AN EVALUATION OF FACTORS INFLUENCING FIREWOOD USAGE AMONG ELECTRIFIED HOUSEHOLDS AT NKOMO VILLAGE, LIMPOPO PROVINCE, REPUBLIC OF SOUTH AFRICA.

By

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DEDICATION

This thesis is dedicated to my one and only daughter. When I started this journey, I promised to make you proud and here we are today. I hope you are proud of mommy's achievement.

DECLARATION

I, **Bongani Lillian Mabunda**, hereby affirm that this research for the Master of Science in Environmental Management degree at the University of South Africa, hereby submitted by me, has not been submitted previously for a degree at this or any other university.

I declare that it is my own work in design and execution, and that all the reference material contained herein has been duly acknowledged.

I declare that I received ethics approval on January 23 2020, which was renewed on May 18 2021 with reference number 2020/CAES_HREC/001, and that I have followed the University of South Africa's CAES Health Research Ethics policy. I have not acted outside the terms approved by the CAES Health Research Committee.

I declare that my study was submitted to TURN-IT-IN prior to the final submission for examination.

…… Date: 30 May 2022

Student

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I would like to give praise to the almighty God for being my leader and for giving me the strength, capability, and good health that I needed to conduct this research. He is my source of strength and my everyday dose of encouragement. Much appreciation, Father – you are undeniably a mighty warrior who is incomparable in battle.

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ABSTRACT

Firewood can be defined as a source of energy generated by burning wood biomass such as logs and twigs. It is the major source of energy in the rural areas of developing countries, where other energy sources such as electricity are limited. In many high mountainous regions in developing countries, the use of firewood as a source of energy is dominant due to the availability of forest wood in such areas. More than two billion people in the world depend on firewood as their primary source of energy. Furthermore, it has been estimated that more than 2.4 billion people rely directly on traditional plant biomass for cooking and heating. Plant biomass use represents half of the residential energy consumption in developing countries.

In South Africa, especially in rural communities, firewood remains a primary energy source, even for electrified households. It is regarded as one of the most significant sources of biomass energy.

The main aim of this study was to evaluate the factors influencing the usage of firewood as an energy source among electrified households in the rural Nkomo Village in the Limpopo province of South Africa.

Both qualitative and quantitative research methods were employed in this research to achieve the main aim of the study. Research instruments such as questionnaires and on-site observation were utilised to collect the data. It was found that, although Nkomo Village had been electrified for more than 25 years, the majority of the residents still rely on firewood for their daily cooking and space and water heating because of its affordability, considering that most of them are dependent on government social grants as a source of income and cannot afford the electricity required for these purposes. Electricity in the area is mainly used for lighting.

It was found that several factors influence the usage of firewood in electrified households in Nkomo, including accessibility, affordability, the age of the heads of households, income, cultural preference, and geographical location. In addition, economic factors such as unemployment, as well as the high cost of electricity and electrical appliances, contribute to the choice to use firewood. This situation might

continue for some time to come. Since the village is electrified, it is recommended that households fully adopt the usage of electricity and electrical appliances for other household activities and not only for lighting, as this will minimise their contributions towards environmental impacts such as biodiversity loss as a result of deforestation (both plants and animal species), soil erosion, air pollution and its health impacts, and greenhouse gas emissions that contribute to global warming and climate change.

However, full adoption of electricity will require government intervention by ensuring that electricity is affordable and also by introducing other sources of energy. Government will therefore have to contribute by formulating policies and strategies related to rural household electricity access and usage, socio-economic factors and impacts associated with firewood use in rural villages, as well as strategies and interventions to reduce environmental impacts (such as air pollution, deforestation, biodiversity loss and desertification) resulting from firewood sourcing. In rural areas like Nkomo Village, the priority should be to provide affordable and reliable energy.

Findings from this study will inform communities in the host village and neighbouring villages, policymakers and the government, by providing information on and awareness of the extent to which firewood is still used as household energy source, the disadvantages of using it, as well as potential environmental impacts associated with its use.

Keywords: *Firewood, energy, electricity, household, Nkomo Village, environmental and socioeconomic impacts, mitigation strategies*

NKOMISI LOWU NGA NA MONGO WA NDZAVISISO

Tihunyi ti nga hlamuseriwa tanihi xihlovo xa eneji leyi yi humesiwaka hi ku tshivela tihunyi ku kufumeta tanihi timhandze na swihlahlana I xihlovo lexikulu xa eneji eka tindhawu ta le makaya ta matiko lama ya ha hluvukaka, laha swihlovo swin'wana swa eneji swo fana na gezi swi nga kumekiku kahle hi ku ringanela. Eka tirijini ta tintshava eka matiko lama ya ha hluvukaka, ku tirhisiwa ka tihunyi tanihi xihlovo xa eneji i nchumu lowu endlekaka ngopfu hikuva ku na swihlahla swinyingi eka tindhawu to tano. Vanhu vo tlula tibiliyoni timbirhi (2) eka misava hinkwayo va tshembela eka tihunyi tanihi xihlovo xo sungula xa eneji. Nakambe, swi ringanyetiwa leswo vanhu vo tlula tibiliyini ta 2.4 va tshembele eka switshiveriwa swa swimila swa ntumbuluko eka ku sweka na ku kufumeta. Ku tirhisiwa ka switshiveriwa swa swimila swi ringana hafu wa eneji leyi tirhisiwaka emakaya eka matiko lama ya ha hluvukaka.

EAfrika Dzonga, ngopfungopfu eka tindhawu ta le makaya, ku tirhisiwa ka tihunyi ka ha ri xihloxo xo sungula xa eneji, hambi na le ka miti leyi yi nga na gezi. Ku tekiwa ku ri yin'wana ya swihlovo swa eneji leyi yi tirhisaka swilo swo fana na tihunyi na swimila swa ntumbuluko.

Xikongomelonkulu xa ndzavisiso lowu a ku ri ku kambela swilo leswi swi susumetaku no kucetela ku tirhisiwa ka tihunyi tanihi xihlovo xa eneji eka miti leyi yi nga na gezi eka muti wa Nkomo Village eka Provhinsi (Xifundzhankulu) xa Limpopo eAfrika Dzonga.

Ku tirhisiwe tindlela timbirhi ta *qualitative* na *quantitative* eka fambiselo ra ndzavisiso ku fikelela xikongomelonkulu xa ndzavisiso. Switirhisiwa swa ndzavisiso leswi swi nga tirhisiwa swo fana na nongonoko wa swivutiso leswi tsariweke ku nga *questionnaires*, ku lemuka kunene leswi endlekaku eka ndhawu (on-site observation), swi tirhisiwe ku hlengeleta vutivi. Ku kumeke leswo hambiloko eka muti wa Nkomo Villlage ku nga na gezi ku tlula nkarhi wa malembe ya 25, vunyingi bya vatshami va ndhawu va ha tshembele ngopfu eka ku tirhisa tihunyi eka mitirho ya masiku, ku sweka, ku kufumeta ndhawu na mati hikuva vunyingi bya vanhu byi tshembele eka mali ya tigranti ta mfumo, na swona a va koti ku hakelela gezi leri lavekaka eka swikongomelo leswi. Gezi eka ndhawu ri tirhisiwa ngopfu ku voninga.

Ku kumeke leswo ku na swilo swo hlaya leswi swi nga swivangelo kumbe swikuceteri swa ku tirhisiwa ka tihunyi eka miti leyi yi nga na gezi eka Nkomo leswi katsaka ku fikeleleka, vukoteki bya nxavo, malembe ya vukhale ya tinhloko ta miti, malinghena, ku hambana ka swa mindhavuko, na ndhawu hi jiyografu laha ndhawu yi nga kona. Na le henhla ka sweswo, swiyimo eka ikhonomi swo fana na ku kala mitirho, xikan'we na mintsengo ya minxavo ya le henhla gezi, na tiaplayense ta gezi, hinkwaswo swi ve na xiavo eka ku langiwa ka ku tirhisiwa ka tihunyi. Xiyimo lexi xi nga ha ya emahlweni eka nkarhi lowu taku. Hikuva vhileji yi na gezi, ku bumabumeriwa leswo miti yi fanele ku amukela ku tirhisiwa ka gezi na tiaplayense eka migingiriko yin'wana, ku nga ri ku voninga ntsena, hikuva leswi swi ta hunguta vuyelo byo biha eka mbangu byo fana na ku lahleka ka swilo swo hambanahambana eka ntumbuluko hikokwalaho ko lahlakeriwa hi swihlahla (haswimbirhi ku nga swimila na tinxaka ta swiharhi), ku khukhuleka ka misava, ku thyakiseka ka moya, na rihanyu, na ku humesiwa ka mimusi ku nga greenhouse gas emissions, leswi swi ngeteleleka ku kufumela ka misava na ku cinca ka klayimete.

Kambe, ku amukeriwa hi xitalo ka ku tirhisiwa ka gezi swi ta lava leswo mfumu wo nghenelela hi ku tiyisa leswo gezi a ri durhi ra fikeleleka eka vanhu na ku nghenisa swihlovo swin'wana swa eneji. Mfumo wu ta fanela ku pfuneta hi ku endla tipholisi na maqhinga lama ya fambelanaka na ku fikelela ka miti eka gezi na ku tirhisiwa, swilo swo fambelana na vanhu na ikhonomi na vuyelo lebyi byi fambelanaku na ku tirhisiwa ka tihunyi eka tindhawu ta le makaya, xikan'we na maqhinga na ku nghenela ku hunguta vuyelo byo biha eka mbangu (byo fana na ku thyakisiwa ka moya, ku herisiwa ka swihlahla, ku lahleka ka swihlovo swa ntumbuluko swo hambana, na ku endla tindhawu ti va mananga, leswi vangeriwaka hi ku tirhisiwa ka tihunyi. Eka tindhawu ta le makaya to fana na Nkomo Village, xo sungula ku fanele ku va ku pfuneta hi eneji leyi fikeleleka na leyi yi tshamaku yi ri kona.

Vuyelo bya ndzavisiso byi ta pfuneta vaakamiti eka vhileji leyi ku nga endliwa ndzavisio eka yona na vaakelani va yona, vaendli va pholisi na mfumo, ku pfuneta hi vutivi na vulemuki hi xiyimo xa ku tirhisiwa ka tihunyi hilaha ti tirhisiwaka ha kona tanihi xihlovo xa eneji eka miti, vuyelo byo biha bya ku tirhisiwa ka tihunyu, xikan'we na vuyelo byo biha eka mbangu lebyi byi fambelanaku na ku tirhisiwa ka tihunyu.

Marito ya nkoka: *Tihunyi, eneji, gezi, makaya, Nkomo Village, swa mbangu, switandzhaku eka vanhu na ikhonomi, maqhinga (switratheji) swa ku pfuneta*

MANWELEDZO

Khuni dzi nga ṱalutshedzwa sa tshiko tsha fulufulu tshine tsha bveledzwa nga u vhasa zwibveledzwa zwi ngaho matanda na matavhi. Ndi tshone tshiko tshihulwane vhuponi ha mahayani kha mashango ane a kha ḓi bvelela, hune zwiṅwe zwiko zwa fulufulu zwi ngaho muḓagasi zwa vha zwo pimea. Kha vhupo vhunzhi ha nṱha dzithavhani, u shumiswa ha khuni sa tshiko tsha fulufulu zwo ḓalesa zwi tshi itiswa nga u wanalesa ha ḓaka ḽa khuni kha vhupo honoho. Vhathu vhane vha fhira biḽioni mbili ḽifhasini vho ḓitika nga khuni sa tshone tshiko tshihulwane tsha fulufulu. U isa phanḓa nga u ralo, ho anganyelwa uri vhathu vhane vha fhira biḽioni dza 2.4 vha ḓitika thwii nga zwibveledzwa zwa miri ya sialala kha u bika na u dudedza. U shumiswa ha zwibveledzwa zwa miri zwo imelwa nga hafu ya u shumiswa ha fulufulu nga vhadzulapo kha mashango ane a kha ḓi bvelela.

Afrika Tshipembe, nga maanḓa vhuponi ha mahayani, khuni dzi dzula dzi tshone tshiko tshihulwane tsha fulufulu, na kha miṱa ire na muḓagasi. Zwi dzhiwa sa tshiṅwe tshiko tsha ndeme tsha fulufulu ḽa tshibveledzwa tsha miri.

Ndivho khulwane ya ngudo iyi ho vha u ṱola zwiṱaluli zwi ṱuṱuwedzaho kushumisele kwa khuni sa tshiko tsha fulufulu vhukati ha miḓi ire na muḓagasi Muḓanani wa Nkomo kha Vundu ḽa Limpopo Afrika Tshipembe.

Ho shumiswa vhuvhili ha ngona dza ṱhoḓisiso ya khwanthethivi na ya khwaḽithethivi u swikelela ndivho khulwane ya ngudo. Zwishumiswa zwa ṱhoḓisiso zwi ngaho sa mbudzisambekanywa, kuitele kwa u dzhiela vhathu nṱha na zwithu u wana mafhungo na dziinthaviwu zwo shumiswa u kuvhanganya data. Ho waniwa zwauri, naho Muḓanani wa Nkomo wo dzheniswa muḓagasi miṅwaha i fhiraho 25, vhunzhi ha vhadzulapo vha kha ḓi ḓitika nga khuni kha u bika ha ḓuvha ḽiṅwe na ḽiṅwe, hune vha bikela hone na u dudedza maḓi ngauri vhunzhi havho vha ḓitika nga magavhelo a muvhuso sa tshone tshiko tsha mbuelo na uri vha nga si kone u badela muḓagasi une wa ṱoḓea kha ndivho dzenedzi. Muḓagasi kha vhupo wo shumiswa nga maanḓa kha u funga mavhone.

Ho wanululwa uri zwiṱaluli zwo vhalaho zwo ṱuṱuwedza u shumiswa ha khuni kha miṱa ire na muḓagasi ha Nkomo, hu tshi katelwa u swikelela, u konea, vhukale ha ṱhoho dza muṱa, mbuelo, mvelele ine ya takalelwa na fhethu vhupo. Nṱha ha zwenezwo, zwiṱaluli zwa ikonomi zwi ngaho sa u shayea ha mishumo, na mutengo wa muḓagasi ure nṱha zwishumiswa zwa muḓagasi, zwo bveledza u nanga u shumiswa khuni. Nyimele iyi i nga bvela phanḓa lwa tshifhinga tshilapfu ngauri muḓana u na muḓagasi, hu khou themendelwa uri miṱa i ṱanganedze u shumiswa ha muḓagasi na zwishumiswa zwa muḓagasi, hu si u shumisela fhedzi mavhone, sa izwi zwi tshi ḓo fhungudza u shela mulenzhe havho kha masiandaitwa a vhupo a nga ho u xelelwa matshilo a zwipuka na zwimela zwo bveledzwa nga u rema maḓaka (vhuvhili hazwo zwigwada zwa zwimela na zwipuka), mukumbululo wa mavu, tshikafhadzo ya muya na masiandaitwa a mutakalo, u phaḓaladza gese ya nnḓu yo fhaṱwaho nga ngilasi zwine zwa bveledza mufhiso wa ḽifhasi na tshandulo ya kilima.

Naho zwo ralo, u ṱanganedzwa tshoṯhe ha muḓagasi zwi ḓo ṱoḓa u dzhenelela ha muvhuso nga u vhona zwauri muḓagasi u a swikelelea na nga u dovha u ḓivhadza zwiṅwe zwiko zwa fulufulu. Muvhuso nga zwenezwo u ḓo tea u shela mulenzhe nga u bveledza mbekanyamaitele na zwiṱirathedzhi zwi elanaho na u swikelela na u shumisa muḓagasi miṱani ya vhupo ha mahayani, zwiṱaluli zwa ikonomi ya matshilisano na masiandaitwa a elanaho na u shumiswa ha khuni miḓanani ya vhuponi ha mahayani, na zwiṱirathedzhi na u dzhenelela u fhungudza masiandaitwa a vhupo (a ngaho tshikafhadzo ya mufhe, u rema maḓaka, u xelelwa nga zwimela na zwipuka na) zwo bveledzwa nga tshiko tsha khuni. Kha vhupo ha mahayani vhungaho Muḓana wa Nkomo, zwine zwa fanela u dzhielwa nṱha hu fanela u vha u ṋetshedza fulufulu ḽine ḽa swikelelwa ḽo khwaṯhaho.

Mawanwa kha ngudo iyi a ḓo ḓivhadza zwitshavha kha muḓana wa ṋemuṱa na miḓana ya nga tsini, vhabveledza mbekanyamaitele na muvhuso, nga u ṋetshedza mafhungo nga ha u dzhiela nṱha nga huhulu nga nḓila ine khuni dzi kha ḓi shumiswa ngayo sa tshiko tsha fulufulu, zwivhi zwa u dzi shumisa, na masiandaitwa a ndeme a re kha vhupo a elanaho na u shumiswa hadzo.

Maipfi a ndeme: *Khuni, fulufulu, muḓagasi, muṱa, Muḓanani wa Nkomo, masiandaitwa a vhupo na matshilisano a ikonomi, zwiṱirathedzhi zwa u khwinisa.*

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FAO	: Food and Agriculture Organisation
GHG	: Green House Gases
HIV	: Human Immunodeficiency Virus
ICEED	: International Centre for Energy, Environment and Development
IEA	: International Energy Agency
IDP	: Integrated Development Plan
KM	: Kilometre
LPG	: Liquefied Petroleum Gas
PRA	: Participatory Rural Approach
SEA	: Sustainable Energy Africa
Stats SA	: Statistics South Africa
SPSS	: Statistical Package for Social Sciences
WHO	: World Health Organisation

CHAPTER ONE: BACKGROUND

1.1 Introduction

Following the demise of apartheid in South Africa, electricity, as a basic service, was installed faster and made available to many more households in Limpopo Province, South Africa, than in other provinces. By 2016, approximately 92,2% of households in the province were connected to the electricity grid (Limpopo Provincial Treasury, 2018). This is the largest increase in electricity connection observed in the province (+20.1%). However, despite this high increase in electricity connections in Limpopo, the use of electricity for cooking is far lower than in other provinces (Stats SA, 2018). Firewood is the preferred energy source for cooking, space heating and water heating in most Southern African countries such as Angola, Lesotho, Malawi, Namibia, Swaziland, Zambia and Zimbabwe (Makonese et al., 2018).

In rural South Africa, firewood is used as an energy source among some electrified families (Uhunamure et al., 2017). A study by Semenya and Machete (2019) reported that the majority of communities in South Africa, including households with electricity, still choose to use solid fuels such as firewood for heating and cooking as a cheaper form of energy than electricity. In addition, the usage of firewood in rural communities is influenced by elevation, the size of the household's private garden, the period of heating in winter, the education level and the low availability of electricity received in the area (Mwaura, 2014).

This high utilisation of firewood by the population of Limpopo, the majority of whom live in rural areas, has increased deforestation and soil erosion in the recent past (Uhunamure, Nethengwe & Musyoki, 2017). This study was conducted to evaluate the factors influencing the usage of firewood among electrified households at Nkomo Village in Limpopo. This village has been electrified for more than 25 years, but many households still utilise firewood as their main source of energy for cooking, water and space heating. To make things easier, some households that are connected through the national electrification programme receive 50kwh free basic electricity each month (SEA & University of Limpopo, 2016).

Firewood is one of the most significant sources of biomass energy because more than two billion people in the world depend on it as their main energy source, especially in developing countries (Pattanayak et al., 2004). Furthermore, it has been estimated by the World Health Organisation (WHO) that approximately 3 billion individuals still use solid fuels such as crop wastes, coal and firewood for cooking (WHO, 2018).

The burning of firewood has significant environmental, health and socioeconomic impacts on communities (Uhunamure et al., 2017). The environmental impacts include deforestation, soil erosion, loss of biodiversity and air pollution, mainly due to the removal of vegetation and the burning of wood to make fire for a variety of purposes (Ujih et al., 2016). Furthermore, one of the environmental issues linked to household dependence on firewood is the harvesting of plants without proper mitigation measures, such as harvesting a huge number of trees without planting new ones (Bailis et al., 2015).

Firewood combustion is one of the causes of climate change and global warming because it releases greenhouse gasses (GHGs) into the atmosphere (Semenya and Machete, 2019). Indoor air pollution derived from firewood cooking has also been linked to health issues. Indoor air pollution causes breathing diseases such as chronic obstructive pulmonary disease and asthma, and non-breathing diseases such as cardiovascular disease and cataracts (Fullerton et al., 2008; Silwal and McKay, 2014).

Moreover, the collection of firewood has become increasingly time-consuming because deforestation and forest degradation have lengthened the distances that must be travelled to collect wood (Hassan et al., 2013). In addition, firewood collection in isolated areas poses significant safety risks to females and leaves them vulnerable to sexual assault and to other forms of gender-based violence (Elijah et al., 2017). Elijah et al. (2017) add that the amount of time spent and distance travelled to collect firewood differs between regions. However, many researchers indicate that females spend a significant portion of their time collecting firewood.

According to Semenya and Machete (2019), major drivers influencing the usage of firewood in South Africa include, but are not limited to, household income, the educational status of breadwinners, family size, place of residence, fuel affordability

and accessibility. The study by Semenya and Machete was limited to Senwabarwana village in Limpopo Province, which is approximately 252 kilometres from Nkomo Village.

The cultural dynamics of Senwabarwana and Nkomo villages are different and constituted by distinct tribes located in Limpopo Province. This research seeks to uncover perspectives that were not found by previous researchers in order to close the gaps in the knowledge base. Type and taste of food are viewed as culture, according to Semenya and Machete (2019). For example, as opposed to Bapedi, VhaVenda and Vatsonga in the northeast of Limpopo prefer to prepare their food using firewood rather than electricity because they believe it is tastier.

1.2 Problem statement

Access to electricity prior to 1994 was very low. The South African government has electrified about 7.2 million households since 1994, using grid technology. More than 143,432 households have been connected in South Africa. It was assumed that once households were electrified, they would shift away from using non-electric energy sources and use electricity as their main source of energy. However, this has not been the case, especially in low-income households, where non-electrical energy sources continue to be utilised on a frequent basis (Francioli, 2018).

The bulk (more than 80%) of South Africa's electricity is generated from coal combustion, that results in high levels of air pollutants and greenhouse gases emitted into the atmosphere causing environmental and human health impacts. The South African government also uses other alternative and cleaner technologies for electricity generation that include nuclear, hydro, wind and solar (Francioli, 2018). They reduce the social and environmental problems associated with other sources of energy, such as firewood and charcoal, and they provide better services for citizens.

Most households in Nkomo Village still use firewood as their main source of energy for cooking, space and water heating, which will have a long-term impact on their health and the environment. Although firewood is cheaper in terms of monetary value, the long-term impacts associated with its prolonged use cannot be ignored.

1.3 Rationale and significance of the study

The use of firewood as a source of energy is still dominant in the Nkomo Village, which is in the Greater Giyani Local Municipality in Limpopo. This practice is associated with socioeconomic issues such as poverty and lack of income in households. Poverty contributes to the use of firewood consistently because a huge number of poor people cannot afford to use another source of energy such as electricity for domestic purposes such as cooking (Greater Giyani Municipality, 2018).

The aim of this study was to evaluate the factors influencing the usage of firewood among electrified households in Nkomo Village with a view to assisting people to understand the need to switch to cleaner energy sources with minimal or no environmental and health impacts. Various studies have been conducted in several areas, but there is insufficient knowledge about the usage of firewood in the study area. The study by Semenya and Machete (2019) conducted in Senwabarwana, for instance, did not consider the price of electric appliances as a factor that influenced the usage of firewood as a source of energy, which was found to be a factor in Nkomo Village.

1.4 Research aim and objectives

The aim of the study was to evaluate the factors that influenced firewood usage among electrified households at Nkomo Village, Limpopo Province of South Africa. To achieve this study aim, the following objectives were assessed:

- To determine the extent to which firewood is being used as a household energy source in Nkomo Village;
- To assess the socioeconomic dynamics of the families in the study area;
- To develop management strategies to address the overlapping issues of the use of firewood and thus mitigate its adverse impacts on the environment and surrounding communities.

1.5 Research outline

The research is presented in five chapters:

In Chapter One, the background, problem statement, rationale and significance of the study, research aim and objectives were presented.

Chapter Two comprises a literature review, in which the factors that influence the use of firewood as an energy source are summarised. Other sources of household energy and environmental problems associated with the use of firewood are also described, as well as the socioeconomic and health impacts associated with the use of firewood, and their management.

Chapter Three outlines the research methodology that covers a description of the study area and the research methods utilised for the study. This includes the research design, sampling method, data collection and analysis methods, and ethical considerations.

Chapter Four comprises a presentation and analysis of the results and study findings.

Chapter Five contains the research summary, a description of the research limitations, recommendations, and conclusion.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter comprises a review of previously published material relating to factors that influence the use of firewood as an energy source in electrified households. The reviewed studies were conducted in a variety of countries. The use of firewood as a household energy source has been associated with a number of factors and the main ones are presented in this chapter. The gaps in knowledge that this study aims to fill are also identified. Moreover, other sources of energy and their advantages and disadvantages are discussed, as well as the impacts of firewood on health, the environment and socioeconomic realities.

Moreover, an outline of management strategies utilised to address the overlapping issues of using firewood as a source of energy are noted. These factors include accessibility to firewood as an energy source, its affordability, the income of the household, the educational level of the household head, family size, age of the household head, geographical location, cultural preferences and price of energy and appliances. The impacts of the use of firewood as an energy source and the management thereof are also identified.

Firewood can be defined as an energy source resulting from burning wood biomass like logs and twigs (Ochwo et al., 2016). According to (Ketlhoilwe, 2018), firewood is the main source of energy in the rural communities of developing countries, in which additional energy sources such as electricity are insufficient. This is particularly true in many high, hilly regions of developing countries, due to the availability of forest wood in the area (Pattanayak et al., 2004).

Ochwo et al. (2016) indicate that the sources of firewood are private gardens, roadsides, public areas and private forests. According to Mehlwana and Qase (1999), firewood is often used during traditional ceremonies or special events for the preparation of meals for a large number of people. In developing countries, which have both rural and urban areas, firewood is used for both domestic (i.e., cooking) and

industrial purposes (i.e., the heating of bricks) and it remains a dominant energy source.

The use of clean energy sources can be seen as the most sustainable option for most countries, especially developing countries; however, huge disparities in household income present a major barrier to its implementation (Ochwo et al., 2016).

2.2 Sources of household energy

2.2.1 Firewood

Firewood is a renewable organic plant material. It continues to be an important energy source in many countries, especially for cooking and heating in developing countries. It is cheap compared to other sources of energy. Because the people in rural areas are mostly poor, they prefer this source of energy. It is easily accessible in the rural areas, where ample areas are covered with forests and vegetation (Chowdhury et al., 2011).

The use of firewood as an energy source for a household is regarded as being non-environmentally friendly because it results in the destruction of the environment through deforestation (Hallberg & Hallme, 2015). Furthermore, its use has health and social effects on the communities that use it. As a result, alternate energy sources have been introduced to eliminate the utilisation of firewood, all of which are used for electricity generation in order to meet the needs and wants of communities.

Table 2.1 below contains a summary of the advantages and disadvantages of using firewood as an energy source.

Table 2.1: The advantages and disadvantages of firewood use (Ochwo et al., 2016; Zidago and Wang, 2016; Ketlhoilwe, 2018).

Advantages of firewood	Disadvantages of firewood
• Low cost or free	• It is not environmentally friendly

• Readily available	• Has health effects such as lung diseases
• Provides heating and cooking for huge households	• Dangerous because it can set fire to the house

2.2.2 Solar energy

Solar energy is a stand-alone source of energy that is generated by the heat from the sun. This energy source is pollution-free and causes no greenhouse gas emissions. It also reduces dependence on foreign oil and fossil fuels. It can be used to generate electricity or heat in areas that have no access to the energy grid (Hallberg & Hallme, 2015).

Developing countries have been seeking innovative alternatives to give families efficient means to meet their basic needs, such as lighting and cooking (ICEED, 2018). Solar energy is recognised as one of the best alternatives for rural areas.

Converting the sun's radiation into energy is free and the source is inexhaustible. Unlike the use of firewood, solar energy is environmentally friendly because it does not cause any environmental damage.

Table 2.2 below indicates the advantages and disadvantages of using solar energy.

Table 2.2: Advantages and disadvantages of using solar energy (Hassan et al., 2013)

Advantages of solar energy	Disadvantages of solar energy
• Environmentally friendly.	• Depends only on sun; thus, if there is no sun there will be no power.
• Free operating costs.	• Solar panels are expensive to install (especially the batteries, which must be replaced every few years).
• No health effects such as respiratory diseases.	• Increases criminal activity because thieves steal power panels.

• It is safe.	
• Can generate sufficient power for basic needs, such as cooking and heating.	

2.2.3 Nuclear energy

Nuclear power entails the utilisation of nuclear reactions which release nuclear energy to produce heat. Steam turbines are mostly used to produce electricity in a nuclear power plant. One method of releasing nuclear fission is utilising devices called “reactors” (Hassan et al., 2013).

This energy source is used all over the world to generate electricity for a huge number of communities, factories, industries and businesses, and it is more compelling and is more efficient than other energy sources. It has higher energy density than fossil fuels (Hassan et al., 2013).

Table 2.3 below shows the advantages and disadvantages of nuclear energy.

Table 2.3: The advantages and disadvantages of nuclear energy (Ochwo et al., 2016)

Advantages of nuclear energy	Disadvantages of nuclear energy
• Very reliable and efficient.	• The radioactive waste produced by nuclear energy generation can have serious health effects on human beings and the environment.
• Generates electricity for a huge number of people.	• Causes air pollution.
• More efficient than fossil fuels.	• It is very expensive.

2.2.4 Wind energy

Wind energy is a form of energy in which wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. Wind energy is one of the fastest-growing renewable energy technologies. The process entails the use of wind to produce electricity through the use of kinetic energy, which is created by the air in motion (Musial & Ram, 2010). The volume of power that can be gathered from the wind is based on the magnitude of the turbine and the length of its blades. According to Lloyd (2014), the advantages of wind energy outweigh its disadvantages.

Table 2.4 below indicates the advantages and disadvantages of wind energy.

Table 2.4: The advantages and disadvantages of wind energy (Lloyd, 2014)

Advantages of wind energy	Disadvantages of wind energy
• It is an unlimited, free and renewable resource (i.e., wind itself).	• Constructing turbines and wind facilities is expensive.
• It is clean source of energy and a non-polluting way to generate electricity.	• The technology is immature.
• It does not emit air pollutants or greenhouse gasses.	• It poses a threat to birdlife
• Is more eco-friendly than burning fossil fuels to generate electricity.	

2.2.5 Coal energy

Coal as the most significant energy in the parts of the world lacking pollution control technologies adversely affects global atmosphere. It is the compound geological material, composed of organic compounds and all chemical elements, together with a wide variety of minerals. It has a lot of energy in it. When it is burned, coal makes heat and light energy. People started using coal in the 1800s to heat their homes (Medunic et al., 2018).

Table 2.5 below indicates the advantages and disadvantages of coal energy.

Table 2.5: The advantages and disadvantages of coal energy (Medunic et al., 2018)

Advantages of Coal Energy	Disadvantages of Coal Energy
• It can be found in many places.	• To dig up coal a lot of mines must be created which can be dangerous and not very nice to look at.
• It can be easily transported.	• Transporting coal causes air pollution.
• It is a comparatively cheap energy source.	• Burning coal produces polluting gases like sulphur dioxide which causes acid rain
	• Coal burning releases the most greenhouse gases which may add to global warming.
	• Coal is a non-renewable source.

2.2.6 Gas Turbine

The gas turbine is a combustion engine at the heart of a power plant that can convert natural gas or other liquid fuels to mechanical energy. This type of turbine uses pressurized gas to spin it in order to generate electricity. The pressurized gas in gas turbines is created by the burning of a fuel like natural gas, paraffin, propane, or jet fuel. The heat generated by this fuel expands air which flows through the turbine to supply useful energy (Mehta & Mehta, 2018).

Table 2.6 below indicates the advantages and disadvantages of gas turbine.

Table 2.6: The advantages and disadvantages of gas turbine (Mehta & Mehta, 2018)

Advantages of gas turbine	Disadvantages of gas turbine
• Simple to design.	• Problem of starting compressor needs to be operating thus external source of power is necessary.
• Lower operating costs.	• Net output is low since greater power is used to drive compressor.
• Less water used since there is no need for a condenser.	• Overall efficiency of plant is low.
• Maintenance charges are low.	• Temperature of combustion chamber is too high thus resulting in a lower life.
• Can be started quickly.	
• No stand-by losses.	

2.2.7 Hydroelectric energy

Hydroelectric energy is one of the oldest and largest sources of renewable energy, which uses the natural flow of moving water to generate electricity. The amount of electricity a hydro-electric system can produce depends on the quantity of water passing through a turbine and the height from which the water falls. The greater the flow and the head, the more electricity produced (Macavoy, 2012).

Table 2.7 below indicates the advantages and disadvantages of hydroelectric energy.

Table 2.7: Advantages and disadvantages of hydroelectric energy (Macavoy, 2012)

Advantages of hydroelectric energy	Disadvantages of hydroelectric energy
• Once the dam is constructed, electricity can be produced at a constant rate.	• It disrupts the aquatic ecosystem.

• If no electricity is needed, the channel gates can be shut to stop electricity generation.	• It causes disruption in the surrounding areas.
• Water can be saved and be used when electricity demand is high.	• It requires large land areas since power generation unit and transformers are needed to connect them to national grid.
• The lake that forms behind the dam can be used for water sports and other leisurely activities.	
• Electricity that is produced by dam systems do not produce greenhouse gases nor do they pollute the atmosphere in any way as gas, coal or power plants do.	

2.2.8 Landfill gas

Landfill gas is a natural by-product of the decomposition of organic material in landfills. It is composed of roughly 50% methane, 50% carbon dioxide and a small amount of non-methane organic compounds. Using landfill gas to generate energy and reduce methane emissions produces positive outcomes for local communities and the environment. Instead of escaping into the air, landfill gas can be captured, converted and used as a renewable energy resource using landfill gas helps to reduce odours and other hazards associated with landfill gas emissions and prevents methane from migrating into the atmosphere and contributing to local smog and global climate change (USEPA, 2021).

Table 2.8 below indicates the advantages and disadvantages of landfill gas.

Table 2.8: Advantages and disadvantages of landfill gas (USEPA, 2021).

Advantages of landfill gas	Disadvantages of landfill gas
• It reduces greenhouse gas emissions.	• It is dirtier than burning natural gas.

• Reduces air pollution by offsetting the use of non-renewable resources.	• It emits more pollution per kilowatt hour than natural gas does.
• Creates health and safety benefits.	
• Benefits the community and economy.	
• Reduce environmental compliance costs.	

2.2.9 Biomass

Biomass refers to all organic matter existing in the biosphere, whether plant or animal origin, as well as those materials obtained through their natural or artificial transformation. Biofuels derived from biomass include firewood, wood shavings, pellets, some fruit stones such as olives and avocados as well as nutshells. Biomass is present in a variety of different materials: wood, sawdust, straw, seed waste, manure, paper waste, household waste and wastewater (Perea-Moreno et al., 2019).

Due to the wide availability of biomass worldwide, mainly because it can be obtained as a by-product of many industrial and agricultural processes, biomass represents growing renewable energy source with high growth potential. One of the main characteristics of biomass that makes it suitable as an energy source is that through direct combustion, it can be burned in waste conversion plants to produce electricity or in boilers to produce heat at industrial and residential levels (Perea-Moreno et al., 2019).

Table 2.9 below indicates the advantages and disadvantages of biomass.

Table 2.9: Advantages and disadvantages of biomass (Mc Farland, 2017)

Advantages of biomass	Disadvantages of biomass
• Always and widely available as a renewable source of energy.	• It is not as efficient as fossil fuels.
• It is carbon neutral.	• It is not entirely clean.

• It reduces the overreliance of fossil fuels.	• It can lead to deforestation.
• It is less expensive than fossil fuels.	• Biomass plants require a lot of space.
• Less garbage in landfills.	

2.3 The choice of energy source by rural households

Hassan et al. (2013) assert that economic inability is the main reason for using firewood in the rural areas in Bangladesh. This is because rural households survive at a subsistence level. Most people in the rural areas of Bangladesh live below the poverty line. Income limitations thus prevent rural households from accessing efficient and modern forms of energy, especially for cooking. Maurice et al. (2015) add that the preference for firewood over other energy sources is based on the concept of utility maximisation. These authors argue that households are expected to use firewood if the satisfaction it derives from utilising the commodity ranks highest among the available energy sources.

Hallberg and Hallme (2015) found that household fuel choices in Zimbabwe were also determined by the income of households. The country is still dependant on firewood to supply the energy needs of the residential areas, although the country has plenty of coal and hydropower resources. In most cases, the households that depend on firewood are low-income earners.

A study conducted in Southern Ethiopia reveals that a statistically significant relationship exists between household cooking energy choices and distance to wood sources, household size, income level and location. Energy choices in households are influenced by income level, family size, access to road, location, education level, the cost of technology and distance to market. The study implies that wealthier and more educated households living near road access are more likely to use cleaner lighting energy sources, while poorer households in areas with limited road access tend to use paraffin and dry-cell batteries (Wassie et al. 2021).

However, Uhunamure et al. (2017) believe that the preference for firewood is not determined by economic factors alone, but that numerous socio-demographic factors also play a significant role, including gender and the educational level of the household head. These authors further indicate that cultural and taste preferences are considered by households in developing countries when choosing a source of energy, especially for cooking.

Due to the unreliability of modern energy sources and the dependability of firewood supply, as well as taste preferences, the convenience of firewood usage and the cooking habits of households, even the wealthiest households that have access to electricity have not abandoned using firewood as their source of energy. They maintain their energy portfolio and continue using firewood as their energy source. The study by Wassie et. al. (2021) also specifies that firewood as the primary source of energy declines and the use of other alternative sources increases when the distance that must be travelled to collect firewood increases. For this reason, firewood accessibility declines and the cost in terms of labour and time for collection increases as distance increases (Wassie et al., 2021).

The study conducted by Bohlmann and Lotz (2018) revealed that although poor South African households who are connected to the national grid are receiving free basic electricity of 50kwh per month to help them cover their basic energy needs, they still use various energy sources like firewood and paraffin to meet their basic energy needs. The study highlighted that having access to electricity simply adds electricity to the mix of energy sources used by rural households and it does not entirely substitute the use of other sources.

2.4 Factors influencing the use of firewood in the household

2.4.1 Accessibility of firewood as a source of household energy

According to Hassan et al. (2013), accessibility can be defined as the ability to get something easily. The accessibility of firewood is a crucial factor for households using it for cooking purpose, especially in rural areas, where alternative fuels such as liquefied petroleum gas (LPGs) are not readily available. Households can always

collect firewood close to their homes due to the fact that it is available any time of the year and it is not prone to heavy seasonal fluctuations (Hera, 2014).

Firewood is supposed to be the cheapest source of energy in both rural and urban areas, although it is regarded as very expensive in terms of useful energy output (Moeen et al., 2016). In many cases, it is the only source of energy available to rural communities due to limited access to commercial energy sources (FAO, 2018).

Owing to its availability and obtainability on the market, firewood cannot be substituted by cheaper alternative energy sources. On the other hand, where firewood is decreasingly available, people are faced with ever-increasing distances and must therefore spend more time and effort to collect it, particularly in dry and semi-dry areas (Hera, 2014).

Elijah et al. (2017), who conducted their study in Zambia, found that there was huge gap between rural and urban households in terms of accessibility to firewood. They found that close to half the population had access to firewood and they used it as an energy source for cooking. Its use was more prevalent in the rural areas than the urban areas. It was the dominant energy source for cooking in the rural areas, in contrast to charcoal in some countries (Elijah et al., 2017).

According to Moeen et al. (2016) in rural Pakistan electricity is a major source of lighting due to large-scale electrification in that country. However, a huge percentage of the rural population relies on outdated sources of energy for cooking and heating, of which firewood is the major source. Traditional sources of energy, such as firewood, are easily accessible. A lack of resources at the household level and the unavailability of modern energy sources are the major reasons for which households depend on out-dated sources like firewood (Moeen et al., 2016).

Maurice et al. (2015) conducted their study in Nigeria. They established that firewood was readily available and was, therefore, the most preferred energy source. Firewood was harvested from the natural forest at no cost or for the payment of a small fee to the property owners (Maurice et al., 2015). Hallberg and Hallme (2015) discovered in the study conducted in the rural areas of Bolivia that the accessibility of firewood as an

energy source determined its preference in rural areas. Moreover, biomass, of which firewood is a part, was the most common energy source (Hallberg & Hallme, 2015).

Due to their easy accessibility and low cost experienced by households, firewood and other forms of biomass are used for cooking in rural areas in South Africa (Bohlmann and Lotz, 2018). Another study conducted in three villages in Phalaborwa, Limpopo Province confirmed that firewood usage for cooking, space and water heating in the three villages is high due to its easy accessibility. The study indicated that firewood is collected from the nearby bush by the households (Adeeyo et al., 2022).

2.4.2 The affordability of firewood as a source of household energy

Affordability, according to Hera (2014), plays a significant role in the use of firewood for cooking. Considering that many households can collect firewood for free, it will remain the cheapest energy source for cooking and heating. If firewood is purchased at the firewood market, households can choose to obtain small amounts of wood, which allows for a degree of financial flexibility. Hera (2014) suggests that it must be recognised that firewood would be extremely expensive if the additional cost of labour done by the women and children collecting firewood were considered, as well as the negative impacts on health and the environment.

Hassan et al. (2013) found that financial constraints was the primary reason for the utilisation of firewood in the rural areas of Bangladesh. This was because rural households relied on a subsistence economy. Most people in the rural communities of Bangladesh lived under the poverty line (Hassan et al., 2013). Because of the limited income of people in the rural areas, rural households cannot afford effective and recent forms of energy sources, especially for cooking and heating. According to Statistics South Africa, people living below the poverty line are those who are earning less than R3,500 a month (Statistics South Africa, 2012).

Firewood is still the most readily affordable domestic energy source for many people in Nigeria, and this situation could continue in the future. According to Maurice et al. (2015), using firewood is a cost-saving mechanism. The firewood is used to cope due

to limited funds being available to meet the basic needs of households (Maurice et al., 2015).

Another study conducted in Nigeria by Ebe (2014) revealed that low-income households in the urban areas also used firewood as their main energy source for heating and cooking, while the middle-income earners used it as a substitute or supplementary fuel for cooking and heating (Ebe, 2014). Households spend about 6% of their income on firewood because of its affordability (Ochwo et al., 2016).

However, Moeen et al. (2016), who conducted their study in Pakistan, support the fuel-stacking model. They point out that a lack of resources at the household level, energy prices and the unavailability of modern energy sources are the major reasons for which households are dependent on traditional fuel sources (Moeen et al., 2016).

Because electricity is expensive, most households in Pakistan use it for lighting only, while firewood is used for cooking and heating (Roubik et al., 2018). The findings of this study are supported by Franciolli (2018), who conducted a study in Cape Town, South Africa. This author points out that households tend to utilise firewood as a cheaper alternative for activities such as cooking, boiling water and home heating (Franciolli, 2018).

Ningi (2020) conducted a study in Melani and Hamburg in the Eastern Cape Province and the study confirmed that affordability is one of the factors influencing energy choice in rural areas. Because of affordability, households spend their limited income on unhealthy sources of energy because they cannot afford to pay for clean sources. This is supported by a study conducted at Matlwang in the Northwest Province where majority of households indicated that electricity is expensive and they cannot afford to use it for cooking, water heating and lighting daily (Lavhelani, 2019).

Moreover, affordability or lack thereof mean that households may still use paraffin for lighting when there is no electricity or in other rooms without an electric light. Also, households in Matlwang indicated that electricity is not sold where they are staying, and they need to travel to the nearest town to purchase electricity. This means they cannot afford transport fee and money to buy electricity (Lavhelani, 2019).

Similarly, most rural areas in the Thulamela Local Municipality in Limpopo Province have low-income earners who earn less than R3,500 per month. These people therefore cannot afford to use electricity alone; they therefore supplement with firewood for cooking and heating (Uhunamure et al., 2017).

2.4.3 Household income

Income is defined as the flow of money received from work, capital or land. A medium to high household income makes it possible to switch to more sustainable energy sources (Ateba, 2018). The household income in developing countries is the main factor affecting the choice of household energy source (Ding et al., 2016).

According to Maurice et al. (2016) study findings, many households in Nigeria depend on firewood as a result of socioeconomic challenges. Furthermore, according to Moeen et al. (2016), income is the major determining factor in selecting the household energy source. Most countries, especially developing countries, wish to use clean household energy sources, but income disparities present a major challenge (Moeen et al*.,* 2016).

However, Ding et al*.* (2016) assert that income is not only an indicator of financial development, but also a reflection of the paying ability of households. Similarly, a study conducted by Mensah and Adu in 2013 confirmed that a medium to high household income had a major positive effect on the probability of choosing cleaner fuels such as LPG and electricity over firewood. Thus, non-poor households have a higher probability of using clean energy sources than extremely poor households.

On the African continent, where the level of development is still low, most households find it difficult to embrace modern energy sources due to financial constraints (Ochwo et al., 2016). The choice of firewood as a source of energy for cooking and heating may be significantly negatively affected by higher income quintiles (Moeen et al., 2016). However, it was argued in the same study that several socioeconomic, institutional and market factors can also influence a household’s choice of energy source.

The use of firewood is likely to decrease in proportion to other energy sources when household income increases. This can be explained by the fact that households now have a choice between a wider variety of available commercial fuels in urban areas. Households might also have a wider choice because of a higher income. Furthermore, cooking, which accounts for most of the firewood supply in high-income households, decreases in relative importance as household energy needs become more sophisticated. As a result, firewood usage is expected to decrease in high-income households (FAO, 2018).

Nevertheless, Hallberg and Hallme (2015) argue that the use of firewood in some countries does not necessarily decrease as income increases. Household fuel choices in Zimbabwe are determined by income, despite the fact that the country has plenty of coal and hydropower resources. In addition, the households that depend on firewood are mostly those with low incomes of less than R500 per month (Hallberg & Hallme, 2015). They tend to shift to modern sources as their income increases (Uhunamure et al., 2017).

Roubik et al. (2018) indicate that the choice of the selected energy source is evaluated based on the functional relationship between household income and the relative prices of available energy sources. Due to the low income of households in Sumatra, Indonesia, and the relatively easy access to firewood, it is the most widespread source of energy for daily usage. This results in the energy-ladder model, which has three phases.

The first phase is absolute dependence on traditional energy sources. The second phase, which relates to the transition to kerosene, coal and charcoal, is linked to a higher income, deforestation and urbanisation. Finally, the third phase is the transition to LPG, natural gas, electricity, biogas and other renewable energy sources. Although Roubik et al. discovered that there was a relationship between the choice of household source of energy and income, they found that even households from higher income groups used firewood as their major source of energy, supported by electricity and LPG (Roubik et al., 2018).

A study conducted on selected South African households by Ateba (2018) revealed that the income level of households influenced their choice of energy. It further indicates that most high-income earners use electricity for cooking and heating, while low-income earners use electricity less for these purposes. As an alternative energy source, the study revealed that high-income households used gas as an alternative for cooking. By contrast, low-income households used paraffin for cooking.

Uhunamure et al. *(*2017), who conducted their study in the rural villages in Thulamela Local Municipality in Limpopo Province, discovered that households with low incomes spent a great deal of their time collecting firewood to meet their domestic energy needs. People who earned less continually harvested firewood to save the small amount of electricity they had for lighting. Household income contributes to energy consumption in many ways. For instance, when the level of income rises, the consumption of energy increases because of an increase in the food prepared. The fuel price is less of a restriction for the household when the income increases (Uhunamure et al., 2017).

Moreover, a study by Adeeyo et al., (2022) in Phalaborwa confirmed that there is a strong relationship between the total income earned by household and the type of energy used. Low income households still prefer firewood for cooking. This is supported by a study conducted by Wassie et al., 2021. It confirms that the use of firewood as an energy source declines as income increases, meaning that households with higher income tend to prefer clean energy sources like electricity compared to poorer households who mostly depend on firewood (Wassie et al., 2021).

2.4.4 Educational level of the household head

Education tends to impact firewood consumption. The higher the education level of the people, the less firewood they use (Mislimshoeva et al., 2014). Furthermore, the higher the number of years the citizens spend in the education system, the lower the number of firewood users in that country or region (Ebe, 2014).

Ateba (2018) indicates that education influences energy choices in two ways. It limits the labour force for fuel acquisition activities such as wood collection, possibly leading

to a tendency to utilise fuel that requires no acquisition efforts, such as paraffin and gas. Education also can initiate change by providing knowledge about the dangers fire poses to health and the environment.

When the use of firewood in rural areas is compared to other energy sources, such as coal, as the education level increases in households, there is a higher likelihood of households using coal rather than firewood. This conforms with the expectation that the more educated a person is, the more likely they are to switch from using firewood to a modern form of energy such as coal (Elijah et al., 2017).

This is confirmed by Moeen et al. (2016), who found that the more literate households in Pakistan tended to use gas rather than firewood as an energy source for heating and cooking (Moeen et al., 2016). There is also a link between an educational accomplishment beyond the primary level of the household head and a change from using firewood. This could be because of improved awareness of the risks associated with the collection of firewood and the relatively higher opportunity cost of firewood collection among educated individuals (Suliman, 2013).

Mensah and Adu (2013) investigated household cooking energy choices and their determinants in Ghana. They also found that having access to education increased the probability of a household shifting from traditional and inefficient energy sources to more efficient and modern energy sources.

Unlike other studies conducted in the developing African countries, the study by Wassie et al., 2021 showed the insignificant relationship between the education level of the household head and the energy source preference. This is different to other studies in rural areas of developing countries which indicate that education is one of the main factors influencing the choice of energy source. This can be because of chronic power shortages and unaffordable electric appliances that makes even the more educated households to depend on firewood.

Furthermore, a study by Adeeyo et al. conducted in Phalaborwa, Limpopo Province confirmed that education level influences the choice of energy source, meaning that

people with higher education level will opt for using clean sources of energy and LPG while those with lower education level are likely to choose firewood.

2.4.5 Family size

The choice of the energy source used by a household is also expected to be influenced by the size of the household. A large household might increase the availability of labour for firewood collection, which could motivate the firewood usage. On the other hand, big households might utilise energy more efficiently per member and might be more likely to adopt cleaner and relatively costly fuel alternatives (Suliman, 2013). This is supported by a study conducted by Wassie et al. in the Sub-Saharan Africa which indicates that the type of energy source for cooking is associated with the family size of the household. The choice of firewood as the primary source of energy increases as the family size increases. This is believed to be influenced by the increase in the availability of family labour to collect firewood (Wassie et al., 2021).

Ebe (2014) suggests that if a household is huge, more might be spent on conventional energy. As a result, they might prefer firewood because it is considered cheaper. However, Elijah et al. (2017) indicate that bigger families might have extra and free labour in terms of firewood collection. The use of firewood thus appears to increase in line with the increase in household size (Mislimshoeva et al., 2014).

According to Deshmukh et al. (2014), the size of a family has a non-linear relationship with the choice of energy sources. Bigger families are more likely to use kerosene and other energy sources. This contradicts the assumption that firewood is the preferred energy source for larger households because it is available for free or cheaper than other energy sources (Deshmukh et al., 2014).

Francioli (2018) states that larger households use firewood for cooking because it is very efficient when cooking for large families. A family of approximately 15 people would prefer to use firewood, which might not be the case for a family with a small number of people (Francioli, 2018).

The study conducted by Adeeyo et al. (2022) conducted at three villages in Phalaborwa, Limpopo Province also confirmed that the household size influences the type of energy source used in the villages. According to the study, households with large family sizes indicated that the reason they are using firewood is because it is cheaper, and it allows them to cook more food for the entire family which will be expensive when they use clean energy sources like LPG and electricity. Also, members with small family sizes indicate that they cook with firewood because it is available, to save money and sometimes because of lack of electricity because of load-shedding.

2.4.6 Age of the household head

Age can be defined as the length of time a person has lived or a thing has existed. In rural Nepal, as in any other rural area in the world, the multigenerational household system prevails, whereby parents, children, grandchildren, and some relatives of various age groups live in the same house. Generally, it is expected that older household members make decisions in the households, because other household members traditionally have respect for the older members, especially because of their knowledge and experience (Devkota, Rauniyar & Parker, 2015).

A study by Deshmukh et al. (2014) demonstrates that the household head age has a significant effect on the choice of energy source. Older household heads might stick to firewood as an energy source as a matter of habit. There also seems to be reduced use of modern sources by households led by older heads. These households will increase their use of traditional fuels, such as firewood (Deshmukh et al., 2014). This was demonstrated by Mensah and Adu (2013) in a study conducted in Ghana, which highlighted that the age of the household head negatively impacted the adoption of cleaner energy sources.

However, in a study by Mwaura et al. (2014) conducted in Uganda, it was revealed that the age of the household head had an opposite relationship with the choice of household energy and usage. Age captures an individual’s lifecycle and its association with influencing the adoption of technologies (Mwaura et al., 2014).

The study conducted in Melani and Hamburg in the Eastern Cape Province revealed that the age of the household head is also one of the significant factors contributing to the choice of energy and energy security in rural areas. It revealed the possibility of the elderly households being at risk of using more unclean energy sources than the young ones (Ningi, 2020). This is similar to a study conducted in Phalaborwa in the Limpopo Province that concluded that the age of household head influences the choice of household energy for cooking (Adeeyo, et al., 2022).

According to Masekela (2019), age has a negative effect on the probability of the use of clean and efficient energy. The study concluded that households would choose the energy source they prefer regardless of age.

2.4.7 Geographical location

Location refers to the place or position in which something happens or is situated. It is estimated that the household location is an important factor when choosing an energy source. A household located in a well-wooded location is more likely to use firewood than other energy sources. Similarly, households in urban areas have an increased probability of using other energy sources (Suliman, 2013). Due to harsh winter conditions in specific areas, households heat the room during the day and prepare warm meals at least three times a day (Mislimshoeva et al., 2014).

As indicated by Sun et al. (2012), firewood accounts for most of the energy consumption in high mountain areas and is affected mainly by per capita firewood forest areas, the distance one would have to travel to purchase coal, household income, electricity price and coal price. Location can also limit the availability of firewood, according to Lindsay et al. (1999). Moreover, as much as 25 to 30% of the forests in mountainous states such as New Hempshire and Vermont are on slopes with a gradient of greater than 15 to 20 degrees, which limits the use of some logging equipment. Cliffs and rock outcrops are also believed to make firewood inaccessible.

According to the Department of Energy (2009), there is a relationship between the type of energy and geographical location. The study confirmed that rural households depend substantially more on biomass resources, especially firewood, than those in

small towns and cities. Among electrified households, the study indicated that about 73% of households use firewood whereas in formal urban areas firewood is used by 15% and 8% in the informal settlements.

2.4.8 Cultural preferences

Culture generally refers to the ideas, customs and social behaviour of a specific people or society. A study conducted in Nigeria indicated that most of the dishes of the poor people in that country required lengthy cooking, probably because of the nature of the food, the size of the household, and the need to destroy germs and parasites (Ebe, 2014). Households might use firewood or a mixture of fuel energy sources due to cultural preferences. Families might prefer using firewood when cooking their food because they are used to cooking in that manner and they might feel more confident using it than any other energy source. Firewood is frequently used at traditional ceremonial events or on special occasions for which households cook traditional meals. Firewood has been shown to be a permanent feature of the identity and culture of poor households (Francioli, 2018).

The study conducted in Cape Town revealed that firewood was utilised more during social events that took place a few times a year, such as family gatherings, for Sunday *braais* (barbeques), holidays and traditional ceremonies, at which many people needed to be fed. Several residents also stated that they would rather eat food that was prepared using firewood because this reminded them of their families and people in the rural areas of South Africa, where cooking with firewood was more common (Francioli, 2018).

Lavhelani, 2019 conducted the study at Matlwang in the Northwest Province and confirmed that the majority of respondents, many of which are female, emphasized that food cooked with firewood tastes good and smells nice. Tradition and culture are attached by some people to various smells that different woods have been burned. It is believed in some cultures that the use of firewood has a benefit in repelling mosquitoes which carry diseases such as malaria (Lavhelani, 2019).

The study conducted in the Thulamela Local Municipality revealed that cultural and taste preferences were considered by the households when choosing an energy source, especially for cooking in developing countries (Uhunamure et al., 2017).

2.4.9 Price of energy and appliances

Price is defined as the amount of money expected, required or given in payment for a product or service. Ebe (2014), emphasises that, due to the high cost of electric power, approximately 70% of the population of Nigeria depend on firewood as their primary source of energy for cooking purposes. The scarcity of conventional energy sources and the hike in the prices of these fuels has also prompted the continued dependence on firewood by many households, together with other commercial fuels (Ebe, 2014).

The price of energy and appliances in rural areas determines the choice of energy in households (Hallberg and Hallme, 2015). The price of electrical appliances also contributes to households choosing to use firewood as an energy source when cooking. Furthermore, electrical appliances such as stoves and ovens generally have high setup costs. It might therefore take some years for households to be able to save up for such appliances. Consequently, it is common for households to use energy sources such as firewood because they are considered low-cost alternatives for activities such as cooking, boiling water and heating homes (Francioli, 2018).

Hallberg and Hallme (2015) also assert that the choice of energy in households in rural areas is determined by the price of energy and appliances, household income, and the accessibility of other fuel sources and appliances. These authors further indicate that firewood is the most common source of energy (Hallberg and Hallme, 2015).

In a study conducted by Bohlmann and Lotz (2018), the price of electricity has been identified as one of the key factors determining its consumption in rural areas. Due to the low cost incurred by rural households, traditional fuels such as firewood are used for cooking, space and water heating. The study confirmed that relationship exists between electricity consumption and the annual changes in residential electricity prices. It was confirmed during the study that electricity prices were raised at a

percentage beating inflation due to various reasons and this forced residents to look at alternative energy sources.

It is evident from the study conducted in the Thulamela Local Municipality in Limpopo Province that the price of electricity is the main factor preventing generally poor households from switching completely to electricity (Uhunamure et al., 2017).

2.5 Environmental problems associated with firewood usage

The use and collection of firewood for household energy poses serious threats to the environment and the surrounding communities. Several environmental impacts are associated with the use of firewood as an energy source in the household:

Due to firewood being the most preferred energy source, forests have been exposed to overexploitation, which constitutes a great risk to the existing resources. Because firewood is taken from trees, a large number of trees have been damaged to attain it. The destruction of trees is causing environmental impacts such as an increase in soil erosion and flooding, soil salinisation and a shortage of firewood (Hassan et al., 2013).

A study conducted in Cambodia revealed that the use of wood energy was a major contributor to forest loss, which has accelerated rapidly over the past few years due to the collection of firewood (FAO, 2018). The Food and Agriculture Organisation (FAO) observed that the challenge of bridging the gap between demand and supply of about 6 million tons of wood per year had led to the depletion of forests and a consequent loss of soil fertility. The reduction of forest resources due to illegal wood harvesting practices was due to the usage of firewood as an energy source (Lambe, 2015).

In Nigeria, firewood extraction led to a state in which forest growth due to natural regeneration has been lower than the volume of wood extracted from the forests every year. With the shrinking of supplies and growth in consumption, finding firewood could become challenging, not to mention the resultant consequences of forest depletion due to substantial tree felling without replenishment (Maurice et al., 2015).

Suliman (2013) also concluded that the use of firewood as an energy source in Sudan exceeded the allowable cut by about 22,000 or 32,000 metric tons, which is an indication of serious deforestation. Natural resource degradation due to increasing firewood harvesting was identified as the main environmental problem, especially in densely populated areas.

In a study conducted in Mozambique, it was identified that, in the past few decades, there have been debates as to whether the use of traditional energy sources such as firewood was leading to deforestation. The study revealed that, in the mid-1970s, it was widely recognised that harvesting firewood was leading to the depletion of forest resources. By the mid-1980s, the evidence was challenged on the grounds that other activities, such as vegetation clearance for agricultural expansion and timber harvesting, were the main causes of deforestation. Moreover, it was argued that firewood collection in rural areas was largely in the form of dead wood or twig wood, without cutting the entire tree (Atanassov, 2010).

Onoja (2012) concluded that the use of firewood in Nigeria contributed to desert encroachment, which had implications for climate change. In the absence of forests, flooding from rainstorms causes serious damage to material objects, not to mention human casualties. This was supported by Atanassov (2010), who conducted a study in Mozambique (Catembe Region). The study specified that firewood burning was believed to impact global warming considerably. In addition to releasing high levels of carbon dioxide, the release of products of incomplete combustion, such as carbon monoxide, methane and particulate matter, further impacted climate change.

2.6 The socioeconomic impacts of firewood usage

In Adigrat, Ethiopia, as in many countries, the collection of firewood is done by females and children, who are vulnerable to injury while carrying heavy loads. They are also vulnerable to being bitten by animals such as dogs, foxes and even hyenas. Moreover, the education of the girl child is affected because they delay going to school and often miss school because they are needed at home to collect firewood. Women and girls are exposed to rape, which in turn exposes them to HIV and unwanted pregnancies (Ochwo et al., 2016).

A study conducted in Cote d' Ivoire showed that the usage of firewood as an energy source had converted society's economic structure and lifestyle, which had led to an increase in the demand for fossil fuels (Zidago and Wang, 2016).

A study conducted across several developing countries revealed that the use of firewood as a household energy source had a negative effect on people's lives. Apart from desertification, deforestation and soil erosion, the utilisation of firewood has extremely low thermal efficiency and the smoke generated by the use of firewood is harmful to the health of human beings, especially females, as well as children, who regularly do the cooking in households. About 1.5 million deaths annually from respiratory infections can be attributed to the environment, including the effects of indoor and outdoor air pollution. Acute respiratory infections in children are one of the primary causes of infant and child morbidity and mortality. There are associations between firewood use and lung cancer (Danlami et al., 2015).

A study conducted by Atanassov (2010) revealed that there was a diverse gender dimension in the household energy sector in many developing countries. Men do not carry the burden of environmental and health factors associated with the use of firewood to the same extent as women in many countries, because the latter are in charge of the collection, transportation, processing and packing of firewood, as well as cooking activities, while men usually make financial decisions.

2.7 Health effects associated with the use of firewood in the household

Danlami et al. (2015), whose study was conducted across several developing countries, found that the use of firewood as a household energy source had a harmful effect on people's lives. Firewood has very low thermal efficiency and the smoke generated by its use is harmful to human health, especially to women and children who do most of the cooking in households.

Several families that depend on firewood as an energy source have suffered from health-related problems, physical challenges and fire accidents (Ochwo et al., 2016). About 1.6 million annual deaths and 27% of the global burden of diseases are because

of indoor air pollution due to the burning of firewood. Firewood burning in the domestic sector is the foundation of a range of emissions, including carbon monoxide, nitrogen dioxide and particulate matter. The level of emissions depends on the types, combustion processes and scale of such solid fuel burning activities (Zidago & Wang, 2016).

In a study by Ketlhoilwe (2018), it was assumed that about 4.3 million premature deaths, mainly females and children, were associated with toxic fumes from fuels such as wood, animal waste and charcoal being burnt for heating and cooking (Ketlhoilwe, 2018).

According to Atanassov (2010), who conducted a study in Mozambique, there are various substances in firewood smoke that can damage one's health, such as nitrogen oxide, carbon monoxide, sulphur oxides and various carcinogens such as formaldehyde and benzene. Additionally, the burning of firewood releases small particles into the air, which hinder the airways and lungs, and weaken immune response.

This is supported by a study conducted in Cote d' Ivoire that revealed that firewood usage in the residential sector was related to severe adverse health consequences, including acute respiratory infections, chronic obstructive pulmonary diseases, cancers, cataracts and low birthweight, which has implications for quality of life and healthcare costs (Zidago and Wang, 2016).

The study conducted in Adigrat indicated that the use of firewood led to the prevalence of diseases that could affect eyesight and the respiratory system, and can lead to physical injuries (Ochwo et al., 2016).

Sepp (2014) also found that exposure to indoor air pollution from the burning of firewood for cooking and heating accounted for a substantial portion of the global burden of death and illness, excessively affecting women and children in developing countries. Indoor air pollution was responsible for 2 million deaths, including more than 1 million deaths from chronic obstructive pulmonary disease, and another million deaths from pneumonia in children under the age of five. Sepp (2014) asserts that

health impacts depend on a range of parameters related to the fuel properties, the type of stove used, the kitchen environment and cooking behaviour. In general, emissions from burning firewood have a more negative impact on health than charcoal or LPG, which are considered relatively clean-burning fuels.

Indoor air pollution caused by firewood is believed to be one of the main health threats for humanity. It is caused by incomplete combustion. Because women are responsible for cooking, they are likely to be exposed to indoor air pollution than men. Women also carry children on their backs, which leads the latter to indoor pollution as well (Hallberg and Hallme, 2015).

Suliman (2013) studied the health impacts of firewood usage in 30 households in Eastern Sudan and used the standard method for indoor air quality monitoring. High levels of particulate matter and carbon monoxide were identified. Suliman (2013) concluded that depending on firewood caused health challenges for women and children less than five years old.

Figure 2.1 below outlines a summary of the environmental and socioeconomic impacts associated with the usage of firewood in households.

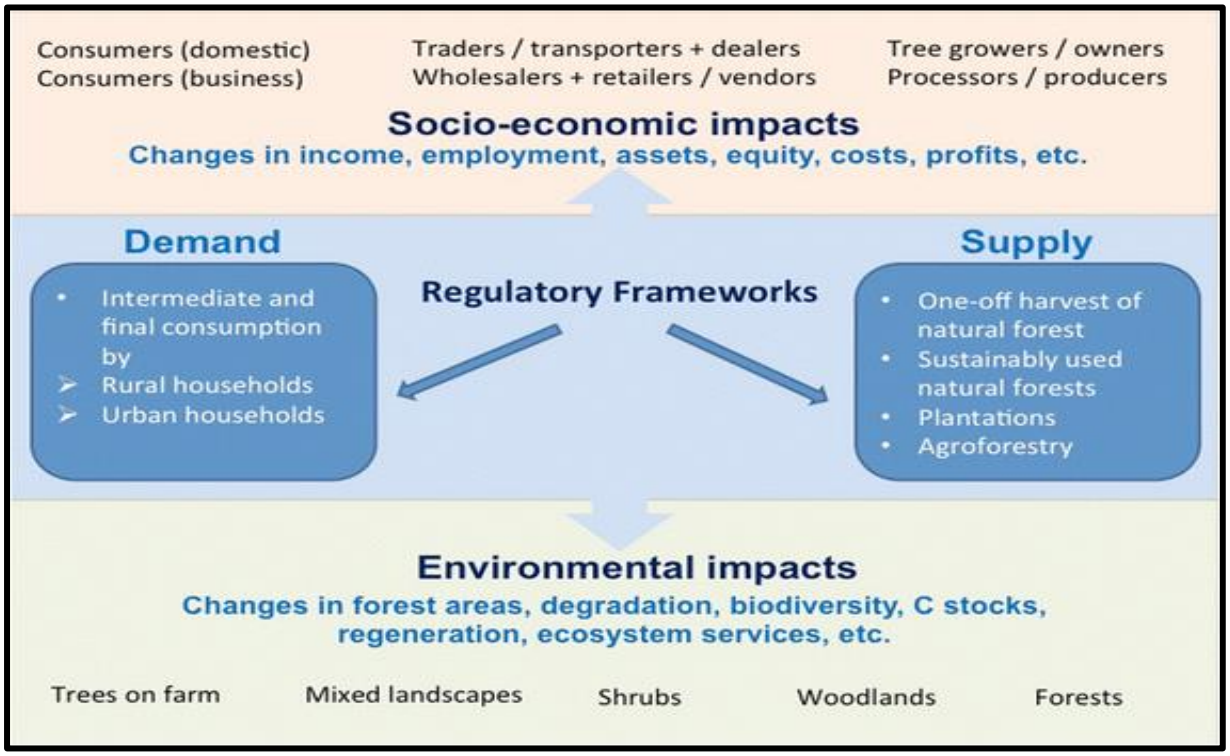

Figure 2.1: Summary of the socioeconomic and environmental impacts of using firewood (adopted from Ebe, 2014).

2.8 Management of impacts associated with the use of firewood as energy sources

Due to the enormous impacts caused by using firewood in the households as an energy source, both on the environment and communities, for instance environmental degradation and air pollution, occupational health and safety. Therefore, there is a need to implement measures to mitigate the effects associated with the usage of firewood in the household (Ebe, 2014). The following section comprises a description of the strategies that can be used to eliminate such impacts:

2.8.1 Environmental education and awareness

Offering environmental education and creating awareness on the consequences of using firewood in the household as a primary energy source is one of the most important management strategies to reduce the impacts associated with such activity (Rahul, 2005). To decrease and manage the impacts of using firewood, the people involved in such activities should be educated about the risks and impacts of firewood on the environment and their health (Ebe, 2014). To reduce the unnecessary removal of natural resources through the collection of firewood, there is a need to educate people involved in such activity about the importance of natural resources and environmental sustainability (FAO, 2018).

2.8.2 Access to alternative and clean household energy source

The lack of provision of clean energy sources such as electricity in rural areas is a key factor influencing the use of dirty energy sources such as firewood in the household (Heltberg, 2005). Poor households do not have access to clean energy such as electricity, especially for cooking and water heating, and they depend heavily on firewood or other biomass energy, which is costly in terms of labour and time (Imran & Ozcatalbas, 2016).

If rural communities were provided with a sufficient and efficient clean source of energy in the household, such as electricity, at low cost, it would eliminate the use of firewood as an energy source, which would, in turn, reduce the environmental impacts (such as deforestation) and health effects (caused by indoor pollution). The introduction of other energy sources such as electricity is the major mitigation measure to eliminate the use of firewood (Owusu and Asumadu-Sarkodie, 2016).

Access to electricity might have a significant impact on the lives of women and children because it would provide them with lighting during the night and could result in significant time and labour saving with respect to cooking, water heating, space heating and ironing due to greater convenience, cleanliness and the speed of electrical appliances (SEA & University of Limpopo, 2016).

In summary, it can be concluded that the factors that influence the usage of firewood as an energy source in electrified households are diverse according to different regions. However, in most countries firewood collection is done by women and children who also takes responsibility in cooking, space and water heating. The use of firewood as an energy source causes a serious environmental and health impacts such as bronchitis, cancer and other lung related diseases. It may also lead to erosion and flooding if it is not done in a controlled manner. Environmental education and awareness are very crucial in areas where firewood is used to make people aware of the challenges (i.e., health, environmental and socioeconomic) and consequences of the removal of vegetation.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter comprises a description of the methodology used in this study. Research methodology, according to Sileyew (2019), is the path researchers take to conduct their study. It shows how the researcher formulated their problem and objective and arrived at their results from the data obtained during the study period. This chapter contains the description of the study area, including the location, climate, pedology and vegetation cover. Then the sampling methods used, the target population, sample size, study design, data collection methods, data analysis and validity, limitations and ethical considerations are described. The research designs used were a survey and observation. A research design is formulated to provide an appropriate framework for a study (Sileyew, 2019). Questionnaires were used to collect data in the study area.

The methods and procedures followed in the collection and analysis of data to fulfil the objectives of this research are shown in Figure 3.1.

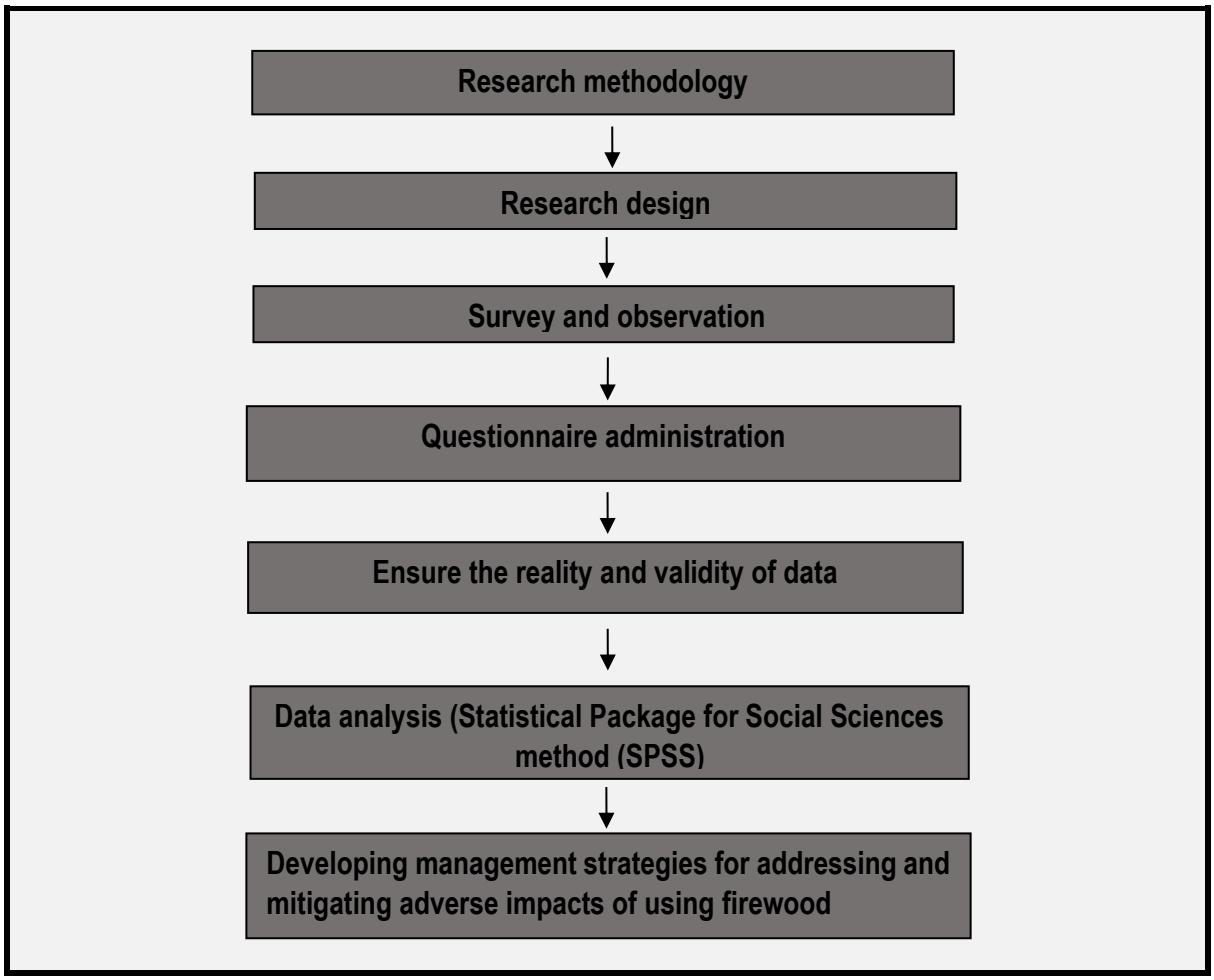

Figure 3.1: The flow chart of the methods and procedures followed in the research

3.2 Description of the study area

Nkomo Village is geographically located within the Greater Giyani Municipality in Limpopo Province in the Republic of South Africa. It is one of the 94 villages. It is located roughly 14km northeast of Giyani Town and 72km from Thohoyandou, on the road between Giyani and Phalaborwa. The village is under the custodianship of the Mahumani Tribal Authority. It is characterised by streams and rivers, considerable land for grazing, subsistence farming, a dilapidated irrigation scheme and natural resources such as Mopani and Marula trees (Greater Giyani Municipality, 2018). The Figure below (Figure 3.2) shows the study area situated in the Mopani District Municipality in South Africa.

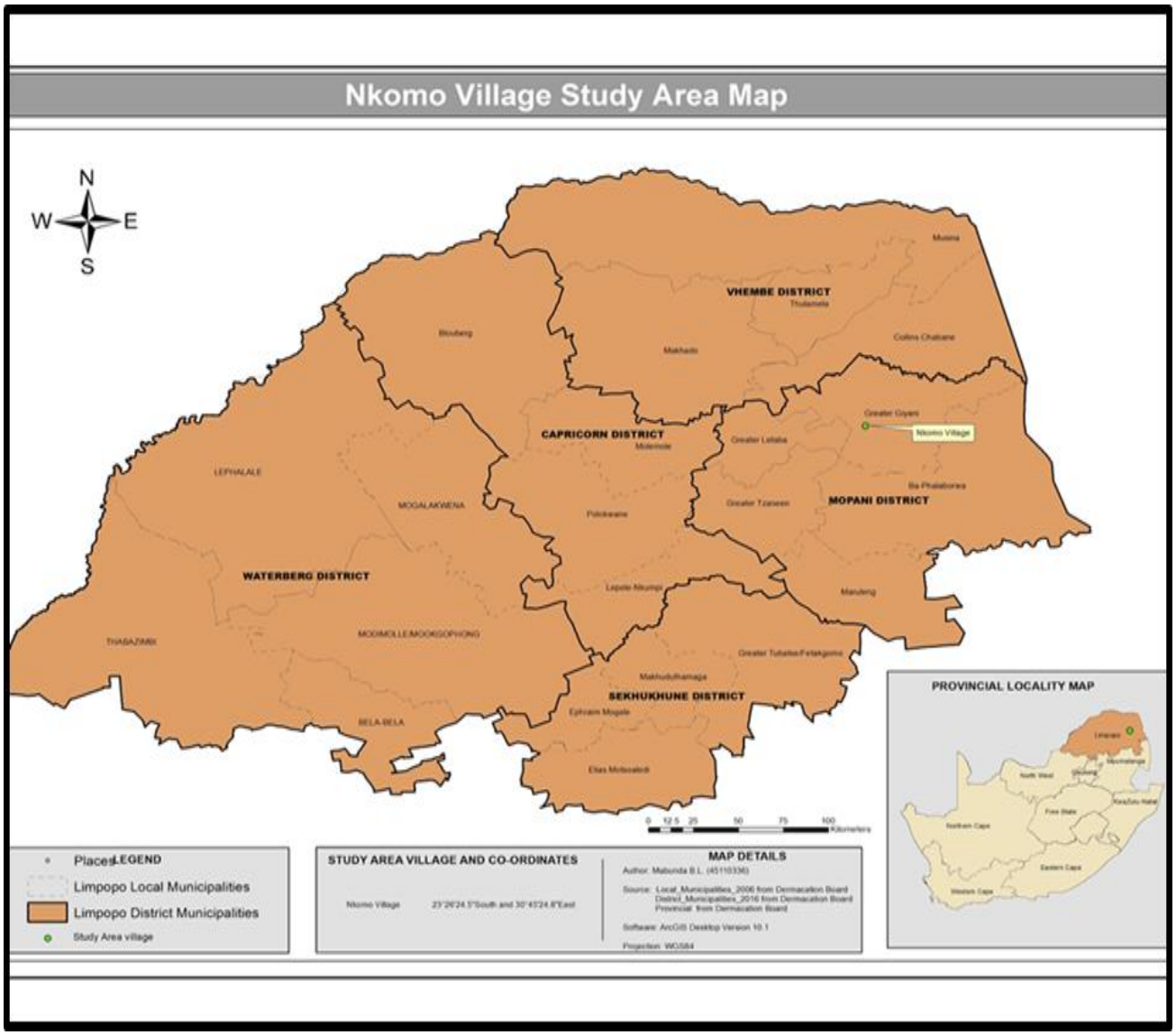

Figure 3.2: Locality of the study area (created using Arc GIS software)

3.2.1 Electricity access

After the end of apartheid in 1994, electricity, as a basic service, was rolled out a lot faster in Limpopo than in other provinces. By 2016, about 92,2% of households in the province were connected to the electricity grid (+20.1%) (Limpopo Provincial Treasury, 2018). However, despite the high increase in electricity connections in the province, the use of electricity for cooking is far lower than in the other provinces (Stats SA, 2018). The provincial rate of electricity usage for cooking is about 57%. Firewood is the leading source of energy for cooking (73%), while paraffin and candles are used for lighting (EcoAfrica, 2015).

The use of firewood is the highest in Limpopo, and specifically in the Mopani District (31.6%) (Stats SA, 2018). Coal is mainly used in the Sekhukhune District, whereas paraffin and gas are commonly used in the Capricorn District Municipality (EcoAfrica, 2015).

The primary source of energy for cooking and space heating in the study area is firewood. Electricity is used for lighting.

3.2.2 Climate of the area

The area is dry and warm, with low annual precipitation. The annual daytime minimum temperatures in the study area range from 14°C to 17°C, while the average maximum is between 28°C and 30°C (Greater Giyani Municipality, 2018). The latter is experienced in January, while the lowest temperatures are recorded in July (Chauke, 2011). The climate is categorised into two seasons, namely, warm and wet, and cool and dry seasons. During the warm, wet period (December to February), the temperatures range from 16°C to 25°C. However, during the cool, dry season (May to August) the temperatures range from 18°C to 25°C. Winters in the Giyani area are mild during the day and cold at the night. The annual rainfall varies from less than 450mm in the low-lying plains to more than 2,300mm in the mountainous areas (Chauke, 2011).

3.2.3 Topography and drainage pattern

The study area is approximately 150m above sea level (Greater Giyani Municipality, 2018). Most of the basins consist of relatively undulating terrain, separated by ranges of steep-sided hills and mountains. The Nsami River, which flows north-eastward, has forged deep gorges through the hills and mountain ranges, resulting in spectacular landscape units. The surrounding areas consist of valleys that disturb the flatness of the area, making it undulating.

The rivers are seasonal, and the area is dominated by Mopani and Marula trees. The Nsami and Rivati rivers flow on the eastern side of the study area. The Nsami and Rivati rivers are situated in low rainfall areas and record peak flow only during the wet summer months. The south-western parts of the study area, including the Nsami and Letaba sub-catchments, have poor drainage and are therefore considered endorheic (Chauke, 2011).

3.2.4 Pedology of the study area

Soil formation across the study area reflects the strong influence of the underlying rocks. The west and south are dominated by moderately deep sand. Sandy, clay loam is another soil type that is dominant in the area. In the north and east, the soil is reddish. This reddish soil plays a significant role in agricultural activities along the Nsami River. The colour of the soil ranges from reddish to brownish (Chauke, 2011).

3.2.5 Land use and vegetation cover

The area around and within Nkomo Village is widely used for settlement. Settlements occupy a large portion of the land in the area, with some land reserved for grazing. Subsistence agriculture is practised in the area (Greater Giyani Municipality, 2018).

The study area falls within the Mopani woodland, where the vegetation is classified under the Lowveld Mopani veld savannahs. It is characterised by a mixture of trees, shrubs and grasses (Rutherford et al., 2006). *Colophospermun Mopani* occurs in abundance, together with many other trees species, such as *Acacia* species,

Commiphora species*, Cassine aethlopica, Terminalia sericea, Diopsyros mespiliformis, Combretum api culatum, Sclerocarya birea, Dichrostachys cinerea* and *Dalbergia melanoxylon* (Makhado et al., 2009).

3.3 Sample size

According to the 2016 census, Nkomo Village had a population size of 6,816 and a total of 1,500 households in that year (Statistics SA, 2016). However, the population may have grown or changed between the year and to date. This household population was used to calculate the sample size at 95% confidence level and 5% error margin using the formula below:

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

n=Sample size.
N=Population size.
e=Margin of error.

Therefore:
n=

$$= \frac{1{,}500}{1 + 1500(0.05)^2}$$

$$= \frac{1{,}500}{1 + (1{,}500X0.0025)}$$

$$= \frac{1{,}500}{1 + (3.75)}$$

1+3.75= 4.75

$$= \frac{\mathbf{1,500}}{\mathbf{4.75}}$$

=315

3.4 Sampling

The participants with knowledge of firewood usage were selected to be part of the study. Convenience and purposive sampling designs were used. The purposive sampling method relies on the researcher's judgement in selecting the respondents (Rubin, 2005). It was used to select the respondents involved in the use of firewood activities.

Convenience sampling enabled the researcher to select respondents who were readily available and willing to take part in the study. The criteria were that the potential participants had to be older than 18 years of age and the oldest members of each household. Both qualitative and quantitative methods were used during the research in order to acquire reliable and valid data and results, and also to achieve the main aim of the study. During the study, the researcher visited the sampled households to explain the benefits of the research and the importance of their participation and involvement.

Questionnaire was the only instrument utilised to collect data. The questionnaire had quantitative questions and open-ended, qualitative questions. Approval to conduct the study was obtained from Mahumani Traditional Authority (Appendix D). The headmen were informed of the study and were requested to assist. Three-hundred-and-fifteen (315) questionnaires were distributed to collect data from 315 households. The questionnaire attached as Appendix A produced both qualitative and quantitative data.

3.5 Target population

The target population consisted of members of Nkomo Village within the jurisdiction of Greater Giyani Municipality in the Limpopo Province. Three-hundred-and-fifteen (315) members of different households of the age of above 18 years who had knowledge of the use of firewood were identified as the target group. With the objective of identifying and assessing the socioeconomic and environmental impacts associated with the use of firewood as a source of energy in households, target groups were selected to complete the questionnaires.

3.6 Study design

Study design is a structure or plan of the research which provides glue that holds a project together, groups or samples, observations or measures, programmes or treatments and other aspects of the methodology (Creswell, 2008). The study design involves accurate measurements and statistical data analysis using computer packages. It is expected that a good research design ensures that there is maximum control over factors that adversely affect the validity of the research results (Gwimbi and Dirwai, 2003). In this study both qualitative and quantitative methods were followed to ensure that valid data and results are acquired. A descriptive research design was selected for this study with a view to accurately and systematically acquiring data.

This study used household survey and primary data that was collected through the use of the questionnaire. The questionnaire had open-ended questions and the same questions were asked to all participants.

3.6.1 Qualitative approach

Qualitative research design is a formal, objective, systematic process for obtaining information about something. This is a method that is used to describe, test relationships, and examine the causes and effects of relationships (Creswell, 2008). Observations and field notes were used as data-collection procedures. This type of research design involves documenting the responses, behaviour observation and also studying written documents (Gwimbi and Dirwai, 2003). In this study, ideas and data were elicited from the selected participants.

According to Tashakkori and Teddlie (2003), qualitative research is more subjective than quantitative research and depends mainly on text. It relies on the collection of qualitative information. During the study, questionnaires were developed and used to collect information from different households. One person per household was selected (the oldest person in the household was selected). Documents related to the topic were also reviewed to gather the information required by the researcher.

3.6.2 Quantitative approach

This type of approach is an explorative non-experimental, descriptive structure that encompasses quantifying relationships between variables (Madyise, 2013). The design deals with figures and numbers. It involves accurate quantities and statistical data analysis using computer packages. A good research design is expected to ensure maximum control over factors that affect the validity of the research results (Gwimbi and Dirwai, 2003).

Numbers and figures were used to analyse the collected data. Three-hundred-and-fifteen (315) questionnaires were distributed to households that agreed to participate in the study. Demographic information such as age, gender, employment status and the highest level of education was collected. Information on energy sources such as firewood, electricity and LPG and how often they were used was also collected. The respondents were asked about their preferences for energy sources and the reasons thereof, where the firewood was collected and the estimated distance that the household members travelled to harvest firewood. They were also asked to indicate their preferred energy sources for different household duties (i.e. for cooking, space heating and water heating).

3.7. Data collection

The data collection techniques for this study involved gathering primary and secondary data. The primary data was collected through a questionnaire and observations, whereas the secondary data was collected from relevant published journals, articles, books and websites. Collecting primary data comprised eliciting first-hand information from the respondents, including their socioeconomic characteristics like employment, educational level, family size and age, and asking information on what they thought were the drivers of the usage of firewood as an energy source (Kitula, 2006).

The data collected from the questionnaire was processed and analysed using the Statistical Package for Social Sciences (SPSS 24) software. Raw data was collected and captured as numbers. The software has a range of available statistics that can easily handle large datasets and multiple variables. The researcher was able to

summarise and display data in frequency tables, bar charts (used to present results in percentages) and cross tabulation (Leedy & Ormrod, 2010).

3.7.1 Questionnaires

The quantitative aspect of the study comprised the distribution of questionnaires to the survey participants. Quantitative methods are explorative and descriptive techniques that involve quantifying relationships between variables (Creswell, 2008). A questionnaire survey was chosen because it enabled the participants to share their views anonymously, thus reducing bias (Mertens and McLaunghlin, 2004). The same questions were repeated to all the participants to get valid answers with minimal resources.

A well-designed questionnaire should align with the objectives of the enquiry, with a fit between content and the research problem (Gwimbi & Dirwai, 2003). Therefore, in this study questionnaires were used to identify factors influencing the use of firewood as an energy source (Appendix A). The questionnaires were used to identify the demographic information of the people involved in the use of firewood, to assist in identifying the environmental and socioeconomic impacts associated with firewood use, as well as to determine beliefs, thoughts and knowledge about firewood usage in the study area.

3.7.2 Observation

Pictures were taken during the visits to the participants' houses, such as of firewood in the households, to illustrate the type of energy used and what it was used for, and to quantify the answers in the questionnaire.

3.7.3 Literature

Secondary data was collected from similar research projects to get more information on the factors that influence the usage of firewood as household energy source in electrified households globally, in the African context and other developing countries,

Limpopo Province and the entire South Africa. This data was collected through the review of books, research articles and articles from the internet.

3.8 Data analysis

After data collection, the collected data were analysed using the Statistical Package for Social Science (SPSS) and Microsoft Excel. Microsoft Excel and SPSS were used to code and log in the data captured in the questionnaires in order to get reports on the collected data. Because the data was both qualitative and quantitative, Microsoft Excel and SPSS were used. SPSS is a powerful tool that is used to manage the collected data.

Spreadsheets are one of the sets of items of SPSS used in this study. Microsoft Excel was used to prepare and make some graphs for data analysis. Tables and charts were used to present the collected data. Frequency distribution, which includes creating the tables as a way of organising and summarising data was used to analyse the data.

3.9 Content Validity

Content validity is used to measure the variables of interest. It is also known as content related validity, intrinsic validity, relevance validity, representative validity and logical or sampling validity. It can be used to measure the appropriate sampling of the content domain of items in a questionnaire. Content validity is an important factor in identifying the concept of measuring, however it is not a sufficient indication that the instrument measures what is that intended to measure (Yagmaie, 2003).

In this study, content validity was ensured by conducting a thorough literature search. The contents of the questionnaire were based on information derived from the review. There are two types of validity, external and internal validity. The former is when the results obtained in a study can be generalised to other people and settings. The latter reflects that a given study makes it possible to eliminate alternative explanations for a finding.

Generalisations are made on the basis of the degree of confidence in sample findings of the population and whether similar findings can be obtained at other times and places (Madyise, 2013). When the researcher meets most of the respondents for the first time to explain the aim of the study, the relationship is formal. In this study, external validity was influenced by the sampling methods, namely convenience and purposive sampling. Therefore, the findings cannot be generalised to other settings.

3.10 Ethical considerations

During the study, questionnaires were disseminated with a consent form asking the participants to consent to taking part in the study. The researcher explained to the selected participants what the study was all about and that their participation would be voluntary and confidential (Appendix B). No participants were forced to take part in the study. No personal information, such as names or ID numbers, were requested on the questionnaires to protect the identity of the participants.

3.10.1 Permission to conduct the study

Permission to conduct the study was obtained from the Mahumani Traditional Authority. A letter requesting permission to conduct the study was written to the authority (dated 4 April 2019) (letter attached as Appendix C) and permission was granted (approval letter attached as Appendix D). Before handing over the questionnaires, the participants who agreed to be part of the study were informed that permission had been requested and granted by the traditional council. The researcher was granted access to their households after they agreed to be part of the study.

3.10.2 Informed consent

Informed consent forms were distributed to the participants before they were given the questionnaires. The consent forms confirmed to the participants the nature, procedure, potential benefits and anticipated inconvenience of taking part in the study. It also ensured that the participants understood the study as it was explained to them by the researcher (Attached as Appendix B).

3.10.3 Participation

Participating in this study was voluntary and the participants were informed as such. They were also informed that it is up to them to decide whether or not they want to take part. The aim of the research was explained to them and they were asked to sign a consent form to show that they had agreed to participate. They were informed that they are free to withdraw at any time during the study without giving a reason.

3.10.4 Confidentiality

No personal information, such as names and ID numbers, were recorded on the questionnaires. Both the participant and the researcher signed the consent form to confirm that the participant's information would be kept confidential. The participants were informed that all the information will be kept anonymous and strictly confidential. Any documents with their names on them were not given to anyone.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction

The analysis of the results presented in this chapter is aimed at achieving the purpose of the study, which was to evaluate the factors influencing the usage of firewood as an energy source among electrified households at Nkomo Village in the Limpopo Province of South Africa. The first part of this chapter comprises a description of the demographic and background information of the respondents, in bar graph or tabular format. This includes gender, age, family size, educational level, employment status and monthly income. The second part contains inferential analysis, for which the cross tabulation was used to measure the association between various factors.

4.2. Demographic information

4.2.1 Gender

The majority of the respondents were female (80.3%, n = 253). Only 19.4% (n = 61) were male out of the 315 respondents, as indicated in Table 4.1. One respondent did not indicate their gender (0.3%, n = 1). The high number of women respondents might be directly linked to the family chores that are related to energy use being taken care of by females within the households. Females are responsible for collecting firewood and other responsibilities related to energy use such as cooking in most households. The study also revealed that most households are female-headed hence they are the ones who decide which energy source to use.

Table 4.1: Gender of respondents

Gender	**Frequency (n)**	**Percentages (%)**
Unknown	1	0.3
Female	253	80.3
Male	61	19.4
Total	***315***	***100.0***

Source: Primary data

4.2.2 Age group

As indicated in Table 4.2, the majority of the respondents (32.1%, n = 101) were within the 18–35 year age group. 29.8% (n = 94) of the respondents were in the 36–50 year age group. 19.4% (n = 61) and 16.8% (n = 53) were aged between 67–81 and 51–66 years; and those who were 82 years old and above were the smallest group at 1.9% (n = 6). This is in line with South African population trends which indicates according to the mid-year population estimate report of 2019 that the youth constitute almost a third of the population (Statistics SA, 2019). Age was one of the factors influencing the choice of energy in the study area. Literature also revealed that age influences the choice of energy source in households.

Table 4.2: Age groups of respondents

Age Groups	**Frequency (n)**	**Percentages (%)**
18-35	101	32.1
36-50	94	29.8
51-66	53	16.8
67-81	61	19.4
82+	6	1.9
Total	***315***	***100.0***

Source: Primary data

4.2.3 Family size

As indicated in Table 4.3, the majority of the respondents (44.8%, n = 141) were from families of 5–8 individuals; 41.0% (n = 129) had 1–4 family members; 12.7% (n = 40) of the families had 9–11 members and 1.5% (n = 5) of the families consisted of more than 13 individuals. Households indicated that their family sizes forced them to use firewood especially for cooking. They revealed that with firewood they can cook once

using a large pot that is able to feed the whole family. They also indicated that when they boil water, they use a large pot that is able to accommodate everyone in the family. It was also revealed that the more members in the family, the more they are able to collect firewood. According to Francioli (2018), a family with more members would prefer to use firewood than a family with a small number of people. Wassie et al., 2021 also believes that family size increases the availability of family labour to collect firewood.

Table 4.3: Family size of respondents

Family Size Groups	Frequency (n)	Percentages (%)
1-4	129	41.0
5-8	141	44.8
9-12	40	12.7
13+	5	1.5
Total	***315***	***100.0***

Source: Primary data

4.2.4 Highest level of education

A total of 42.9% (n = 135) of the respondents had secondary schooling certificates; 25.1% (n = 79) had no formal education; 9.8% (n = 31) had primary schooling certificates; 3.5% (n = 11) had higher education certificates; 9.2% (n = 29) had diplomas; 6% (n = 19) had degrees; and 3.5% (n = 11) had completed their post-graduate studies. It can be generally concluded that the level of literacy within the study area was low as per Table 4.4 below. According to Mislimshoeva et al., 2014, the level of education has an influence on the choice of energy source. The study indicated that the higher the level of education, the less the firewood people use. This is because the more educated people are, the more they understand the dangers firewood pose to their health and the environment.

It is believed that when the person is more educated, they are more likely to switch to cleaner sources of energy like electricity. This is confirmed in the study area where

people who are more educated were using electricity and they cited health and safety as their reasons.

Table 4.4: Level of education of respondents

Level of Education	Frequency (n)	Percentages (%)
No formal education	79	25.1
Primary Schooling	31	9.8
Secondary Schooling	135	42.9
Higher Certificate	11	3.5
Diploma	29	9.2
Degree	19	6.0
Postgraduate	11	3.5
Total	***315***	***100.0***

Source: Primary data

4.2.5 Employment status

As indicated in Table 4.5, the majority of the respondents (35%, n = 110) were unemployed; 30% (n = 95) were pensioners; only 30% (n = 94) were employed; and 5% (n = 16) were self-employed. It can therefore be concluded that the majority of respondents were unemployed. The majority of households at Nkomo Village are with unemployed individuals who depend on government grants. According to Statistics SA, 2016, almost half of the South African youth (18-35) are unemployed. The unemployment rate among the youth is high irrespective of educational level. It can be concluded that the employment status of households in the study area affects affordability of cleaner sources of energy.

Table 4.5: Employment status of respondents

Employment Status	Frequency (n)	Percentages (%)
Unemployed	110	35
Employed	94	30
Self -employed	16	5
Pensioner	95	30
Total	***315***	***100.0***

Source: Primary data

4.2.6 Monthly income

Most (39.04%, n = 123) of the respondents' monthly income ranged between R1,501 and R3,000, mostly in the form of government grants; 22.0% (n = 69) had a monthly income of R501–R1,500. 12,38% (n=39) of the households earned more than R15000, whereas 11.11% (n = 35), who were grant recipients, received less than R500. 4,76% (n=15) earned between R10501 and R15000, followed by 3.17% (n=10) who earned between R3001 and R4500 and R9001 and R10500 respectively. 0.95% (n=3) earned between R6001 and R7500. The lowest group was those earning between R7501 and R9000 at 0.6% (n=2) (see Table 4.6 below).

According to Ding et al., 2016, household income is the main factor influencing the choice of household energy source. This is supported by a study by Ateba et al., 2018 that revealed that income level of the households influenced their choice of energy. Household monthly income is directly linked to employment rate. A high number of people in the study area are unemployed and receive their income in the form of government grants and they resort to using firewood as their source of energy.

Table 4.6: Monthly income of respondents

Total Monthly Income (Rand)	Frequency (n)	Percentages (%)
0-500	35	11.11
501-1500	69	22.0

	1501-3000	123	39.04
	3001-4500	10	3.17
	4501-6000	9	2.85
	6001-7500	3	0.95
	7501-9000	2	0.64
	9001-10500	10	3.10
	10501-15000	15	4.76
	15001+	39	12.38
	Total	***315***	***100.0***

Source: Primary data

4.3. Energy choice and use by households

4.3.1 Energy access

Similar to the study conducted by Masekela (2019), most of the respondents from Nkomo village in Limpopo indicated that they had easier access to firewood than other sources of energy. Firewood was mostly accessed by collection from the nearby forest (67.0%, n = 211) or purchased from local suppliers (19.4%, n = 61). Those that purchase from local suppliers indicated that they buy a load ranging from R200 to R400 per load, depending on the mode of transport being used to deliver. The estimated distances travelled to collect firewood were found to be within the 3km to 45km range, as indicated by Table 4.7 below.

Table 4.7: Estimated distance travelled to collect firewood

Distance Travelled	**Frequency (n)**	**Percent (%)**
0-5	87	32.2
6-10	45	16.7
11-20	36	13.3
21-30	19	7.0
30-40	23	8.5

	41+	1	0.4
	Delivered by supplier	59	21.9
	Total	***315***	***100.0***

Source: Primary data

4.3.2 Preferred household energy sources

Firewood and electricity were the preferred sources of energy for household energy needs: 81.9% (n = 258) preferred firewood for water heating, 81.9% (n = 258) preferred it for space heating and 78.7% (n = 248) for cooking, while 20.6% (n = 65) preferred electricity for cooking, and 16.8% (n = 53) preferred it for both space and water heating (see Figure 4.1 below). Most of the respondents 52.7% (n = 166) cut branches from live trees in the nearest forest, which they dried at their homes, whereas 97.0% (n = 249) used dry wood collected from the nearest forest.

The reasons for which firewood was preferred included easy accessibility, the large family size, low household income, affordability, convenient and reliable. Households preferring electricity cited health and safety as their reasons. No households indicated that they preferred LP Gas for cooking, water and space heating.

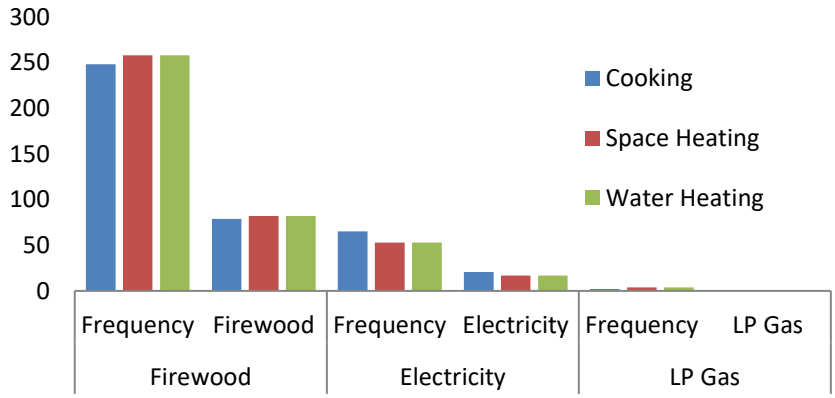

Figure 4.1: Preferred energy sources for household energy needs (cooking, water and space heating)

4.3.2.1. Energy sources used for cooking

Figure 4.2 depicts Nkomo village respondents' energy source used by household for cooking. Most of the respondents (78.7%, n = 248) used firewood for cooking due to cultural preferences (4.8%), or because food cooked using firewood tasted better (4.1%), easy access (26%) and affordability (33%).

The respondents indicated that firewood was collected for cooking daily (79.4%, n = 250); monthly (0.3%, n =1); once a week (5.6%, n = 18) or "other" (4.1%, n = 13). The latter included when there was load shedding. Only 12.7% (n = 40) of the respondents indicated that they did not collect firewood for cooking purposes. Those that do not collect firewood buy from the local suppliers on a monthly basis or use firewood for cooking.

The respondents who specified that they use firewood for cooking indicated that food cooked with firewood tastes better than the one cooked with electricity. Those that cook with electricity indicated that it is safer than firewood and cooks faster as you can cook more than one pot at the same time. It can be concluded that firewood is the main source for cooking at Nkomo Village because it is easily accessible, affordable, due to cultural preference and food taste.

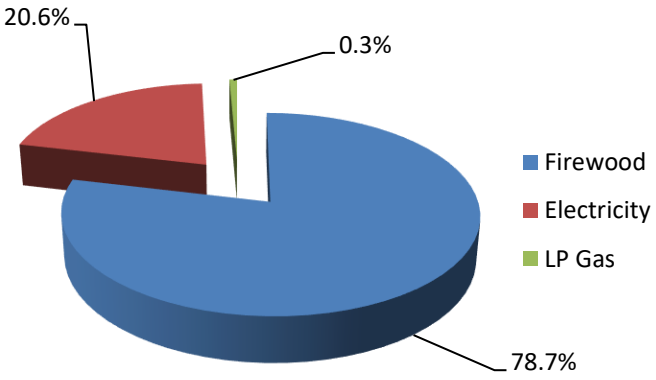

Figure 4.2: Energy sources used for cooking

4.3.2.2. Energy sources used for water heating

Figure 4.3 shows the energy sources the households utilised for water heating. Firewood was utilised by 81.9% (n = 258) of the respondents, followed by electricity (16.8%, n = 53) and LPG (0.3%, n =1).

A variety of reasons were provided by the respondents for why firewood was preferred, including that water heated by firewood remained warm for longer and that a bigger pot could be used for the entire family. The respondents who preferred using electricity highlighted that it was quicker and more convenient than using firewood. Some also indicated a preference for electricity over firewood for health reasons and because it was environmentally friendly.

81.6% of the respondents indicated that they collect firewood daily for water heating (n=257), while 2.2% indicated that they collect once a week (n=7), 1,3% indicated that they collect monthly (n=4) or other. The reasons provided by the respondents who indicated "other" was when there is loadshedding. At least 14,9% (n = 47) of the respondents indicated that they do not collect firewood for water heating purposes. Those that indicated that they do not collect firewood indicated that firewood is delivered to their households by suppliers, or they use electricity. It seems that most of the households considered firewood more reliable than electricity, possibly due to frequent load shedding.

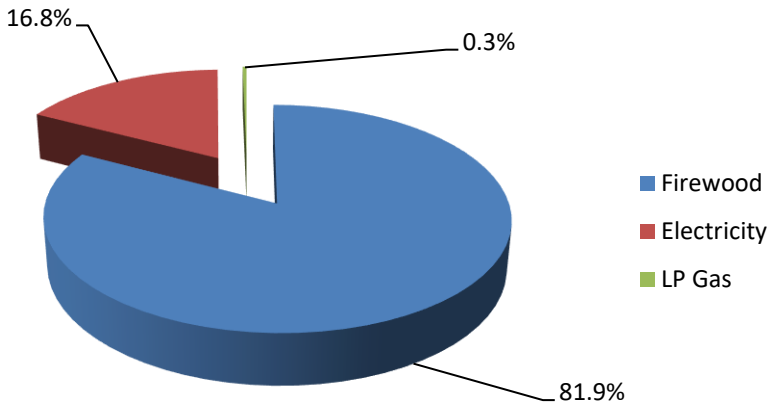

Figure 4.3: Energy sources used for water heating

4.3.2.3. Energy sources used for space heating

Figure 4.4 depicts the energy sources used by the respondents for space heating. Firewood was utilised by 81.9% (n = 258) of households, followed by electricity (16.8%, n = 53) and LPG (0.3%, n =4).

A range of reasons was provided by the respondents for why they preferred firewood, including cultural preferences and that the house remained warm longer, whereas those who preferred using electricity highlighted that it was faster and more convenient than firewood. Some also indicated an electricity preference over firewood for health reasons and being environmentally friendly.

Firewood for space heating was collected daily (32.7%, n = 103), once a week (4.1%, n = 13), monthly (1.0%, n = 3) or "other" (40.8%, n = 129). The remaining 19.4% (n = 61) of the respondents indicated no collection of firewood for heating. The reasons provided by those respondents who indicated "other" included "when necessary" and during load shedding.

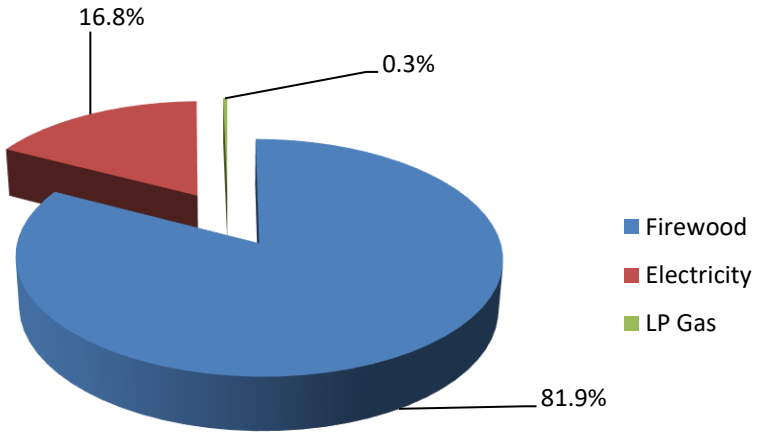

Figure 4.4: Energy sources used for space heating

4.3.3 Endogenous factors that influence firewood use

This section spoke about the possibility of association between the energy sources used for cooking, water and space heating and the demographic information about the respondents which include the gender, age, family size, educational level, employment status and monthly income.

4.3.3.1 The cross-tabulation between household preferred energy source used for cooking, water and space heating vs. gender

The possibility of an association between the energy sources used for cooking and gender was determined using a two-by-two cross tabulation. As indicated in Table 4.8, the most reported preferred source of energy for cooking by household irrespective of gender is firewood 78.7% (n = 248) over electricity 20.6% (n= 65). Total number of respondents was 315, 0.7% (n = 2) did not indicate their preferred energy source.

The preference of energy source reported by respondents in terms of gender in the use of firewood for cooking indicates that females have a much higher 84.2% (n = 213) preference compared to males with only 55.7% (n = 34). In case where electricity is a preferred source of energy by gender, males 42.6% (n= 26) showed higher use.

From the current analysis, one can therefore conclude that the female respondents had a much higher preference of using firewood than the male respondents within households. This is because females are responsible for cooking and firewood collection in the households (Lambrou & Piana, 2006).

Table 4.8: Cross tabulation between household preferred energy source for cooking and gender.

			Gender		
			Female	Male	Total
	Electricity	Count	39	26	65
		% within Gender	15.4%	42.6%	20.6%
	Firewood	Count	213	34	248

Household Preferred energy source for cooking	% within Gender	84.2%	55.7%	78.7%
Total	Count	253	61	315
	% within Gender	100.0%	100.0%	100.0%

Source: Primary data

The possibility of an association between the energy sources used for water heating and gender was determined using a two-by-two cross tabulation. As indicated in Table 4.9, the most reported preferred source of energy for water heating by household irrespective of gender is firewood at 81.9% (n = 258) over electricity at 16.8% (n= 53). The preference of energy source reported by respondents in terms of gender in the use of firewood for household water heating were characterised by females having a much higher 88.1% (n = 223) preference compared to males with only 55.7% (n = 34). The findings of the study revealed that females are generally responsible for household responsibilities including water heating and selecting the energy source for it.

Table 4.9: Cross tabulation between household preferred energy source for water heating and gender

			Gender		
				Female	Male	Total
Household preferred energy source for water heating		Count	0	0	1	1
		% within Gender	0.0%	0.0%	1.6%	0.3%
	Electricity	Count	0	28	25	53
		% within Gender	0.0%	11.1%	41.0%	16.8%
	Firewood	Count	1	223	34	258
		% within Gender	100.0%	88.1%	55.7%	81.9%
Total		Count	1	253	61	315
		% within Gender	100.0%	100.0%	100.0%	100.0%

Source: Primary data

The possibility of an association between the energy sources used for space heating, and gender was determined using cross tabulation. As indicated in Table 4.10, the most reported preferred source of energy for space heating by households irrespective of gender is firewood at 77.4% (n = 233) over electricity at 21.0% (n= 66). The preference of energy source reported by respondents in terms of gender in the use of

firewood for household space heating were characterised by females having a much higher 79.1% (n = 200) preference compared to males with only 52.5% (n = 32). Total number of respondents was 315, 0.3% (n=1) did not indicate their preferred energy source for space heating.

Table 4.10: Cross tabulation between household preferred energy source for space heating and gender

			Gender		Total
			Female	Male	
Household preferred energy source for space heating		Count	0	1	1
		% within Gender	0.0%	1.6%	0.3%
	Electricity	Count	28	25	53
		% within Gender	11.1%	41.0%	16.8%
	Firewood	Count	223	34	258
		% within Gender	88.1%	55.7%	81.9%
Total		Count	253	61	315
		% within Gender	100.0%	100.0%	100.0%

Source: Primary data

4.3.3.2 The cross-tabulation between household preferred energy source used for cooking, water and space heating vs. age

Table 4.11 shows the preference of energy sources used for household cooking by age of the respondents. Most households specified preference of using firewood 78.7% (n = 248) as compared to electricity 20.6% (n = 65) as a source of energy for cooking in terms of age. The majority of household with the age group of over 51 years old disclosed preference (90 – 100%) of using firewood when compared to younger age groups (66 – 69%).

One can therefore conclude that older people (100%) (n = 61) are more highly likely to use firewood than younger ones 69.3% (n = 70), which might be due to cultural beliefs and preferences. It might also be linked to disposable income, since most of the older respondents relied on government grants and indicated affordability as a

reason. Other studies have found age to be having a negative effect on the probability of the use of clean and efficient energy (Jessel et al., 2019).

Table 4.11: Cross tabulation between household preferred energy source for cooking and age

			Age Group					
			18-35	36-50	51-66	67-81	82+	Total
Household preferred energy source for cooking	Electricity	Count	31	30	4	0	0	65
		% within Age Group	30.7%	31.9%	7.5%	0.0%	0.0%	20.6%
	Firewood	Count	70	62	49	61	6	248
		% within Age Group	69.3%	66.0%	92.5%	100.0%	100.0%	78.7%
Total		Count	101	94	53	61	6	315
		% within Age Group	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

Table 4.12 shows the preference of energy sources used for household water heating by the age of the respondents. Many households indicated preference of using firewood 81.9% (n = 258) when compared to electricity 16.8% (n = 53) as source of energy for water heating in terms of age. The majority of household with age group of over 51 years old prefer (90 – 100%) using firewood when compared to younger age groups (66 – 69%).

One can therefore conclude that older people (100%) (n = 61) are more highly likely to use firewood than younger ones 73.3% (n = 74), which might be due to cultural beliefs and preferences. It might also be linked to disposable income, since most of the older respondents relied on government grants and also specified affordability as a reason. Other studies have found age to be having a negative effect on the preference of the use of clean and efficient energy.

Table 4.12: Cross tabulation between household preferred energy source for water heating and age

			Age Group					Total
			18-35	36-50	51-66	67-81	82+	
Household preferred energy source for water heating	Electricity	Count	25	25	3	0	0	53
		% within Age Group	24.8%	26.6%	5.7%	0.0%	0.0%	16.8%
	Firewood	Count	74	67	50	61	6	258
		% within Age Group	73.3%	71.3%	94.3%	100.0%	100.0%	81.9%
Total		Count	101	94	53	61	6	315
		% within Age Group	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

Table 4.13 shows the preference of energy sources used for household space heating between the respondents age groups. Most household respondents indicated preference of using firewood 74.0% (n = 233) as compared to electricity 21.0% (n = 65) as source of energy for space heating in terms of age. The majority of household within the age group of over 51 years old (84.9 – 100%) prefer using firewood when compared to younger age groups (61.7 – 64%).

One can therefore conclude that older people (100%) (n = 61) are more highly likely to use firewood than younger ones 62.4% (n = 63), which might be due to cultural beliefs and preferences. It might also be linked to disposable income, since many of the older respondents relied on government grants and indicated affordability as a reason. This study concluded that age is associated with the use of firewood and it influences the choice of energy source. Other studies have found age to be having a negative effect on the preference of the use of clean and efficient energy. Total number of household respondents was 315, 1.6% (n =15) did not indicate their preferred energy source for space heating.

Table 4.13: Cross tabulation between household preferred energy source for space heating and age

			Age Group					
			18-35	36-50	51-66	67-81	82+	Total
Household preferred energy source for space heating		Count	0	1	0	0	0	1
		% within Age Group	0.0%	1.1%	0.0%	0.0%	0.0%	0.3%
	Electricity	Count	32	29	5	0	0	66
		% within Age Group	31.7%	30.9%	9.4%	0.0%	0.0%	21.0%
	Firewood	Count	63	58	45	61	6	233
		% within Age Group	62.4%	61.7%	84.9%	100.0%	100.0%	74.0%
Total		Count	101	94	53	61	6	315
		% within Age Group	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

4.3.3.3 The cross-tabulation between household preferred energy source used for cooking, water and space heating vs. family size

The influence of household family size in the energy sources use preference for cooking was also determined using the two-by-two cross-tabulation. Table 4.14 reveals that firewood 78.7% (n = 248) is a much more preferred energy source by households for cooking in terms of family size as compared to electricity 20.6% (n = 65). The larger household family size from above 5 members 80.1% (n = 113) seems to prefer firewood as their energy source for cooking when compared to smaller families with less than 4 members 72.9% (n = 94). According to the current study, households with more family members had a high probability of choosing firewood compared to smaller families. The reasons provided are aligned with other studies, namely that they are able prepare enough food for the entire family, can boil bigger pots of water for the entire family and that it is affordable.

Table 4.14: Cross tabulation between household preferred energy source for cooking and family size

			Family Size Group				
			1-4	5-8	9-12	13+	Total
Household preferred energy source for cooking		Count	0	0	1	0	1
		% within Family Size Group	0.0%	0.0%	2.5%	0.0%	0.3%
	Electricity	Count	34	28	2	1	65
		% within Family Size Group	26.4%	19.9%	5.0%	20.0%	20.6%
	Firewood	Count	94	113	37	4	248
		% within Family Size Group	72.9%	80.1%	92.5%	80.0%	78.7%
Total		Count	129	141	40	5	315
		% within Family Size Group	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

The influence of household family size in the energy sources use preference for water heating was determined using the two-by-two cross-tabulation. Table 4.15 reveals that firewood 81.9% (n = 258) is a much preferred energy source by households for water heating in terms of family size as compared to electricity 16.8% (n = 53). The larger household family size from above 5 members 81.6% (n = 115) seems to prefer firewood for water heating when compared to small family size of less than 4 members 77.5% (n = 100). The reason provided was that for big families, larger size container can be used to boil water for the whole family.

Table 4.15: Cross tabulation between household preferred energy source for water heating and family size

			Family Size Group				
			1-4	5-8	9-12	13+	Total
Household preferred energy source		Count	0	0	1	0	1
		% within Family Size Group	0.0%	0.0%	2.5%	0.0%	0.3%
	Electricity	Count	28	24	1	0	53
		% within Family Size Group	21.7%	17.0%	2.5%	0.0%	16.8%

for water heating	Firewood	Count	100	115	38	5	258
		% within Family Size Group	77.5%	81.6%	95.0%	100.0%	81.9%
Total		Count	129	141	40	5	315
		% within family Size Group	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

The influence of household family size in the energy sources use preference for space heating was determined using the two-by-two cross-tabulation. Table 4.16 reveals that firewood 74.0% (n = 233) is much more preferred by households for space heating in terms of family size as compared to electricity 21.0% (n = 66). The larger households with more than 5 members 73.0% (n = 103) seems to prefer firewood for space heating when compared to small families with less than 4 members 69.0% (n = 35). The total number of household respondents was 315, 1.3% (n = 14) did not indicate their preferred energy source for space heating.

Table 4.16: Cross tabulation between household preferred energy source for space heating and family size

			Family Size Group				Total
			1-4	5-8	9-12	13+	
Household preferred energy source for space heating		Count	0	0	1	0	1
		% within Family Size Group	0.0%	0.0%	2.5%	0.0%	0.3%
	Electricity	Count	35	29	2	0	66
		% within Family Size Group	27.1%	20.6%	5.0%	0.0%	21.0%
	Firewood	Count	89	103	36	5	233
		% within Family Size Group	69.0%	73.0%	90.0%	100.0%	74.0%
Total		Count	129	141	40	5	315
		% within Family Size Group	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

4.3.3.4 The cross-tabulation between energy source preference for cooking, water and space heating vs. education level

Table 4.17 indicates the results of the two-by-two cross-tabulation that was done to determine whether there is a difference in household preference in energy sources

used for cooking by the education level. The test revealed that there were differences in the choice of energy source used for cooking in as far as household education level is concerned with the usage of firewood 78.7% (n = 248) being the most preferred as compared to electricity 20.6% (n = 65) for cooking. Firewood was mostly preferred by respondents with no formal education 100% (n = 79), primary schooling 100% (n = 31) and secondary schooling 89.6% (n = 121). Whereas the households with Postgraduate 0% (n = 0), Degree 5.3% (n = 1), Diploma 34.5% (n = 10) and Higher certificate 54.5% (n= 6) had less preference of using firewood as a source of energy for cooking. This indicates that the uneducated respondents were far more likely to utilise firewood than the educated respondents and this is a confirmation that education level has a positive relationship with the choice of energy source for cooking. The higher educated the person is, the less firewood they use.

Table 4.17: Cross tabulation between household preferred energy source for cooking and educational level

			Educational Status							Total
			No formal education	Primary Schooling	Secondary Schooling	Diploma	Higher Certificate	Degree	Postgraduate	
Household preferred energy source for cooking		Count	0	0	0	0	0	1	0	1
		% within Educational Status	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%	0.0%	0.3%
	Electricity	Count	0	0	13	19	5	17	11	65
		% within Educational Status	0.0%	0.0%	9.6%	65.5%	45.5%	89.5%	100.0%	20.6%
	Firewood	Count	79	31	121	10	6	1	0	248
		% within Educational Status	100.0%	100.0%	89.6%	34.5%	54.5%	5.3%	0.0%	78.7%
Total		Count	79	31	135	29	11	19	11	315
		% within Educational Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

Table 4.18 indicates the results of the two-by-two cross-tabulations that was done to determine whether there is difference between household energy preference for water heating and the education level. The test revealed that there were differences in choice of energy source used for water heating in as far as household education level is concerned. Majority of respondents, 81.9% (n = 258) indicated that they prefer to use firewood as compared to electricity 16.8% (n = 53) for water heating. Firewood was mostly preferred for water heating by respondents with no formal education 100% (n = 79), primary schooling 100% (n = 31) followed by those with secondary schooling 89.6% (n = 127). There was a low number of respondents with Postgraduate qualifications 9.1% (n = 1), Degree 5.3% (n = 1), Diploma 41.4% (n = 12) and Higher certificate 45.5% (n= 5) that indicated that they prefer using firewood as source of energy for water heating.

Table 4.18: Cross tabulation between household preferred energy source for water heating and educational level

			Educational Status							
			No formal education	Primary Schooling	Secondary Schooling	Higher Certificate	Diploma	Degree	Postgraduate	Total
Household preferred energy source for water heating		Count	0	0	0	0	0	1	0	1
		% within Educational Status	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%	0.0%	0.3%
	Electricity	Count	0	0	5	4	17	17	10	53
		% within Educational Status	0.0%	0.0%	3.7%	36.4%	58.6%	89.5%	90.9%	16.8%
	Firewood	Count	79	31	127	7	12	1	1	258
		% within Educational Status	100.0%	100.0%	94.1%	63.6%	41.4%	5.3%	9.1%	81.9%
Total		Count	79	31	135	11	29	19	11	315

		% within Educational Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

Table 4.19 indicates the results of the two-by-two cross-tabulation that was done to determine whether relationship exists between the choice of energy source for space heating and education level of the respondents. The test revealed that there is a positive relationship between the energy source used for space heating and education level. Majority of respondents 74.0% (n = 233) indicated that they prefer firewood as compared to electricity 21.0% (n = 65) for space heating. Firewood was mostly preferred by respondents with no formal education 98.7% (n = 78), primary schooling 100% (n = 31) and secondary schooling 80.7% (n = 109) for space heating. However, a low number of household respondents with Postgraduate 0% (n = 0), Degree 5.3% (n= 1), Diploma 24.1% (n = 7) and Higher certificate 63.6% (n = 7) indicated that they prefer using firewood as source of energy for space heating.

Table 4.19: Cross tabulation between household preferred energy source for space heating and educational level

			Educational Status							
			No formal education	Primary Schooling	Secondary Schooling	Higher Certificate	Diploma	Degree	Postgraduate	Total
Household preferred		Count	0	0	0	0	0	1	0	1
		% within Educational Status	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%	0.0%	0.3%
	Electricity	Count	0	0	5	4	17	17	10	53
		% within Educational Status	0.0%	0.0%	3.7%	36.4%	58.6%	89.5%	90.9%	16.8%
	Firewood	Count	79	31	127	7	12	1	1	258

energy source for space heating	% within Educational Status	100.0%	100.0%	94.1%	63.6%	41.4%	5.3%	9.1%	81.9%
Total	Count	79	31	135	11	29	19	11	315
	% within Educational Status	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

4.3.3.5 The cross-tabulation between the energy source preference for cooking, water and space heating vs. employment status

Table 4.20 shows the association between the household energy source preferred for cooking and employment status of the respondents. As indicated by the results of two-by-two cross tabulation, the majority of respondents indicated that they prefer using firewood for cooking 78.7% (n = 248) over electricity 20.6% (n = 65). The study revealed that majority of pensioners 96.8% (n = 92), unemployed 94.5% (n = 104), and self-employed 75.0% (n = 12) respondents preferred using firewood. Respondents who are employed 55.3% (n = 52) prefer using electricity for cooking. The reason indicated by respondents using firewood was that it is affordable and easily accessible. Those that use electricity cited health and safety as their reasons. It can therefore be concluded that it is more likely for the unemployed and pensioners to utilise firewood for cooking than the employed and self-employed respondents.

Table 4.20: Cross tabulation between household preferred energy source for cooking and employment status

			Employment status Category				
			Unemployed	Employed	Self employed	Pensioner	Total
Household preferred energy source for cooking		Count	0	1	0	0	1
		% within Employment status Category	0.0%	1.1%	0.0%	0.0%	0.3%
	Electricity	Count	6	52	4	3	65

		% within Employment status Category	5.5%	55.3%	25.0%	3.2%	20.6%
	Firewood	Count	104	40	12	92	248
		% within Employment status Category	94.5%	42.6%	75.0%	96.8%	78.7%
Total		Count	110	94	16	95	315
		% within Employment status Category	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

The influence of household employment status in the energy source preference for water heating was determined using the two-by-two cross-tabulation. Table 4.21 reveals that firewood 81.9% (n = 258) is a much more preferred energy source by households for water heating as compared to electricity 16.8% (n = 53). The pensioner 91.9% (n = 93), unemployed 97.3% (n = 107) and self-employed 81.3% (n = 13) respondents seem to prefer firewood as an energy source for water heating in comparison employed 50.0% (n = 47) who indicated high preference of electricity for water heating.

Table 4.21: Cross tabulation between household preferred energy source for water heating and employment status

			Employment status Category				
			Unemployed	Employed	Self employed	Pensioner	Total
Household preferred energy source for water heating		Count	0	1	0	0	1
		% within Employment status Category	0.0%	1.1%	0.0%	0.0%	0.3%
	Electricity	Count	1	47	3	2	53
		% within Employment status Category	0.9%	50.0%	18.8%	2.1%	16.8%
	Firewood	Count	107	45	13	93	258

		% within Employment status Category	97.3%	47.9%	81.3%	97.9%	81.9%
Total		Count	110	94	16	95	315
		% within Employment status Category	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

Table 4.22 shows the household energy sources preferred for space heating compared to the employment status of the respondents. As indicated by the results of the two-by-two cross-tabulation, the majority of respondents indicated the preference of using firewood 74.0% (n = 233) over the use of electricity 21.0% (n = 66) for space heating. According to the respondent's employment status, most pensioners 95.8% (n = 91) unemployed 90.0% (n = 99), and self-employed 68.8% (n = 11) prefer using firewood for space heating. Respondents who are employed 60.6% (n = 57) indicated that they prefer using electricity for space heating. Total number of respondents was 315, 1.3% (n =4) did not indicate their preferred energy source for space heating.

Table 4.22: Cross tabulation between household preferred energy source for space heating and employment status

			Employment status Category				
			Unemployed	Employed	Self employed	Pensioner	Total
Household preferred energy source for space heating		Count	0	1	0	0	1
		% within Employment status Category	0.0%	1.1%	0.0%	0.0%	0.3%
	Electricity	Count	4	57	3	2	66
		% within Employment status Category	3.6%	60.6%	18.8%	2.1%	21.0%
	Firewood	Count	99	32	11	91	233
		% within Employment status Category	90.0%	34.0%	68.8%	95.8%	74.0%

Total	Count	110	94	16	95	315
	% within Employment status Category	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

4.3.3.6 The cross-tabulation between the choice of energy source for cooking, water and space heating vs. monthly income

Table 4.23 indicates the results of the two-by-two cross tabulation that was done to determine the household preference of the energy sources used for cooking compared to the monthly income of the respondents. The test revealed that the majority of households preferred using firewood 78.7% (n = 248) over electricity 20.6% (n = 65) as an energy source for cooking. The households with monthly income of R1 501 – R3 000, R501 – R1 500, and R3 001 – R4 500, showed the most preference at 98.7% (n = 119), 98.6% (n = 68), and 90.0% (n = 9) in using firewood for cooking respectively.

However, half of the respondents with monthly income ranging from R7 501 to over R15 000 showed a 50.0% to 97.4% preference of using electricity for cooking.

One can therefore deduce that the respondents from a low household monthly income were more likely to use firewood than the households with a much higher monthly income who prefer using electricity. Thus, the households with higher disposable incomes were more likely to choose electricity as their source of energy than the lower income households. The reasons as indicated by the households with higher monthly income were affordability and health concerns.

Table 4.23: Cross tabulation between household preferred energy source for cooking and monthly income of households

			Total Monthly Income									
			0-500	501-1500	1501-3000	3001-4500	4501-6000	6001-7500	7501-9000	9001-10500	10501-15000	15001+	Total
Household preferred energy source for cooking		Count	0	0	0	0	0	0	0	0	1	0	1
		% within Total Monthly Income	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%	0.0%	0.3%
	Electricity	Count	2	1	4	0	2	1	1	5	11	38	65
		% within Total Monthly Income	5.7%	1.4%	3.3%	0.0%	22.2%	33.3%	50.0%	50.0%	73.3%	97.4%	20.6%
	Firewood	Count	33	68	119	9	7	2	1	5	3	1	248
		% within Total Monthly Income	94.3%	98.6%	96.7%	90.0%	77.8%	66.7%	50.0%	50.0%	20.0%	2.6%	78.7%
Total		Count	35	69	123	10	9	3	2	10	15	39	315

	% within Total Monthly Income	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

The influence of household monthly income in the energy source preference for water heating was determined using the two-by-two cross-tabulation. Table 4.24 reveals that firewood 81.9% (n = 258) is much more preferred by households for water heating as compared to electricity 16.8% (n = 53). The households with monthly income ranging from R4 501 – R7 500 showed a 100% preference of using firewood. The household with monthly income of over R15 001 showed over 92.3% (n = 36) preference of using electricity for water heating. The study can therefore conclude that there is association between the household preferred energy source and monthly income of the household.

Table 4.24: Cross tabulation between the household preferred energy source for water heating and monthly income of households

			Total Monthly Income									
			0-500	501-1500	1501-3000	3001-4500	4501-6000	6001-7500	7501-9000	9001-10500	10501-15000	15001+	Total
Household preferred energy source for water heating		Count	0	0	0	0	0	0	0	0	1	0	1
		% within Total Monthly Income	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%	0.0%	0.3%
	Electricity	Count	1	0	1	1	0	0	1	4	9	36	53
		% within Total Monthly Income	2.9%	0.0%	0.8%	10.0%	0.0%	0.0%	50.0%	40.0%	60.0%	92.3%	16.8%
	Firewood	Count	33	69	120	9	9	3	1	6	5	3	258
		% within Total Monthly Income	94.3%	100.0%	97.6%	90.0%	100.0%	100.0%	50.0%	60.0%	33.3%	7.7%	81.9%
Total		Count	35	69	123	10	9	3	2	10	15	39	315
		% within Total Monthly Income	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 4.25 shows the association between household energy source preferred for space heating and monthly income of the respondents. As indicated by the results of the two-by-two cross-tabulation, most respondents indicated preference of using firewood 74.4% (n = 233) over the use of electricity 21.0% (n = 66) for space heating. The majority of households with monthly incomes of R501 – R1 500, R1 501 – R3 000, and R3 001 – R4 500 showed a much higher 92.8% (n = 64), 92.7% (n = 114) and 80.0% (n = 8) preference of using firewood for space heating. The household respondents with monthly income of R7 500 – R9 000 showed a 100% (n = 2) preference of using electricity. Those with monthly income of over R15 001 showed a 97.4% (n = 38) preference of using electricity for space heating. Total number of household respondents was 315, 0.6% (n=2) did not indicate their preferred energy source for space heating.

Table 4.25: Cross tabulation between the household preferred energy source for space heating and monthly income of households

			Total Monthly Income										
			0-500	501-1500	1501-3000	3001-4500	4501-6000	6001-7500	7501-9000	9001-10500	10501-15000	15001+	Total
Household preferred energy source for space heating		Count	0	0	0	0	0	0	0	0	1	0	1
		% within Total Monthly Income	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%	0.0%	0.3%
	Electricity	Count	1	1	2	0	3	2	2	4	13	38	66
		% within Total Monthly Income	2.9%	1.4%	1.6%	0.0%	33.3%	66.7%	100.0%	40.0%	86.7%	97.4%	21.0%
	Firewood	Count	32	64	114	8	6	1	0	6	1	1	233

	% within Total Monthly Income	91.4%	92.8%	92.7%	80.0%	66.7%	33.3%	0.0%	60.0%	6.7%	2.6%	74.0%
Total	Count	35	69	123	10	9	3	2	10	15	39	315
	% within Total Monthly Income	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Primary data

CHAPTER FIVE: SUMMARY, STUDY LIMITATIONS, RECOMMENDATIONS AND, CONCLUSION

The purpose of this chapter is to provide a summary of the findings related to the research problems, and to make recommendations for mitigation strategies and further research regarding factors influencing the usage of firewood as an energy source among electrified households and provide conclusion.

5.1 Summary

The aim of the study was to evaluate the factors influencing the use of firewood in electrified households in Nkomo Village, Limpopo Province. If was found that most households used firewood for cooking, and space and water heating. This is due to the fact that most households depend on government grants and are unable to afford other sources of energy. The literature reviewed indicated that firewood was the most preferred source in many rural areas across developing countries in Africa, including South Africa for a variety of reasons.

It was also found that firewood was the most-used energy source for cooking in Nkomo Village because it was easily accessible It was indicated that firewood was mostly collected from the nearby forest or bought from local suppliers. It was also found that firewood is used because it is affordable when compared to electricity and large families are able to cook more food when using firewood. People also believe that food cooked by firewood tastes better than the one cooked with electricity.

5.1.1 The extent to which firewood is being used

The study revealed that firewood in the study area was used mostly by females (80.3%) because most of the house chores, especially cooking, were done by females. Most of the respondents who took responsibility for all household activities and made decisions, including regarding which energy source was the most suitable for their households were females and above 18 years of age.

Dry wood was collected from the nearby forest and used by 97% of the households. As indicated by the respondents, firewood is preferred because it is easily accessible, affordable/cheaper, convenient and reliable, particularly for large family sizes and low income household.

Moreover, firewood was accessible and more affordable than other sources of energy, especially electricity. For water heating, a number of reasons were given as to why firewood was the preferred energy source (81.9%), including the fact that water heated by firewood remained warm for longer and that a large pot could be used to accommodate the whole family at once. Due to constant load shedding in the area, the respondents indicated that firewood was more reliable because it could be used any time of the day and during power outages.

Few respondents (4.8%) specified cultural preferences as one of the reasons for which they preferred firewood for cooking. They indicated that food cooked with firewood tasted better.

For space heating, 81.9% of households used firewood because it was the cultural practice that they had inherited. They also indicated that the space remained warm for longer if firewood was used.

5.1.2 Socioeconomic dynamics of the families in the area

It was found that gender had an influence on the choice of energy used for cooking, water and space heating. Furthermore, female-headed households were more likely to use firewood than male-headed households, due to the fact that the women were responsible for the household duties. It was also found that the majority of the respondents were between 18 and 35 years, which is consistent with South African population trends.

The family size dominant in the study area was between five and eight members (44.8%). It was confirmed that the study area had more respondents who had finished secondary school (42.9%) than those who had done post-graduate studies (3.5%). It can be concluded that the level of literacy in the study area was generally low.

The unemployment rate in the area was high (34.9%). This explains the reliance on firewood as an energy source. The majority of the respondents had an income of between R1,501 and R3,000, which was from government grants. Because the majority of the respondents were unemployed, they accessed firewood by collecting it from the nearby forest (67.0%).

5.1.3 Management strategies to address the overlapping issues of firewood, and mitigate the adverse impacts on the environment and surrounding communities

Because of the high unemployment rate and the price of electricity, firewood will continue to be used for the foreseeable future. This must be used as a starting point when developing management strategies or policies to deal with firewood usage in rural areas. Households using firewood need to be educated on the consequences of using it as an energy source in order to ensure that the impacts on health and the environment are managed. They must also be taught that the unnecessary removal of natural resources needs to be reduced in order to ensure environmental sustainability.

Rural areas in the African Continent and other developing countries also need to have access to clean sources of energy, such as electricity, to ensure that the use of firewood is reduced, which will, in turn, reduce environmental and health impacts. Each and every qualifying household needs to have access to free basic electricity because currently not all households receive it. Government needs to subsidize the substitution of firewood by clean energy sources to households that cannot afford

5.2 Study Limitations

5.2.1 Sample size

The limitation regarding the sample size was that the process of data collection from the 315 households consumed a great deal of time. The unwillingness of some households to participate was also a limitation because the researcher had to go to the next available house if there were no willing participants at one house and if the people in the next house were all below 18 they were not eligible to participate.

5.2.2 Data collection

The limitations regarding data collection were that many residents of Nkomo Village are uneducated; thus, having to complete a questionnaire in English was challenging for them. The researcher had to translate the questionnaire into Xitsonga so that they could understand. Some respondents wanted to pull out because they complained that the questionnaire was too long and time consuming. Data collection took longer than anticipated because of the high sample size (n=315) that required a lot of questionnaires.

5.2.3 Lack of previous studies in the study area

No similar study has been conducted at Nkomo Village. This was the first time the factors influencing the usage of firewood among electrified households had been researched. If previous studies had been conducted on the topic in Nkomo village, the researcher would have compared the findings with the previous ones.

5.2.4 Data analysis

Data analysis was affected by the sample size. Some data could not be verified because some of the respondents did not include all their information, such as gender, and the researcher had to set such questionnaires aside and replace them with new ones with complete information.

5.3 Recommendations

5.3.1 Firewood collection policies and regulations

The study discovered that at Nkomo Village there is no firewood collection policies and regulations in place. Firewood collection regulations is traditionally done by local authorities to manage sustainable use (Lenfers et al., 2018). Even with increasing electrification, firewood collection is done in order to reduce the costs, and this may increase the levels of unsustainable wood harvesting.

It is recommended that firewood collection policies and regulations be implemented and enforced by the traditional authority which will indicate how firewood collection should be done by households. This will assist in addressing environmental impacts such as deforestation and biodiversity loss that will lead to the extinction of tree and animal species. Households also need to be informed and empowered about the advantages of using firewood in a cleaner way.

5.3.2 The use of alternative energy sources

Families should be encouraged to use low-emitting stoves to reduce indoor air pollution and greenhouse gas emissions, that are associated with human health impacts, global warming, and climate change. It is recommended that government assist in subsidizing the rollout of low-emitting stoves to residents who cannot afford to use them because of the low income.

The use of other renewable sources of energy such as solar is also encouraged because this will reduce the time spent by households (especially women and children) collecting firewood. It will also enable women to participate in income-generating activities during the time they would have been collecting firewood.

Electrified households should be encouraged and supported to use electricity coupled with energy efficient electrical appliances (that use minimal electricity) not only for lighting, but also for cooking, water, and space heating. It is understood that the reason why alternative energy sources are not utilised is because of the financial implications they come with.

5.3.3 Increase Free Basic Electricity

The lack of electricity and the increasing costs forces most poor households in rural areas to depend on firewood for cooking, water and space heating. Having access to electricity does not necessarily mean that people can afford it. Poor households use electricity for lighting but rely on firewood for cooking, water and space heating.

Although some households receive free basic electricity of 50kwh per month, this is not enough to ensure the complete switch to electricity as it is only enough to run basic lighting and ironing for few days. The government should consider increasing the current free basic electricity of 50kwh to all qualifying households to ensure that their daily energy requirements for cooking, water and space heating are met. This will reduce the dependence on firewood and assist in ensuring that there is no extinction of forests through wood harvesting.

5.3.4 Future Research

Future research is recommended as the scope of this research was only limited to Nkomo Village. In order to get a picture of the factors influencing the usage of firewood among electrified households, similar study is recommended in neighbouring villages and other villages around Giyani. The study should also look at other energy sources available in different places. A follow up study may also be conducted at Nkomo Village to determine if similar findings will be revealed.

5.4 Conclusion

This study was conducted to evaluate the factors influencing the usage of firewood in electrified households at Nkomo Village, Limpopo Province. Relevant literature was reviewed to check previous studies conducted in other countries and regions. It can be concluded that firewood is the main source of energy for cooking, water and space heating at Nkomo Village. Factors influencing the usage of firewood in the village were also determined. These include income, size of the household and the availability of electricity.

It is evident that, although Nkomo Village has been electrified for over 25 years, the residents still rely on firewood for their daily cooking, and space and water heating. Not all households receive the free basic electricity provided by government and those that do not receive it have to purchase it. Furthermore, the low employment rate in the village contributes to relying on firewood as an energy source. Many people are unemployed, and they rely on government grants for survival. As a result, they rely

mostly on firewood as their main source of energy for cooking, water and space heating.

Educational level is also believed to influence the choice of energy source. The more educated people in the village use electricity, whereas the less educated ones stick to firewood. This is because the more educated a person is, the better they understand the impacts of using firewood as an energy source.

Bigger families also stick to using firewood because it reduces the economic burden of having to buy a lot of electricity. When they warm water, they can use one big pot that will be used by all the family members. Families with many members also are able to collect firewood themselves.

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APPENDICES

Appendix A: Questionnaire

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APPENDIX A: QUESTIONNAIRE

Kindly complete the following demographics about (respondent)

1. Gender	
2. Age	
3. Total monthly income	
4. Family size	
5. Employment status	
6. Highest level of education obtained	

On a scale of 1 to 5, (5 being the most used and 1 being the least used) rank the following energy sources as used in your household.

	Cooking	Space heating	Water heating	Reason
7. Firewood				
8. Electricity				
9. LP Gas				
10. Other (specify)				

11. What is your preferred energy source for cooking in your household and why?

.....
.....
.....
.....

12. What is your preferred energy source for water heating in your household and why?

.....
.....
.....
.....

13. What is your preferred energy source for space heating in your household and why?

.....
.....
.....
.....

Which situation is applicable in your household (select only one applicable answer?)

	Daily	Once a week	Monthly	Other (specify)

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14. How frequent does your household make fire for cooking?				
15. How frequent does your household make fire for space heating?				
16. How frequent does your household make fire for water heating?				
17. How frequent does, your household collect wood?				

18. Where does your household commonly find or harvest firewood?

…….....

19. What is the estimated distance (km for single trip) that your household members travel to collect firewood?

…….

How would you rate your household energy use situation (use the scale below)

	agree	**Disagree**
20. Live trees from the nearest forest are cut and dried at my household		
21. Dry wood is collected from the nearest forest by household		
22. Wood is collected by donkey cart from the nearest forest		
23. Wood is collected by vehicle from the nearest forest		
24. Wood is bought from firewood suppliers		

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Appendix B: Consent form

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PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: **2020/CAES_HREC/001**
Research permission reference number:

<date>

Title: **An Evaluation of factors influencing firewood usage among electrified households at Nkomo Village, Limpopo Province**

Dear Prospective Participant

My name is **Bongani Lillian Mabunda** and I am doing research with Dr **Khomotso Semenya**, a lecturer in the Department of Environmental Sciences towards a Master of Science in Environmental Management at the University of South Africa. We are inviting you to participate in a study entitled **An Evaluation of Factors influencing firewood usage among electrified households at Nkomo Village, Limpopo Province.**

WHAT IS THE PURPOSE OF THE STUDY?

I am conducting this research to find out the factors influencing the usage of firewood as a household energy source among electrified households in Nkomo Village, in the Limpopo Province.

WHY AM I BEING INVITED TO PARTICIPATE?

Why did you choose this particular person/group as participants?
The study is trying to assess the factors influencing the use of firewood in electrified households. To find this out the study needs to select the participants that are using firewood as an energy source in electrified households.

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Appendix C: Request to conduct a study

Enq: Ms Mabunda BL
Tel: 012 399 9568
Cell: 072 644 9833

35N Mayvillas
852 Paul Kruger Street
Mayville
PRETORIA
0084
04 April 2019

The Manager
Mahumani Tribal Authority
Nkomo Village
GIYANI
0826

Dear Sir/ Madam

REQUEST TO CONDUCT A RESEARCH AT NKOMO VILLAGE

I, Bongani L. Mabunda with Student Number 45110336, am currently registered for Master of Science in Environmental Management with the University of South Africa and as part of the study I need to conduct a research at Nkomo Village. The topic for my study is "EVALUATION OF FACTORS THAT INFLUENCE FIREWOOD USE AMONG ELECTRIFIED HOUSEHOLDS IN NKOMO VILLAGE, SOUTH AFRICA

In light of this, I humbly request your permission to conduct the above mentioned research at the village for the duration of my studies. The information collected during the study will only be used for academic purposes and it will not be shared with any person other than the University.

Hope you will find this in order and thanking you in advance for your swift response and assistance.

Yours faithfully

Ms. Bongani L. Mabunda

Appendix D: Permission to conduct a study

MAHUMANI TRADITIONAL COUNCIL
Nkomo-Goxani Village
P.O. Box 272
GIYANI
0826

Enq: Tsundzuka Mahumani
Tel: 015 811 6900
Cell: 072 412 9439

To: Ms Mabunda BI

APPROVAL TO CONDUCT RESEARCH TOWARDS MASTERS QUALIFICATION AT NKOMO VILLAGE.

Mahumani Traditions. Authority approves your request to conduct research towards your Master's Degree at Nkomo Village and other villages under the jurisdiction under Mahumani Traditional Authority. If you need assistance to communicate with the community members, the Induna's will be available to provide assistance.

Hoping that you will find this in orders

Kind regards

Princo: Tsundzuka Mahumani

Appendix E: Ethics approval

UNISA

UNISA-CAES HEALTH RESEARCH ETHICS COMMITTEE

Date: 18/05/2021

Dear Ms Mabunda

Decision: Ethics Approval Confirmation after First Review from 23/01/2020 to completion

NHREC Registration # : REC-170616-051
REC Reference # : 2020/CAES_HREC/001
Name : Ms BL Mabunda
Student #: 45110336

Researcher(s): Ms BL Mabunda
Bongani.mabunda@yahoo.com

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

Working title of research:

An evaluation of factors influencing firewood usage among electrified households at Nkomo Village, Limpopo Province, South Africa

Qualification: MSc Environmental Management

Thank you for the submission of your yearly progress report to the Unisa-CAES Health Research Ethics Committee for the above mentioned research. Ethics approval is confirmed to continue for the originally approved period, **subject to submission of yearly progress reports. Failure to submit the progress report will lead to withdrawal of the ethics clearance until the report has been submitted.**

The researcher is cautioned to adhere to the Unisa protocols for research during Covid-19.

Due date for next progress report: 31 May 2022

Please note the points below for further action:

1. The sample size calculation should be amended – the researcher used 7% as the margin of error which is usually not acceptable for academic research. The generally

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Appendix F: Editorial confirmation

DR MICHELLE COETZEE
(D.Phil.Theology – St Augustine's College, 2014)
AUTHORISED LANDUAGE PRACTITIONER
TRADING AS: DR MICKY'S (SA) PROFESSIONAL LANGLITCH FIXING SERVICE
(English)
45A Collins St, Brixton, 2092, RSA • Cell +27 (0)79-516-8067 • coetzee.michelle71@gmail.com

February 8 2022

Dear Bongani Mabunda

Language editing

This is to confirm that I edited your master's thesis, *An Evaluation of Factors that Influence Firewood Use in Electrified Households in Nkomo village, Limpopo,* and that I indicated the necessary grammatical corrections.

Although I took all reasonable precautions to ensure that all grammatical and stylistic corrections are indicated, you remain responsible for the final product. Therefore, please check these suggested corrections before applying them and, if possible, again perform a spell check after you have implemented them, in order to eliminate typing errors.

Please contact me if there are any queries or if I can be of further assistance.

Yours sincerely

Michelle Coetzee

Appendix G: Turn-it-in Digital Receipt

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:	Bongani L Mabunda
Assignment title:	Revision 1
Submission title:	Msc_2022_29 May 2022
File name:	Msc__2022__29_May_2022.pdf
File size:	1.65M
Page count:	120
Word count:	28,978
Character count:	158,857
Submission date:	29-May-2022 07:13PM (UTC+0200)
Submission ID:	1846497908