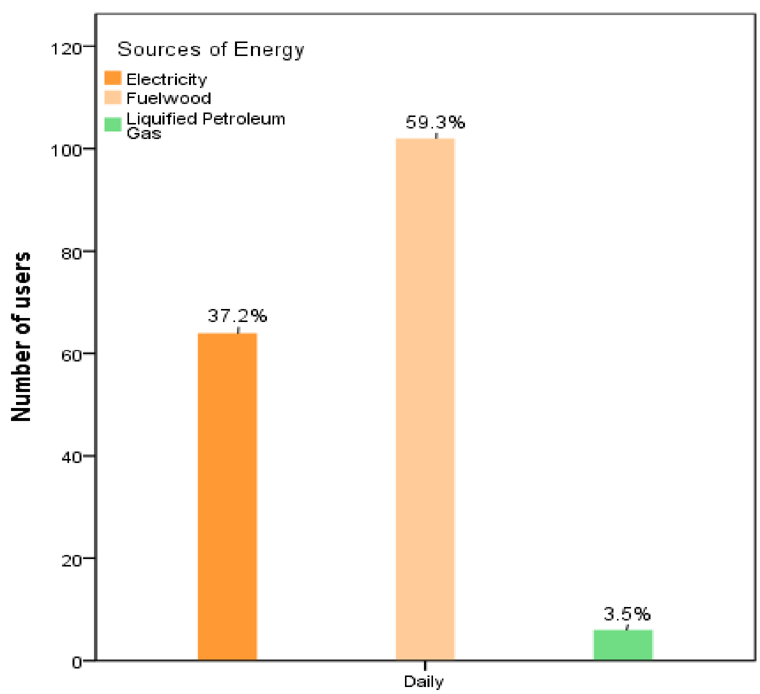

Figure 4. 8: Source of energy and frequency of use.

From the results it is evident that fuelwood is the most preferred energy source for meeting domiciliary needs despite the cumulative impacts it has on both the environment and human life. Fuelwood is considered an easily accessible source of energy which is always available for cooking (Figure 4.9). The analysis of results further shows that energy stacking is highly practiced within the Village of Khubvi. Participants indicated that they use different types of fuel for cooking different types of food. For example, fuelwood and LPG were used for cooking food that takes times to prepare, whereas electricity was usually used for cooking simple foods that does not require much effort to prepare such as cooking eggs or making tea. Finding of energy stacking is like the results obtained by Makonese *et al*. (2016), who indicated that multiple fuels are used by households to meet their domiciliary needs. Additionally, participants indicated that they are struggling to switch completely to modern energy source due to financial constraints, which is why they use electricity mainly for lighting purpose only and fuelwood for cooking and water heating. Consequently, this results in excessive harvesting of fuelwood and subsequent increase of detrimental impacts such as deforestation, loss of biodiversity, soil erosion and fuelwood crisis.

As aforementioned, fuelwood is easily accessible and available bundles, with no requirement for expensive initial investment such as electrical cooking appliances. As such, its preferences outpace other rival's energy sources. Respondents indicated that they can easily construct their own cooking equipment's either using bricks as a cooking tripod or store-bought metal braai tripod. A three-leg cast iron is often used as showed below in Figure 4.9.

Figure 4. 9: Fuelwood used for cooking

Nevertheless, it was noted that fuelwood is often burned in poorly ventilated kitchens or open space in a blaze. This contributed to household indoor air pollution which is associated with respiratory diseases that are harmful to human health.

4.2.2. Source of energy for lighting

Figure 4.10 indicated that the majority (98.3%) of the participants used electricity exclusively for lighting, while candles were seldomly used (1.7%). Candles are used mostly by unelectrified low-income households with limited access to modern and efficient energy technologies.

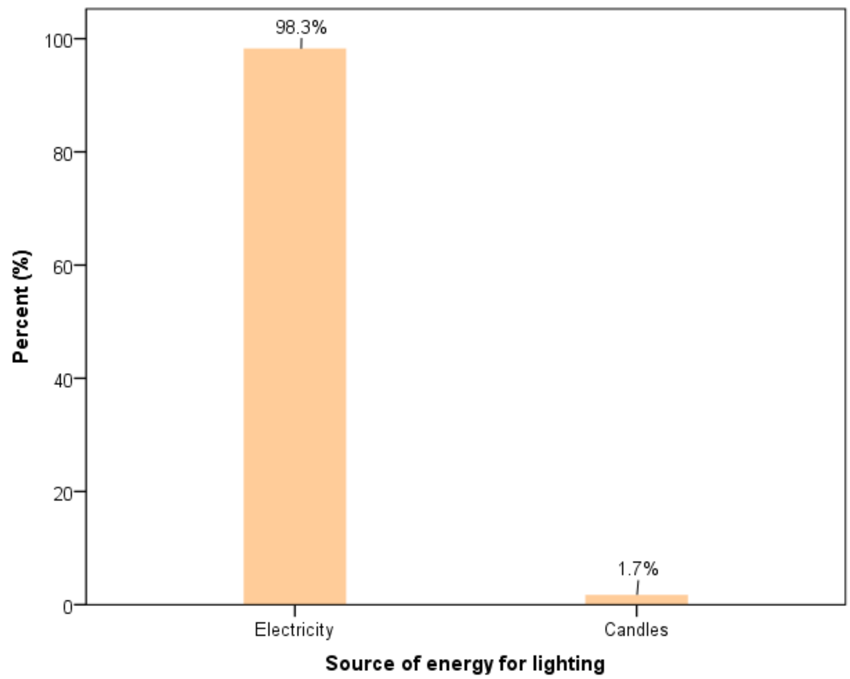

Figure 4. 10: Source of energy for lighting

In electrified families, candles are mainly used in extreme cases where load sheading or power cuts that has lasted for more than one day or in cases where a household is struggling to purchase electricity due to limited financial resources. The reason why candles are seldomly preferred is due to the high number of reported cases in the past that has resulted in accidental fires. The accidental fires have often led to burned down houses or death of family members, and sometimes in rare cases, a neighbour dies or is seriously injured while trying to rescue family members.

4.2.3. Reasons for using the source of energy for lighting

The majority (31.8%) of participants mostly used electricity for lighting because of economic value (Figure 4.11). this is followed by (23.1%) of participants who indicated that they use electricity for lighting purpose due to convenience. Participants further indicated that they prefer to use electricity for lighting purposes only because it does not cost them much and saves them a lot of money.

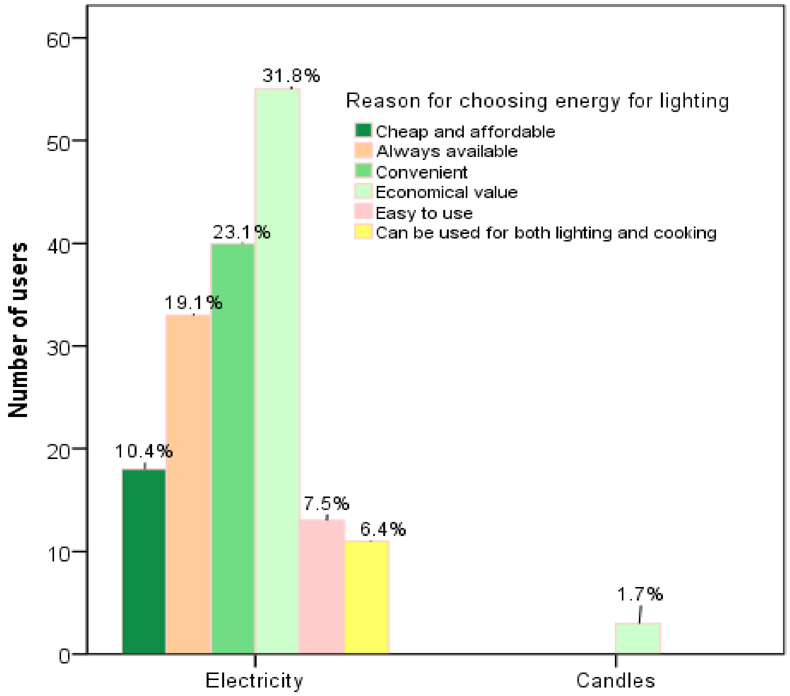

Figure 4. 11: Reasons for using the source of energy for lighting

This is in-contrast to households that use electricity for meeting all the domestic needs such as lighting, cooking, and water heating. A family could spend as little as R100 on electricity for lighting purposes only for a long period of time, depending on the household size. This amount is a substantial saving in comparison to a household that spends R1000 or more on electricity to meet all their domestic needs. Furthermore, participants stated that electricity is expensive for meeting all domiciliary needs, and their meter boxes are too frail to support concurrent plugging of electrical appliances. For example, if a household plugs too many appliances simultaneously, these can either put pressure on the already frail electricity grid or depletes the electricity traffics quickly. As such, the high cost of electricity, the cost of electrical appliances together limited financial support experienced in majority of low-income households, hinders the use of electricity for cooking and water heating. Instead they practice energy stacking by using electricity for lighting purpose only. Other frequencies for using electricity for lighting are that it is always available (19.1%), cheap and affordable (10.4%), easy to use (7.5%) and can be used for both lighting and cooking purpose (6.4%). Only a least number (1.7) of participants indicated that they use candles for lighting purposes.

4.2.4. Access to electricity

Figure 4.12 indicated that most members (97.7%) of the community have access to electricity, while (1.7%) indicated that they do not have access to electricity.

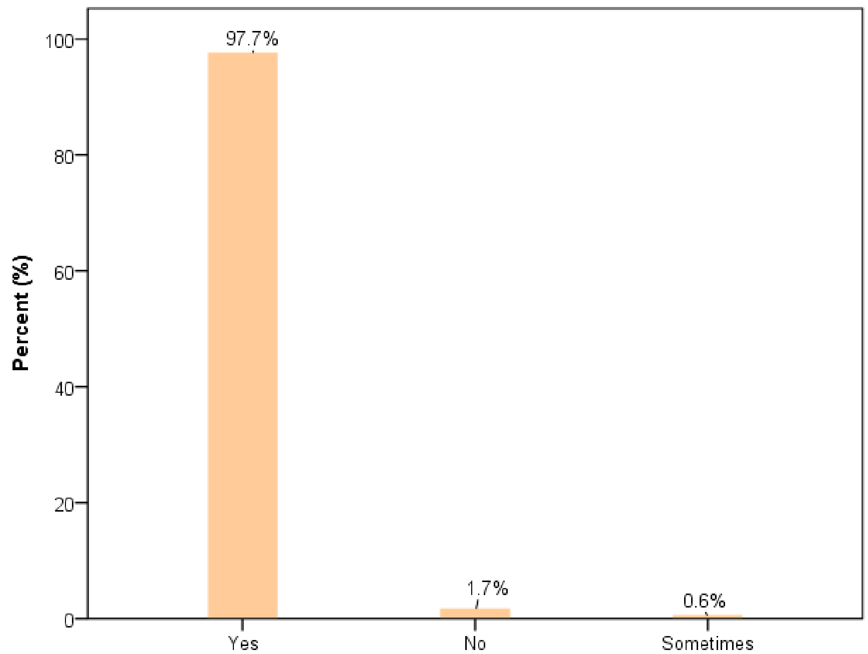

Figure 4. 12: Access to electricity

About (0.6%) of participants indicated that electricity accessibility in their area is mostly unreliable due to technical problems that are related to electricity supply resulting from load shedding, technical issues related to their meter boxes or unaffordability of the high electricity traffics. The identified reason for non-availability of electricity among households includes households not connected to the electricity grid at all (particularly in new stands).

4.2.5. Access to electricity and frequency of use

The results indicated that majority (40.0%) of participants only use electricity for cooking once a month, followed by those (36.5%) who used electricity daily. Other participants (20.0%) indicated that they use electricity weekly, followed by (2.9%) of participants who affirmed that they never use electricity for cooking purpose, instead they prefer to use fuelwood or LPG for cooking purposes.

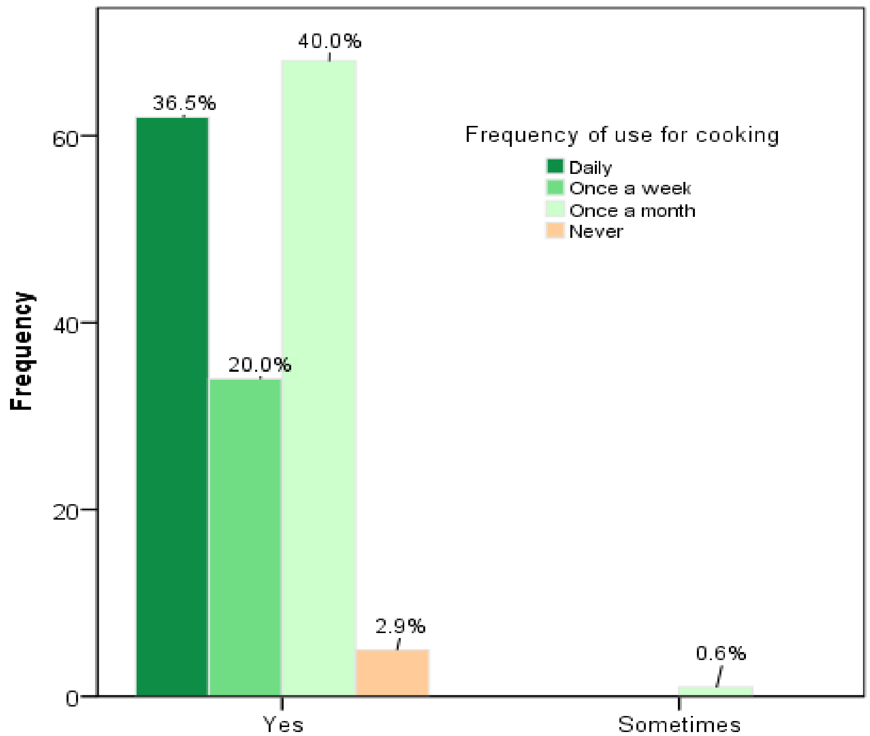

Figure 4. 13: Access to electricity and frequency of use

Lastly (0.6%) indicated that they sometimes use electricity for cooking (Figure 4.13). The high electricity hampers the exclusive transition of households to switch to electricity for meeting all domiciliary needs. For households that use electricity for cooking and water heating, participants indicated that electricity allows them to cook three to four different kinds of meals on the same stove at the same time, which cannot be done when using fuelwood as it requires a person to cook once at a time. Also, electricity is much safer and reliable than fuelwood as it does not emit indoor air pollution or result in accidental fires. Yet the main power backup system is fuelwood for majority of households.

4.2.6. Power backup system

Figure 4.14 showed that the primary backup energy resource for the majority (72.8%) of households is fuelwood. The reason for using fuelwood as a main power backup system is that fuelwood is available in abundance. Fuelwood is easily accessible and supplied in more secured bundles that can last for a month when used accurately, at a lower rate. It also does not require additional expenses that are associated with other alternative energy sources.

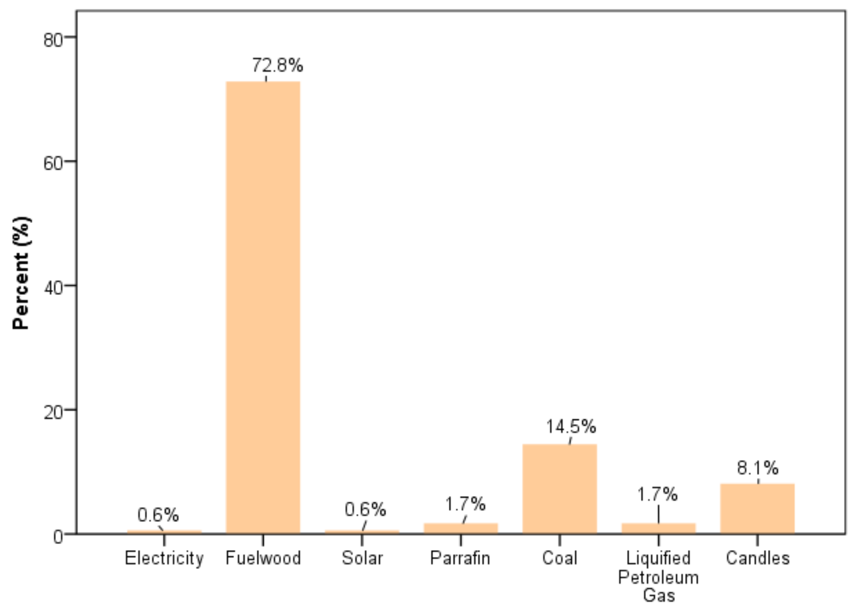

Figure 4. 14: Power backup system

Other energy sources used as backup are coal (14.5%), candles (8.1%), liquified petroleum gas (1.7%), paraffin (1.7%), electricity (0.6%) and solar (0.6%). The use of these energy sources varies in different households. Furthermore, the preference and use of these alternative backup energy sources is associated with the price attached to each fuel monthly. From the observed results, fuelwood ranks high in-terms of usage and preference in-comparison with other energy alternatives.

4.2.7. Reasons for using fuelwood

Figure 4.15 indicated that the main reason why majority (52.5%) of households use fuelwood is that it is always available. Other participants (38.4%) indicated that fuelwood is cheap and affordable, which means that almost everyone can afford to use fuelwood to meet domestic needs. This attributes to fuelwood being seen as a compelling energy source. Fuelwood as an energy source plays an integral part within the low-income households and clear majority of rural areas that have the least privileges to afford modern and efficient energy resources such as electricity, solar or LPG. Moreover, the preference of fuelwood as an energy fount for meeting domiciliary needs is usually influenced by energy expenditure, affordability, accessibility, and availability.

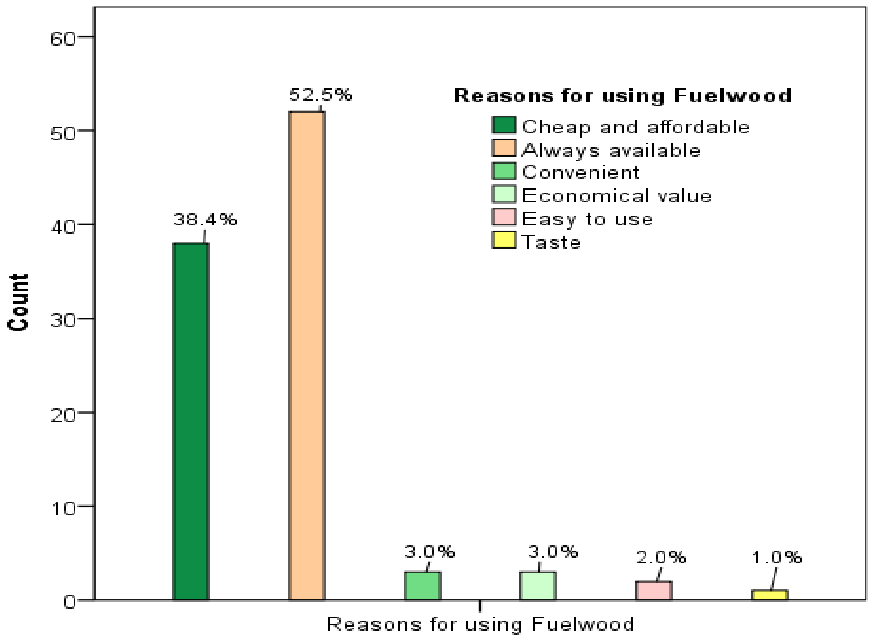

Figure 4. 15: Reasons for using fuelwood

In the Village of Khubvi, fuelwood is either bought in bundles from the fuelwood market (a truck is hired to deliver a load of fuelwood) or self-harvested. Although there were participants who stated that they favoured the use of fuelwood due to convenience (3.0%), economic value (3.0%), easy to use (2.0%) and taste (1.0%), they were in the minority.

From the observations and transact walks undertaken by the researcher and five households that were available and willing to be accompanied to harvest fuelwood, the researcher observed that people usually gather fuelwood in the morning around the communal lands, farms or mountains. It usually takes between 2-3 hours to go to the area where fuelwood is harvested, choose the preferred trees for harvesting. Participants also indicated that they preferred certain trees for fuelwood harvesting as they burn faster than other trees (Table 4.1). In most cases these trees are easily accessible to the households. Furthermore, the preferred trees are usually fast-growing, and they are resistant to extreme heat (Mphephu, 2017; Uhunamure, 2015; Rampedi, 2010; SANBI, n.d.). The heights of these trees result in them being highly sought out because when harvested, it yields more fuelwoods. The preferred trees are tabulated in Table 4.1.

Table 4. 1: Preferred trees for fuelwood harvesting.

Scientific name	**English name**	**Local name (Tshivenda)**	**Growth height**	**National conservation status**	**Protected trees under the National Forest Act, 1998**
Vachellia xanthophloea	Fever tree	*Munzhelenga*	15-25m	Least concern	Not protected
Bridelia micrantha	Mitzeeri	*Munzere*	20m	Least concern	Not protected
Parinari curatefolia	Mobola plum	*Muvhula*	10-13m	Least concern	Not protected
Bauhinia galpinii	Pride of De Kaap	*Mutswiriri*	1.2m	Least concern	Not protected
Cinnamomum camphora	Camphor tree	*Mitwari*	46m	Not evaluated	Not protected
Combretum mole	Velvet bushwillow	*Mugwiti*	13m	Least concern	Not protected
Diospyros lycioides	Quilted bluebush	*Muthala*	5m	Least concern	Not protected
Annona reticulate	Wild custard apple	*Muembe*	11m	Least concern	Not protected
Berchemia discolor	Brown ivory	*Munii*	20m	Least concern	Not protected
Diospyros mespiliformis	Jackal berry	*Musuma*	25m	Least concern	Not protected
Colophospermum Mopane	Turpentine tree	*Mupani*	30m	Least concern	Not protected
Englerophytum magalismontanum	Transvaal milkplum	*Munombelo wa daka*	3-15m	Least concern	Not protected
Sclerocarya birrea	Marula Tree	*Mufula*	18m	Least concern	Protected
Peltophorum africanum	African wattle	*Musese*	15m	Least concern	Not protected
Ficus sycomorus	Wild fig	*Muhuyu*	20m	Least concern	Not protected
Dichrostachys cineria	Sickle bush	*Murenzhe*	7m	Least concern	Not protected

Scientific name	English name	Local name (Tshivenda)	Growth height	National conservation status	Protected trees under the National Forest Act, 1998
Strychnos madagascariensis	Black monkey orange	*Mukhwakhwa*	5-8m	Least concern	Not protected
Terminalia sericea	Silver cluster-leaf	*Mususu*	9-23m	Least concern	Not protected
Combretum erythrophyllum	River bush willow	*Muvuvha*	4-6m	Least concern	Not protected

(*Source: DAFF,2018; Mphephu, 2017; Uhunamure, 2015; Rampedi, 2010; SANBI, n.d.)*

The researcher observed that were some households do not go to the mountains or forest to harvest fuelwood, but instead, they hire a truck to deliver fuelwood for them monthly. Each load for fuelwood costs less than R500 depending on the distance from where the fuelwood is harvested to where it is delivered. In-case where fuelwood was bought from the garage, each pack cost R24 rand per bundle. Furthermore, other households chop trees in their yards and wait for them to dry. Once dry, they use them for cooking and water heating. Fuelwood bought or harvested is usually stored in bundles which can sustain a household for a period of three to four months depending on the size of the household.

The findings of this study are consistent with the conclusions of the literature. For instance, a study by Variawa (2012) revealed that the availability of natural resources such as fuelwood is seen as the stronghold for the poor, as they provide a safety net against the erratic nature of poor modern energy provision as well as against energy inequalities. Fuelwood is cheap and always available, which reduces household energy expenditure especially among large families with limited financial resources. The reduction in energy expenditure, can also favour low-income households as they can invest the limited financial resources on other necessary revenues that can provide long-term gains such as education and health. One main strength of fuelwood is that it cooks faster, easily accessible, and more reliable than other alternative energy sources. Hence it is always available and does not result in load shedding as compared to electricity or explosion as compared to LPG. However, the extensive use of fuelwood resources can result in fuelwood scarcity since its availability and accessibility of fuelwood is seriously reduced. Additionally, the high preference rate of fuelwood over other energy alternatives is a clear indication that fuelwood harvesting levels are unsustainable and above ecological limits.

4.2.8. Frequency of fuelwood use

Figure 4.16 shows that a majority (99.0%) of participants use fuelwood daily, whereas (1.0%) indicated that they use fuelwood for cooking and water heating once a month. The high rate of fuelwood utilisation is mainly attributed to the availability, accessibility, and low cost as aforementioned.

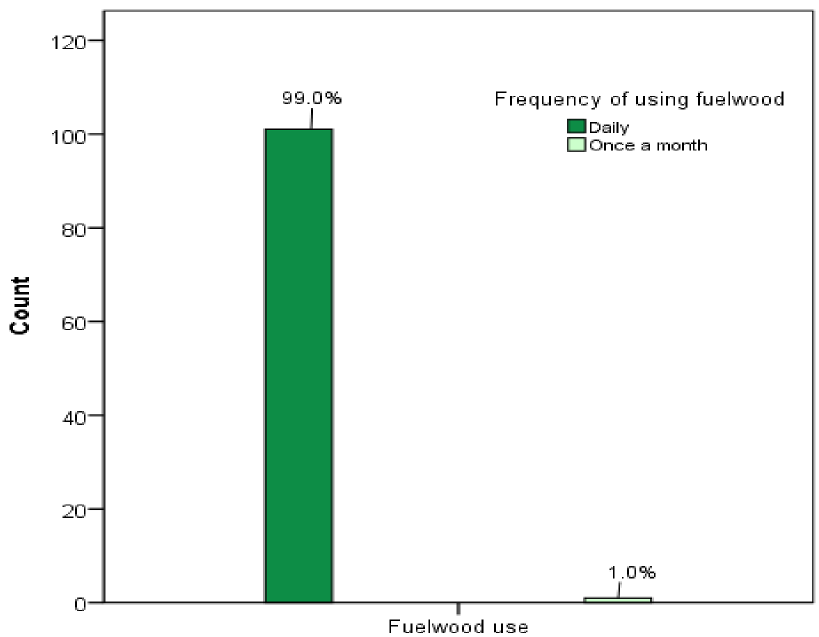

Figure 4. 16: Frequency of fuelwood use

Although fuelwood is associated with many benefits as previously mention, extensive fuelwood consumption can lead to overexploitation of these resources. Moreover, since fuelwood is consumed daily, livelihoods of local people are often adversely affected by the fuelwood scarcity. This notion is supported by Mercer and Soussan (1992) who stated that fuelwood harvesting is time-consuming and hard labour that women often endures as they are responsible for carrying out these tasks. Furthermore, as fuelwood becomes scarce due to extensive use, agricultural and human settlement, pressure amounts on local resource development as women and children must endure long and exhausting distance in search of fuelwood. It is worth noting that fuelwood use problems are not limited to fuelwood scarcity. Heavy reliance of fuelwood leads to fragmentation as siltation of water courses, and vital sources of substance products such as food and fuel materials are significantly reduced. While fuelwood consumption does not necessarily cause deforestation, overexploitation of fuelwood can be quite destructive. Fuelwood consumption can accelerate social consequences such as the quality of life, the risk of stability of the climate and local weather and undermining of the valuable service provided by biological diversity, often with long term impacts. It can be argued that extensive fuelwood use is a catalyst for fuelwood scarcity and possible deforestation.

4.2.9. Payment responsibility

Figure 4.17 shows that the majority (38.7%) of household heads pay for their household energy requirements and it is mainly the father or mother. The payment responsibility varies with each household. In the case where households are headed by females such a mother, grandmother and aunt, they become the sole breadwinner of that family and must be solely responsible for household energy expenditure and other necessary costs that are acquired by the household on a monthly basis. Same applies to the home that is headed by men.

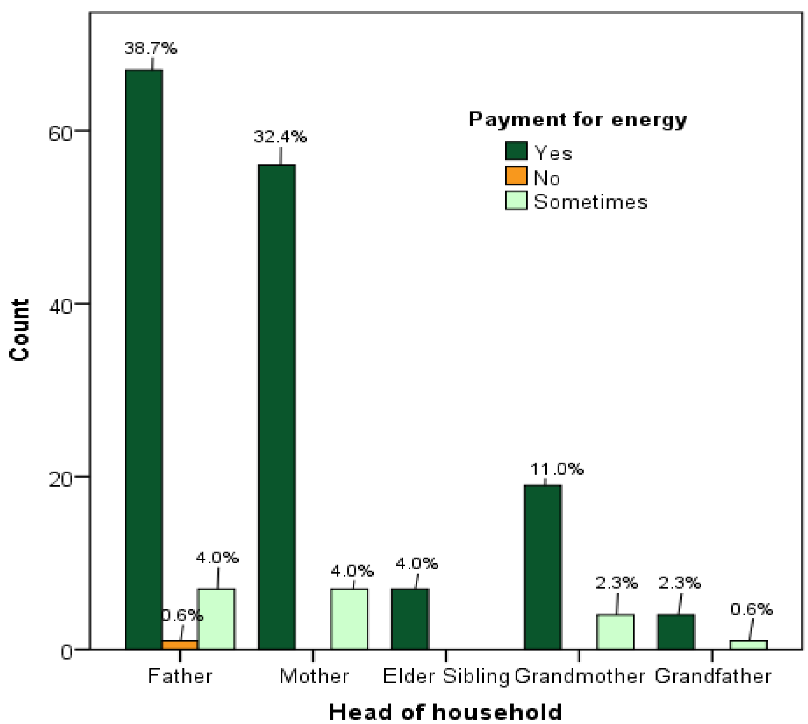

Figure 4. 17: Payment responsibility

In households where participants are married, they indicated that they share expenditure cost. For example, a father can be responsible for certain expenses that a family generates monthly such as school, transport, and energy expenditure. At the same time, the wife is responsible for grocery expenditure. Benefits of shared energy expenditure are that households can save money for emergency price volatility, educational and medical expenses.

4.2.10. Frequency of cooking

The results in Figure 4.18 depicts that the use of energy source for cooking duration varies with different households. The (30.1%) of participants indicated that the food they prepare lasts over an hour, followed by (27.2%) of participants who indicated that the duration of the meal cooked is within one hour.

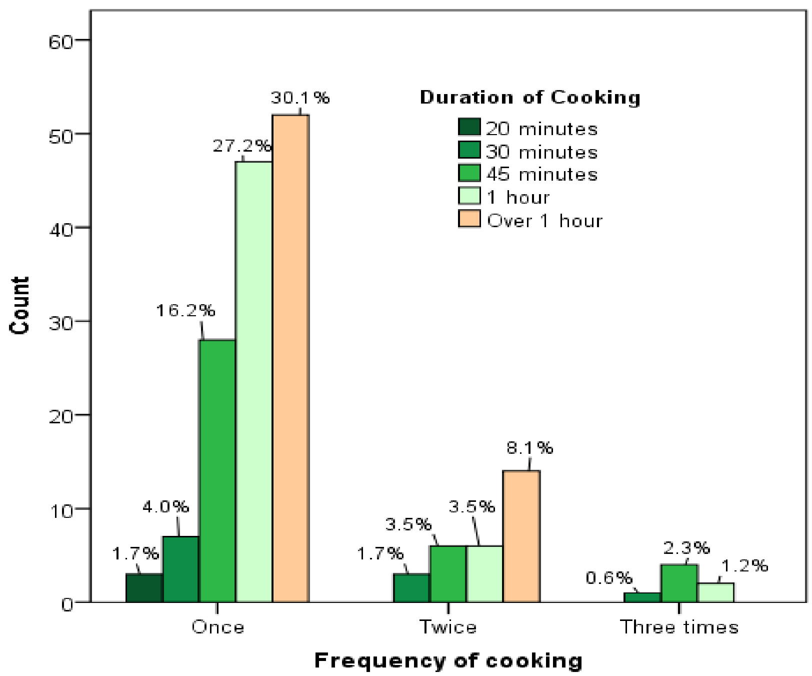

Figure 4. 18: Frequency of cooking

Other frequencies are for households that prepare their meals within 45 minutes, 30 minutes, and 20 minutes, both having (16.2%), (4.0%) and (1.7%) respectively. The cooking frequency and energy sources are linked as it is crystal clear that households that require longer cooking duration, only cook once a day. The number of cooking times is influenced by the duration of the meal that is being prepared. For participants who indicated that they cook twice a day, their frequency is as follows; (8.1%) of participants indicated that the food they prepare last over an hour, while (3.5%) indicated that the food they prepare last 1 hour. Other households indicated that they food preparation are within 45 minutes and 30 minutes, both having (3.5%) & (1.7%) respectively. The least number of cooking duration was that of people who cooks three times a day. Their food preparation frequency was 1 hour, 45 minutes and 30 minutes, with both having (1.2%), (2.3%) and (0.6%) respectively.

4.2.11. Energy-saving technique

Figure 4.19 shows that different household have different saving techniques. To save the cooking fuel, (72.8%) of households whose cooking duration is longer, usually cooks once a day and cooks in batches as the main energy-saving technique.

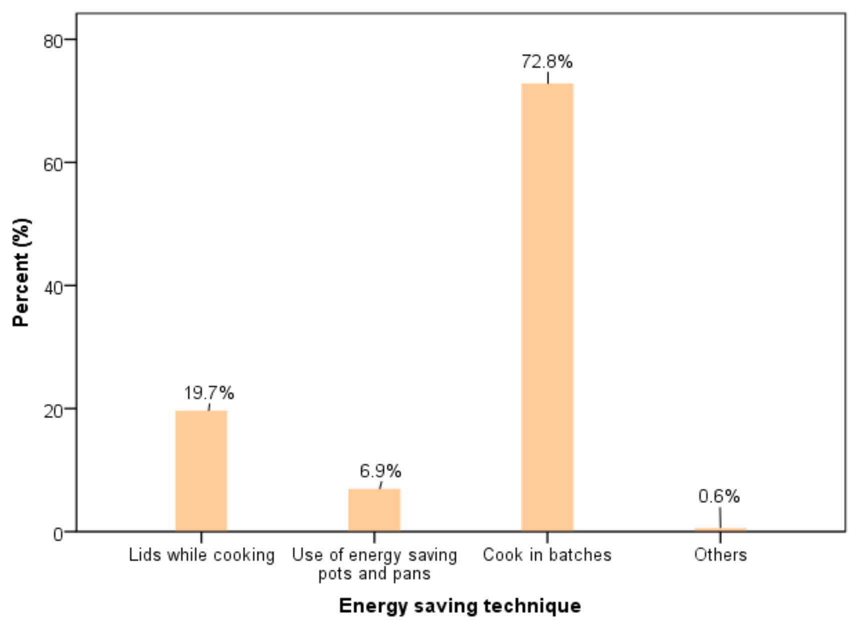

Figure 4. 19: Energy saving techniques

This is followed by (19.7%) of households that indicated that they cook with lids on their pots. While (6.9%) also indicated that they use energy-saving pots and pans as an energy-saving technique. Lastly, (0.6%) of participants indicated that they prefer other energy-saving methods such as skipping a day, then cook thereafter.

4.2.12. Substitute for main energy sources

Most respondents (92.5%) indicated that they had substituted fuel for use if their main type of energy decreases (Figure 4.20). The study participants highlighted that most households used multiple fuel because certain fuels are preferred to perform certain cooking activities. Furthermore, multiple fuel stacking makes life easier for those who have limited financial resources as food preparation that required long hours consumed more energy sources. Multiple fuel stacking saves families from the enduring high cost of monthly energy expenditure.

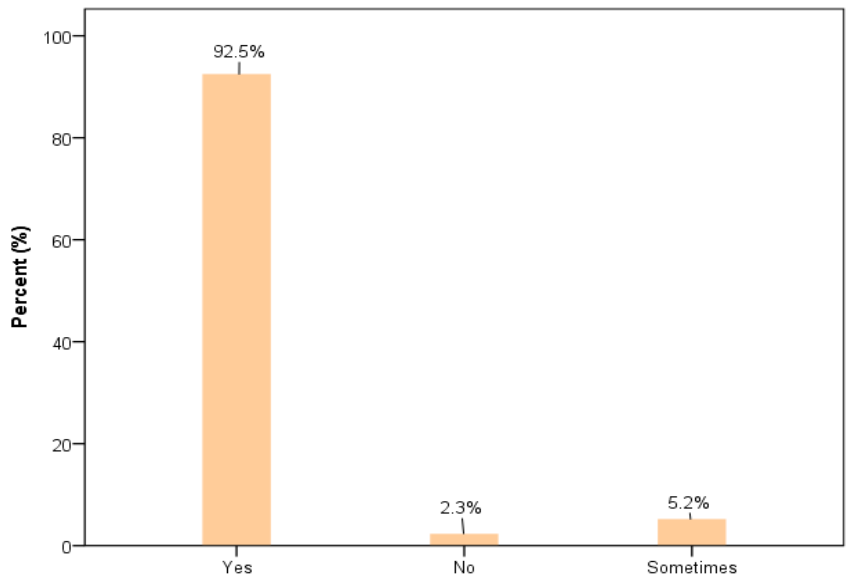

Figure 4. 20: Substitutes for main energy sources.

A good example is that electricity is preferred for cooking eggs while fuelwood is used for cooking all the main dishes. The aforementioned percentage is followed by 5.2% of participants who indicated that they sometimes have a substitute energy sources, especially for special occasions (weddings, funerals, parties and etc.) or for food that takes longer to cook. A minor number (2.3%) of participants have indicated that they do not have a substitute energy source as they prefer to use one main energy source. Income is considered to be another reason that promotes multiple fuel stacking as low-income households are burdened by the prohibitively high cost of electricity rates. Supplementation of the main energy source saves households from unnecessary energy expenditure.

4.2.13. Expenditure on Energy Substitutes

Participants indicated in Figure 4.21 that expenditure on a substitute's fuel is mostly under R500. This is an indication that, although households substitute on the main fuel, they do not spend much. In the case where the main energy fuel is electricity, households substitute electricity with fuelwood or LPG, same applies to fuelwood or LPG. For example, if the main energy source is fuelwood, household substitute fuelwood for electricity of LPG for cooking and water heating.

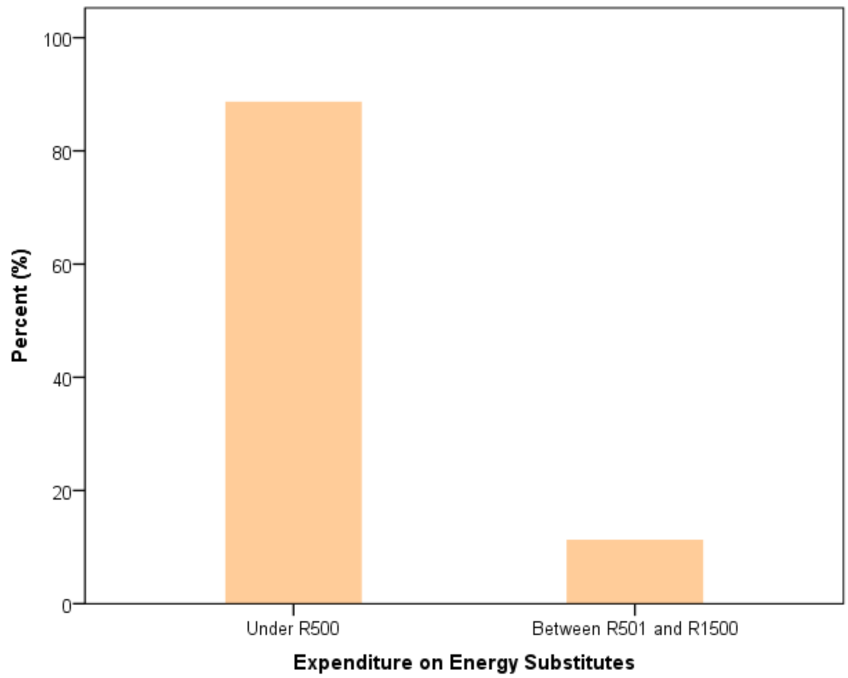

Figure 4. 21: Expenditure on Energy Substitutes

Fuelwood is always available and can be self-harvested or bought from the fuelwood market sales. If a household opted for self-harvested fuelwood, then there is no energy expenditure, but in the case where a household must hire a truckload of fuelwood, the energy expenditure cost is R500 depending on the location where the load must be delivered.

In instances where the primary fuel is fuelwood, then the substitute energy fuel is electricity or LPG. The cost of electricity is between R501 and R1 500 per month depending on the household size. Electricity is expensive and requires more money for purchasing and maintenance of electrical appliances. From Figure 4.21, it can be argued that most households prefer to substitute their energy means with fuelwood, which in this case is cheap and always available.

4.2.14. Fuelwood bundles

Figure 4.22 depicts a fuelwood bundle that was bought and delivered at one of the study participants' household. The fuelwood is purchased in bundles and loaded into the truck for subsequent delivery to the household monthly.

Figure 4. 22: Fuelwood bundles

Each load for fuelwood normally costs less than R500 depending on the distance from where the fuelwood is harvested to where it is delivered. In cases were fuelwood is self-harvested, the households chop trees in their yards, mountains or neighbouring Villages and wait for them to dry. Once dry, they use them for cooking and water heating.

4.2.15. Impact of fuel used on the taste of food cooked

According to Uhunamure *et al.* (2017), the selection of fuel type is particularly influenced by cultural norms and taste preferentiality. Similarly, the results in Figure 4.23 depicts the impact of fuel on the taste of food cooked. The study findings have indicated that (67.6%) of participants select certain fuel for cooking due to taste.

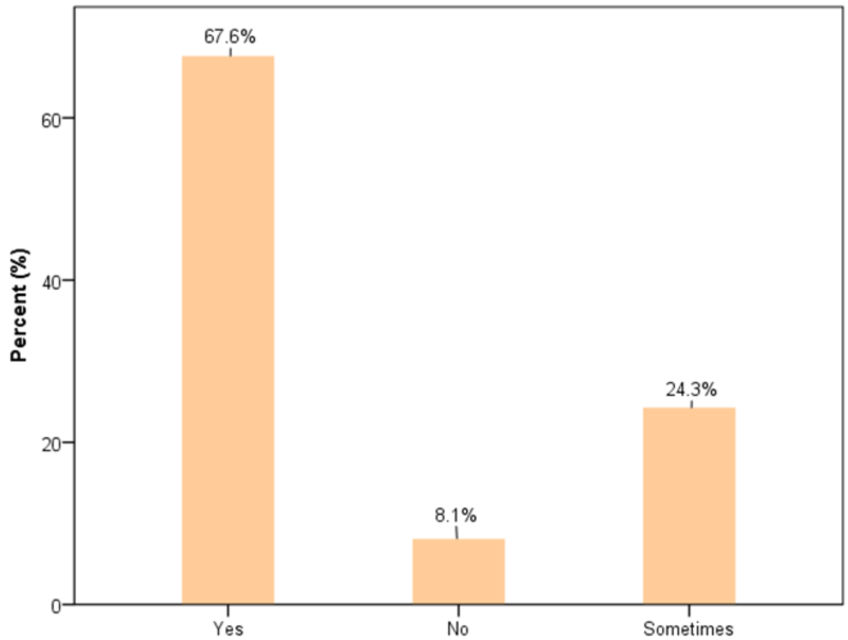

Figure 4. 23: Impact of fuel used on taste on food being cooked

This is followed by (24.3%)of participants who indicated that sometimes they prefer to cook certain food with fuelwood, as meals that have been cooked with fuelwood taste better than meals that have been prepared by electricity. Modern energy technologies cannot duplicate the traditional recipe. Furthermore, the use of fuelwood cooking conserve food for a long period of time. Only (8.1%) of participants have indicated that taste does not influence the type of fuel used for cooking purposes. These participants further explained that they use the preferred fuel source out of convenience.

4.2.16. Effect of traditional biomass on quality of life

Study findings in Figure 4.24 have indicated that (45.1%) of the participants believed that traditional biomass has negative impacts on quality of life such as the fact that fuelwood is becoming scarce due to population growth, agricultural and household settlement expansions.

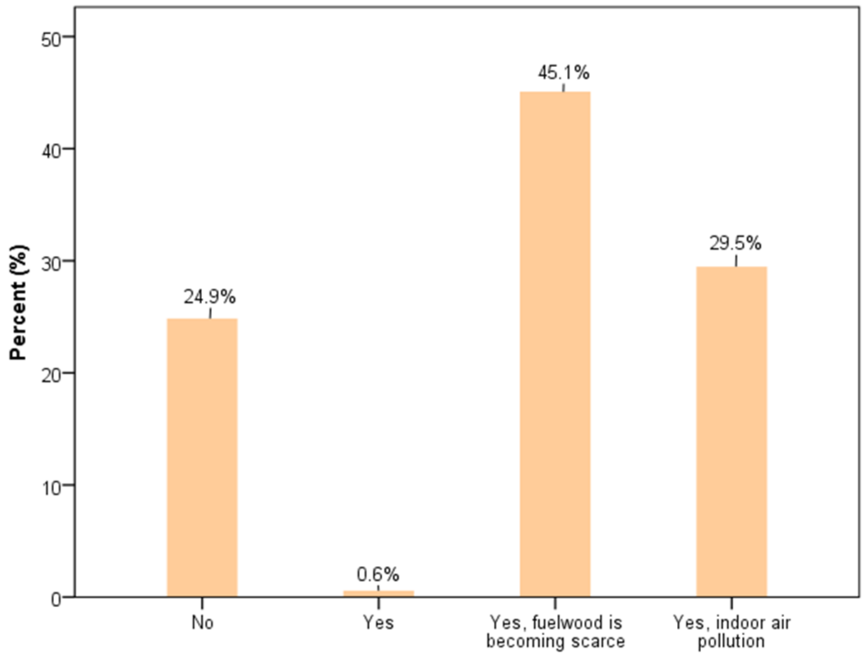

Figure 4. 24: Effects of traditional biomass on quality of life

The scarcity of fuelwood promotes the use of dirty and in-efficient materials such as agricultural residues. It also results in households being deprived of quality time with their loved ones as they must endure long walks. In some cases, households must spend 2-3 hours in search of fuelwood. The search of fuelwood in the mountains can have devastating consequences, as household members maybe be kidnaped, injured, or killed by wild animals. The aforementioned percentage is followed by (29.5%) of participants who stated that the prolonged use of fuelwood has resulted in participant gasping for air due to indoor air pollution, which is associated with respiratory infections. The issue of indoor air pollution has inspired investment into the energy-efficient cooking devices, such as for LPG, electricity, and paraffin stoves. While (0.6%) of participants also indicated that the use of traditional biomass had affected their quality of life without stating the reasons. While some participants have shown that traditional biomass has affected their quality of life, (24.9%) of the participants have stated that the use of traditional biomass does not have an effect on their lives. This is attributed to the fact that some of these participants do not use fuelwood at all. In cases were traditional biomass affect the quality of life, participants have indicated that they remain oblivious to these effects because their limited financial resources cannot fully sustain a household. Thus, they are forced to use fuelwood to meet their domestic needs despite their shortcomings.

4.2.17. Coping strategies of the community

Due to the looming fuelwood crisis, the community members in Khubvi Village have implemented various coping mechanisms to improve fuel supply (Figure 4.25). majority (38.2%) of the participants said that they prefer to use fuel sparingly or economically.

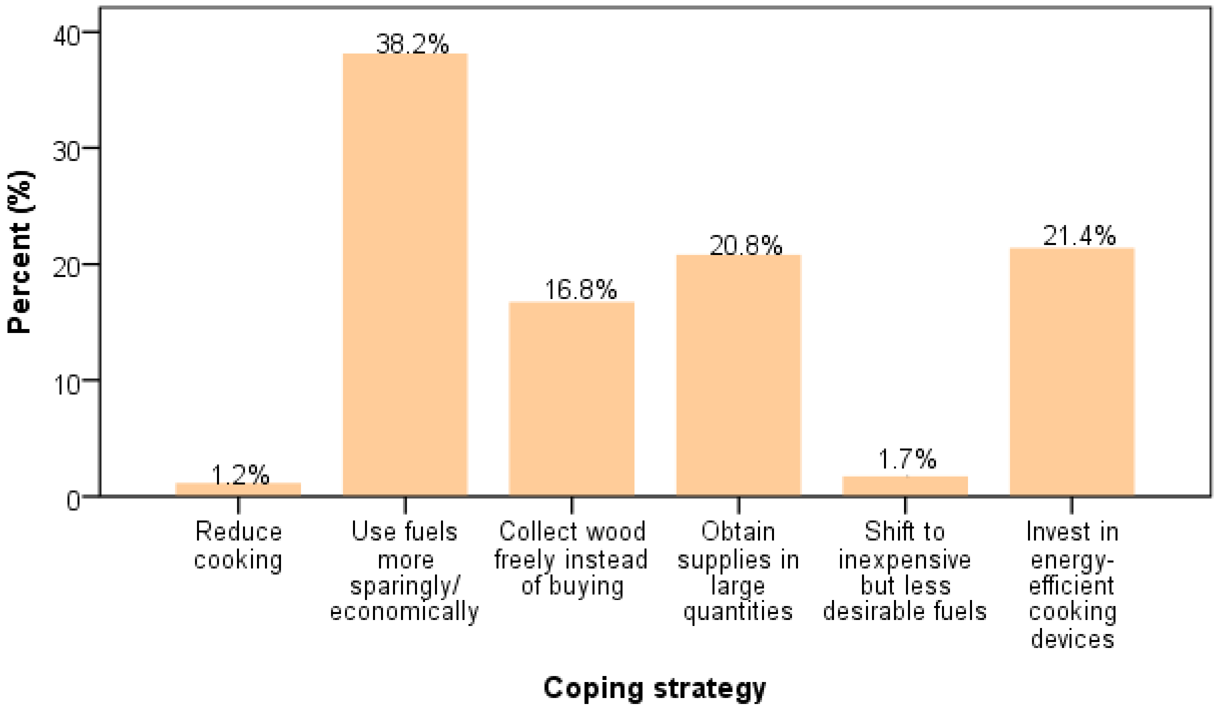

Figure 4. 25: Coping strategies of the community

In most case, after cooking and water heating, fuelwood is often spread-out to give it room to cool off and avoid longer burning duration; while in some cases, adequate amount of water is poured over the fuelwood to extinguish the fire. The aforementioned percentage is followed by (21.4%) of the participants believed that they should invest in energy-efficient cooking devices, while (20.8%) of the participants stated that they prefer to obtain their supplies in large quantities. The large supplies usually last these households for a period of three to four months, depending on the household size. 16.8% of the participants have said that they prefer to collect wood freely instead of buying. This is mainly attributed to limited financial resources. Hence, fuelwood is often collected in backyards, mountains, and farms. And lastly, (1.2%) of the participants stated that to cope with fuelwood scarcity, they prefer to reduce the number of cooking times. Thus, instead of cooking three to four times a day, a household will cook only one in batches. Participants have stated that these strategies that have been implemented in their households are working-out for them and they have perfectly adjusted to them as it economically saves them money on energy expenditure.

4.2.18. Opinion on municipal interventions

The results in Figure 4.26 indicated that (70.5%) of the participants thought that municipal interventions are not adequate in reducing dependency on fuelwood. This is attributed to the fact that electricity rates continue to increase all the time, and this impedes greatly on a household's social and economic development. Furthermore, in-cases where there are technical problems with the electricity grid or meter box, participants stated that although they report these incidents on time, the municipality takes time to resolve the issues. This yields in high rate of fuelwood dependency.

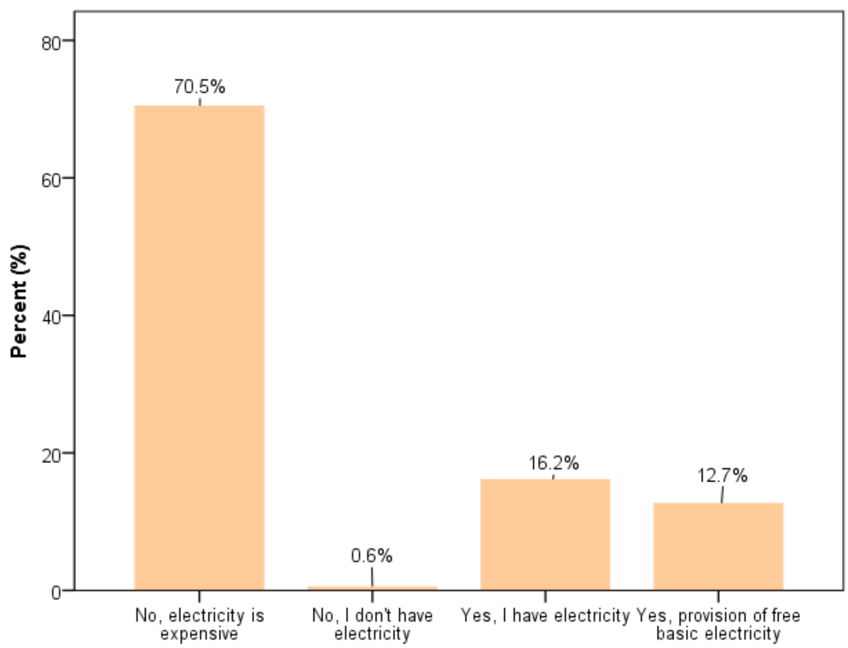

Figure 4. 26: Opinion on municipal interventions

The aforementioned percentage is followed by (16.2%0 of the participants who claimed that their local municipality was doing enough as they have electricity daily, except when there are technical issues such as load shedding resulting from bad weather. Also, (12.7%) of the participants stated that the municipality is doing enough because indigent households are being provided with free basic electricity, which significantly helps in sustaining a household. Lastly, (0.6%) of the participants said that the municipality is not doing enough as they do not have electricity. This is a clear indication that different families have different opinions regarding municipal intervention concerning to the provision of electricity and their plight in reducing the high rate of fuelwood dependency.

4.2.19. Opinion on own interventions on reducing dependency on fuelwood.

Figure 4.28 depicts that most respondents (83.8%) believed that their own individual interventions could reduce dependency on fuelwood.

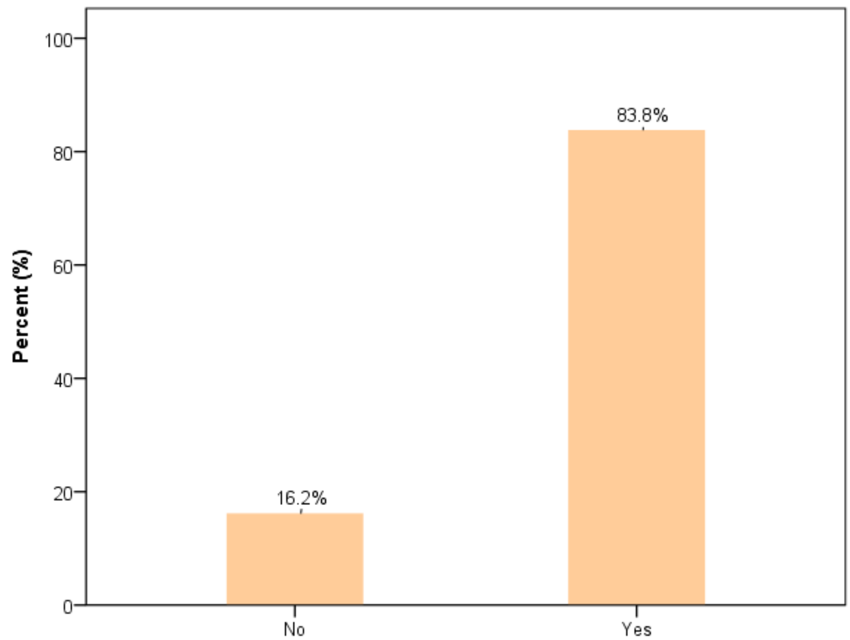

Figure 4. 27: Opinion on own interventions on reducing dependency on fuelwood

While (16.2%) of the participants said that they have no personal intervention strategy on reducing dependency on fuelwood. Instead of implementing their own intervention, these families said that they would rather wait for the government to intervene.

4.3. An evaluation of the factors influencing the community energy matrix through analysis

The following sub-sections discusses the findings related to the energy matrix through the analysis of households within the Khubvi Village. A Chi-square (χ^2) test was used to measure the degree of association between two categorical variables for cross-tabulation. If the p-value is less than 0.05, there is a significant association between variables, i.e. the variables explaining each other.

4.3.1. Age group and source of energy

A Chi-squared test was done between the age groups and source of energy to determine if any relationship exist between the variables.

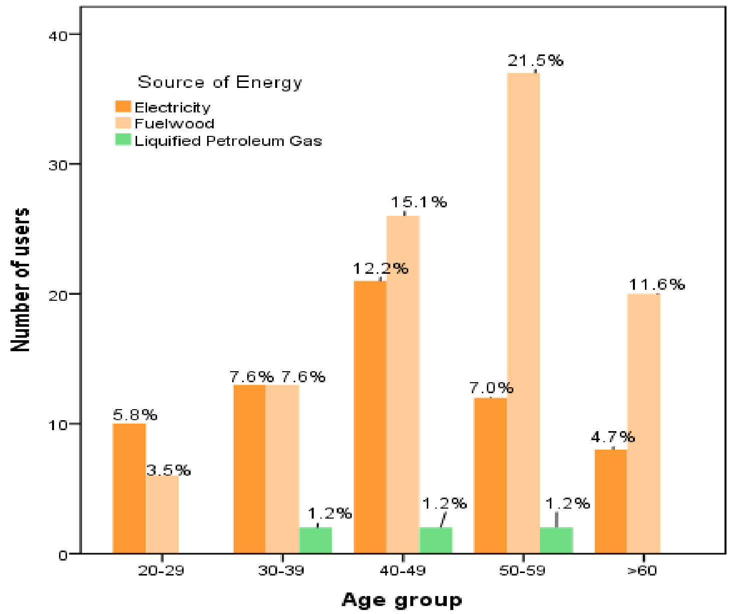

Figure 4. 28: Age group and source of energy

The test found that there is no statistically significant association between age category and source of energy used (Chi-square = 14.21, p = 0.076). The p > 0.05, this is concluded by the p-values which are more than the significance level p > 0.05, therefore age category cannot explain or conclude the source of energy used or its influences on the source of energy (Figure 4.28, Table 4.2). As such, the test indicates that an energy preference is not influenced by age. This implies that a household's preferences to certain energy sources are not influenced by age. Hence age has a negative effect on the preferences or probability to use efficient modern energy.

Table 4. 2: The relationship between age group and source of energy

Variable	**Attributes**	**Source of energy used for heating and cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	

Age category	20-29	6	10	0	0.76
	30-39	13	13	2	
	40-49	26	21	2	
	50-59	37	12	2	
	>60	20	8	0	

4.3.2. Gender category and source of energy

A Chi-squared test was done between gender category and source of energy to determine if any relationship exist between the variables. The study revealed that there is a statistically significant association between gender category and source of energy used (Chi-square = 7.52, p = 0.023).

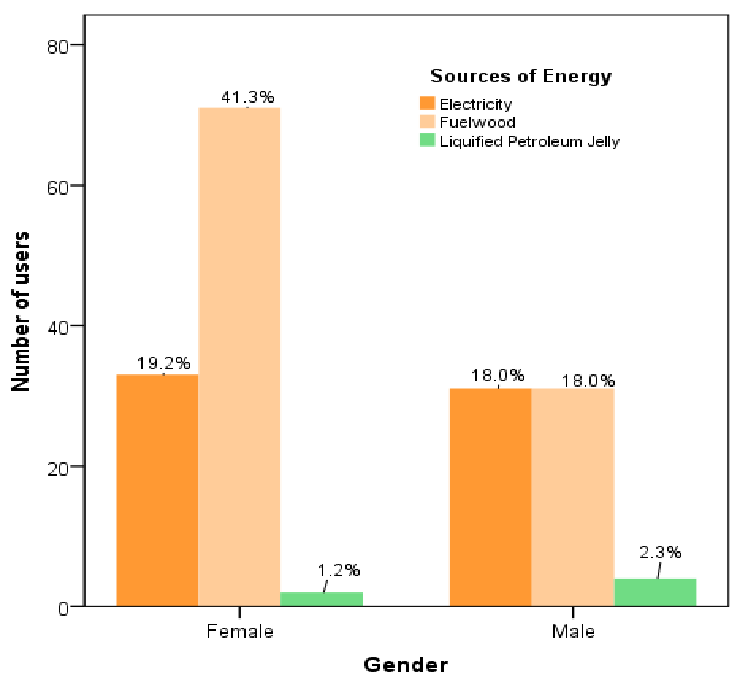

Figure 4. 29: Relationship between gender and source of energy

This refers to the $p < 0.05$, the Chi-squared test had determined the association between the variables as the significance level is less than the p-value, therefore gender can explain the source of energy used (Figure 4.29, Table 4.3). The test implies that gender plays a significant role in household energy use. Women plays a huge role in acquiring household energy for domestic purposes; they are responsible for fuelwood harvesting, collection, and transportation. The role of gender in household energy use should be taken into consideration by policy makers as it deprives women academically. Women in most cases have experienced a strong social disciplining from society in a form of general expectation of household task performances and homemaking. This is mainly accredited to cultural norms and traditional beliefs. Findings of this study found household energy acquisition particularly fuelwood, is time consuming. In some cases, it usually takes between 2-3 hours to go to the area where fuelwood is harvested, choose the preferred trees for harvesting. Then harvest and collect their fuelwood using head load methods or wheelbarrow. This time could have been used to do homework's or preparation of school exams. Hence, it can be concluded that there is a positive relationship between gender and source of energy.

Table 4. 3: Relationship between gender and source of energy

Variables	**Attributes**	**Source of energy used for heating and cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	
Gender	Female	71	33	2	0.023
	Male	31	31	4	

4.3.3. Marital status and source of energy

The current study showed that there is no statistically significant association between marital status category and source of energy used (Chi-square = 7.04, p = 0.317).

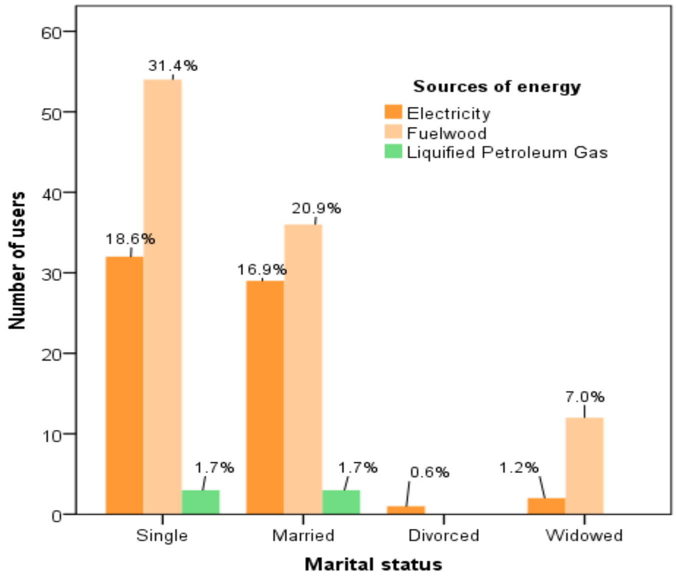

Figure 4. 30: Relationship between marital and source of energy

The p > 0.05, this is concluded by the p-value which is more than the significance level p > 0.05, therefore marital status cannot explain the source of energy used (Figure 4.30, Table 4.4). The test implies that households that are headed by a married couple are less likely to consume fuelwood. The non-existence relationship between marital status and source of energy can be attributed to the fact that married couple could combine their income and share expenditure responsibilities of a household among themselves. Hence, marital status has a negative effect on the preferences or probability to use fuelwood.

Table 4. 4: Relationship between marital status and source of energy

Variable	**Attributes**	**Energy sources preferred for cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	
Marital status	Single	54	32	3	0.317
	Married	36	29	3	
	Divorced	0	1	0	

	Widowed	12	2	0	

4.3.4. Education level and source of energy

The study found that there is a statistically significant association between the level of education of household head and source of energy used (Chi-square = 50.045, p = 0.000).

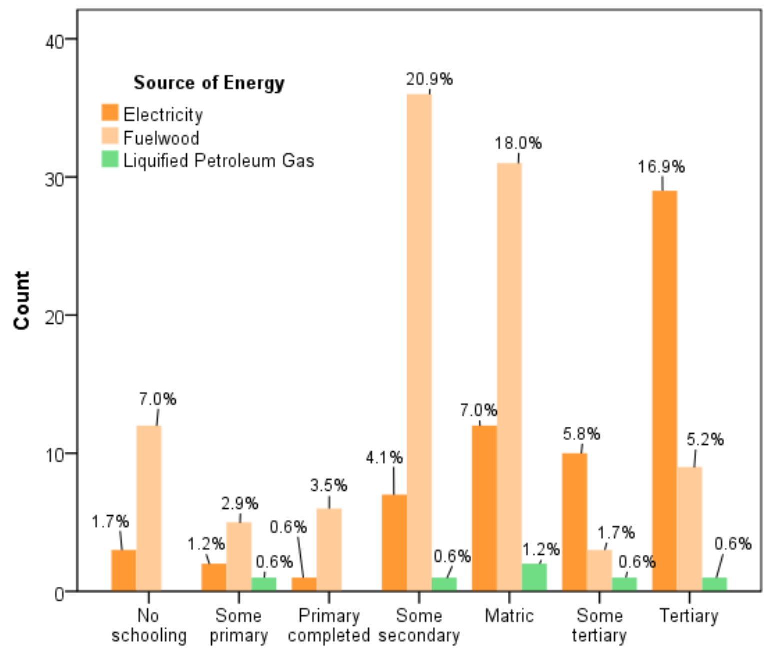

Figure 4. 31: Relationship between education level of household head and source of energy

The $p < 0.05$, the Chi-squared test has determined the association between the variables as the significance level is less than the p-value, therefore the level of education of the head of the household can explain the source of energy used (Figure 4.31, Table 4.5). The test implies that the level of education of the head of the household influence the decision to move to cleaner energy technologies. This is mainly attributed to affordability. High level of educational attainment yields better employment opportunities, which result in high level of income and comfortable lifestyles. Households with higher educational level are more likely to favour the use of modern energy technologies such as electricity or solar because they can afford the monthly commitments that are associated with these technologies. Moreover, these households have least probability in the use of fuelwood. It can be argued that a combination of educational backgrounds and a decent income could mitigate excessive fuelwood harvesting. Thus, it can be concluded that there is a positive relationship between the level of education and source of energy. The study supports the outcomes of other previous studies done by Semenya and Machete (2019); Ateba *et al.* (2018); Uhunamure *et al.* (2017); Ogwuche and Asobo (2013), which revealed that the level of education influence fuel use as educational attainment is associated with decent income. Uhunamure *et al.*, 2017, further argued that people who have elevated educational attainment are more likely to embrace the use of cleaner energy forms which enhance the conservation of natural resources.

Table 4. 5: Relationship between education level of household head and source of energy

Variable	**Attributes**	**Energy sources preferred for cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	
Level of Education of Head of household	No schooling	12	3	0	0.000001
	Some primary	5	2	1	
	Primary completed	6	1	0	
	Some secondary	36	7	1	
	Matric	31	12	2	
	Some tertiary	3	10	1	
	Tertiary	9	29	1	

4.3.5. Employment status and source of energy

In the present study, it was revealed that there is a statistically significant association between employment status and source of energy used (Chi-square = 23.34, p = 0.000).

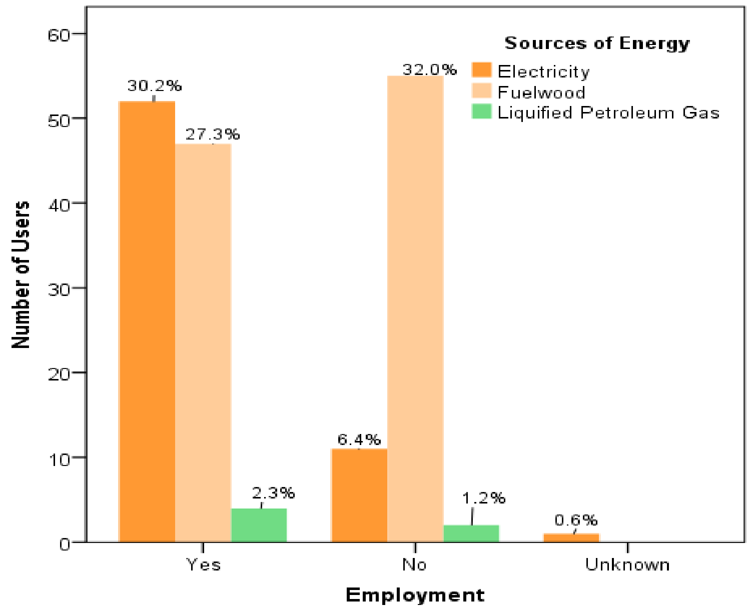

Figure 4. 32: Relationship between employment status and source of energy

The p < 0.05, the Chi-squared test has determined the association between the variables as the significance level is less than the p-value, therefore employment status can explain the source of energy used (Figure 4.32, Table 4.6). The test implies that when unemployed members dominate a household, they are faced with a great burden, resulting from household spending and income burden which result in their minimum income being far less than their needs. As, such they are deemed both energy and resource poor as they live below the poverty line. It can be concluded that there is a positive relationship between employment status and source of energy. Employment status and fuelwood consumption are inextricably linked.

Table 4. 6: Relationship between employment status and source of energy

Variable	**Attributes**	**Energy sources preferred for cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	
Employment status	Employed	47	55	4	0.0001
	Unemployed	55	11	2	

	Unknown	1	0	0	

4.3.6. Income level and Source of energy

The study found that there is a statistically significant association between income level and source of energy used (Chi-square = 58.999, p = 0.000). The $p < 0.05$, the Chi-squared test has determined the association between the variables as the significance level is less than the p-value, therefore income level can explain the source of energy used (Figure 4.33, Table 4.7).

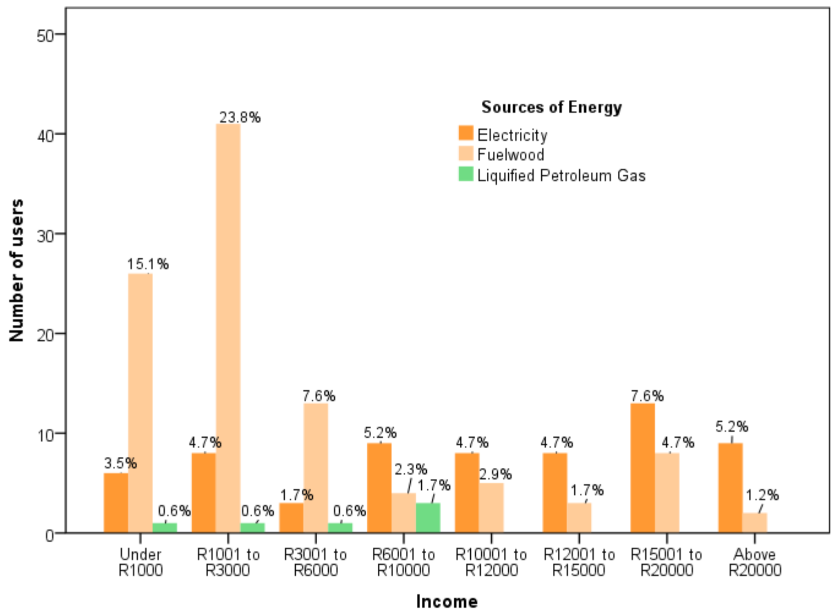

Figure 4. 33: Relationship between income level and source of energy

The test implies that the income level of a household influences energy use. People who earn more money tend to drift away from traditional biomass, and in other cases, they tend to incorporate modern energy in their domestic energy mix. High-income households are associated with the use of LPG and electricity for cooking and water heating as an alternative energy source. It can be concluded that there is a positive relationship between income level and source of energy.

Table 4. 7: Relationship between income level and source of energy

Variable	Attributes	Energy sources preferred for cooking	p-value

		Fuelwood	Electricity	Liquefied Petroleum Gas	
Monthly income	Under R1 000	26	6	1	0.0000
	Between R1 001 and R3 000	41	8	1	
	Between R3 001 and R6 000	13	3	1	
	Between R6 001 and R10 000	4	9	3	
	Between R10 001 and R12 000	5	8	0	
	Between R12 001 and R15 000	3	8	0	
	Between R15 001 and R20 000	8	13	0	
	Above R20 000	2	9	0	

4.3.7. Number of employed household members and source of energy

In the current study, it was shown that there is a statistically significant association between the number of employed household members and the source of energy used (Chi-square = 43.663, p = 0.000). The $p < 0.05$, the Chi-squared test has determined the association between the variables as the significant level is less than the p-value, therefore the number of employed household members can explain the source of energy used (Figure 4. 34, Table 4.8).

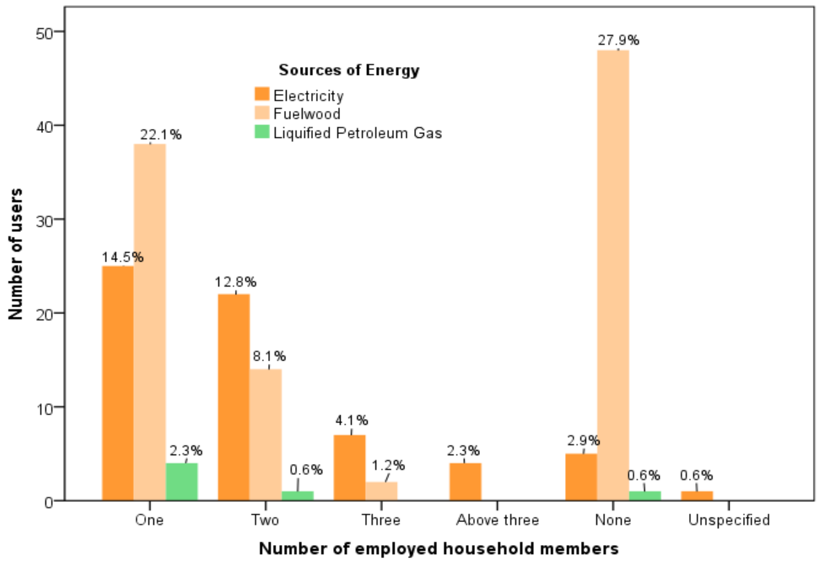

Figure 4. 34: Relationship between number of employed household members and source of energy

The test implies that the more the household members are employed, the more they will shift to modern energy technologies. Usually, when people use traditional biomass, it is due to limited financial resources. Thus, if a household can afford modern energy such as electricity, they tend to use it. It can be concluded that there is a positive relationship between the number of employed household members and sources of energy.

Table 4. 8: Relationship between number of employed household members ad and source of energy

Variable	**Attributes**	**Energy sources preferred for cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	

Number of employed household members	One	38	25	4	0.000004
	Two	14	22	1	
	Three	2	7	0	
	More than three	0	4	0	
	None	48	5	1	
	Unspecified	0	1	0	

4.3.8. Occupation and source of energy

The study found that there is a statistically significant association between occupation and source of energy used (Chi-square = 55.911, p = 0.000). The $p < 0.05$, the Chi-squared test has determined the association between the variables as the significance level is less than the p-value, therefore occupation can explain the source of energy used (Figure 4.35, Table 4.9).

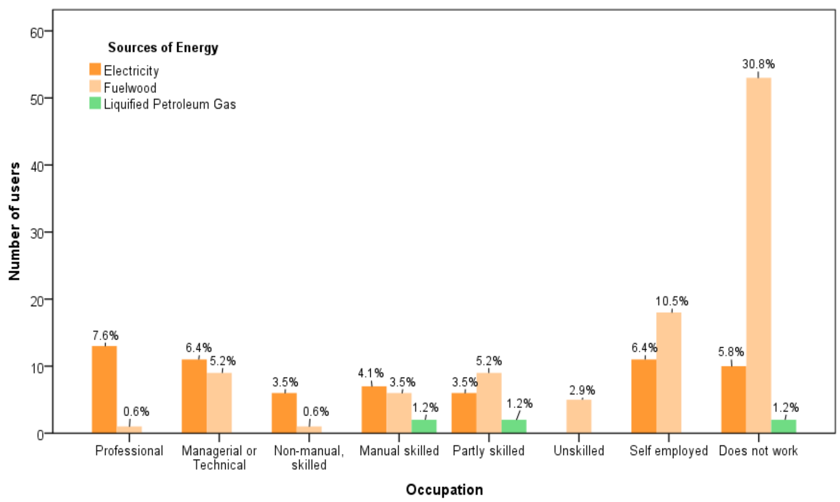

Figure 4. 35: Relationship between type of occupation and source of energy

The test implies that people who earn a higher income tend to use more efficient and convenient energy technologies. This is attributed to accredited to affordability. People who are employed who are employed in companies where they are paid decent salaries or have established their own businesses; they tend to associate themselves with modern energy use. The use of modern energy technologies such as electricity or solar yields so many social benefits in a household as it provides relief in performance of household chores as well as simultaneous use of other devices such as television. It can be argued that there is a positive relationship between occupations and sources of energy.

Table 4. 9: Relationship between type of occupation and source of energy

Variable	**Attributes**	**Energy sources preferred for cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	
Job/ Occupation	Professional	1	13	0	0.000001
	Managerial or technical	9	11	0	
	Non- manual, skilled	1	6	0	
	Manual, skilled	6	7	2	
	Partly skilled	9	6	2	
	Unskilled	5	0	0	
	Self employed	18	11	0	
	Does not work	53	10	2	

4.3.9. Head of the household and Source of energy

The study showed that there is a statistically significant association between the head of the household and source of energy used (Chi-square = 19.182, p = 0.013).

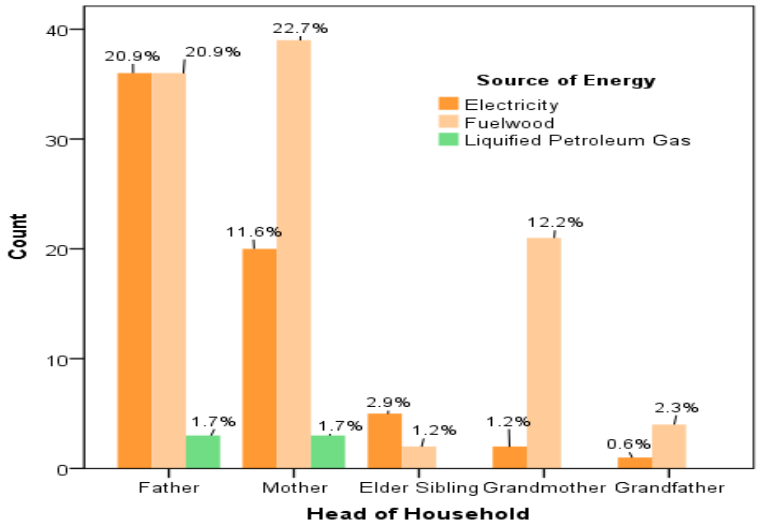

Figure 4. 36: Relationship between the head of household and source of energy

The $p < 0.05$, the Chi-squared test has determined the association between the variables as the significance level is less than the p-value, therefore head of the household can explain the source of energy used (Figure 4.36, Table 4.10). The test implies that households that are headed by women differ from households that are led by men in terms of decision making. Women tend to favour the use of fuelwood because of financial constraints and taste perception. Fuelwood is seen as a convenient way of cooking because it does not hamper the taste of the food prepared nor consumes a lot of time in food preparation. The finding of this study are consistent are with finding of the study done by Lourens (2018), the author concurred that most people prefer the use of traditional biomass for preparation of their food out of habit, even though they have electricity, or because they are used to how their food tastes when prepared with fuelwood. The author further explained that people prefer the use of traditional energy fuel because modern technologies cannot duplicate the traditional recipes. It is believed that the taste differs for electricity prepared meals from those that are prepared by traditional fuels. It can be argued that there is a positive relationship between the head of the household and the source of energy.

Table 4. 10: Relationship between the head of household and the source of energy

Variable	**Attributes**	**Energy sources preferred for cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	
Head of household	Father	36	36	3	0.013915
	Mother	39	20	3	
	Elder Sibling	2	5	0	
	Grandmother	21	2	0	
	Grandfather	4	1	0	

4.3.10. Household size and source of energy

The study showed that there is no statistically significant association between household size and the source of energy used (Chi-square = 10.316, $p = 0.413$). $p > 0.05$, this is concluded by the p-values which are more than the significance level $p > 0.05$, therefore household size cannot explain the source of energy used (Figure 4.37, Table 4.11).

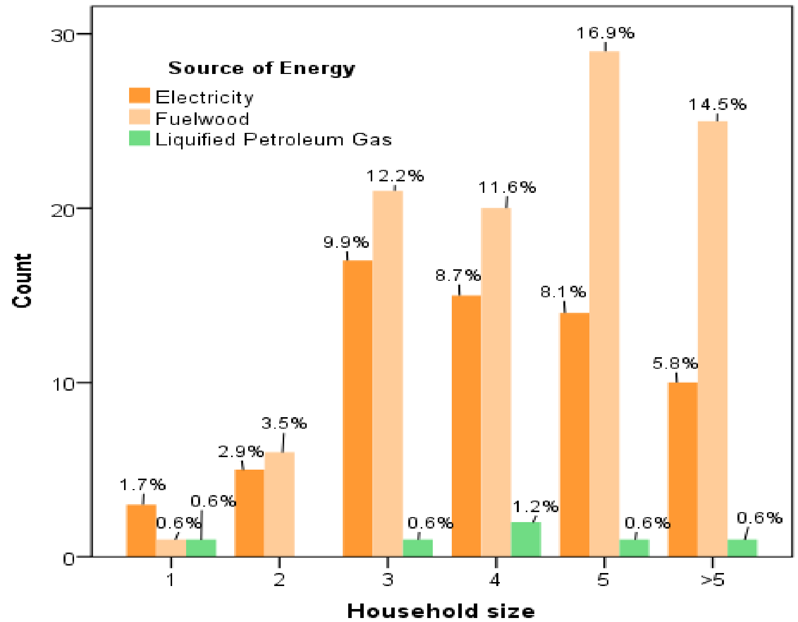

Figure 4. 37: Relationship between household size and source of energy

As such, this indicates that an energy preference is not influenced by household size. This further the test implies that poor small households tend to consume more fuelwood than households with more members. Additionally, large households tend to have more family members who can assist with the acquisition of energy sources, which could favour the use of certain energy sources. This means larger household members can result in more combined income which promotes the use of modern energy technologies. Thus, it can be argued that household sizes have a negative effect on the preferences or probability to use fuelwood.

Table 4. 11: Relationship between household size and source of energy

Variable	**Attributes**	**Energy sources preferred for cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	
Household size	1	1	3	1	0.413233
	2	6	5	0	
	3	21	17	1	

	4	20	15	2	
	5	29	14	1	
	>5	25	10	1	

4.3.11. Number of children and source of energy

The study revealed that there is no statistically significant association between the number of children and the source of energy used (Chi-square = 12.447, p = 0.132). The p > 0.05, this is concluded by the p-values which are more than the significance level p > 0.05, therefore the number of children cannot explain the source of energy used (Figure 4.38, Table 4.12).

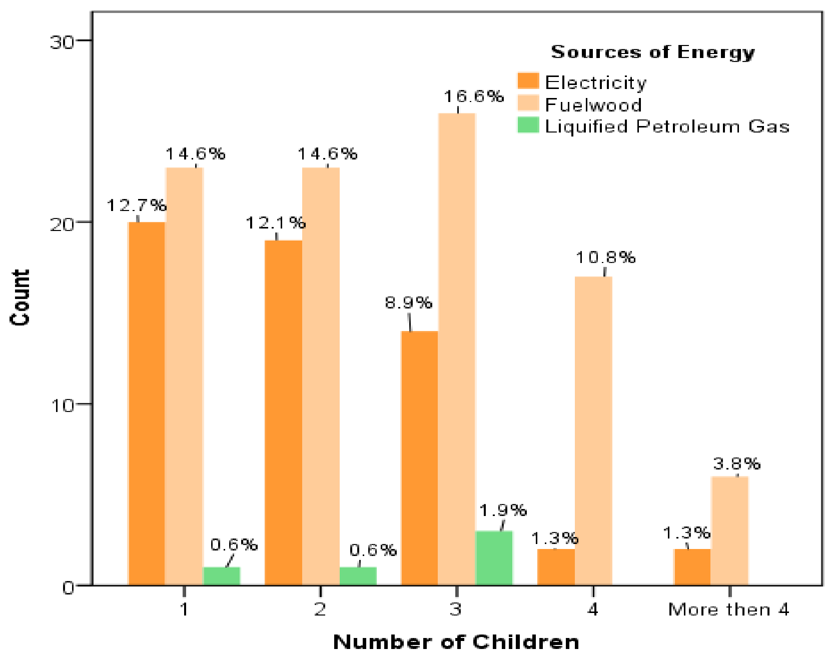

Figure 4. 38: Relationship between number of children and source of energy.

The Chi-square test suggests that the number of children in households does not influence energy use. The household size as mentioned above, does not influence fuelwood consumption because if the parents of the children are working, they can afford to support their children. It can be concluded that the number of children in the household has a negative effect on the preferences or probability to use fuelwood.

Table 4. 12: Relationship between number of children and source of energy

Variable	Attributes	Energy sources preferred for cooking			p-value
		Fuelwood	Electricity	Liquefied Petroleum Gas	
Number of children	1	23	20	1	0.132334
	2	23	19	1	
	3	26	14	3	
	4	17	2	0	
	>4	6	2	0	

4.3.12. Energy expenditure and Source of energy

In the present study, it was shown that there is a statistically significant association between energy expenditure and source of energy used (Chi-square = 12.044, p = 0.017). The $p < 0.05$, the Chi-squared test has determined the association between the variables as the significance level is less than the p-value.

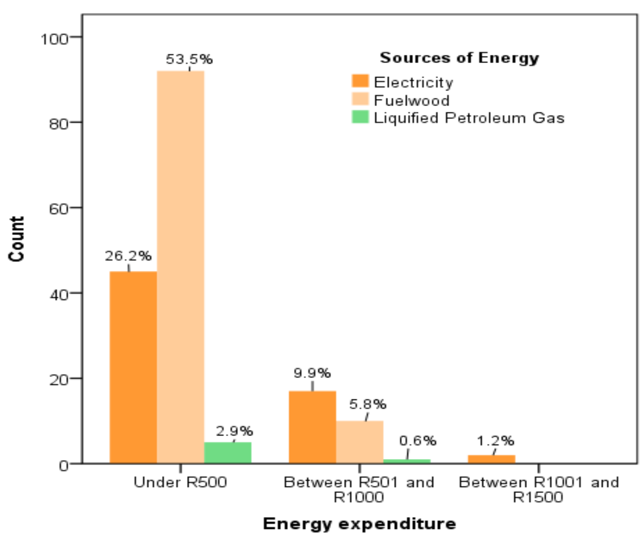

Figure 4. 39: Relationship between energy expenditure and source of energy

Therefore, energy expenditure can explain the source of energy used (Figure 4.39, Table 4.13). The test implies that as the price of food increases, the household should also set aside the budget for energy expenditure. If a household energy expenditure budget exceeds 10% of their income, they are deemed energy poor. It can therefore be concluded that there is a positive relationship between energy expenditure and source of energy.

Table 4. 13: Relationship energy expenditure and source of energy

Variable	**Attributes**	**Energy sources preferred for cooking**			**p-value**
		Fuelwood	**Electricity**	**Liquefied Petroleum Gas**	
Energy expenditure	Under R500	92	45	5	0.017029
	Between R501 and R1000	10	17	1	
	Between R1001 and R1500	0	2	0	

The results show that the community energy matrix is influenced by:

1. Gender
2. Education level
3. Employment status
4. Income level
5. Number of employed household members
6. Type of occupation
7. Nature of head of household
8. Energy expenditure

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

This chapter summarises the main findings on factors that influence fuelwood consumption within the Thulamela Local Municipality, with the objective of assessing fuelwood utilisation in comparison with electricity usage within the Thulamela Local Municipality in the case study of Khubvi Village. The chapter also draws a conclusion from the results and makes recommendations for mitigation measures that could reduce the high dependency on fuelwood.

5.1. Conclusion

The main aim of this study was to evaluate the factors that influence fuelwood consumption in households at the Thulamela Local Municipality. Socio-economic characteristics were used to assess these factors because the use of fuelwood is superimposed in socio-economic dynamics. This dissertation has focused on highlighting the significant role that socioeconomic characteristics has on the factors that influence fuelwood consumption.

The study indicated that the majority (53.9%) of households use fuelwood as a primary source for cooking and heating. This is despite the high rate of household electrification (electricity is mainly used for lighting purpose only). The use of fuelwood as a primary source of energy is influenced by several factors such as gender, education level of the household head, employment status, income level, number of employed household members, type of occupation, the nature of the head of the household and energy expenditure. Other energy alternatives such as LPG, electricity and solar are used by a minority of households for cooking and heating purposes. Reasons why these energy sources are seldomly used is due to the high costs involved in their maintenance and acquisition. For lighting purpose, a majority of households prefers to exclusively use electricity, and in rare cases, candles are used.

The findings of this study are consistent with the current literature, which states that socio-economic characteristic does influence the factors that influence fuelwood consumption in households. The results further corroborate the findings of Semenya and Machete (2019) which indicated that the socio-economic factor plays a significant role in the factors that influence fuelwood usage. A good example is the limited financial resources or lack of employment which hinders most families from successfully disregarding the use of traditional biomass such as fuelwood for meeting all their domestic needs.

Financial independence plays a significant role in social welfare as well as intensifying the momentary position of a household. Conversely, Semenya & Machete (2019), reported that employment status is usually attributed to education, it is often concluded that employment status plays a role in household energy use. Education can enhance community members to have a positive attitude and perception for the conservation of natural resources. These influence households to seek the use of other alternative energy sources such as electricity, solar, biogas and LPG for meeting domestic need. Amongst the discussed factors gender might be most important as forecasted by Ateba *et al.* (2018), who stated that society regards women as people who should be accountable for cooking, fuelwood harvesting and performing various domestic chores around the house. These women are liable for the decision-making process of energy choices within the household and are involved in sourcing and collection of fuelwoods. As such, gender is indeed another key factor that influence fuelwood usage and influences the fuel choice in households.

However, the findings of this study also revealed that not all factors discussed in the literature influence the factors that influence fuelwood consumption. The Chi-square test analysis indicated that, factors such as age, marital status, household size and the number of children in the household were not significant drivers that influence fuelwood consumption. This finding is supported by the statement made by Masekela (2019), who stated that not all factors have a similar influence on household energy use. Therefore, further research should be conducted to evaluate which other factors influence fuelwood consumption and to which extent do fuelwood consumption affect human health within Khubvi Village.

Findings of the study also demonstrated that the majority of residents of Khubvi Village practice fuel staking, where electricity is mainly used for lighting due to financial constraints (people cannot afford to exclusively use electricity for all their energy requirements) and fuelwood, LPG and sometimes paraffin is used for cooking and water heating. Candles are also use in rare cases, such as when load shedding has lasted for more than one day or in situation where household are not connected to the electricity grid (which are in minority). Literature and observations from this study also showed that multiple fuel stacking still play a huge role in the energy mix in household energy use. Thus, households use numerous fuels in their domestic mix, regardless of income increase. The results of this study support the arguments by Masera *et al.* (2000), who stated that multiple fuel stacking is frequently practised in both rural and urban areas regardless of income.

Some households indicated that they use multiple fuel due to taste preferences, while other uses fuel staking out of conveniences and accessibility. A good example of the preference of fuelwood due to its taste perception is that a lot of people favour the use of fuelwood for meeting domestic needs because modern energy use cannot duplicate traditional recipes. Furthermore, households that are headed by elderly people believes that the use of fuelwood cooks better as it does not hamper the taste of food prepared. Hence, the findings of this study showed that households within Khubvi Village will not drift away from fuelwood despite an increase in income but rather practice the multiple fuel staking, where fuelwood is used together with other modern and efficient energy sources such as electricity and LPG.

The study made use of both literature and results of this study to conclude that although a majority (97.7%) of households are electrified, fuelwood as a primary source of energy for meeting domestics needs such as cooking and water heating will remain their preferred source of energy due to its availability, cost-effective and lack of environmental awareness regarding trees. However, the persistent use of fuelwood has resulted in environmental degradation, soil erosion and excess land clearance. Also, by extensively using fuelwood, all potential future revenues and future employment that could have been derived from the unsustainable management. The consequence of persistent use of fuelwood are not limited to environmental and momentary impacts only. Fuelwood is combusted in confined environment using poorly designed cooking devices or kitchens. As a result, black soot from the smoke was seen on the walls of the kitchen and according to the literature, this smoke contains hazardous pollutants which has the potential to cause ill health.

Furthermore, fuelwood is becoming scarce, which results in households embarking on long distances in search of fuelwood. This does not only deprive these household from spending quality time with their family members but also places their lives in danger, as people can be killed, kidnaped, or injury in the mountains. It can be argued that policy makers need to pay special attention in order to keep abreast of the complex state of these household socio-economic dynamics and energy use trends. It is also clear from the results of the study that there is a need for intervention by the government and policy makers to make informed-decisions and strive to make continual improvement on energy alternatives that are affordable by everyone. Moreover, environmental awareness.

5.2. Recommendations

Recommendations are made based on the key findings of the study. It is recommended that fuelwood consumption trends should be treated with special attention to reduce the heavy reliance of households on traditional biomass such as fuelwood.

5.2.1. Encouragement of environmental education and public participation

There is also a need to raise environmental awareness. It is through education that people's perception, attitudes and behaviour towards fuelwood consumption practices can be changed. Furthermore, education enhances knowledge and raises environmental awareness about the proper way in which fuelwood can be harvested and further promote sustainable development. When the community is knowledgeable about the impacts of extensive fuelwood consumption, they tend to have the right attitude about the proper fuelwood management practices. Education plays a critical role in the decision-making process of fuel use and poverty alleviation. Moreover, public participation should be promoted, and the community should be involved in issues that concern household energy consumptions as this address issues such as service delivery and energy inequality. There should also be consistency within the municipality and relevant stakeholders to improve their service delivery. From the interviews that were conducted with the residents, one particular resident indicated that his meter box was not working properly, and the participant had reported this issue several times at the local municipality without any success. As a result, the participant is without electricity and has taken refuge in the use of fuelwood to meet all domestic chores within the household. Issues like this still need to be addressed during the public participation with the representatives of the local municipality. Energy development planning programmes should be taken seriously, particularly within the fuelwood sector as the as extensive fuelwood consumptive trends go against the sustain5able development policy and further have negative impacts in the economy.

5.2.2. Promote sustainable development through harvest control and afforestation

In order to promote sustainable harvest control and forest management, it must be sustainable environmentally, economically and socially. Achieving environmental sustainability means that the environmental values of the forest must not be degraded; instead, people should seek to improve it. Tress such as Dichrostachys cineria, Ficus sycomorus, Colophospermum Mopane, Barchemia zeyheri, Cinnamomum camphora, Bridelia micrantha and Combretum mole should be planted as they are fast-growing, resistant to heat, frost and colds and can produce high quality timber. Other trees such as *acacia implexa* and *eucalyptus* should also be planted as they have high growth rate. The growth rate of *eucalyptus* exceeds 35m^3 hectares annually, while *acacia implexa* can reach 15m (Albaugh *et al.*, 2013; Kaplan, *et al.,* 2012). The plantation of these trees can also make a significant benefaction for products that includes timber use for fuelwood, manufacturing, construction, and energy. These trees grow rapidly and can be grown under any variety of climatic conditions. are as follows; pine tree Silviculture and management should not reduce biodiversity, soil erosion should be controlled, promotion of excessive land clearance should be significantly reduced and water quality on and off-site should be safely guarded. Also, certain trees that are harvested for fuelwood are listed as protected trees under the National Forest Act, 1998 (E.G. Marula). As such, people are prohibited from cutting down these tresses. In case where people are found in possession with these tress species, they should be prosecuted. Additionally, management of the environment alone is not economically and socially sustainable. Sustainability can only happen if policymakers, traditional leaders, and residents reach an agreement that involve sustainable way in which fuelwood can be harvested. This agreement can be achieved through rotational harvesting, where there is a law that indicates which section of households should harvest fuelwood, e.g. once a week. The government should be consistent in establishing strategies that promote forest plantation. Increased tree plantation can be achieved by using vacant land, marginal land such as roadsides, along railway tracts, on boundaries, on contours and in the household yards. Planting trees will significantly reduce deforestation, fuelwood demand and pressures on forests for timber.

5.2.3. Increase the area of forest permanently reserved for timber production

The provision of protected areas is fundamental in any attempt to conserve biodiversity. Protected areas alone, however, are not sufficient to conserve biodiversity. They should be considered alongside, and as part of, a wider strategy to conserve biodiversity. The minimum area of forest to be protected is generally considered to be 10 per cent of total 17 forest area. The most serious impediment to sustainable forest management is the lack of dedicated forests specifically set aside for timber production. If the forest does not have a dedicated long-term tenure for timber production then there is no incentive to care for the long-term interests of the forest. FAO in 2001 found that 89 per cent of forests in industrialized countries were under some form of management but only about six per cent were in developing countries. If 20 per cent could be set aside, not only could timber demand be sustainably met but buffer zones could be established to consolidate the protected areas. This would form a conservation estate that would be one of the largest and most important in the world.

5.2.4. Encouragement of renewable energy use

With the rapid issue of energy supply crisis, the government should prioritise in investments that promote environmental awareness and support sustainable development. These initiatives can help in the conservation of natural resources. Furthermore, the government can also implement policies that encourages energy efficiency by mitigating environmental impacts. This will be made possible by collaborating with relevant stakeholders (E.g. traditional headmasters) in their discussions, which can also help in educating them as aforementioned. Intervention by both the local government and communities can help to encourage households to seek the use of renewable energy in their domestic energy mix to alleviate energy poverty and reduce the heavy reliance on fuelwood use. The use of modern energy technologies such as biogas, solar, together with the improved cooking stoves can help to reduce overexploitation of natural resources and also prevent indoor air pollution which is associated with heart diseases and immortality. Since most household are deemed energy-poor, the government should subsidize on renewable energy, especially among rural households were there are limited resources. This can be achieved by the implementation of keeping the price of renewable energy for customers below the market levels.

Renewable energy resources which include biogas and solar are the best option to reduce extensive fuelwood usage among households. Biogas is a renewable energy source that is produced from the bioremediation of organic materials such as cattle, pig, human, sheep and chicken manure, since it is usually available to low-income households (Mukumba *et al.,* 2016; Msibi, 2015). It should be highly encouraged in rural areas since most household's own livestock. Biogas energy can be used for cooking, water heating and can also be easily converted into electricity (Msibi, 2015). Households should be trained on how to use animal dung to produce energy from biogas technology. Solar energy is another leading potential since South Africa is prominent for having the highest level of solar radiation. The Limpopo province has the highest sunlight radiations annually. The temperature in Thulamela Local Municipality can reach as high as 45^0 during the summer seasons, which is a great advantage for the Khubvi Village since solar can be used to generate heat for cooking and lighting. The adoption of solar technology could also create employment for contractors and the retail industry that would employ local residents for the installation and maintenance of the solar system. Moreover, the adoption of renewable energy would also improve the livelihoods of local residents, especially women and children as they remained the most deprived. Women and children are further exposed to indoor air pollution and must endure exhausting long walks in search of fuelwood which can lead to assault by strangers on some occasions during these long walks.

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LIST OF APPENDICES

Appendix A: Participant's information leaflet and informed consent form for anonymous resident's questionnaires

PARTICIPANT'S INFORMATION LEAFLET AND INFORMED CONSENT FORM FOR ANONYMOUS RESIDENTS QUESTIONNAIRES

Dear participant

My name is Lusani Netshipise and I am a Masters student in the College of Agriculture and Environmental Sciences at the University of South Africa. I am conducting research in evaluating the factors that influence fuelwood consumption in households within the Thulamela Local Municipality, South Africa.

You are invited to volunteer to participate in my research project for evaluating the factors that influence fuelwood consumption in households at the Thulamela Local Municipality. The information obtained from you will assist the researcher in understanding the factors that influence fuelwood consumption and also to understand the main reasons behind high dependence on fuelwood despite most household being connected to the national electricity grid. Additionally, what actions are taken by the residences to mitigate high levels of fuelwood consumption.

This leaflet provides relevant information regarding the study and helps you make an informed decision regarding your participation in this study. I would encourage you to read it thoroughly. Should you have any questions please feel free to ask the researcher. You can withdraw from filling in the questionnaire anytime should you feel uncomfortable. Please respond to the questionnaire provided and it will take approximately 20 minutes to complete. All the information collected will be strictly confidential. No names will be included in the research report. Furthermore, your participation is voluntary, and you can withdraw anytime from this study.

I highly appreciate your help.

Kind regards

Lusani Netshipise

Contact details: 0711128342

Email addressed: lusief@gmail.com

Consent to participate in this study

- I consent that the person asking for my consent to participate in this study has explained all the relevant information (purpose, procedure and confidentiality of this study)
- I have read the abovementioned information and understand it
- I am aware that the information from this study such as personal details will be treated with strict confidentiality and anonymity
- I am participating voluntary and have agreed that the interview can be audio-recorded
- I have had the chance to ask question and have no objection regarding this study
- I understand that I can withdraw from this study anytime and my withdrawal won’t affect me in anyway
- I will receive a copy of this informed consent leaflet should I wish to have one

Participant’s signature……………………………….. Date……………………

Researcher’s signature……………………………….. Date…………………..

Witness’s signature………………………………….. Date……………………….

Appendix B: Household Questionnaire

SEMI- STRUCTURED QUESTIONNAIRES FOR RESIDENTS

HOUSEHOLD ENERGY USE

Date ……………………………………………………………………………….……

Start time ………………………….…… End time ……………………………………....

Residential addressed ……………………………………………………………..

SECTION A: Background information of the participant

Instructions

Please respond to the following questions by making an **X** next to the correct answer and where necessary fill in the space as indicated deemed

1. Age: a) < 19 [ ] b) 20-29 [ ] c) 30-39 [ ] d) 40-49 [ ] e) 50-59 [ ] f) > 60 [ ]
2. Gender: F [ ] M [ ]
3. Race: a) African [ ] b) Coloured [ ] c) Indians [ ] d) White [ ]
4. Marital status:

a) Single [ ] b) Married [ ] c) Divorced [ ] d) Widowed [ ]

5. Highest level of education:

a) No schooling [ ] b) Some primary [ ] c) Primary completed [ ] d) Some secondary [ ] e) Matric [ ] f) Some tertiary [ ] g) Tertiary [ ]

6. Are you employed? Yes [ ] No [ ]
7. What is your monthly income in Rand?

a) Under R1 000 [ ] b) Between R1 001 and R3 000 [ ] c) Between R3 001 and R6 000 [ ] d) Between R6 001 and R10 000 [ ] e) Between R10 001 and R12 000 [ ] f) Between R12 001 and R15 000 [ ] g) Between R15 001 and R20 000 [ ] h) Above R20 000 [ ]

8. How many people are employed in the household

   a) One [ ] b) Two [ ] c) Three [ ] d) More than three [ ] e) None [ ]

9. Please tick your job/occupation?

1	Professional	e.g. engineers, doctors, accountants, lawyers, architects etc.	
2	Managerial or technical	e.g. general managers, educators, nurses, public servants etc.	
3	Non- manual, skilled	e.g. clerks, cashiers, sales personnel, secretaries etc.	
5	Manual, skilled	e.g. skilled construction workers, electricians, plumbers, craftsmen, technicians etc.	
6	Partly skilled	e.g. domestic workers, machine setters/ operators, protective services, waiters	
7	Unskilled	e.g. construction workers, miners, manufacturing workers, labourers	
8	Self employed	e.g. shop owner, contractor, temporal work	
9	Does not work	e.g. pensioner, student, stay at home parent	

SECTION B: Background information on the type of energy used by the households

10. Please tick the type of energy fuel that you usually use for different cooking and water heating activities

a) Electricity [ ] b) Fuelwood [ ] c) Solar [ ] d) Paraffin [ ]

e) Coal [ ] f) Liquefied petroleum gas [ ] g) Other [ ]

If other, please specify? ………………………………………………………………………

11. How often do you use this type of fuel for cooking activities?

a) Daily [ ]

b) Once a week [ ]

c) Once a month [ ]

12. Please tick the type of energy source that you usually use for lighting

a) Electricity [ ] b) Fuelwood [ ] c) Solar [ ] d) Paraffin [ ]

e) Coal [ ] f) Liquefied petroleum gas [ ] g) Candles [ ]

h) Other [ ]

If other, please specify? ………………………………………………………………………

13. Reasons for using this type of energy source only for Lighting

a) Cheap and affordable [ ] b) Always available [ ] c) Convenient [ ]

d) Economical value [ ] e) Easy to use [ ] f) Can be used for both lighting and cooking [ ] g) Other [ ]

If other, please specify? …………………………………………………………………………

14. Does your household have access to electricity?

a) Yes [ ] b) No [ ] c) Sometimes [ ]

15. If yes, how often do you use it for your cooking activities

a) Daily [ ]

b) Once a week [ ]

c) Once a month [ ]

d) Never [ ]

16. If you're household experiences electric power failure, what are the backup energy sources do you use for cooking, lighting and space water heating?

a) Electricity [ ] b) Fuelwood [ ] c) Solar [ ] d) Paraffin [ ]

e) Coal [ ] f) Liquefied petroleum gas [ ] g) Candles [ ] h) Other [ ]

If other, please specify? …………………………………………………………………………

17. If you choose fuelwood, why do you use this fuel in your household?

a) Cheap and affordable [ ] b) Always available [ ] c) Convenient [ ]

d) Economical value [ ] e) Easy to use [ ] f) Taste [ ] g) Other [ ]

If other, please specify? …………………………………………………………………………

18. How often do you use the fuel wood in your household?

a) Daily [ ]

b) Once a week [ ]

c) Once a month [ ]

d) Never [ ]

SECTION C: Factors that influence household energy use

Age and Gender

19. Who is the head of the household?

a) Father [ ] b) Mother [ ] c) Elder sibling [ ] d) Grandmother [ ]
e) Grandfather [ ] f) Other [ ]

If other, please specify? ……………………………………………………………………………

20. Does he/she provide money for the purchase of the type of energy fuel used for this household?

a) Yes [ ] b) No [ ] c) Sometimes [ ]

Number of cooking times

21. How many times do you cook food in a day?

a) Once [ ] b) Twice [ ] c) Three times [ ] d) Four times [ ] e) More than four times [ ]

22. How long does it take to prepare a single meal?

a) 20 minutes [ ] b) 30 minutes [ ] c) 45 minutes [ ] d) One hour [ ] e) Over one hour [ ]

23. Does your household use any energy saving techniques? Such as the use of:

a) Lids while cooking [ ] b) Use of energy saving pots and pans [ ]
c) Cook in batches [ ] d) Others [ ]

If other, please specify? ……………………………………………………………………………

Education of the household head

24. What is the highest education level of the household head/ or the person who provides money for the purchase of the energy for the household?

a) No schooling [ ] b) Some primary [ ] c) Primary completed [ ] d) Some secondary [ ] e) Matric [ ] f) Some tertiary [ ] g) Tertiary [ ]

Household size

25. How many members does your household have?

a) 1 [ ] b) 2 [ ] c) 3 [ ] d) 4 [ ] e) 5 [ ] f) More than 5 people [ ]

26. How many children are there in the household?

a) 1 [ ] b) 2 [ ] c) 3 [ ] d) 4 [ ] e) More than 4 children [ ]

Cost of the energy

27. How much money does the household use on energy month?

a) Under R500 [ ] b) Between R501 and R1 000 [ ] c) Between R1 001 and R1 500 [ ] d) Between R1 501 and R2 000 [ ] e) Between R2 001 and R2 500 [ ] f) Between R1 501 and R3 000 [ ] g) Above R3 000 [ ]

28. Does the household have other substitutes for use if the main type of energy decreases?

a) Yes [ ] b) No [ ] c) Sometimes [ ]

29. If yes how much does the household spend on it?

a) Under R500 [ ] b) Between R501 and R1 000 [ ] c) Between R1 001 and R1 500 [ ] d) Between R1 501 and R2 000 [ ] e) Between R2 001 and R2 500 [ ] f) Between R1 501 and R3 000 [ ] g) Above R3 000 [ ]

Taste and preferences

30. Does taste have an impact in the type of food being cooked

a) Yes [ ] b) No [ ] c) Sometimes [ ]

If yes, please specify

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31. Does your household use different fuel for cooking different foods?

a) Yes [ ] b) No [ ] c) Sometimes [ ]

If yes, please specify the type of fuel and type of food cooked with that fuel

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32. Has the use of traditional biomass affected your quality of life? If so in what way?

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33. If your household has been adversely affected by scarcity of fuel supplies in recent years, please indicate what strategies you have adopted to cope with the situation. Please Tick more than one answer if possible

a) Reduce cooking [ ] b) Use fuel more sparingly/economically [ ] c) Collect wood freely instead of buying [ ] d) Obtain supplies in large quantities [ ] e) Shift to inexpensive but less desirable fuel [ ] f) Invest in energy-efficient cooking devices [ ] g) Other [ ]

34. Do you think the municipality is doing enough to halt fuelwood dependency? If so what?

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35. Do you think your contribution can have an impact on extensive fuelwood dependency?

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Thank you for the time and participation in this study

Appendix C: Approval letter from the royal council to conduct the research

UNISA

To: The Headmaster

Khubvi Village

From: The Researcher

Ms Netshipise Lusani

Date: 10 April 2019

Ref: Requesting Permission for student to conduct a research study at the village of Khubvi

I am a student at the University of South Africa doing a Masters in Environmental Management. I humbly request for your permission to conduct a research on the factors that influence fuelwood consumption in households within your community.

The title of the research is "Evaluating the factors that influence fuelwood consumption in households at the Thulamela Local Municipality. South Africa"

Your corporation will be highly appreciated. If you have any queries or reservations, please do not hesitate to contact me. The following are my contact details:

Tel: ...0711128342...........

Email: ...lusief@gmail.com...

Yours sincerely

L.F. Netshipise

university
of south africa

University of South Africa
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UNISA

Permission to conduct the research within the village of Khubvi

The Headmaster

Khubvi village

RANDIMA THENAWANGA LEONARD ... Randima T.L

Name of the headmaster Signature

KHOSI VHO-RANDIMA T.L
DEPARTMENT OF HUMAN SETTLEMENT
& CO-OPERATIVE GOVERNANCE
KHUBVI TRADITIONAL COUNCIL
2019 -05- 03
P.O. BOX 50 MAKONDE 0984
THULAMELA MUNICIPALITY
VHEMBE DISTRICT
CELL: 079 393 6848 SIGN Randima T.L

Village Stamp

university
of south africa

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Appendix D: Ethical Clearance

UNISA university of south africa

UNISA-CAES HEALTH RESEARCH ETHICS COMMITTEE

Date: 16/03/2020

NHREC Registration # : REC-170616-051
REC Reference # : 2020/CAES_HREC/038
Name : Ms LF Netshipise
Student #: 40811174

Dear Ms Netshipise

Decision: Ethics Approval from 12/03/2020 to completion

Researcher(s): Ms LF Netshipise
40811174@mylife.unisa.ac.za

Supervisor (s): Ms K Semenya
semenk@unisa.ac.za; 011-471-2138

Working title of research:

Evaluating the factors that influence fuelwood consumption in households at the Thulamela local municipality, South Africa

Qualification: MSc Environmental Management

Thank you for the application for research ethics clearance by the Unisa-CAES Health Research Ethics Committee for the above mentioned research. Ethics approval is granted until the completion of the project, **subject to submission of yearly progress reports and further clarification. Failure to submit the progress report will lead to withdrawal of the ethics clearance until the report has been submitted.**

Due date for progress report: 31 March 2021

Please note the points below for further action:

1. The questionnaire asks for the residential address of the participant. Is this information essential to the research? If it is essential, the researcher should stipulate how the confidentiality of the participants will be protected. If the information is not essential, the committee recommends that it be removed from the questionnaire.

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2. The researcher did not identify any possible risk to herself – however, as she will visit the community there could be risks to her own safety. How will this be mitigated? Will she be accompanied by anyone during data collection?
3. Unisa has a standard consent form that must be used to obtain consent from participants. The researcher may not use any other consent form, and is requested to submit the corrected draft consent form to the Committee for record purposes. The forms are provided on the college website: https://www.unisa.ac.za/sites/corporate/default/Colleges/Agriculture-&-Environmental-Sciences/Research/Research-Ethics
4. What is the motivation for the use of systematic sampling? The researcher should indicate whether the population is homogenous or heterogeneous. What is the motivation for using the particular formula to calculate the sample size? The researcher should check that the formula is correct. What is the motivation for selecting one in every fifth household?
5. The researcher did not stipulate any data analysis methods and models. She should indicate what model will be applied to analyse the data for each objective, how they will be applied, and what the variables will be.
6. The timeframes provided in the research proposal for the research is unrealistic and must be amended.

*The **low risk application** was **reviewed** by the UNISA-CAES Health Research Ethics Committee on 12 March 2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and

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scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.

6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No field work activities may continue after the expiry date. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2020/CAES_HREC/038** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Prof MA Antwi
Chair of UNISA-CAES Health REC
E-mail: antwima@unisa.ac.za
Tel: (011) 670-9391

Prof MJ Linington
Executive Dean : CAES
E-mail: lininmj@unisa.ac.za
Tel: (011) 471-3806

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Appendix E: Language Editing Certificate

CERTIFICATE OF EDITING

This is to certify that

Bonani Contents Pty (Ltd)

has edited and proofread the Master's Dissertation by
Lusani Faith Netshipise

24 September 2020	Lindy Ntuli
DATE	EDITOR

Appendix E: Digital Report

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Lusani Netshipise
Assignment title:	Revision 2
Submission title:	MPENV90 dissertation
File name:	MPENV90-_Dissertation-1.docx
File size:	4.94M
Page count:	147
Word count:	36,710
Character count:	203,206
Submission date:	18-Oct-2020 02:13AM (UTC+0200)
Submission ID:	1418253435

Evaluating the factors that influence fuelwood consumption in households at the Thulamela Local Municipality, South Africa

By

LUSANI FAITH NETSHIPISE

Submitted in accordance with the requirements for the degree of

MASTER OF SCIENCE

in the subject

ENVIRONMENT MANAGEMENT

at the

UNIVERSITY OF SOUTH AFRICA

Supervisor: Ms K SEMENYA

JUNE 2020

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Appendix G: Article submission for publication

P

Pieter Levecque 11:37
to me

Lusani Netshipise:

Thank you for submitting the manuscript, "Evaluating factors that influences the use of firewood in an unpleasant manner in Thulamela Local Municipality, RSA" to Journal of Energy in Southern Africa. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://journals.assaf.org.za/index.php/jesa/authorDashboard/submission/9233
Username: lusani-netshipise

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Pieter Levecque

The following message is being delivered on behalf of Journal of Energy in Southern Africa (JESA).

____

Assoc Prof Pieter Levecque
Journal of Energy of Southern Africa (Editor)
Department of Chemical Engineering
University of Cape Town