The Impact of solar energy on improving socio-economic livelihoods: A case of Ward 14 (Kezi) in Matobo District Zimbabwe

By

Khumbulani Lupahla (67118356)

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Supervisor: Dr M.S Motebang

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DECLARATION

Name: Khumbulani Lupahla

Student number: 67118356

Degree: MA (DEVELOPMENT STUDIES)

Exact wording of the title of the dissertation as appearing on the copies submitted for examination:

The impact of solar energy on improving socio-economic livelihoods: A case of Ward 14 (Kezi) in Matobo District Zimbabwe.

I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

_____ 6 December 2021

SIGNATURE DATE

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DEDICATION

I dedicate this work to the Almighty God who strengthened me throughout this academic journey. I also dedicate the work to my wife, my parents and my siblings who have been my support system from the beginning to the completion of this dissertation.

ABSTRACT

Access to solar energy has positively affected people worldwide; more so, the lives of women have been greatly improved, particularly in rural areas. This qualitative study deploys the comparative research approach with the aim to understand the socio-economic impact on the livelihoods of the people of Matobo District Ward 14, in Zimbabwe. The study employed the Sustainable Livelihoods Framework as the theoretical framework to contextualise the study.

Data collection was conducted through semi-structured interviews, focus group discussions and key informant interviews with selected participants through WhatsApp video and audio due to Covid-19 restrictions on physical interaction. The 30 participants in the study were selected through purposive sampling and snowball sampling approaches. Participants included councillors, village heads, health and education personnel, NGO field workers, business owners and local villagers with and without access to solar power.

The data was analysed using thematic content analysis. The findings reveal that the access to solar energy has generally improved the socio-economic livelihoods of the Matobo District Ward 14 residents. Specifically, access to solar energy had a greater positive impact on financial, physical, social and human capitals. The impact on natural capital can only be determined in the long term. The study recommended, amongst other things, the continuation of support from government and international and local NGOs. The study also recommends further solar electricity expansion to remedy the rural poverty and reduce social and economic inequality due to disproportionate access to and ownership of solar panels.

ISIFINQO

Ukuthola amandla elanga kube nomthelela omuhle kubantu emhlabeni wonke; ngaphezu kwalokho, izimpilo zabesifazane zibe ngcono kakhulu, ikakhulukazi ezindaweni zasemakhaya. Lolu cwaningo oluphathelene nesimo lusebenzisa indlela yocwaningo yokuqhathanisa ngenhloso yokuqonda umthelela wenhlalonhle-yomnotho ezimpilweni zabantu baseSigcemeni se-14 saseMatobo, eZimbabwe. Lolu cwaningo lusebenzise Uhlaka Lwezimpilo Ezisimeme njengohlaka lwethiyori ukuze luhambisane nesimo socwaningo.

Ukuqoqwa kwedatha kwenziwa ngezingxoxo ezihleliwe, izingxoxo zamaqembu okugxilwe kuwo kanye nezingxoxo zabanolwazi ababalulekile nabakhethiwe ngevidiyo ye-WhatsApp nomsindo ngenxa yemikhawulo ye-Covid-19 yokuxhumana ngokomzimba. Ababambiqhaza abangama-30 ocwaningweni bakhethwa ngokusebenzisa amasampula okuhlosiwe kanye nezindlela zokusampula zesnowball.$Abahlanganyeli bahlanganisa amakhansela, izinhloko zedolobhana, abasebenzi bezempilo nezemfundo, abasebenzi bezinhlangano Ezingekho Ngaphansi kukaHulumeni ezaziwa ngokuthi ngama-NGO, abanikazi bamabhizinisi kanye nezakhamuzi zendawo ezikwazi ukuthola noma ezingenawo amandla kagesi welanga.

Idatha yahlaziywa kusetshenziswa ukuhlaziya okuqukethwe kwetimu. Okutholakele kuveza ukuthi ukutholakala kwamandla elanga sekwenze kwaphucula impilo yenhlalakahle yezomnotho kuzakhamizi zeSigceme se-14 saseMatobo. Ikakhulukazi, ukufinyelela kumandla elanga kube nomthelela omuhle kakhulu kwezezimali, ngokomzimba, kwezenhlalakahle kanye nabantu. Umthelela emalini yemvelo unganqunywa kuphela esikhathini eside. Ucwaningo lwancoma, phakathi kwezinye izinto, ukuqhubeka kokwesekwa kukahulumeni kanye nezinhlangano ezizimele zamazwe ngamazwe nezendawo. Lolu cwaningo luphinde luncome ukunwetshwa kukagesi welanga ukuze kulungiswe ubumpofu basezindaweni zasemakhaya futhi kuncishiswe ukungalingani kwezenhlalo nezomnotho ngenxa yokungafinyeleleki okulinganiselwe kanye nobunikazi bamaphaneli elanga2$

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MANWELEDZO

U swikelela fulufulu zwo kwama nga nḓila ya vhuḓi vhathu ḽifhasini; nga yeneyo nḓila, matshilo a vhafumakadzi o khwinisea zwihulwane, nga maanḓa vhuponi ha mahayani. Ngudo iyi ya khwaḽithethivi yo dzudzanya kuitele kwa ṱhoḓiso ya mbambedzo hu na muhumbulo wa u pfesesa mveledzwa dza ikonomi ya matshilisano kha matshilo a vhathu vha Wadi 14 Tshiṱirikini tsha Matobo, Zimbambwe. Ṱhoḓisiso yo shumisa Furemiweke ya Nḓila dza u tshila dzi sa Nyeṱhi sa furemiweke ine nḓivho yoṱhe ya ngudo ya bva khayo u bveledza ngudo.

U kuvhanganya data ho itwa nga kha inthaviwu dza mbudziso dzi songo dzudzanywaho, therisano dzo sedzaho kha tshigwada na inthaviwu dza vhathu vha re na ndivho na vhadzheneli vho nangwaho nga kha odio na WhatsApp vidio zwo itiswa nga phimo ya Covid-19 ya vhukwamani. Vhadzheneli vha 30 kha ngudo vho khethwa nga kha maitele a tsumbonanguludzwa dzo sedzaho kha zwiṱaluli na tsumbonanguludzwa dza u livhiswa nga mudzheneli. Vhadzheneli hu katelwa vhakhantseḽara, magota, vhashumeli vha mutakalo na vha pfunzo, vhashumela nnḓa vha NGO, vhoramabindu na vhadzulapo vhane vha kona u swikelela fulufulu ḽa ḓuvha.

Data yo saukanywa hu tshi shumiswa musaukanyo wa u saukanya data wa khwaḽithethivi. Mawanwa o bvisela khagala uri u swikelela fulufulu ḽa ḓuvha zwo khwinisa zwihulwane ikonomi ya matshilisano kha matshilo a vhadzulapo vha Wadi 14 Tshiṱirikini tsha Matobo. Nga maanḓa, u swikelela fulufulu ḽa ḓuvha ho vha na mveledzwa dzavhuḓi kha masheleni, zwifhaṱo, matshilisano na ndeme ya ikonomi ya tshenzhemo na zwikili zwa vhashumi. Mveledzwa kha ndaka ya zwiko dzi nga tiwa lwa tshifhinga tshilapfu. Ngudo yo themendela, vhukati ha zwinzhi, u bvela phanḓa na u tikedza u bva kha muvhuso na dzi NGO dzapo kana dza muvhuso. Ngudo yo dovha ya themendela nyengedzedzo i yaho phanḓa ya fulufulu ḽa ḓuvha sa khakhululo ya vhushai ha vhuponi ha mahayani na u fhungudza u sa lingana kha matshilisano na ikonomi zwi tshi itiswa nga u sa swikelela u lingana kha na u vha na soḽaphaneḽe.

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LIST OF ABREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
COVID19	Corona Virus Disease 2019
CSP	Concentrating Solar Photovoltaic
DSTV	Digital Satellite Television
EGP	Enel Green Power
EP	Energy Poverty
GDP	Gross Domestic Product
GWH	Gigawatt Hours
HD	High Definition
HIV	Human Immunodeficiency Virus
IGA	Income Generating Activities
KWL	Kilowatt Hours
MMR	Mixed Methods Research
MW	Megawatts
PA	Public Address System
PV	Photovoltaic
REA	Rural Electrification Agency
REF	Rural Electrification Fund
SDGs	Sustainable Development Goals
SLF	Sustainable Livelihoods Framework
SSA	Sub Saharan Africa
UN	United Nations
UNDP	United National Development Program
UNEP	United Nations Environmental Program
UNICEF	United Nations Children’s Fund
WHO	World Health Organisation

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

National economic well-being is to some extent determined by availability and access to energy by its citizens as it is requisite for human development (WEC 2008). In light of this, this research is focused on understanding how solar energy impacts the socio-economic livelihoods of residents of Ward 14 of Matobo district (Kezi) in Zimbabwe. Rural electrification is considered to be an important development indicator in developing economies. A study of 11 countries by the World Bank (2013) showed improvements in health as people move from biomass-based energy to clean energy due to a reduction in indoor pollution. Karekezi and Sihag (2004) argued that education and health conditions in rural areas cannot be sufficiently improved without provision and access to power. According, to Kaplin (2007) persistent exposure to fumes from paraffin lamps and candles can lead to mental problems and other health challenges in both children and adults. In Matobo, as in many rural areas school children do their school work during the day due to lack of reliable and adequate lighting at night. Access to electricity at night is likely to improve students' performance as they have more time studying. Rural electrification has potential to significantly improve socio-economic conditions of rural communities.

The project implemented by Rural Electrification Agency (REA) in Zimbabwe is broad and tackles several issues affecting communities in rural areas, such as health, food security, water and sanitation, education and other rural livelihoods. This project aims to electrify schools, business centres and clinics including irrigation schemes in disadvantaged communities. This research study, therefore, seeks to measure the benefits that have accrued to individuals and communities as a result of access to solar energy and the persistent challenges still being faced by those households who are still without access to solar energy.

1.2 Background to the problem

The REA is a government parastatal whose mission is to empower rural communities of Zimbabwe through provision of sustainable modern energy services. The REA envisions rural communities with access to power through the installation of solar panel grids. In line with this vision, the solar electrification agency has embarked on the electrification of Matobo district with a target to install 21 solar panels in the district (Mangena 2014:69-76) to remedy the problems resulting from the lack of energy. This assessment investigates the contributions made thus far to improve livelihoods within the households and community at large while unearthing any bottlenecks encountered and the consequences thereof (REA ECP Report 2020).

1.3 Statement of the Problem

Poor provision of services has been a prevalent in Zimbabwe for a prolonged period of time and has hampered the economic growth of the nation. Communities in remote areas have especially been the most affected with little to no development activities and opportunities. This includes limited and lack of access to power for both domestic and commercial use in communal areas. However, the REA initiative is set to remedy the situation. According to Creswell (2017) the solar electrification program will target 1,237 institutions, such as schools, rural clinics, community business centers, government extension offices, smallholder irrigation schemes, and other government departments. The provision of renewable energy is in response to the poor living conditions that are especially affecting people living in the rural communities (Creswell, 2017). The REA initiative has already made significant contributions to improving access to solar power in some communities, including in Matobo ward 14.

This research aims to examine the impact of solar energy on rural livelihoods in the selected study area. It also seeks to explain the various effects of solar electrification on social and economic aspects of the community including impact on education and health. I hypothesize that; if rural households and communities at large are without the provision

of modern energy services, this will not only negatively affect their quality of life but also impede sustainable livelihood improvement opportunities/assets. Access to modern energy (solar energy) greatly improves the sustainability of their livelihoods leading to better and ultimately good quality of life. This study therefore seeks to demonstrate the spectrum of benefits that can accrue to rural communities through enhanced access to solar power and how this contributes to rural and community development.

1.4 Importance of the study

Rural Electrification Agency currently operates in 20 wards in Matobo District and so far it has implemented its program in 16 wards. The government parastatal covers clinics, schools and business centers, such as Bhazha, Natisa, Kezi, Sontala, Mbembeswana, St Josephs, Tshelanyemba, Sankonjane, Beula, Sigangatsha, Zwehamba, Ndabankulu, Silawa, Tudi 1&2, Mabonyane, Lingwe, and Gohole. As these communities have been exposed to solar energy largely at public institutional level, households have embarked on self-funded endeavors to purchase solar panel systems for mere basic amenities and commercial purposes in some instances. This research adds to the body of knowledge on the benefits of solar energy among rural residents at household and community level. In so doing the study demonstrates the linkages between the provision of solar power and access to social services such as health and education. The study also highlights how energy is integral to entrepreneurship and social and economic development in rural communities. Overall, the study provides insight into the typology of assets created as a result of access to solar power through the application of the Sustainable Livelihoods Framework.

1.5 Research objectives

This aim of the study is to evaluate the socio-economic impact of solar energy on the livelihoods of people (household and community level) living in Ward 14 Matobo district.

The specific objectives of the study are:

1. To establish the general living conditions of the households before acquiring the solar panel system
2. To examine the challenges faced by residents without solar panel system
3. To establish sustainable livelihood improvement opportunities/assets created as a result of solar energy access

1.5.1 Key research questions

The study will be guided by the following research questions:

1. How were the general living conditions of the households before acquiring the solar panel system?
2. What are the challenges faced by residents without solar panel systems?
3. What sustainable livelihood improvement opportunities/assets are created as a result of solar energy access?

The answers to these questions will thus provide the desired information regarding the extent to which solar energy enhances livelihoods of the people in Matobo district.

1.6 Area of Study

Matobo district is located in Matabeleland South province of Zimbabwe. There are thirty primary and 9 secondary schools in the district. Four of the secondary schools offer Advanced level education. There one district hospital and three clinics in Matobo South. Most NGOs in the constituency focus on the field of humanitarian and poverty alleviation and HIV/AIDS programs. Matobo is characterized by drought and chronic food shortages with high levels of poverty, especially among female-headed households (World Vision International 2010; ZIMVAC, 2010). The majority of the households in Matobo depend on rain fed agriculture crop farming and livestock with unreliable and erratic rainfall patterns contributing to increased incidences of poverty and malnutrition.

The variability in climatic conditions across Southern Africa puts livelihoods at risk in rural communities dependent on rain fed agriculture. Rainfall variability ranges between 30%

and 35% which makes dry land farming unsustainable (Chibisa *et al.*, 2010). From early in the implementation of the land reform access to basic needs such as drinking water, sanitation facilities, shops, schools, and medical facilities was limited, especially in rural and resettlement areas. The program did not include access to energy hence the need to examine the outcomes related to the rural electrification programs and other public and private electrification efforts. Achieving effective energy provision in Matobo ward 14 will aid the process of ensuring that most households have access to the basic needs mentioned above.

1.7 Limitations of the study

1.7.1 Mobilisation of research participants

The research was conducted through the use of technological communications devices: smartphones with audio and video recording software. Initially a cellphone from one of the participants was secured before commencing data collection. A problem was encountered and I had to provide a smart cellphone and sufficient data at the last minute as the smartphone I had secured through one of the participants had been damaged beyond repair. I was however able to provide an alternative to carry on with the research process which went well. The major lesson learnt through the process is that, the use of one smartphone to conduct focus group discussion is more efficient when coupled with a PA sound system that loops the cellphone to an amplifier to get the conversations or interview audible through a speaker. Additionally a condenser microphone should be added to the PA system to enable audibility of the participants without having to handle or pass the microphone around as it captures people as they speak from their sitting position. This is problematic as silence is required when another speaks since the condenser microphone picks up all sounds in the room as in a recording studio. This is an affordable yet efficient method of data collection.

Some participants lamented fears of leaving their homes as the police would arrest them since Zimbabwe was under Lockdown Level 4 at the time of the research. In addition, many of the elderly participants cited fears of contracting the virus as their age made them

more susceptible to infection. This is the limitation caused by using smartphones where the respondents had to report to a venue where the gadget was setup for easy access and control. However, all this was averted. Covid19 regulation compliance was observed through the joint efforts of the councilor, district administrator and NGO representatives in ward 14.

1.7.2 Gathering the focus group members

The COVID19 lockdown also made it difficult to gather people in one venue so as to conduct the focus group discussions. However, with assistance from the Councillor the venue was secured where screening and sanitisation of the required participants took place and the sitting arrangement was according to the social distance stipulations.

CHAPTER 2: RESEARCH METHODOLOGY

2.1 Introduction

This chapter discusses the research methodology followed in gathering data for the study. The study population, sample and sampling techniques used to identify and select research participants are discussed. The data collection instruments, data source, data collection methods used in this study are also presented. This chapter also discusses how the data was analyzed and highlights the ethical considerations that were observed during the research.

2.2 Research design

Bryman (2012) defines research design as a strategy to outline how data will be gathered and analysed in a study. Yin (2003) further suggests that a research design links the research questions to the data to be collected and conclusions made. This research adopted a comparative research design. A comparative study is a kind of method that analyzes phenomena and then put them together to find the points of differentiation and similarity (Esser & Vliegenthart 2017). This design enabled the researcher to examine the differences in livelihoods of people in Matobo district with access to solar power energy and those without. The study is also adopted a qualitative approach by gathering data for the study through in-depth interviews and focus group discussions guided by interview guides with open-ended questions.

The subjective nature of qualitative research allowed participants to express their opinions based on their own experiences. This attribute enabled the researcher to effectively measure impact on livelihoods based on respondents' experiences, feelings, and attitudes. According to Creswell (2014), qualitative research enables the researcher to acquire gain knowledge based on the participants' experiences; hence, my adoption of in-depth interviews to gather such information.

2.3 Population Sample

Burns and Grove (2009), states that researchers sample populations by selecting a group of respondents from a population to give you the type of information needed. According to Burns and Grove (2009), purposive sampling is a method of subjectively choosing individuals based on specific criteria. This study adopted the purposive sampling method to identify households that could provide information on the relationship between energy provision and poverty reduction on livelihoods. In this study, Councilors, village heads, health/education personnel, NGO field workers, business people/residents using solar power for commercial purposes and few villagers with and those without access to solar energy systems were chosen to participate.

2.3.1 Sample frame

A sample frame refers to a list of all elements or individuals in a group who could be selected for the study (Wheeldon & Ahiberg 2012:59). The sample frame is intended to ensure that the sample structure is satisfactorily comprehensive and accurate by including all groups of individuals who make up the target population (Currivan, 2011). In light of this, the researcher accounted for all requisite components (residents with solar access, residents without solar access) to ensure that the research results are representative of Ward 14's socio-economic experiences resulting from use of solar energy.

2.3.2 Sampling Techniques

Participants for in-depth interviews were selected through snowball sampling based on referrals by other community members. The researcher had to first identify the first household with the assistance of the Councillor. Thereafter, the researcher was referred to potential participants by other participants. The researcher reached up to 12 villagers and subjectively decided on the adequacy of the sample size. The snowball sampling

approach was preferred as it is less time-consuming as participants immediately suggested other potential participants and the process continues. Purposive sampling was used based on the researcher's judgement and insights from community leaders to obtain the participants who would be able to provide sufficient information to enrich the study. The teachers, nurses, village heads, lead farmers and entrepreneurs were all sampled using the purposive sampling approach. Purposive sampling is frequently used in social sciences and in studies where results are not intended to be generalized across a large population.

2.3.3 Sample Size

The sample size comprised 30 participants inclusive of; Councilors, village heads, health and education personnel, NGO field workers, business people/residents using solar power for commercial purposes and villagers with and those without access to solar energy systems. The sample composition and size is shown in Table 2.1 below.

Table 2:1: Study sample

Population group	**Number of Participants**
Villagers	12
Entrepreneurs	5
Lead Farmers	5
Key informants	
Local leadership	4
Nurses	2
Teachers	2
Total	30

Channels (1985:106) indicates that sample size is used to determine the number of individuals to include in sample for it to be considered representative. While representativeness is necessary in quantitative studies, in qualitative studies sample size

varies from across studies and is influenced by the nature of each study. The sample size was sufficient to cover the various groups in the community and large enough to gather adequate data to answer the research questions.

2.4 Data-Gathering Procedures

Primary data was gathered from through in-depth interviews and focus groups. English and IsiNdebele were used interchangeably according to the participants' preferences to ensure that they responded freely and accurately without any language barriers hindering effective response. Focus groups discussions were conducted with Councillors, village heads and selected villagers. Key informants in this study include Councillors, village heads, business operators, villagers, health and education personnel and NGO. Qualitative research studies use such techniques observations, interviews and case studies to gather data about a specific phenomenon (Taylor, 2005:240). The researcher used these techniques in order to gather as much information about the res, thus these procedures were highly effective in achieving the research objective. As a result of the COVID 19 pandemic and restrictions on activities; all data collection methods were conducted telephonically as well as virtually through the WhatsApp group and video calling platform. Matobo district among many other rural settings in Zimbabwe has access to cellular phone reception and internet connectivity. The targeted participants that took part in the research were known to the researcher and had access to a smartphone to access WhatsApp and take part in the telephonic interviews. The researcher provided a mini-PA system to connect the smartphone to enhance focus group discussion audibility. Sufficient data bundles were made available for all my participants through the local service provider facility for sending airtime and data to networks outside South Africa. The mobile phone used by the researcher has a call recording application installed to enable all conversations to be recorded and safely stored. Thereafter all recordings were moved to a password protected laptop as well as external cloud storage to keep the information safe and confidential.

2.4.1 Data Gathering Instruments

Primary data was gathered from individuals through audio-recorded telephone interviews guided by semi-structured interview guides. Data from focus groups was gathered through WhatsApp group video interviews. These video calls and voice call interviews facilitated the sharing of experiences, perceptions, emotions with the researcher. The researcher and the participants created rapport that led to a free flow of in-depth information that addresses the issues of concern (Roller & Lavrakas 2015:58).

Councillors, village heads, business operators, villagers, health and education personnel and NGO partners were the main participants from whom the researcher gathered relevant information in response to the research questions. A calendar and a pocket diary in addition to the digital time and date stamp signatures that come with the call recording application were used for the dates and times of the meetings with individuals and group meetings. These assisted in monitoring the estimated time frame for data gathering and coding of respondent's recordings (Belli, Stafford & Alwin 2009:16).

2.4.1.1 Face to Face interviews

The research participants consisted of 16 elderly women aged between 40 and 70 and 9 women and 6 men aged between 23 and 60 years. It was difficult for the elderly to use phones without assistance. For those that agreed to meet at a scheduled venue a phone was looped onto an in-house PA system to prevent handling the phone by many people. Most of those who responded lamented fears of leaving their homes as the police would arrest them since Zimbabwe was under Lockdown Level 4 at the time of the research. In addition, many of the elderly respondents cited fears of contracting the virus as their age made them more susceptible to infection. However, all this was averted and a way forward comfortable for the respondents and COVID compliant was implemented through the joint efforts of the Councillor, district administrator and NGO representatives in ward 14.

2.4.1.2 Focus Groups discussions

The focus group discussion was conducted in a similar manner as the individual interviews using the semi-structured guiding questions. A virtual WhatsApp video call facility using one smartphone connected to a high definition (HD) webcam to cover visibility all group participants was used to facilitate the discussion. The focus group was conducted to gain an understanding of the perceptions of participants regarding the impact of solar energy on the socio-economic livelihoods of households and residents of Matobo District ward 14.

According to Onwuegbuzie *et al*. (2009:3) the effectiveness of focus groups can be enhanced by addressing various aspects, such as optimal group size (between 6 and 16 participants) and allocating adequate time for discussions. In addition, the group should be set in an environment and arranged in a manner that allows spontaneous sharing of ideas, opinions and beliefs (Onwuegbuzie *et al*. 2009:3).

For the purpose of this study, a total of eight (8) men and women constituted the focus group discussion. The venue was conducive and the weather was favorable to conduct effective discussions with the participants. The COVID-induced lockdown made it difficult to have the focus group discussions as gatherings were prohibited. However, through the councilor the venue was secured where screening and sanitization of the required participants took place and the sitting arrangement was according to the social distance stipulations.

2.4.1.3 Key Informants and Secondary data

Data for the study was also obtained through key informant interviews with the Councilor, 3 village heads, 2 nurses and 5 teachers. The guiding semi-structured questions from the study made it possible to obtain the data that was relevant to have a deep insight into the socio-economic livelihoods of the study participants. These participants also provided

records and documents on relevant issues, such as, Rural Electrification Agency (REA) projects reports.

According to the key informant interviews, most households had their solar systems installed through the state-funded initiative. However, there were concerns that most of those who benefited from the initiative were affiliated to the ruling party. Therefore, securing willing respondents among the villagers to speak to this assertion was a challenge as they were not generally willing to discuss how they acquired the solar panels. However, responses from other participants, (particularly those without the solar systems in their homes) were sincere although indicative of the biased system/process of solar distribution as it favored those politically affiliated to the ruling party (perhaps as an incentive for loyalty) while those from the opposition parties were left out of the solar allocation list. Business people were also reluctant to express the extent of the benefits accrued as a result of accessing solar energy. However, they were rather willing to share regarding the challenges they faced before they had access to the solar panels.

The study also relied on secondary data to answer the research questions. The advantages of secondary data are that it is already available and can be easily accessible to researchers (Berg 2001:258). Furthermore, secondary data eliminates the challenges associated with interacting with participants during data collection more especially during the COVID19 restrictions. The downside of secondary data is around its relevance or availability in the format desired by the researcher and suitability for the study (Berg, 2001:108). According to Dey (2005:105), the selection and choice of the sources of secondary data should be guided by the study problem statement. Secondary data was used as background information as well as to augment and validate primary data collected for the study.

2.4.2 Data Sources

Both primary and secondary data was collected for the study to acquire an in-depth understanding of the socio-economic livelihoods of households and community members

in Matobo District ward 14. The collection of primary data was through WhatsApp video interviews and telephonic calls with individual participants mostly women and key informants and through focus groups discussions with a group of selected men and women. The process of data collection aided the researcher to acquire information directly from the participants and enriched the data analysis and interpretation process.

Secondary data was obtained from documents and reports on the work the Rural Electrification Agency in Matobo and other parts of the province. Secondary data refers to data already in the public domain (Bhattacherjee, 2012:39). In the event that the cost of gathering primary data is prohibitive, secondary data may be equally useful if available to suitably answer the researcher's questions (Bhattacherjee, 2012:39). It was fundamental for the researcher to obtain information as it would provide more answers for the research questions.

2.4.3 Data Analysis Method

According to Harding (2013:9), qualitative data analysis consists of cutting data up to put it together again in a manner that seems relevant and meaningful to describe a phenomenon and what it means. Furthermore, Saldana (2013:58), indicate that coding is the arrangement of things in a systematic order or to make something part of a system or classification. In other words, coding is a method that enables researchers to group data that share the same characteristics. Qualitative analysis involves labeling and coding of all data so that similarities and differences can be recognized. Thus, the data gathered was analysed through thematic analysis and coded to come up with concepts and themes presented in Chapter 4.

2.4.4 Validity and Reliability

Validity and reliability are the commonly used measures of quality of social research. Although mostly associated with the positivist approach in quantitative research, these measures are also used in qualitative research (Golafshan 2003). However, other

researchers choose to focus on trustworthiness and authenticity to assess the rigour in qualitative research. In this study, validity and reliability measures were used to determine the credibility of the study. Validity refers to how closely a construct or indicator measures a theory/concept it was intended to measure (Bryman, 2012). Therefore, validity focuses more on the extent to which data analysis and interpretation is accurate. The research measured the intended constructs through triangulation and gathering information from multiple participants using different methods. Validity of the study was enhanced through ensuring that the interview guide was comprehensive and asked the appropriate questions. The interview guides and focus group discussion guides were designed by the researcher and were reviewed and approved by the academic supervisor. The analysis method was also cleared in consultation with the supervisor. Furthermore, the researcher engaged in rigorous analysis in order to produce credible results.

Reliability refers to the acquisition of the same results by a researcher in a new study having used the same instruments and procedures used by another researcher in a previous study (Yin 2014). Therefore, reliability indicates consistence of results in research where similar instruments have been deployed. Reliability requires transparency from the researcher. To fulfill this requirement, the researcher transcribed all the procedures of this study in detail to aid other researchers to make use of it and compare their results to those from this study. Notably, the detailing of the sampling of research participants and the conduct of the researcher in performing interviews and facilitating focus group discussions provided adequate guidance to other researchers who might want to conduct similar studies in other localities under similar contexts. It is therefore noted that due to dynamic times it may be impossible or difficult to acquire similar results as those from this research regardless of the detailed written/recorded procedures. The context in the research site may change by the time another researcher carries out similar research. Social, economic and political factors can influence the context. Currently, Covid19 is a major factor that could change the local context.

2.5 Ethical Considerations

Mouton (2001:276) argues that analysts should act competently and be answerable to the people when leading research. Terre Blanche *et al.* (2006), indicate four broadly settled philosophical rules that ought to be connected to research to guarantee that it is moral, independent and regard for the respect of people; no wrathfulness; value and equity which have turned out to be known as "principalism". Therefore the researcher was guided by principalism as it stipulated and guided on when and how to obtain informed consent as well as how much information should be disclosed while maintaining confidentiality. This made the researcher aware and sensitive to the rights of the research participants that include privacy, anonymity, confidentiality, voluntary participation and the right to withdraw, informed consent and the right to not be harmed (Filippa 2011). The ethical concerns of the proposed study were genuinely regarded as the research involved human participation, more so, the research environment has residents and leadership that are affiliated to different political parties which could have endangered the lives of the respondents had this information leaked.

2.5.1 Privacy

I know and understand that privacy is about the participants and their right to be protected during and after the research study. Other than the requirements of the participants taking part in this study, I did not invade their privacy. In this study, I considered how to obtain data from and about prospective participants, for instance, the correct tool to use to collect data. Since privacy is for the participants, this study considered approaches that protected and ensured the safety of the participants and access to their private data.

2.5.2 Anonymity and Confidentiality

This study thoroughly safeguarded the identities of the participants and their responses from public access. To ensure anonymity, the researcher used pseudonyms and code names for the participants and their locations. The confidentiality of data collected and how it was handled was of paramount importance as this gave the participants confidence in the researcher and the research. Through a mini clip the researchers educated the research participants of precautionary measures that were to be taken to ensure the

privacy of their data and were informed concerning who would have access it other than the researcher. Confidentiality is an augmentation of security and is about recognizable information and its preservation. It is about who has access to this identifiable data so that the research participants are not left vulnerable but adequately protected from being recognised as research partakers. Secrecy was guaranteed through the interpretation of information completed by the researcher (Terre Blanche 2006).

2.5.3 Voluntary Participation and the Right to Withdraw

The researcher informed participants of that participation was voluntary prior to commencing the interviews. Furthermore, the researcher informed participants of their right to withdraw from the interview without any negative repercussions on them. It was emphasized that this was their right and they should not be under any pressure to answer any questions if they did not feel comfortable. Thus, all responses participated in the study willingly and with full awareness of their rights.

2.5.4 Informed Consent

The researcher gave participants adequate information relating to the research to enable them to make an informed decision to participate or otherwise. The research participants signed consent forms before commencing interviews and focus group discussions.

2.5.5 Do not harm

This necessitates that no mischief will be done to the participants either specifically or in a roundabout way as an outcome of this research. All members of the community under study as well as public institution personnel were protected from any harm throughout my research. They were not subjected to any direct physical and emotional harm for the duration of the study. This study also guaranteed that no participant was placed in any form of risk by adhering to research ethics.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

This chapter presents a review of literature on energy and how it is linked to socio-economic development. The review will also focus on the Zimbabwean energy context in order to give background to the study. The chapter details the Sustainable Livelihoods Framework (SLF) chosen to guide the collection and analysis of the data gather for the research.

3.1.1 Understanding energy and development

Access to energy is pivotal in eradicating poverty, employment creation and promoting better standards of living, although it is not the sole catalyst for economic development (IIASA 2012). Furthermore, access to energy promotes the attainment of the Sustainable Development Goals (SDGs) related to poverty alleviation, health, education, communication services, gender equality and productivity (UNIDO 2011). Figure 3.1, below, illustrates the relationship between energy and development, particularly relating to the SDGs.

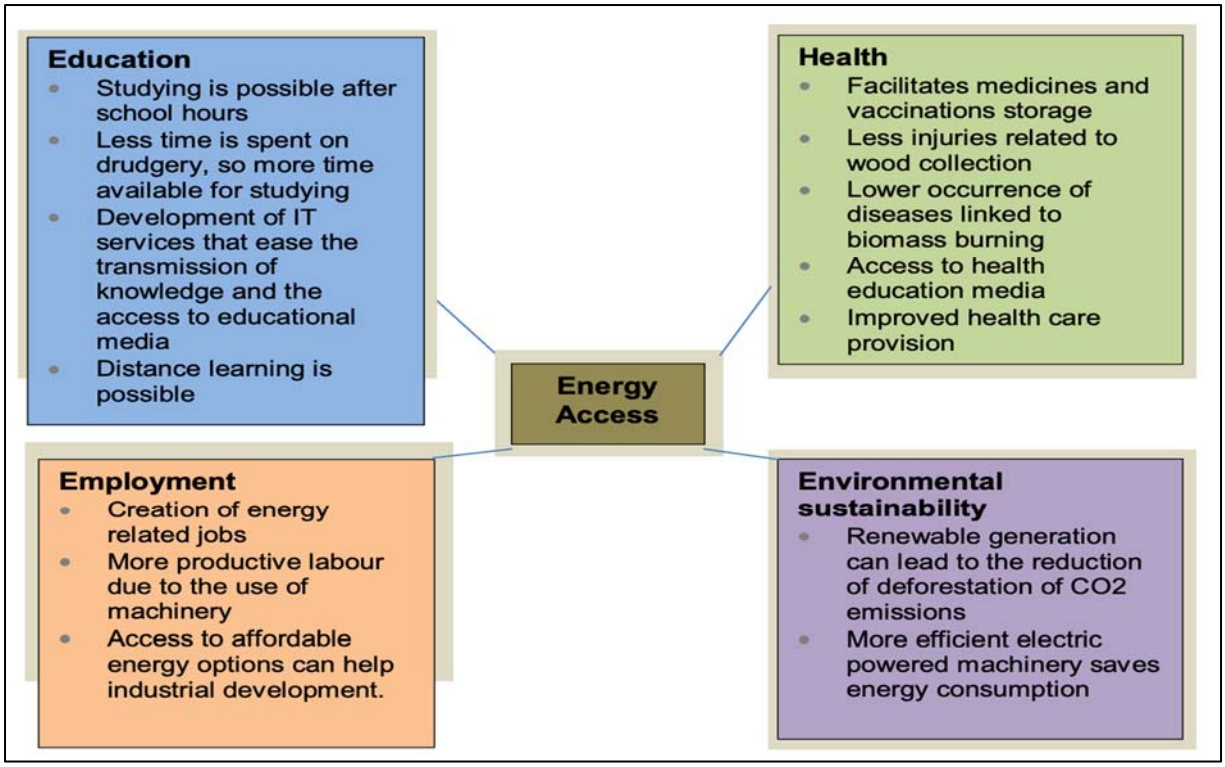

Figure 3.1: The impact of energy on development goals

Source: IIASA (2012)

3.2 Energy in the context of Zimbabwe

Zimbabwe is dependent on hydroelectric power generated from Kariba Dam on the Zambezi River. However, the majority of people in rural Zimbabwe depend on wood-fuel and kerosene (commonly known as paraffin) for cooking and lighting (World Factbook Zimbabwe, 2010). According to The Zimbabwe (2010), the task of processing food, such as milling and grinding, is widely carried out through the use of diesel-powered machinery. Additionally, it postulates that of the 7,900 gigawatt hours (Gwh) of electricity generated in 2009, 53% was produced from renewable sources. Electricity consumption per capita in 2009 stood at 1,022-kilowatt hours (kWh) of which 33.9% was installed capacity was from hydroelectric plants.

According to an article by The Herald (2019), in April 2018, the Rural Electrification Fund (REF) in Zimbabwe announced an initiative to electrify all public institutions, such as

government extension offices, schools and clinics at no charge. The REF only required these public institutions to pay for the internal wiring and connection fees. The REF subsidized the connection fees for schools but also indicated that they were required to pay for the internal wiring of administration block, science laboratories and computer laboratories. Since 2002, the REF has electrified 2 699 primary schools, 1 359 secondary schools, 1175 villages, 952 business centres, 874 rural health centres, 774 small scale farms, 411 government extension offices, 244 chiefs' households, , , and 803 other public institutions (The Herald, 2019).

According to Ndlhovu (2019), the Zimbabwe government made significant effort to promote the provision and access to solar energy in the country. Such efforts included the removal of import duties solar batteries and other solar-related products and mandating new buildings to make provisions for solar installation. The Zimbabwean government aims to produce 1575 MW of power from solar by 2030. Ndlhovu (1029) adds that the government also rolled out innovation mechanisms such as net metering and feed-in tariff for clean energy to enable Independent Power Producers (IPP) to add their excess electricity to the national grid; the latter initiative is what has led to this research as provision of energy is no longer the sole mandate of the government and also the fact that clean energy sources have become the answer to assist the nation and mostly individual homes and communities to improve their livelihoods through the use of solar energy.

Energy supply is a major problem in Zimbabwe with current production levels failing to meet current levels of demand and consumption. With one hydropower plant and four thermal generators producing a combined output of 2,240 megawatts (MW), only 40% of the population has access to electricity (Ishioma 2020). As a result, the majority of the population continues to rely on firewood resulting in deforestation, especially in rural communities.

The use of thermal power stations to generate electricity adds to greenhouse gas emissions in Zimbabwe including fugitive emissions from coal mining processes.

However, Zimbabwe has committed to promote clean energy as part of its response to climate change (Zimbabwe National Climate Change Strategy, 2015).

3.2.1 The energy mix in Zimbabwe

Zimbabwe has a well-developed electricity supply grid comprising hydroelectricity, coal and renewable sources. Since 1980, the Zimbabwean government has made efforts to extend access to electricity to rural businesses and government administrative areas.

3.2.1.1 Wood-fuel

Wood fuel is the most important prominent fuel for domestic fuel use in Zimbabwe. In 2001 it was estimated that wood fuel accounted for about 50% of the total consumption (UNEP Report 2001). This has come with huge environmental costs such as extensive erosion and diminishing wildlife populations due to habit destruction through deforestation.

3.2.1.2 Coal

There are 21 known coal deposits with about 30 billion tons of reserves in Zimbabwe. These reserves are estimated to last for over 100 years. Although the government has made commitments to promote clean energy it continues to support initiatives that use coal to generate power. For example, the government supported a project initiated by China Africa Sunlight Energy, a Chinese backed company to construct a 600 MW thermal power plant in the country (Reuters, 2013).

3.2.1.3 Liquid fuels

There are no known oil or gas reserves in Zimbabwe and the country depends on oil and gas imports (World Bank Factbook, 2010). The bulk of refined oil and diesel used in

Zimbabwe is imported from the Beira in Mozambique and South Africa (The Zimbabwe, 2010).

3.2.1.4 Hydro and Micro-hydro

Kariba Dam power station is the major source of hydropower in Zimbabwe with potential to generate additional power along the Zambezi River. To date only about 3, 500 GWh has been harnessed for utilization (African Energy Commission 2012). Zimbabwe has also potential to generate up to 120MW from small hydropower plans. Currently, the 8 installed small hydropower plants generate between 3 kW to over 700 kW with plans to add another 5MW Gairezi River, in Nyanga district, is estimated to have 30 MW of potential capacity making it a promising source of hydropower.

3.2.1.5 Solar electricity

According to UNEP (2012) solar power presents opportunities for both small scale and industrial production. However, under the current economic climate, there are fewer incentives for large scale investments including construction of solar power plants. There is a general shortage of capital and reluctance by developed economies to engage in technology transfers to developing countries. The solar power industry in Zimbabwe is however thriving with several companies providing solar energy solutions for domestic and commercial enterprises. Currently, Kefalos cheese factory has the largest PV power system of about 600 kWp (Fidelis, 2019). There is potential for construction of what could be the largest solar power (2000 MW) plant in the world if the project by government in partnership with the United Arab Emirates is successful.

3.2.1.6 Wind power

Another source of clean energy for Zimbabwe could be wind turbine farms. This form of energy will definitely comply with the current SDGs (UNDP 2015).

3.3 Factors affecting access to energy

There are various factors that determine access to energy ranging from, affordability, marital status, household size and employment status (Leeds, 2016).

3.3.1 Income

The income of a household is a major factor determining access to energy at household level (Zaakirah & Khembo 2015) with Woldeamanuel (2017) stressing that households with high incomes are likely to have energy security compared to households with low incomes. This is because the average cost per unit of electricity is $4.50 and an average family requires a minimum of 50 units for approximately 1 week. However, the average household income in rural areas is $75 (The Herald 2021) and that makes access to electricity prohibitive for most rural households. Therefore, most rural households in Zimbabwe rely on wood collected from forests on communal land.

Employment status of household members influences their access to energy as households with members that are employment are likely to afford clean reliable energy. On the other hand, households comprising of members who are unemployed are likely to rely on cheaper and alternative sources of energy, such as firewood (Gerbery and Richards, 2014). Employment status determines household income and as well as the type of energy a household is likely to afford. This is the situation in most rural communities including Matobo District ward 14.

3.3.2 Marital Status

Being married, unmarried or widowed also determines a household's access to energy. For instance, a household with a married couple is more likely to have energy security than a household with a single person (The Zimbabwe 2010). This results from the couple combining their income when purchasing energy also enabling them to share other household expenses (Ibid). However, Tchereni *et al*. (2013) postulate that where some

married couples still have low income after combining their wages/salaries and more household expenses access to energy is disrupted. The authors also add that despite the effect of low income, marriage status could yield positive results regarding to access to firewood in rural areas as this means that there are more people to collect firewood.

3.3.3 Household size

According to Woldeamanuel (2017) the size of a household could be a determining factor for access to energy given that the more the people in a household the greater the odds of distributing the available income to cater for everyone's needs. Furthermore, the more people there are in the household the higher the likelihood of having sufficient labour required to gather and collect firewood.

3.3.4 Age

The age of the household head is a common factor that determines access to energy in rural areas (Jessel *et al*., 2019). Elderly households heads are more likely to be energy insecure than their younger counterparts. As the household head advances in age, they tend to opt for unclean energy sources which lead to energy insecurity (Abebaw 2007).

3.4 The benefits of solar power

According to the World Bank (2015) report, estimates show that demand for energy is expected to increase by about 60% by 2030. In this context, the need to expand solar electrification programs becomes urgent. Renewable energy can improve energy security by reducing reliance on grid expansion initiatives and volatility of fossil fuel prices. Furthermore, renewable energy can support productive activities while contributing towards electricity portfolio diversification.

3.4.1 Economic benefits

Renewable energy industries are a significant source of employment with currently over 5 million jobs. It is estimated that investments in renewable energy is likely to increase jobs by 3-5% by 2050 (UNEP Report 2011). Therefore, job creation and the introduction of new innovative technologies to potentially attract investment and new areas of technical expertise can be an additional positive outcome.

Heggie (2017) states that Africa has potential to generate off-grid renewable energy through solar power. The costs associated with installing the solar panels continue to drop and in the last decade they have dropped by 80 percent. Solar energy offers medical facilities reliable low-cost and independent sources of electricity in the remote rural areas.

3.4.2 Environmental benefits

In general, most people in developing countries cannot afford modern fuels and energy efficiency technologies (Norman 2011). The use of renewable energy will most likely reduce air pollution. According to the United Nations Secretary General's Report, climate change is a major threat to food and water security globally, especially for rural households in developing countries. As a basic human right, access to reliable and affordable energy should be promoted to ensure social and economic stability. Furthermore, strategies for providing access to sustainable energy ought to contribute towards economic growth and environmental sustainability for future generations.

According to UNICEF (2016), mini-grid systems to electrify small villages and sparsely populated communities have become popular. Off-grid solutions are a cheaper alternative to grid expansion and also sustainable. Besides, there are investment opportunities in the “green" energy sectors with potential to create more jobs.

The United Nations General Assembly declared 2012 the International Year of Sustainable Energy for All in recognition of the role played by solar energy in rural development. The focus was on increasing access to solar panels and clean energy

technologies in order to promote sustainable development. This message has been taken up in most regions and countries across the globe with effort to scale up energy access intensifying.

3.4.3 Health benefits of solar

Access to electricity is increasingly driving provision of healthcare in Africa where energy tends to be inaccessible and unreliable (Heggie 2017). In high income countries, hospitals consume a lot of energy to power medical equipment as well as to supply lighting, heating and ventilation. On the contrary, in Africa hospitals and clinics lack access to electricity. This creates numerous problems including inability to use essential medical equipment and spoiling of medicines due to poor storage conditions. This has led to limited opening hours for clinics as well reduced potential to deliver adequate healthcare to the communities.

A case in point is that of the project initiated by Enel Green Power (EGP) in Wolisso Ethiopia. According to the EGP report (2019) St. Luke hospital in Wolisso Ethiopia, despite catering for over a million patients endured perennial power outages. As a result, EGP had to build an innovative solar hybrid system which produces about 320 kWh of electricity to ensure that the hospital has access to uninterrupted electricity supply. This initiative has led to approximately 79,000 outpatient visits, 15,000 hospitalizations and 4,000 births annually. Moreover; this has enabled the hospital to save costs and thereby allowing for the channeling resources to other healthcare programs.

For Ethiopia, as for all of Africa access to modern healthcare depends on availability of electricity. Therefore, Matobo as a growing rural community among several other African rural communities is realizing the need for solar energy to promote good health as is the case in Wolisso Ethiopia.

The use of coal and firewood at household level has negative health effects. For instance, the risk of pneumonia has been reported to increase by 80% when cooking using biomass

compared to the use of electric stoves for cooking (Kohlin *et al*., 2011, 23). More so, other medical conditions such as heart disease, stroke, lung cancer and chronic obstructive pulmonary disease have been known to be caused by indoor pollution from the use of biomass (WHO 2018). Women are traditionally ascribed domestic roles including cooking which exposes them directly to this pollution. Therefore, access to electric stoves can contribute towards the improvement of the health of women, especially in rural communities.

Furthermore, at community level, powering health clinics can yield positive effects on women's wellbeing and maternal health (IBRD 2017:3). In a study conducted by Essendi *et al.* (2015:6-7), mothers, their partners and healthcare workers stated that lack of access to electricity was the major threat to the delivery of health services, such as safe storage of medicines, safe delivery of babies and the functioning of resuscitative and newborn care services. The findings reveal that the provision of sustainable solar electricity to health institutions has a positive impact on maternal health and infant care.

3.4.4 Solar energy benefits for Women

Energy prosperity is one of the requirements in Africa as it seeks to improve access to energy in peripheral places in an effort to improve people's lives (Pact 2020). Misra (undated) maintains that energy prosperity has the face of a woman. The implication of this assertion is that women as primary caregivers carry the burden of creating a home as they juggle tasks including tending to their children, husbands, cooking, cleaning, fetching water and firewood. In Matobo Ward 14 the majority of home owners and breadwinners are women thereby putting additional pressure on them to maintain their households. However, women from households with access to solar electricity seem to have an easier and more balanced life than those from households without electricity.

According to Habtezion (2012:6) time poverty refers to scarcity of time for rest as a result of too much time spent working on household chores and other traditionally ascribed gender roles. Therefore, rural electrification can potentially eliminate certain tasks or at

least reduce the time required to complete them. These tasks and the time it takes to complete them are referred to as “drudgery” (Winther *et al*., 2017:393). Access to energy will thus reduce the drudgery and alleviate women’s time poverty.

In most developing countries women spend approximately 4 hours on unpaid household chores and care work per day (U.N. Women, undated). In Sub-Saharan Africa (SSA), women spend three times more the amount of time on unpaid household chores (Jagoe *et al*., 2020:1). In Nigeria, women spend about 3 hours a day preparing grains for pounding; over 2 hours grating a basic of cassava and over 80 hours processing a drum of oil palm fruits (IBRD, 2017:8-9). Access to and use of electrical appliances such as, cookers, food processors and refrigerators can significantly reduce time spent on household chores (ENERGIA, 2020:2; IBRD, 2017:2-3). This shows that ownership of solar systems will improve the lives of women and thus lead to energy prosperity.

The safety of women is also at risk due to lack of access to solar energy. According to World Bank (2018:7) availability of electric water pumps in communities provide women with quick and reliable water supply within reasonable distance. Access to water is a challenging issue in Matobo district which suffers from perennial drought owing to poor and erratic rainfall patterns. As a result, women have to walk long distances and spend many hours fetching water from dams and other available water sources. Evidence shows that in Sub Saharan Africa, it takes on average 33 round trips to draw water in rural areas and 25 minutes in urban areas (UNICEF, 2016). These long distances and many hours leave women vulnerable to attacks and sexual abuse. Sommer *et al*. (2015:109) highlights instances where women have been sexually harassed while standing in line for water, or raped on the way to and from fetching water and firewood. Reducing the time and distance required to fetch firewood and water by using solar powered appliances may therefore reduce time and safety costs to women in rural areas.

3.4.5 Educational benefits

Household electrification can be a substantive catalyst to educational attainment for children living in rural communities. A community with electrified school improves the school's enrolment and performance of students. Matobo district stands to benefit from more electrified homes and schools.

Studies in India and Kenya have reported positive correlation between school attendance and study time with household electrification (Lee, Miguel & Wolfram 2020a: 130). In a survey of 100 households in Madagascar, findings revealed that children have more study time when their homes have electricity lighting. Girls were noted to benefit more as they assist with household duties during the day and are still able to study at night (Daka & Ballet 2011: 2869-2872).

More comparative studies in Burkina Faso, Rwanda and Senegal show that children cn study during the day and in the night (Peter & Sievert 2015:86-87). They found that children practice shifts studying into the night when they have electricity lights in the home. This therefore accommodates the girls that are usually disadvantaged not only by lack of lighting, but also by socially ascribed gender roles and chores while benefiting the boys who often have more time to study.

3.5 Theoretical Framework

This section presents the existing body of scientific literature published in the same field as the proposed study. The literature review consists of reviewed empirical and theoretical literature. Literature resources on existing scholarly work and views on the impact of solar energy on the socio-economic well-being of communities are reviewed and summarized in this section.

3.5.1 Sustainable Livelihood Framework (SLF)

The Sustainable Livelihoods Framework (SLF) was chosen as the appropriate conceptual framework for assessing the impact of solar energy in Matobo. The SLF enhances the

understanding of the livelihoods through organizing factors that constrain or enhance livelihood opportunities and the relationship between the factors (Serrat 2017). The sustainable livelihoods model is an asset-building approach to poverty reduction based on the premise that everyone has assets on which to build and that strengthening a number of asset areas can enable people and families to not just get by, but to actually get ahead. As stated by Chambers and Conway (1991:6) “a livelihood is sustainable when it can cope with and recover from stress and shocks, and maintain or enhance its capabilities and assets”. Serrat (2017) asserts that the Sustainable Livelihoods Framework can aid in the designing of development activities and evaluate the contribution that existing activities have made to sustain livelihoods. This framework is appropriate to this research as it unearths possible constraints to livelihood opportunities resulting from lack of access to solar energy systems while showing the benefits to livelihoods realized by the people of Matobo emanating from using solar panels.

3.5.2 Livelihoods

Livelihoods are described as techniques and ways that grant people access to the resources or assets fundamental for their sustenance (Ellies 2000). People may choose short term or long term survival strategies depending on their goals and needs. In a simplified definition Mazzone (2019) states that livelihood refers to coping mechanisms households and individuals adopt in order to make a living.

Livelihoods are categorized into five essential capitals namely; natural, physical, social, human and financial capitals (Carney *et al*. 1999). This research seeks to measure the impact of solar energy on these five forms of capital. The SLF shows the linkages between these five capitals and solar energy. According to Chambers and Conway (1991) the sustainability of a good lifestyle relies on non-exposure to adverse circumstances and the ability to recuperate and improve from such, whilst averting the destabilization of the natural resource base. This segment of the model is pivotal in analyzing the research questions on the impact of solar energy livelihood opportunities on the livelihoods of residents of Ward 14 in Matobo District.

3.5.2.1 Physical Capital

Physical capital relates to basic infrastructure and production merchandise necessary to support livelihoods. Basic infrastructure includes transport, housing, and buildings, as well as provision of water and sanitation (Dyner *et al*. 2005). Lack of access to basic infrastructure yields grave social problems like illiteracy, unemployment, poor health and generally poverty (Carney *et al*. 1999). Access to solar energy is likely to improve livelihoods through enhancing physical capital.

3.5.2.2 Human Capital

Good health, knowledge, skills and the ability to work all constitute human capital. They are all equally significant as physical capital for a sustainable livelihood income (Carney *et al.* 1999). Thus clean energy increases production hours while positively impacting on health, education and well-being. Buragohain (2012) in his description of the impact of solar energy in rural development India noted that the installation of solar systems has led to drastic reductions in paraffin expenditure across all income groups. Women are major beneficiaries of solar systems as they use them for their daily chores. Additionally, lighting in the community has led to a significant drop in crime rates. More so, parents have reported massive educational improvements from their school-going children resulting from lighting systems in their homes.

3.5.2.3 Natural Capital

Natural capital refers to natural resources like land, forests, water, and a clean atmosphere accessible to households (Carney *et al*. 1999). Renewable resources such as solar radiation and wind also constitute natural capital (Dyner *et al*. 2005). Appropriate access to electricity advances people's livelihoods while decreasing the damaging effects on the environment (Carney *et al*. 1999).

3.5.2.4 Social Capital

Social capital incorporates all forms of social interactions. Access to social capital is pivotal for an advantageous impact on people's livelihoods as well as promoting collective efforts (Carney *et al*. 1999). The utilization of such a source to gain access to a particular form of livelihood outcome is social capital. Likewise, access to electricity will advance social capital by delivering new opportunities that enhance social interactions of people in communities.

3.5.2.5 Financial Capital

Financial capital can be coined as the availability of cash or any form of legal tender which enhances planning or budgeting towards livelihoods. Accessible stock is cash, bank deposits or liquid assets and it can be in the form of credits. However, earned income, state transfers, and remittances are known as consistent influx of money where reliability is principal among all the five types of assets (Dyner *et al*. 2005). Like other capitals, this capital is useful in helping people to access electricity through the use of efficient technologies. Furthermore, new opportunities will be availed from access to electricity, consequently creating comfortable livelihoods that will generate more income leading to improved financial capital (Carney *et al*. 1999).

3.5.3 Impact Assessment

The objective of this impact assessment on livelihood improvement is to evaluate social and economic impacts achieved from the solar electrification initiative and poverty reduction while providing recommendations for the future based on lessons in Matobo ward 14 as case study.

Impact assessment involves the evaluation of a program's impact or intervention. For example, this study looks at the impact that solar energy has on the socio-economic well-being of the households. Such impact can be attributed to income changes, education,

health, and access to information, and other forms of capital. Impact assessment measures the changes that occur following the execution of a program at individual, household and community levels (Conning & Deb 2007). Two groups are mandatory for the evaluation of such program intervention. Either the researcher can have the treated and the untreated group or the assessment can focus on the change in the data before and after the intervention (Conning & Deb 2007). The methods that are typically used in impact assessments are the difference in difference technique, instrumental variable technique and propensity score matching. .

The SLF is presented in Figure 3.2 below. In this study, the SLF has been deployed to acquire a better understanding of how capital assets are being impacted by the provision of solar energy in the rural households of Matobo ward 14. The literature reviewed above reveals various debates concerning solar energy on the rural communities' livelihoods by focusing on key variables such as, economy, health, education and gender.

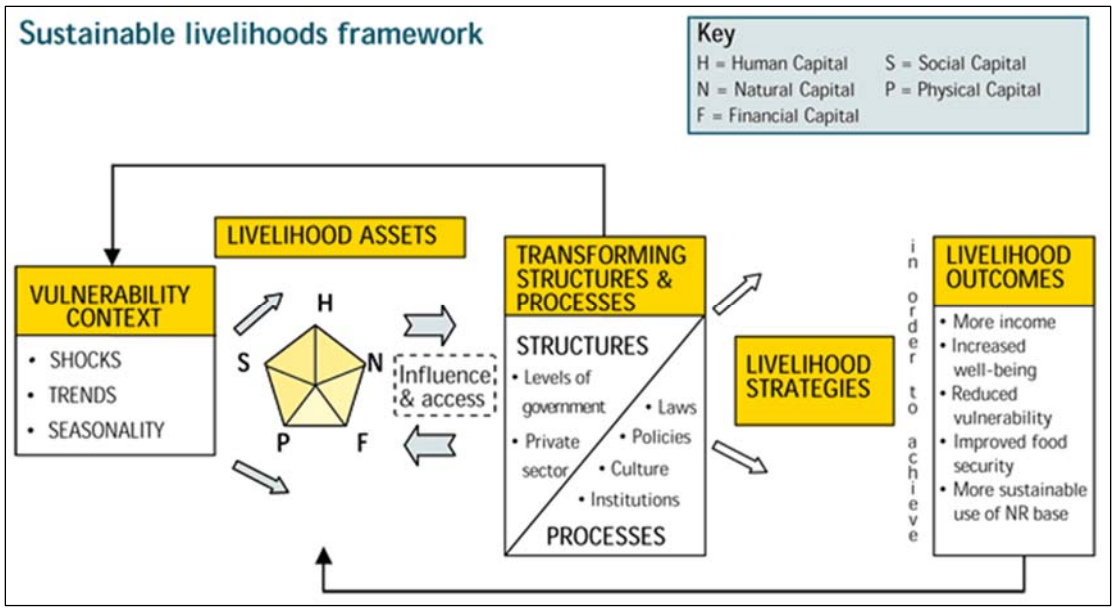

Figure 3.2: Sustainable Livelihoods Framework

3.6 Clarification of key terms

3.6.1 Renewable energy

Renewable energy refers to natural energy sources that are replenished constantly (OECD 2010). These sources include solar, wind, hydropower, geothermal, biogas, ocean resources and liquid biofuels (OECD 2010). Renewable sources of energy are also referred to as modern or alternative energy sources. According to Martinot *et al*. (2002) fuelwood and crop residues also form part of renewable energy sources However, in this study fuelwood is not considered as renewable energy given the rate of deforestation of indigenous forests in the study area which does not conform with sustainable harvesting. Therefore, for this study, renewable energy shall refer to energy derived from natural sources such as solar, wind or geothermal and which are replenished constantly by natural processes when used.

3.6.2 Solar energy

Solar energy can be defined as electrical energy harnessed from sunlight. There are two main ways electricity is obtained from solar energy. The first one is using solar photovoltaic (PV) modules which are solid-state semi-conductor devices that convert sunlight into direct-current electricity (Devabhaktuni *et al*. 2013). The second way that is regarded as more efficient is using concentrating solar photovoltaic systems (CSP). CSP systems use lenses or mirrors to focus sunlight gathered over a large area into a small area where high-temperature heat is produced and converted into electricity through a thermal generator (Devabhaktuni *et al*. 2013). Therefore, in this research, the term solar energy refers to the use of solar panels to convert sunlight into electrical energy.

3.6.3 Energy poverty

Energy poverty (EP) refers to the lack of access by households clean energy sources and their consequent reliance on solid biomass fuels for cooking and other domestic uses (Sesan 2012). The IEA (2010), and Practical Action (2013), defined EP as a lack of energy services to meet basic needs for cooking, heating, lighting, healthcare, education, communication, and income-generating activities (IGA). For this research, EP is referred to as the lack of access to modern and clean energy services by rural households in study

area to meet their basic needs and the consequent reliance on use inefficient biomass fuels.

3.6.4 Vulnerability

Adger (2006) defines vulnerability as the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt. According to Drèze and Sen (1989), the term vulnerability refers to entitlement failure among people in the face of societal and environmental shocks and changes. Both definitions are applicable in this research.

3.6.5 Socio-economic development

According to Jaffee (1998:3), socio-economic development refers to the ability to produce an adequate and growing supply of goods and services productively and efficiently to accumulate capital and to distribute fruits of production in a relatively equitable manner. Socio-economic development involves the processes of production, accumulation and distribution. The study of development has been heavily influenced by sociological concepts and economic measures.

3.6.6 Livelihoods

Livelihoods refer to a means of living comprising of assets (stores, resources, and claims), capabilities and access to activities. The important feature of this livelihood definition is to direct attention to the links between assets and the options people possess in practice to pursue alternative activities that can generate the income level for survival (Ellis 2000:7).

CHAPTER 4: DATA ANALYSIS AND PRESENTATION

4.1 Introduction

This chapter presents the study findings based on the analysis of qualitative data collected using semi-structured interview guides with individuals, focus groups and key informant interviews. The researcher interviewed thirty participants. The participants comprised 13 males and 17 females. 13 households were headed by men while 17 were headed by women. The gender distribution of the participants is shown in Table 4.2 below. The table shows that in total there 18 female and 12 male participants.

Table 4:1: Gender representation

Population group	Number of Participants	SEX	
		Male	Female
Entrepreneurs	5	**2**	**3**
Lead Farmers	5	**2**	**3**
Teachers	2	**1**	**1**
Local leadership	4	**2**	**2**
Villagers	12	**5**	**7**
Nurses	2	**0**	**2**

According to the participant entrepreneurs the types of businesses they ran include the following:

- Farming
- Grinding mills
- Peanut-butter making
- Garment making
- Welding and Carpentry
- Cell phone charging
- Beer halls

- Recreation (Sport and film/movie live screening).

4.2 The energy sources used prior to solar electrification

The participants all noted that before the adoption and ownership of solar panels, the greater population was solely dependent on biomass energy, mainly wood and in a few cases, cow dung for cooking and heating. Other sources of light and heating mentioned by the participants are paraffin, candles and oil lamps (Figure 4.1).

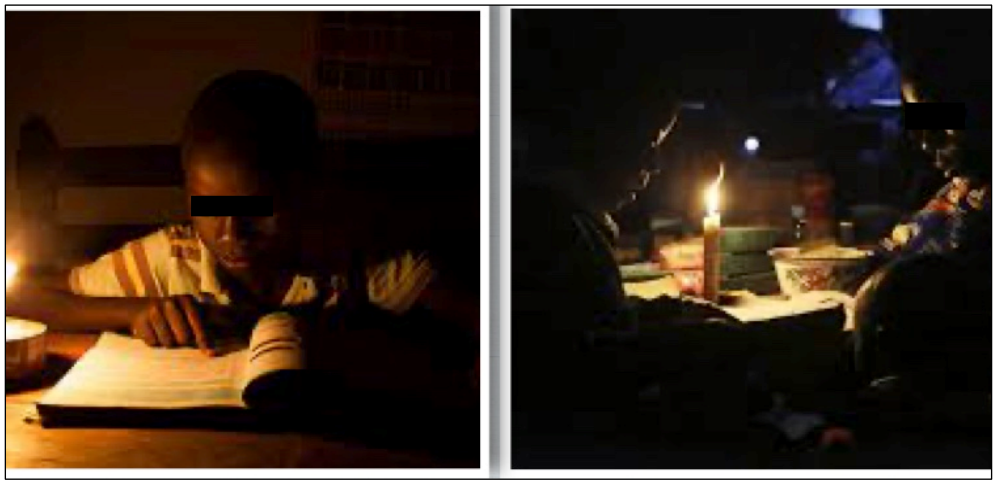

Figure 4.1: Candle and Oil energy lamps for lighting in Matobo households

Most of these sources were either very expensive to purchase or involved excessive hard labour to acquire, especially for the elderly, disabled and children. Participants singled out paraffin as being expensive while gathering wood has become a major chore and individuals have to walk longer distances as the forests get depleted.

These findings are corroborated in literature by various authors. For example, Wicke *et al*. (2015) states that bio energy from biomass is the primary source of energy for more than 2.7 billion people globally and serve a traditional role in Africa. In addition, more than 81% of the population accounting for 635 million Africans rely on biomass for their energy demands and this figure is expected to rise to 720 million by 2030 (OECD 2010). Bildirici and Ozaksoy (2016) further submit that the African population mostly depended on biomass from wood use it mostly for economic, household and cooking activities. In

addition, Martínez-Moreno *et al*. (2012) maintain that direct use of biomass is not always feasible and in some cases require additional treatment (biologically and physically) to prevent effects of conventional fuels. It is in the light of this major dependency on biomass energy and the inherent hazards that rural electrification was rolled out in villages include Matobo Ward 14. However, there are villagers who are still relying on biomass and other sources of energy mentioned above as they do not own solar panels.

4.3 The living standards of the households and residents before acquiring solar panel systems

The acquisition of solar panels has alleviated some of the challenges that villagers used to face in the community. For instance, water collection was a difficult task as the manual bush pump required two able bodied adults to operate. As a result the community had devised a schedule to enable the elderly to fetch water when they needed it. However, due to the high demand for water there would normally be a long queue while villagers waited for their turn to collect water (Figure 4.2). This resulted in villagers spending long hours fetching water. Furthermore, the bush pump broke down often and villagers would have to walk longer distances to fetch water from other sources. Sometimes it would take several days before the bush pump was repaired.

Figure 4.2: Women pumping water for their homes and livestock

The reliance on firewood resulted in the depletion of forests over time. Furthermore, the increased demand for firewood to support the feeding schemes established at local schools also put pressure on the deteriorating forests. The feeding schemes provided porridge for learners as a dietary and nutrition supplement to support households and avert the likelihood of hunger and malnutrition in the villages. As a result, household members had to walk long distances and spend increasingly more time fetching firewood. The gender perception and practice that girls and women are mostly responsible for these household chores meant that girls would often miss school in order to ensure that there is adequate water and firewood within the household.

The challenges of walking long distances to fetch water and firewood and the long periods of time taken on these chores were further exacerbated by the need for security, especially for young girls and women. According to Habtezion (2012:6), the gendered roles in domestic work mean that women will tend to face these challenges. There were cases of rape and robberies that were reported by villagers that women experienced in the forests or on their way to and from fetching water and firewood. As a result, women were now walking in groups in order to reduce the possibility of being attacked. According to Sommer *et al*. (2015:109), women become vulnerable when they walk in the forests or spend long hours queuing for water at collection points. A World Bank (2018: 7) reported found that electric water pumps in communities reduces the distances that women and young girls have to walk thereby improving their safety.

4.3.1 Time and money spent on accessing other sources of energy

According to Jagoe *et al.* (2020:1), women spend more time doing unpaid domestic work, especially in Southern Africa. In the study area participants confirmed that they walked long distances and spent many hours collecting firewood and water for domestic use meant that household members, especially women would have little time with their children. At the end of the day they would be very tired and unable to assist children with their school work. When the bush pump was broken, in addition to walking long distances to nearby farms to fetch water, most households would be forced to buy water for

domestic use. The research participants reported that they would buy a 20 litre gallon of water for $1. Those households that could afford would buy more water per trip in order to limit the number of trips they have to make. This water was also only reserved for cooking given the cost and scarcity. These challenges were experienced by almost all households in the villages prior to having access to solar panels that were used to pump water from boreholes thereby making it relatively easily available.

4.4 Benefits of solar energy in Matobo

The results from the study show that use of renewable energy has helped villagers in reducing poverty. The introduction of solar power and continued rural electrification expansion in Matobo ward 14 has enabled local farmers to improve their production capacity in the irrigation schemes, as well allowing households to enjoy a range of benefits including social, economic and health, education, women empowerment and security benefits.

4.4.1 Social benefits

From a social benefit perspective access to solar energy has positively impacted on the lives of communities. They can power lights and charge phones have also improved the living conditions and communication by villagers. Participants are able to accomplish more tasks (tending to their children's needs i.e. homework, health, laundry and spending quality time with their families) as they now spend less time fetching water or collecting firewood. Even the elderly now find it easier to perform chores as they no longer walk long distances to fetch water from the solar powered water sources (Figure 4.3). Therefore, this is a time saving benefited that has freed time for community members to engage in other household duties as well as social commitments.

Figure 4.3: New solar powered communal water source in Matobo ward 14.

One participant stated that they can now iron their clothes and get a confidence boost from the experience. However, more generally, villagers now drink clean water, use cleaner energy sources in place of the paraffin lamp.

Participants can now also easily listen to radios or watch television to keep abreast with what is happening in the country, especially in the wake of the Covid-19 pandemic. Radios and television are also a source of entertainment through listen and dancing to music or watching entertainment programs on television. At the business centres, revelers can also dance to music in public places such as bars. Furthermore, access to improved education and health services has also been made possible by the availability of solar energy according to the participants.

4.4.2 Economic benefits

The availability of solar powered energy has enabled most farmers to use electric water pumps to draw water for watering their crops (Figure 4.4). This has greatly improved productivity as farmers are able to water their crops consistently and adequately to improve yields. The vegetable market where villagers sell their produce has also grown as a result of improved access to water by farmers. This has also improved the livelihoods

of both farmers and vegetable vendors according to the respondents thereby contributing towards poverty reduction in Matobo district.

Figure 4.4: Lead farmers in Malindi solar powered garden

Another economic benefit mentioned by participants is that solar power has enabled villagers to refrigerate products such as milk and meat and horticultural products like fruits and vegetables. This has enabled farmers to stock their products and keep them fresh for prolonged periods. Participants also indicate that solar energy provision in ward 14 is positively impacting on livelihoods as it is aiding the community through employment creation. This observation is corroborated by Green Economy Report (2011) that states that the renewable energy industries are increasing employment. Installing off-grid solar systems in the irrigation schemes/projects has increased the number of farm workers employed in the fields. The majority of people who are employed are in the dairy and poultry farming which have grown largely as a result of installation of solar systems. Being employed has enabled more people to support their families, as they can now buy essentials such as; food and clothing for the children.

As indicated above, away from the farms more jobs have been created at the business centres where entrepreneurs are now able to utilise solar power to run their open businesses. The Green Economy Report (2011) further states that solar power is

successfully providing low-cost and reliable energy for economic activities in remote areas.

These businesses include grinding mills, welding and carpentry services. Participants in a focus group indicated that solar power has both promoted entrepreneurship thereby improving access to a variety of services by villagers. For example, villagers now have easy access to welding services for making window and door frames and metal gates and tools. The welders also provide other services including repairing broken wheel barrows, scotch carts, gates and other metal objects. From the carpentry shops villagers can now buy doors as well as other basic furniture for their households

Taking advantage of rural electrification, a respondent who runs a small-scale door manufacturing business diversified from the manual hand driven machines to electric mortars for all their manufacturing jobs. According to Gorge (2011) the shift to electrical machines with the coming up of rural electrification program was a mammoth task. Furthermore he adds that, his electric powered door manufacturing company began in the year 2006 having amassed some of the much needed machinery. The respondent stated that quality of doors manufactured depend on the number of machines available such as the heavy spindle moulders for moulding panels. The respondent stated that, the only problems faced by small-scale door manufacturers emanate from the fact that as a start-up business it was not easy to break into the market but solar energy made their work easier and quicker.

One of the most common uses of energy in the rural areas is lighting. Lighting is reported to have improved the quality of the productive activities and to attract more customers. One of respondents indicated that restaurants have been established at the business centre inspired by the availability of solar electricity. Electricity has enabled the restaurant owners to cook and serve food as well as to store beverages including alcoholic drinks in refrigerators for the regular customers who prefer to dine and drink in these rural restaurant establishments.

According to the participants, apart from lighting up their places of business electricity also provides power for music, television and simple appliances such as electric kettle for boiling water.

4.4.3 Health benefits

Installation of solar system grid in ward 14 has improved access to clean water for drinking by villagers. Availability of clean water has enabled people who are near the electricity grid to drink safe water being pumped through solar energy. Improvement of clean water has helped people to be less affected by water borne diseases, such as dysentery and Cholera. One respondent said that people who have access to clean water were those who are near electricity grid as they are able to use tap water while others use borehole water. This argument is supported by OECD (2012) who notes that use of electric pumps in Tanzanian rural schools has reduced the number of water borne diseases especially among pupils. The availability of electricity in schools in the country has enabled pupils to drink safe and clean as the school has tap water. Therefore, in the same manner this has improved water and sanitation in the schools around Matobo district and has reduced the likelihood of incidences of water borne disease outbreaks.

One of the major contributions of energy provision on livelihoods is the improvement of health condition of residents. The replacement of traditional energy sources with modern energy such as solar energy can reduce indoor pollution. A health personnel informant pointed out that electricity helps the clinic in many ways such as lighting during the night, working longer hours to care for patients and the refrigeration of medicines. Furthermore, the respondent indicated that the use of electricity has helped in other administrative duties, such as typing, photocopying and accessing the internet. The respondent added that some of the nurses use solar lighting to study in the evenings.

A nurse from the local hospital stated that the availability of solar systems has made it possible for nurses to work more efficiently, especially on the night shift. Previously, before the installation of solar panels the clinic was prone to fires started by paraffin lamps

and candles. As a result of the frequent fires at night the clinic has to operate during the day only until 6pm.

The smoke from paraffin lamps also affected new born babies in the clinic and no patients could also be admitted at night. According to Essendi *et al*. (2015), the use of clean energy improves maternal health and the health of new-born babies. Therefore, the availability of solar power has greatly improved how the clinic operates as it now can also admit patients at night. Availability of power has made modern health services available even in remote areas as demonstrated by the EGP Report (2019) on St. Luke hospital in Wolisso Ethiopia where power installation increased the number of admissions and outpatients at the hospital.

According to the nurses at the clinic access to solar energy has given these facilities access to clean and safe water. They have refrigerators for patient medication that requires specific temperature storage. More especially currently during the Covid19 pandemic the clinic was able to provide ventilators for covid-19 patients without having to lose patients or incurring the costs of transporting referral patients to the Provincial hospitals as some of the patients unfortunately die on the way.

4.4.4 Education

The benefits that accrue to education as a result of access to solar energy were also described by participants. A key informant that the government and some local NGOs have collaborated on an initiative to install solar panels at the local school. This initiative improved access to resources such as computers, late evening classes for examination classes and this is likely to result in better academic outcomes. A study by Lee, Miguel and Wolfram (2019:130) has also demonstrated that provision of energy to light schools and households increases the amount of study time available to students. Daka and Ballet (2011) also argued that girls benefitted the most as they would study in the evening as they often spend the day doing household chores.

In addition, a solar powered borehole was installed to supply fresh running water to improve the hygiene and sanitation of the learners and teachers (Figure 4.5). The school now has hand washing points that protect the students and teachers from the ravaging cholera that has plagued Zimbabwean communities for years. Moreover, this development came at a time when the country and the rest of the word were ailing from the tormenting Covid19, running water allows students to wash their hands after using ablution facilities, and students can also wash their cloth masks as rural families cannot afford disposable masks.

Figure 4.5: Solar powered borehole and tanks donates to a local school

Other benefits that have accrued to the local school include the ability of teachers to now mark student's class work and tests in the evening. Previously, teachers had to use candles and paraffin lamps which affected them through constant inhalation of the fumes as well as straining their eyes because of the inadequate light. There is an expectation that the pass rate of learners that has always been poor due to limited study time, may now improve as the school can now accommodate learners who need remedial lessons and examination preparation in the evenings.

Apart from the benefits on their work as teachers, they have also benefited from access to clean water and solar power in their homes. Most of the teachers live within the school

premises hence they benefit from solar powered lights and taps which have reduced the number of hours they spend collecting firewood and money they spend on paying for charging cell phones, candles and paraffin.

4.4.5 Women empowerment

A female local leader in Matobo ward 14 indicated that one of the benefits of solar energy has been the role it has played in empowering women. According to Pact (2020) the challenges of lack of access to clean energy affect women the most. Therefore, the availability and accessibility to solar power provides opportunities for empowerment of women. According to the respondent women have been the major beneficiaries of solar panel systems for several reasons: the majority of women in ward 14 are widows and those that are married are female-headed households as their husbands are either working in the City (Bulawayo) or are in South Africa seeking greener pastures. Many of the men who have left have not looked back to support their families. The last group of women are single and bread winners in their homes. According to Diederichs (2013) such households, especially where there is income from a single member of the household access to energy is limited or often disrupted. Therefore, targeting women made a positive impact in alleviating challenges related to access to energy.

The ward has more women than men and the local leadership is predominantly female. The irrigation and nutritional gardens are mostly managed by women. These garden projects help women to supplement their diets as well as provide household income. There are various home-based women owned businesses in ward14 namely; cell phone charging garment making, peanut butter making, and grinding mills, among others. It is evident that the solar panel systems have improved socio-economic livelihoods of most women and their households.

These findings show that communities, particularly in rural localities can develop socially and economically through the empowerment of women where solar energy has been made available.

4.4.6 Security

Electrification has enabled households with lighting for their homes and businesses. Lighting in the homes provides a sense of security at night as it discourages house breaking. This was found to particularly important for the elderly or female headed households with no male figures to protect the family. Furthermore, some households indicated that the use of solar energy for lighting has also reduced the incidence of fires started through the use of candles and paraffin lamps. Farmers and entrepreneurs also use electricity for lighting in the night to protect their premises or animals such as pigs and chickens. In addition, the results indicate that electricity has helped farmers to safeguard their crops especially horticultural products. Electricity has provided lighting and security from thieves who break in and steal our crops and animals. This is a positive contribution to the livelihoods.

4.4.7 Livestock rearing

The use of electricity among some local villagers has been to pump water for cattle, livestock operations have improved, and watering places in addition to natural water sources become necessary in such scenarios. Effective watering systems are also needed to protect natural water sources. Quetz (2009) notes that photovoltaic pumping for cattle watering is one of the alternatives that is gaining prominence in off-grid areas. Some of the respondents among Matobo farmers concerning cattle-watering have highlighted positive impacts such as: increased cattle production as the cattle do not struggle to access water, some of these changes have been highly noted in the improved quantities of milk and meat quality as compared to the years where cattle shared water sources with the residents. This has consequently led to improved natural resource management.

4.4.8 Covid19 pandemic resilient livelihoods

Access to solar powered energy increased access to opportunities for community development in the district. In the wake of the Covid-19 pandemic solar energy has been reported to help empower poverty stricken communities through access to health information and updates on the spread of the corona virus. During the pandemic the whole

world had to practice social distancing among other lifestyle changes in order to reduce the spread of the virus. Matobo ward 14 in Zimbabwe was no exception. As a result, access to energy dependent devices and technology (cell phones and internet connectivity) became a fundamental need for the Matobo ward 14 residents. For instance, while socially distancing themselves solar energy would allow them to charge their mobile phones, which came in handy in accessing telehealth services from the Zimbabwean department of health. Access to health and safety updates aided the households in Matobo to be better prepared for pandemic related shocks, stresses and developments, this raised awareness in an effort to combat the transmission of the virus.

4.5 Challenges faced by residents who do not have solar panels

Access to solar panels and services made possible by the availability of solar energy has alleviated challenges previously faced by households. However, there are still villagers who have no access to solar power and services due to their socio-economic status and as such cannot afford to buy solar panels; and their geographic location being away from major roads or service centres where some of the services are provided. According to one of the local leaders, while there are solar powered boreholes in the village, some villagers live far from these sources and therefore still encounter challenges accessing water. Villagers also reported that political affiliations also determined access to solar panels distributed by government. They indicated that those villagers who were not aligned with the ruling party were denied access to solar panels.

One respondent with a local NGO observed that socio-economic status of the villagers determined their access to solar energy. According to this respondent poorer households cannot afford solar panels and tend to be reliant on remittances from relatives in the city or in the diaspora The little money they get from these relatives they use it to feed their families.

Generally, many residents have no steady income and as such they miss out on pivotal information that is necessitated by the technology that relies on electricity to function. For instance, since the advent of Covid19 lock downs the government has embarked on a

zero-contact campaign where even the chiefs in rural areas should promote social media, radio and television communication to curb the spread of the virus. This favoured the poor who cannot afford solar panels, cell phones and subsequently Covid related information and updates. These chiefs are thus forced to continue the traditional means of disseminating information through messengers in the rural areas which in turn becomes a health hazard as these messengers move from one household to the other.

Another challenge mentioned by respondents is that lack of access to solar powered electricity by households indirectly impacts on education. This is because children in these households do not have the necessary light at night to help them study. Parents also do not have access to a consistently reliable source of power to charge their phones to help their children study. For example, during the hard lockdown the government made available free radio and televised lessons to assist learners to still learn from home. Parents who had no access to solar power services, such as, charging their phones struggled to have their children access the zero-rated learning sites made available by the government.

The other challenge mentioned by respondents relates to how schools have been struggling to keep the agriculture curriculum running. Agriculture is a major subject in schools in Zimbabwe but has been affected by the lack of access to perennial sources of water in some schools such as in Matobo. Teachers have now been forced to adjust the curriculum due to water scarcity. In addition to adjusted curriculum, water scarcity has also led to disease outbreaks in some schools. In essence the availability of solar powered water pumps does not only alleviate the drought induced stresses and disease outbreaks from water shortages, but it provides safer and closer water sources for teaching and learning to continue in the schools.

In addition to charging phones, some families also pay for refrigeration services to keep fresh food, such as meat and milk. However, these services drain the little income that households received through remittances. More so, of the all the households interviewed 60% belong to category of those without access to solar power. According to one

respondent, they spend up to US$20 per month to pay for refrigeration space. Most households dry their meat in order to avoid the additional costs of keeping it fresh. Therefore, owning solar panels could drastically reduce costs for most households and improve their livelihoods.

4.6 Conclusion

The findings above can be linked to the forms of capital described in the SLF. The introduction of solar energy contributed to the physical capital through provision of powered boreholes. These powered boreholes helped in the provision of clean water and improved sanitation. The provision of solar power also contributed to financial capital, especially for the entrepreneurs who were able to establish or expand their businesses in the community. Farmers were also able to engage in irrigation thereby boosting their productivity and incomes. Furthermore, access to solar energy also resulted in financial savings for households as they no longer had to buy paraffin or candles as they used to before. Access to solar power also contributed to improvement in social capital in that community members were able to work together, especially in the farming groups with access to irrigation.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the entire study. The chapter highlights the aim and objectives of the study and the methodology adopted to gather data. A summary of the results is also provided including the conclusions reached and recommendations suggested.

The aim of the study is to evaluate the socio-economic impact of solar energy on the livelihoods of households living in Ward 14 Matobo district. The study was guided by the following research questions: Which energy sources were used before the use of solar energy?; How were the general living conditions of the households before acquiring the solar panel system?; What are the challenges faced by residents without solar panel systems?; and What sustainable livelihood improvement opportunities/assets are created as a result of solar energy access?

The study adopted a qualitative approach and data was gathered through semi-structured interviews and focus group discussions with a sample of 30 participants including household members, farmers, nurses and teachers, entrepreneurs and local community and political leadership. The study also took a comparative approach to establish the differences in livelihoods for households with access to solar energy and those households that still have no access to solar energy.

5.2 Conclusion on the research findings

Biomass was found to be the major source of energy used. Wood and cow dung were particularly used for cooking and heating while paraffin, oil and candles were used for lighting. Gathering wood was an indicated to be an extremely tedious process, more especially for the elderly. Villagers indicated that they are increasingly walking long

distances to gather firewood as the forests get depleted. For the elderly who cannot walk these long distances, the use of cow dung becomes the only feasible option for them.

Oil and wood are still commonly used by many households. However, wood is free which makes it the most preferred and sought-after source of energy although it is increasingly leading to uncontrolled levels of deforestation. This is largely due to a significant number of households and schools heavily relying on wood energy for their day-to-day tasks and school feeding schemes. The demand for energy is also increasing with bigger families utilizing more energy for cooking, heating water to bath.

Oil and paraffin are very expensive commodities which forces many households to use such sources of energy sparingly. The need to lead a normal life pushes such households to sacrifice their little money in order to purchase paraffin or oil for their lamps.

The study findings revealed that before acquiring solar panels households experienced challenges related to lack of access to clean energy, poor water supply with widespread water borne diseases from unprotected water sources and generally high levels of poverty. The study confirmed that, life before the advent of solar energy in Matobo district ward 14 subjected the households and the community at large to a life of poverty, gender inequality in education access, poor educational access, wide spread water borne diseases and livestock and wild animal starvation due to draught.

Renewable energy source has reduced violence and violations against women and girls' rights. For instance the research findings revealed that, the cases of women and girls being raped were most prevalent in places and times associated with either the fetching of firewood or water. Thus the provision of water sources powered by solar and closer to households has reduced the vulnerability of women and young girls to sexual abuse.
The role of the girl child had been redefined through the chores they had to carry out within the household. Girls would miss school to accompany their mothers to gather firewood for the household while boys continued with school. In addition, the girls and women walked long distances and spent long hours in the bush gathering firewood. They

also spend long hours waiting in queues waiting their turn to collect water. As a result, girls and women hardly had time for recreation or to rest. Therefore, access to solar energy has provided alternatives that have eliminated the need to spend long hours fetching water or gathering firewood.

Education is among the parts of society that suffered the most from lack of clean, reliable renewable energy in Matobo ward 14. Poor attendance was a common factor as families prioritized survival over the need to educate their children, especially the girl child. Therefore poor attendance was mostly by children from poor families. Students from households with solar panels had better attendance at schools and also have a better chance to excel in their studies as compared to their counterparts from homes without access to solar energy.

Residents who do not have solar seem to suffer as they have to walk long distances to reach nutritional gardens, water taps, clinics and general dealer stores. Road networks are extremely bad, preventing aid from reaching those secluded parts of ward 14. Low household income is chief among the challenges faced by residents of ward 14. As in any rural setting, poverty due to lack of rainfall and unemployment subjects ward 14 residents to adverse living conditions. Therefore, purchasing a solar panel system is not an available option for several households in Matobo ward 14.

Access to solar panels is being politicised with households supporting the ruling party being prioritised. This disadvantages other villagers whose political affiliation may be with other parties. Therefore, several ward 14 residents have failed to access solar panels as the distribution process has been largely politicised.

Solar energy access has aided the fight against poverty and hunger through powering boreholes for irrigation schemes, and grinding mills, as well as providing power for sewing and welding opportunities. These are some of the economic benefits that have accrued to households as a result of having access to solar energy. Generally, access to solar energy has created income generating initiatives while through creating employment

opportunities for residents of Matobo ward 14. In light of this it can be noted without doubt that the rapid expansion of electrification through solar energy has contributed immensely towards combatting poverty and other socio-economic stresses and shocks.

The researcher has also noted that solar energy has created pandemic resilient livelihoods in Matobo district during the Covid19 period. Learning was continued from home through the use of solar powered devices, such as cellphones, televisions and radios. More so, the health and safety of the people of Matobo ward 14 has been kept in check through the technological devices and platforms. The use of these platforms is not possible without electricity. Therefore solar energy aided the use of cellphones, televisions and radios among the ward 14 residents in accessing information on Covid19 safety precautions as well as other safety updates from the government through the Ministry of Health.

Solar energy has improved security in Matobo district through the use of flood lights in several homesteads. According to many residents, the availability of lighting in their yards has given them peace of mind, particularly women headed households. Moreover, solar powered lighting systems in the ward has led to a reduction in stock theft cases as compared to the years when solar energy was not yet accessible in ward 14.

The provision of solar power has also led to the establishment of several businesses. Entrepreneurs have open restaurants and liquor stores and are able to keep the drinks cool and their establishments well lit. Entertainment activities have also been improved through the solar powered radios for playing music and for watching television programs.

Gender empowerment has been one of the great benefits brought by the availability of solar energy in Matobo ward 14. The majority of the population are women; they are the home owners and breadwinners. Women have been empowered by solar panel systems to venture into income generating initiatives (garment making, peanut butter making, cellphone charging, and nutritional gardens in order to feed and clothe their families.

Solar energy access has also reduced house fires, deaths and destruction of public institutions. At household level, the study has revealed that smoke from firewood, cow dung, paraffin and oil lamps have become an experience of the past. People have gained access to less hazardous energy sources that provides heat and lighting in their homes.

The study revealed that clinics have been capacitated to cater for the admission of overnight patients. This has led to reduced death rates through the ability admit and treat patients for the duration of their illness and recovery. Moreover, medication can be procured and stored in refrigerators for availability when emergencies occur. More so, during Covid 19 Matobo district rural clinics and hospitals can also provide ventilators for Covid patients as they can be operated through solar energy. Therefore, solar energy has improved the health of Matobo ward 14 and largely the country's overall health facilities.

Schools have recorded higher enrolment and attendance numbers due to the availability of modern water sources in the community which has reduced absenteeism and water borne diseases. Students and teachers can work and study late into the night as they have lighting through solar panels in schools and homes. The improved sanitation of the schools helps the community to thrive in their education.

The elderly, disabled and children have easy access to safe and clean water; livestock has access to reliable solar powered water sources. The wellbeing of Matobo ward 14 residents has been improved through solar energy availability and access.

5.3 Recommendations of the study

The recommendations presented below are based on the findings of this study, and are stated as follows: It is recommended that:

- There should be provision of more solar powered communal water sources.

- There should be more solar electricity expansion initiatives to remote parts of Matobo district. The government and local NGOs can engage in joint initiatives in collaboration with communities to enable all villagers to have access to power.

- Road networks should be rehabilitated and improved. Good road networks create potential for new development initiatives due to improved accessibility. It is likely that with improved road networks, rural electrification can spread to all parts of the district.

- The distribution of solar energy panels donated to communities should be de-politicised as this disadvantages other households who might not support the ruling party.

- There should be an inclusive after school program where students can gather at solar equipped local churches or halls to study after normal school hours.

- More community-based empowerment/profit-making initiatives should be implemented through government and NGO community development initiatives to eradicate poverty across Matobo district.

- More gender specific income generating solar projects for women should be implemented through the offices of the government rural community development and NGOs active in rural community development.

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APPENDIX A: INTERVIEW GUIDES

A. Guiding Semi Structured Interview Questions

1 How were the general living standards of the households before acquiring the solar panel system?

- Eliciting information on conditions faced by families prior to owning solar systems.
- How much did they spend on activities that required electric power?

2 What are the challenges faced by residents without solar panel systems?

- Eliciting information on the socio-economic burden experienced.
- The amount of money spent on acquiring services that require the use of solar energy.
- Effects it has on school children i.e. completion of homework etc.

3 What sustainable livelihood improvement opportunities/assets that are created as a result of solar energy access?

- The various uses of solar energy in the household and community.
- Eliciting information on economic activities being done and changes over the years.
- Solar power enhanced opportunities for commercial activities that benefit the community?
- Benefits/enhanced performance for school-going children.
- Solutions or recommendations for Government/NGO wishing to provide electricity in the community?

B. Interview guide for Councillor and village head

1. Has there been any change in the community since the adoption of solar energy as the main energy source in the ward/village?
2. Security impact with more lights at night?
3. Has the use of biomass (Firewood and Charcoal) increased or decreased since connecting to the mini-grid? (If there are any significant changes)
4. Health effects since less biomass is used?
5. Education impact? Longer hours of lighting for reading? Other impacts?
6. Increase in employment opportunities?

C. Sample questionnaire for residents owning solar systems.

UNIVERSITY OF SOUTH AFRICA

Department of Development studies

My name is Khumbulani Lupahla, a student at the University of South Africa (UNISA) studying for a MA in Development Studies. I am conducting a research on "The Impact of solar energy on improving socio-economic livelihoods: A case of Ward 14 (Kezi) in Matobo District Zimbabwe". I am kindly inviting you to answer the questions below. The information you provide will be treated as confidential, and anonymous. The information will not be used for any other purposes other than academic.

NB: Do not write your name and your surname.
Answer by either putting an X in the box or filling in where applicable.

Section 1**:** Personal Information

(1) Gender

(a) Male ☐ (b) Female ☐

(2) Age (please tick where applicable)

18 - 29 ☐ **30- 39** ☐ **40 -49** ☐ **50 – 59** ☐

60 – 69 ☐ **70 -80** ☐

(3) Marital status

(a) Married ☐ (b) Single ☐ (c) Divorced ☐

Section 2:

In this section I would like to ask you about the contributions made by rural electrification on the people's livelihoods.

(1) Which type of energy source is used in your home?

(a) Solar ☐

(b) Hydro ☐

(2) What are the various uses of energy (solar and hydroelectricity) in people's livelihoods?

a) Cooking ☐ b) farming ☐ c) lighting ☐ d)business ☐

e) entertainment ☐ f) Studying ☐

(3). How has solar energy provision enhanced livelihoods activities in the village?

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(4). Has the solar electrification system increased your incomes? If Yes or No state reason?

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……

(5) Which income opportunities do you enjoy at household level? (**You can select more than one)**

a) Irrigation Scheme ☐ b) Phone Charging ☐ c) Garment making ☐

d) Salon ☐ e) TV centre ☐ f) Gaming centre ☐

g) Shebeen ☐ h) Printing/typing ☐ i) Tuck shop ☐

(6) a) Have these new energy enhanced opportunities improved the education of school-going children?

Yes ☐ No ☐

b) if yes How?

Studying hours increased ☐ Improved performance ☐

access to internet-based research platforms ☐ homework completion ☐

(7) How sustainable is energy on rural livelihoods activities?

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……

D. Questionnaire for residents NOT owning solar systems

Section 1**:** Personal Information

(1) Gender

(a) Male ☐ (b) Female ☐

(2) Age (please tick where applicable)

18 - 29 ☐ **30- 39** ☐ **40 -49** ☐ **50 – 59** ☐

60 – 69 ☐ **70 -80** ☐

(3) Marital status

(a) Married ☐ (b) Single ☐ (c) Divorced ☐

(1) Which type of energy source is used in your home? (Tick where applicable)

(a) biomass ☐ (b) Hydro ☐ c) paraffin ☐

(2) What are the challenges faced due to not owning a solar system?

Paying to charge phones ☐ storage of perishable foods ☐

studying for school children ☐ gathering firewood ☐

health hazards oil lamps ☐

(3) How have these obstacles affected livelihood activities such as income generation and education, and other activities in the community?……

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(4) What do you think can be done to solve the challenges faced by households/ communities in accessing

electricity?.....

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APPENDIX B: RESEARCH CLEARANCE LETTER

UNISA university of south africa

COLLEGE OF HUMAN SCIENCES RESEARCH ETHICS REVIEW COMMITTEE

23 April 2021

Dear Khumbulani Lupahla

Decision:
Ethics Approval from 23 April 2021 to 23 April 2024

NHREC Registration # :
Rec-240816-052
CREC Reference # :
67118356_CREC_CHS_2021

Researcher(s): **Name: Khumbulani Lupahla**
Contact details: 67118356@mylife.unisa.ac.za
Supervisor(s): **Name: M S Motebang**
Contact details: motebams@unisa.ac.za

Title: The Impact of solar energy on improving socio-economic livelihoods: Case of Ward 14 (Kezi) in Matobo District Zimbabwe

Purpose: MA

Thank you for the application for research ethics clearance by the Unisa College of Human Science Ethics Committee. Ethics approval is granted for three years.

The ***Low risk application*** *was* ***reviewed on the 23 April 2021*** by College of Human Sciences Research Ethics Committee, in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College Ethics Review Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.

5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No fieldwork activities may continue after the expiry date **(23 April 2024).** Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **67118356_*CREC_CHS_2021*** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Signature : pp

Prof. KB Khan
CHS Ethics Chairperson
Email: khankb@unisa.ac.za
Tel: (012) 429 8210

Signature : PP

Prof K. Masemola
Exécutive Dean : CHS
E-mail: masemk@unisa.ac.za
Tel: (012) 429 2298

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za