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Towards a renewable energy framework for poverty reduction in South African townships: A case of South-West Township (Soweto)

By

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DECLARATION

I, **Mondli Gina**, declare that:

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Mondli Gina

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I would like to dedicate this thesis to my late mother Nomusa "Dudu" Grace Sithole. Thank you for all the prayers and love you gave me. I can only imagine the joy and smile on your face that this degree would have brought to you.

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ABSTRACT

Poverty is one of the world's most fundamental issues negatively impacting livelihoods, with South Africa experiencing high poverty levels. Central to addressing basic human needs towards poverty eradication lies the provision of renewable energy. Poverty can be addressed through access to energy sources that are modern, clean, and affordable. Therefore, energy is necessary for meeting basic human needs and a prerequisite for economic development. The study investigated the ways and extent to which a move towards cheap and clean renewable energy for poor communities contributed towards poverty reduction in an urban context. The purpose of the study was to develop a renewable energy framework for poverty reduction in South African townships, focusing on the Soweto township as a case study.

The study employed a mixed research design that included quantitative and qualitative methods. Quantitative data was gathered from a stratified random sample size of 384 respondents selected from a target population of Soweto residents at Dobsonville neighbourhood. Questionnaires were distributed through electronic mail and self-administered questionnaire. Qualitative data was gathered through interviews from a sample of 15 purposively selected participants. Interviews were analysed using conversational analysis and the data collected from the interviews were merged with the questionnaire data, seeking depth as well as breadth. The thematic analysis was the process used to identify patterns or themes within qualitative data. Data collected from respondents was analysed using descriptive and inferential statistical techniques. The tool utilised to analyse quantitative data was the latest Statistical Package for the Social Sciences (SPSS).

The study findings revealed that the implementation of renewable energy technologies in South Africa will help alleviate poverty, improve the socio-economic status of citizens, enhance economic growth and save the environment. The study recommended a framework for clean and affordable renewable energy as a poverty reduction strategy in Soweto township. Further recommendations were that the South African government should provide the citizens with affordable renewable energy equipment, such as solar panels to those that are regarded as poor and provide incentives to those that install solar panels in their household.

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CHAPTER 1

INTRODUCTION AND BACKROUND OF THE STUDY

1.1 INTRODUCTION

Access to affordable, reliable, and sustainable energy services is a fundamental component of modern life, with significant implications for economic development, social well-being, and environmental sustainability (Lesala, Shambira, Makaka and Mukumba, 2023). According to Thiam (2011: 23), poverty is one of the world's most fundamental issues that urgently needs to be addressed. Reducing energy and utility costs for poor communities could be a strong driving force for poverty reduction in countries with significant urban and rural chronic poverty. Soliman (2012: 127) states that energy is a key component of any sustainable development strategy. According to Akachi and Canning (2015), access to energy is one cause of duality in development. Access to modern, clean, and sustainable energy could be of paramount importance in poverty reduction.

Habib, Narayan, Olivieri and Sanchez-Paramo (2010) argue that no country has substantially reduced poverty without exponentially increasing the use of energy, replacing human and animal labour with more convenient and efficient sources of energy and technology. Hussein and Filho (2012) state that essential aspects of human welfare, such as living long and productive lives, enjoying good health, having access to knowledge and education opportunities, having the potential to earn sufficient income to supply themselves with ample nutrition, shelter and other material and aesthetic needs, may improve only if modern, affordable, and clean energy becomes available for all. Failure to adopt affordable and cleaner sources of energy contributes to energy poverty (Njiru and Letema, 2018: 3).

According to Fatona, Abiodun, Olumide, Adeola, and Abiodun, (2013: 83), energy is necessary for meeting basic human needs and a prerequisite for economic development. Nnaji, Uzoma and Chukwu (2010: 32) specify that the energy and poverty reduction link is strong and operates through socio-economic development, which involves productivity, income growth, education, health, and gender. Household consumption of energy enhances standards of living because health is improved through refrigeration, education enhanced through lighting and improved communication, income is improved due to increased productivity and the environment is conserved due to reduced pressure on traditional energy sources (Njiru and Letema, 2018: 2). Fatona, et al., (2013: 84) argues that lack of energy services is directly correlated with the major elements of poverty, including inadequate healthcare, low education levels and limited employment opportunities.

Nnaji, et al., (2010: 33) argues that, universally accessible energy services in the form of renewable energy resources that are adequate, affordable, reliable, of good quality, safe and environmentally benign are, therefore, a necessary condition for sustainable development and poverty reduction. As a complementary measure, careful management of energy resources is important to reduce poverty, promote economic growth, improve socio-economic conditions, protect the environment, and provide trade opportunities. Njiru and Letema (2018: 8) concludes that access to modern, affordable, and clean energy services has a positive impact on standard of living and is an essential element in a poverty reduction strategy.

The study therefore explores renewable energy situation in Soweto towards developing a renewable energy framework towards poverty reduction in South Africa. This chapter introduces the study and provides a background of the study. The problem statement and aim of the study is presented. The research objectives and null hypothesis are explained. Significance of the study narrates the importance of the study to several stakeholders. The chosen location of the study is discussed in detail, including historical events and activities that took place in the study area. The chapter further highlights brief research design and presents working definitions for terms that are key in the study. Furthermore, the chapter presents the organisation of the study before winding off with a chapter summary.

1.2 BACKGROUND OF THE STUDY

According to Mahajan (2014: 3), the history of South African townships is very much rooted in the country's apartheid past, their culture steeped in the richness of the struggle against it, their economic infrastructure left in tatters by its' oppressive rules and regulations. The term township according to Pernegger and Godehar (2007: 1), has no formal definition but is commonly understood to refer to the underdeveloped, usually (but not only) urban, residential areas that during apartheid were reserved for non-whites (Africans, Coloured and Indians) who lived near or worked in areas that were designated 'white only' (under the Black Communities Development Act - Section 33 and Proclamation R293 of 1962, Proclamation R154 of 1983 and GN R1886 of 1990 in Trust Areas, National Home lands and Independent States).

Jürgens, Donaldson, Rule and Bähr. (2013: 256) argue that the most obvious remnants of apartheid doctrine, at least about spatial organisation, is the so-called township, a term that emerged to identify 'non-white' neighbourhood alone and was thus a core spatial concept of the apartheid era, but it is a term that nevertheless continues to be used today. Pernegger and Godehar (2007: 6) state that townships are considered a specifically South African 'invention' but they were inspired by colonial town planning and can be found in many African cities, such as Nairobi, Lusaka, cities in the Democratic Republic of Congo and even in Zanzibar. Mahajan (2014: 4) mentions that uniquely South African concept of a township: a dormitory town built at a distance from economic activity as well as from white residential areas; with rows of uniform houses; and historically lacking services and infrastructure such as tarred roads, sanitation, water, or electricity. Even more so, it lacked economic infrastructure in a context in which far from promoting local economic development, apartheid laws curtailed it (Mahajan, 2014).

Bond (2000: 405) argues that townships were racially discriminatory in that black African, Coloured (mixed-race), and Indian people were ordered by the Land Act of 1913 and the Group Areas Act of 1950 to live separately. Townships are defined by Lester, Menguele, Karuri-Sebina, and Kruger (2009), as areas that were designated under apartheid legislation for exclusive occupation by people classified as Africans, Coloured and Indians. This definition was supported by Sibiya (2012: 3) who mentions that in South Africa, the term ‘former black township’ refers to areas that were designated for people who were classified as Africans, Coloured or Indians under the apartheid regime. Jürgens et al., (2013: 256) argue that as opposed to the ‘white’ suburbs, the townships developed as dormitory settlements without any substantial ‘urban’ elements, as witnessed by their rudimentary infrastructure (public services, recreation, industry, transport, green spaces). As a rule, the townships were and are still located on city peripheries and were deliberately separated from the characteristically city centre by natural or artificial buffer zones (Jürgens, et. Al., 2013: 256).

In South Africa, the first townships were founded more than a hundred years ago; the oldest existing one is New Brighton in Port Elizabeth. It was built in 1902-1903. Several townships were built between the two World Wars by the municipalities at the peripheries of the cities and separated from the cities by a green belt. Examples are Langa in Cape Town, Lamontville and Chesterville in Durban and Meadowlands in Johannesburg (Pernegger and Godehar, 2007: 6). According to Bond (2000), Cape Town and Port Elizabeth had townships dating to the early nineteenth century, the first modern, formal townships were in Kimberley, where migrant workers came to work in the mines following the discovery of diamonds in 1867. Lester et al., (2009: 6) argue that over the years, townships have developed an iconic profile in South African society, representing the very heart of where the struggle for freedom was waged, where many of today’s leaders, including famous politicians, artists, business icons, sportsmen and women were born and grew up.

Pernegger and Godehar (2007: 7) mention that most large townships were built after 1950 by the apartheid government or saw significant expansion after this period. The entire non-white urban population was forced to live in townships through the enforcement of the Group Areas Act of 1950 and other pieces of town planning legislation which determined the strict separation of race groups by stipulating, for example, that: each race group should have its own consolidated residential area and each residential group area should be separated by a strong physical buffer such as a river or ridge or by use of a buffer such as an industrial or commercial area (Pernegger and Godehar, 2007). Should buffers of this kind not be available, then an open space or buffer

zone was to be left between group areas. According to Bond (2000: 405), South Africa's largest metropolis (founded with the discovery of gold in 1886), the best-known townships are Soweto (an acronym for South-Western Townships) and Alexandra. Others include Bosmont (largely Coloured), Daveyton, Diepsloot, Duduza, Eldorado Park (colored), Etwatwa, Evaton, Ivory Park, Kagiso, Katlehong, KwaThema, Lenasia (Indian), Orange Farm, Tembisa, Thokoza, Tsakane, Vosloorus, and Wattville. These stretch more than 30 miles (50 kilometers) East–West and North–South, and they fuse into other townships near Pretoria and the Vaal River (Bond, 2000).
This study then takes a close look at Soweto, a large township in the Johannesburg Metropolitan Area, to bring out more vividly the poverty realities and energy choices of township residents.

1.2.1 The location of the study

South-West Township, known as Soweto, located in the City of Johannesburg metropolitan municipality in the province of Gauteng. According to Harrison and Harrison (2020: 296), Soweto had its origins in 1905 when the slum yards of Newtown in central Johannesburg were razed to the ground and African residents were moved to Pimville (initially known as Klipspruit). Soweto lies 15 kilometers southwest of Johannesburg, South Africa. Soweto, the township was designed and created precisely to separate the black urban population out of the white city, except when they were needed there, temporarily, to work (McCormick, 2006). Morontse (2010) states that the formation of Soweto is associated directly to the discovery of gold in 1885. Soweto grew as black workers came to the industrialised area and responding to labour demands after First World War (Vosloo, 2020; Morontse, 2010; McCormick, 2006). As the gold mining industry developed, so did the requirement for labour increase. Vosloo (2020) also states that migrant labour was started and most of these workers lived in mines compounds. However, other workers had to find their own accommodation often in appalling conditions.

The increase of migrant labour, which was predominantly blacks, many of whom came for labour in the gold mining industry, had to be located in Soweto. Harrison and Harrison (2020: 296) show that Soweto's population is officially estimated at approximately 1.3 million, with between 600 000 and a million people in the township regarded as living in abject poverty. The township covers an area of approximately 150 km², just more than 9% of the 1 644 km² of the City of Johannesburg and is home to 43% of the City of Johannesburg's population. It has an estimated density of approximately 8 667 people/km² compared to the 1 962 people/km² for the whole City area (Harrison and Harrison, 2016: 293). Maphela and Cloete (2019) shows there are four entrances to Soweto, which extends for 120 km. Soweto consists of 34 suburbs or neighbourhood and covers an area estimated at 9 640 ha.

Soweto is well-known for the role it played in the struggle against apartheid. The IOL (2022) revealed that in 1976, students revolted against the apartheid regime after many years of repression of the Soweto community, starting with the establishment of the suburb in the 1950s through the forcible removal of people from one of the neighbourhoods, known as Sophiatown. Soweto is a township developed for black people under the apartheid system. Most of the struggle against apartheid was fought in and from Soweto. The 1976 student uprising, also known as the Soweto uprising, started in Soweto, and spread to the rest of the country (McCormick, 2006). Soweto's street level map showing the suburbs and landmarks of Soweto in the context of South Africa geographic map, follows.

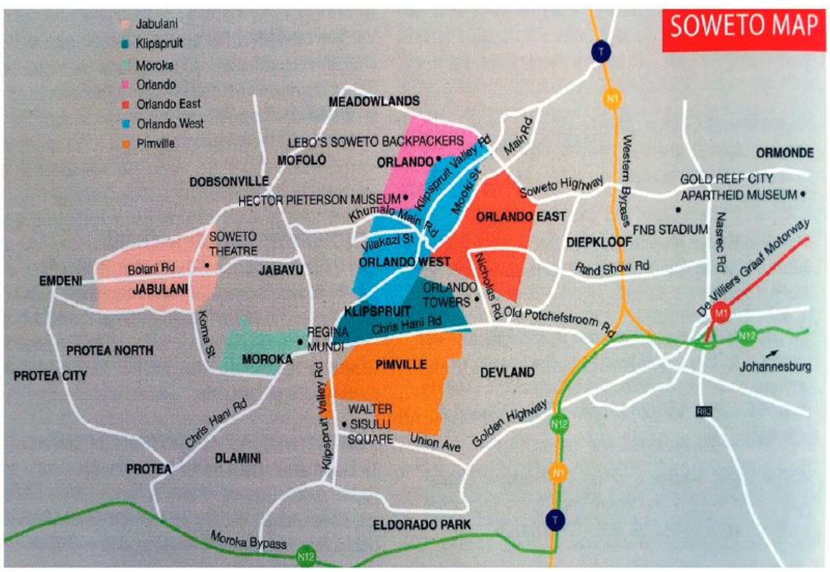


Figure 1.1: Map of Soweto

Source: Maphela and Cloete (2019)

According to Statistics South Africa there were 1,271,628 people living in Soweto at the time of the last Census (Social Statistics, 2017). There were 355 351 households in Soweto, 9.3% of residents aged over 20 years had a higher education, only 55% of Soweto residents had piped water inside their dwelling, while around 93% had electricity of lighting, and around 91% had access to a flush toilet connected to a sewerage system (Social Statistics, 2017). During the apartheid years, Black Africans were forced to live on the outer edges of cities, thus Black African's dominates the population profile of Soweto. Black Africans in Soweto makes up a population 98.5% (Social Statistics, 2017). The most spoken language in Soweto is IsiZulu with 37.1% of citizens speaking it, and Sesotho being the second most spoken language (15.5%) out of the 11 official languages in South Africa (Social Statistics, 2017). Many Sowetans speak between three and five languages, with Soweto's city slickers speaking a brand of streetwise Afrikaans commonly referred to as *tsotsi taal* (Ramchander, 2004).

1.2.2 The Socio-economic status of Soweto residents

The housing in Soweto is diverse, ranging from the 4 roomed houses originally built by the apartheid regime to backyard dwellings of corrugated iron and brick-built rooms in backyards (McCormick, 2006; Ramchander, 2004; StatsSA 2011). The area is interspersed with informal settlements containing approximately 12800 shacks (IOL, 2022). According to Social Statistics (2017), a majority of households rent the dwellings they stay in (28.6%) and a further proportion of households in Soweto are reported as owned and fully paid dwelling (21.4%). A large part of the Soweto dwelling is informal shacks or government provided housing for which limited payment was required or housing was supplied free of charge to the beneficiaries. Soweto is known for being extremely close to very affluent areas, yet the majority of people living in Soweto are still living in poverty. The graph below provides an indication of the percentage of Soweto population earning between various income groups.

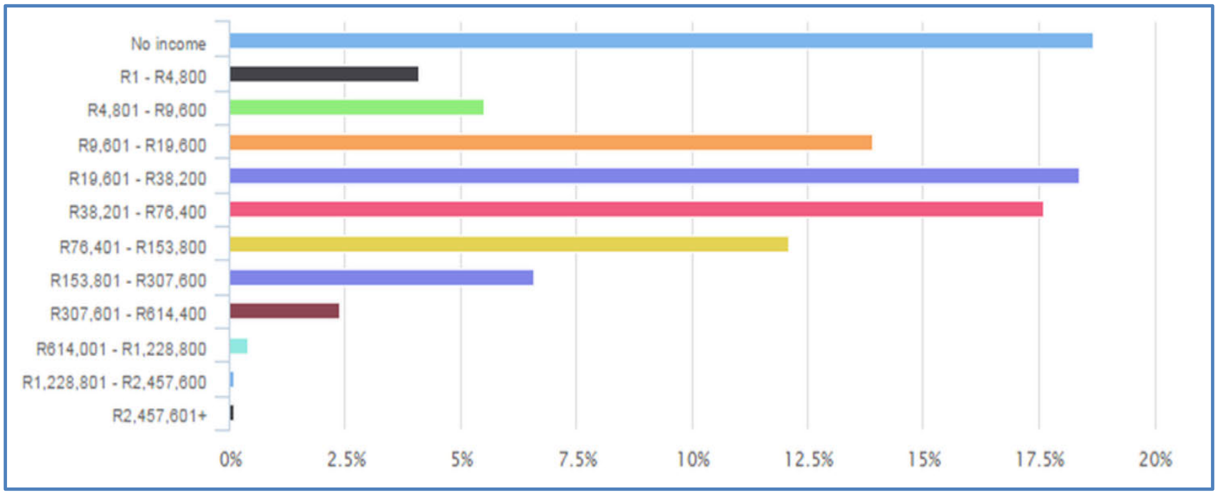


Figure 1.2: Average Household Income

Source: Social Statistics (2017)

As indicated in figure 1.2 above, the graphic depicts a large proportion (roughly 19%) of Soweto population earns absolutely no income. Maphela and Cloete (2019) argue that it is estimated that 40% of the population of Soweto is unemployed, giving rise to a high incidence of crime. The graph above indicates that those that earns more than R38,200 and R76,400 is 18% and 17.5% respectively. Only 2.5% of Soweto total population earns more than R307 600 a year.

1.2.3 Electricity Crisis in Soweto

Ramchander (2004:12) affirms that Soweto is internationally known and is South Africa's most famous township because it symbolises political freedom to people around the world. As a result, with little or no marketing, and despite a great deal of adverse publicity, it has established itself as a major destination for foreign tourists in South Africa. According to Sunday Independent (2022), majority of people in Soweto, they bridge electricity because they cannot afford to pay for it. According to IOL (2022), most of the people who live in Soweto are unemployed and don't have a steady income.

Soweto is known for refusing to pay for electricity. Bond (2002) argues that its struggle for access to electricity for all is well-documented, especially its strategy of 'communing' electricity, namely, re-connecting residents who are cut off by the authorities for failure to pay their bills on time. Under apartheid, according to Naidoo and Veriava (2009), the majority of Soweto residents, together with other township dwellers, boycotted paying for basic services such as electricity in a collective strategy of resistance against the provision of poor and unequal services. IOL (2022) describe the Soweto Electricity Crisis Committee (SECC) as a social movement organisation that made a substantial impact in Soweto on issues of service delivery in the township. This issue includes but not limited to electricity crisis', service delivery, land redistribution and evictions to major court cases around issues like water meters to more spectacular demonstrations at the United Nations World Conference Against Racism (WCAR) and the World Summit for Sustainable Development (WSSD), the movements have shown an ability to mobilise and build, in broad terms, a progressive, anti-neoliberal momentum (IOL, 2022).

According to Fiil-Flynn et al. (2001: 5), it is widely accepted that access to affordable electricity has a wide range of positive developmental effects. Increased usage of electricity generally improves the level of welfare (particularly for women and children), decreases health expenditures, and improves life opportunities for low-income families. In Soweto, a combination of arrears and inability to pay for electricity led to widespread electricity cut-offs from 2000 on (Naidoo and Veriava, 2009: 324). In the context of post-apartheid, Soweto and promises made by the democratic government for affordable basic services for all, electricity is understood to be a right that is due to the people of Soweto, most of whom make up the membership of the Soweto Electricity Crisis Committee (IOL, 2022). In this respect, electricity is symbolic of what it means to have dispensed with apartheid.

Electricity tariffs have increased more than 400% over the past 20 years (Sunday Independent, 2022). According to IOL (2022), In Soweto compliant and non-compliant residents find themselves protesting side-by-side when Eskom shuts down electricity for up to two months in other areas where the overloaded system often causes transformers to explode leaving residents in the dark.

1.3 AIMS OF THE STUDY

The aim of the study was to develop a renewable energy framework towards poverty reduction in South African townships focusing on the Soweto township as a case study, through a survey in which the interview and questionnaire are used to gather data to enhance economic growth and better socio-economic status of the people living in the South African townships. The study further provide contribution to body of knowledge, community, business, and energy utility, and outline the scope for future research. A renewable energy business framework is developed for entrepreneurs.

1.4 PROBLEM STATEMENT

The historically grown structures of the South African energy sector continue to fuel both the country's high poverty and emissions levels (Rennkamp, 2018: 3). Poverty is regarded by Hussein and Filho (2012: 2656) as one of the world most fundamental burning issues, which needs to be addressed through socio-economic development. Nnaji, et al., (2010: 31) claims that poverty refers to an individual's (or family's) lack of access associated primarily with inadequate income to basic human needs such as food, shelter, fuel, clothing, safe water, sanitation, health care and education. Hussein and Filho (2012: 2656) conceptualise poverty in material terms as not having access to adequate levels of food, water, clothing, shelter, sanitation, health care and education, which can be translated into people having insufficient income. Poverty can be addressed through access to energy sources that are modern, clean, and affordable. Increased access to energy resources is the most fundamental requirement for poverty reduction and economic growth (Fatona, et al., 2013: 83).

According to Nnaji et al., (2010: 32), energy services are paramount to the basic development challenge of providing adequate food, shelter, clothing, water, sanitation, medical care, schooling, and access to information. Although energy is one dimension or determinant of poverty and development, it is vital. Fatona et al., (2013: 84) argues that without access to basic energy services for lighting, cooking, heating, pumping, transportation, communication and other productive purposes, people, most often women, are forced to spend the majority of their time and physical energy on subsistence activities. Nnaji et al., (2010: 32) further argues that energy supports the provision of basic needs such as cooked food, a comfortable living temperature, lighting, the use of appliances, piped water or sewerage, essential health care (refrigerated vaccines, emergency and intensive care), educational aids, communication (radio, television, electronic mail, the world wide web) and transport.

Thiam (2011: 25) states that linking energy access to poverty reduction requires a preliminary definition of poverty. Considering the monetary definitions of poverty, the relationship between energy access and poverty reduction could be captured through a causality analysis. Energy consumption is related to poverty reduction issues in various ways such as improvement of social wellbeing. Sandor, Bódis, Huld and Moner-Girona (2013) argue that lacking access to sufficient and clean energy sources has several consequences on the living conditions of people, on their health and on their ability to engage in productive activities and can result in situations where people are ‘trapped’ in poverty. Therefore, Nadia (2013) recommends that giving people access to affordable and clean energy sources is an important lever of poverty reduction policies. Several empirical studies have been conducted using econometric instruments to analyse the causal relationship between energy consumption and economic growth (Lee 2005; Odhiambo 2009; Wolde-Rufael 2008; Akinlo 2008). The bidirectional trend of a causality effect means that energy consumption draws economic growth and inversely an increase of economic growth draws energy consumption upwards. Thiam (2011:25) concludes that if the multidimensional aspect is performed, Socio-economic analyses provide better results about the link between energy access and improvement in the standard of living.

Modern, clean, and affordable energy plays a crucial role in poverty reduction such as improve health care and better socio-economic status. The relationship between energy access and poverty reduction has a growing literature (World Bank, 2007; Maiga, 2008). According to Thiam (2011: 23), the desire to increase energy access remains a strong driving force for poverty reduction in the rural and urban areas of developing countries. This was also supported by Fatona, et al., (2013: 83) who indicated that energy services are an essential engine for growth to enable developing countries to overcome poverty and the conditions of poverty. Hussein and Filho (2012: 2656) consider energy as an important input to achieving sustainable development, including the reduction of poverty. Fatona et al., (2013: 84) states that lack of energy services is directly correlated with the major elements of poverty, including inadequate healthcare, low education levels and limited employment opportunities. Poverty and lack of access to modern energy services are often inter-related whereby lack of access to modern energy aggravates poverty by limiting opportunities for the population to better itself (Kanagawa and Nakata, 2008; Kaygusuz, 2011). Brew-Hammond (2010) also mentions that access to modern, reliable, and affordable energy is one of the essential elements for socio-economic development and poverty reduction. Limited availability of modern energy critically impairs socio-economic development, whereby women travel long distance to get wood for cooking (Fatona et al., 2013: 85). Hakirii (2015: 8) argues that energy plays a significant role in reducing poverty.

Maradin et al., (2017: 49) also maintains that energy is essential in the economy and in modern society in general. The study conducted by Groh (2014) states that approximately 1.3 billion people globally are living without access to electricity and another 2.6 billion people are dependent on traditional biomass. In South Africa, the energy sector continues to fuel high levels of emissions (Rennkamp, 2018: 3). The generation of electricity in South Africa is dominated by coal which causes harm to the environment through carbon emissions. The study by Timmons, Harris, and Roach (2014) mentions that the twenty-first century is already seeing the start of the next great transition in energy sources away from fossil fuels towards renewable energy sources. This transition is motivated by many factors, including concerns about environmental impacts (particularly climate change), limits on fossil fuel supplies, prices, and technological change. There is a strong relation between energy access and environment sustainability.

Thiam (2011: 26) indicated that on the global level, the affordability of modern clean energy diminishes the environmental damages caused by greenhouse gas emissions (GHG). In this regard, different policies could be applied to reduce carbon emissions, such as enhancing renewable energy deployment and encouraging technological innovations (Thiam, 2011). Visagie (2006: 1) mentions that to promote economic development and environmental protection it is imperative for the country to consider new paradigms for energy production and consumption, thus incorporating the exploitation of its renewable energy resources. This study therefore, investigated the significance of renewable energy, which is clean, affordable, and environmentally friendly as a poverty reduction strategy in South African townships. Considering the above problem statement, the lead-research question for this study is: To what extent can affordable renewable energy technologies contribute to a poverty reduction strategy in the community of Soweto that promotes socio-economic and climate change benefits?

1.5 THE RESEARCH OBJECTIVES

The primary objective of the study was to develop a renewable energy framework towards poverty reduction. In doing so, the study investigates the role of clean and affordable renewable energy as the alternate source of energy in reducing urban poverty and contribute to poverty reduction in a South African township neighbourhood, at the same time develop a renewable energy framework towards poverty reduction. In support of the primary objectives, the study sought to address the following secondary objectives:

1. Establish renewable energy practices towards poverty reduction in Soweto.
2. To assess the effect of an increase in renewable energy on the socio-economic status of communities.
3. Identify trade opportunities in green energy power and the renewable energy sector for community sectors.
4. Develop a renewable energy framework that would reduce poverty, thereby improving economic growth and better socio-economic status of the people living in the South African townships.

1.6 THE HYPOTHESES OF THE STUDY

The study further investigates the following null hypotheses:

- H_1: There is no relationship between access to affordable renewable energy and poverty reduction in urban areas.
- H_2: There is no relationship between access to affordable renewable energy and economic growth in urban areas.
- H_3: There is no relationship between access to affordable renewable energy and socio-economic conditions in urban areas.
- H_4: There is no relationship between access to affordable renewable energy and environmental conditions in urban areas.
- H_5: There is no relationship between access to affordable renewable energy and trade opportunities in urban areas.

1.7 THE SIGNIFICANCE OF THE STUDY

The study is significant to several stakeholders which include but not limited to: Soweto community, the government, the energy sector, and the researcher. For the empirical work, in Soweto community, this study would create new data about a neighbourhood and its salient features, in the terms of the study, and would open a window (an observatory) into the lives of residents living within a community characterised by chronic urban poverty (the consumers). In many parts of the world, renewables represent the lowest-cost source of new power generation technology, and costs continue to decline. For cities in middle-income and low-income like Soweto, renewable energy is the only way to expand energy access to all residents, particularly those living in urban townships and informal settlements, in suburban and peri-urban areas and in remote areas. This study contributes to knowledge of the lives of people in Soweto and in larger population of South African township residents, and to government and NGO township development policies.

In terms of government, South African government can dramatically decrease their carbon footprint by procuring or directly producing electricity from clean, affordable renewable sources. South African government can lead by example by producing energy on-site, procuring green power, or obtaining renewable energy. Using a mixture of renewable energy options can support South African government to meet green emission goals especially in some regions where accessibility and quality of renewable resources fluctuate. More important, renewable energy sources can help South African government to realising environmental and economic benefits of using renewable energy include. In South Africa, renewable energy source can help government to meet it 2030 goals for energy mix and assist in relieving pressure on government from the current challenge of loadshedding experienced by all South Africans.

Renewable energy can also aid the energy sector by generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution. Diversifying energy supply and reducing dependence on imported fuels can be favorable to the energy sector. The combustion of fossil fuels for energy results in a significant amount of greenhouse gas emissions that contribute to global warming. Most sources of renewable energy result in little to no emissions, even when considering the full life cycle of the technologies. The implementation of renewables in the energy sector would help government in creating economic development and jobs in manufacturing, installation, and more. Renewables make urban energy infrastructures more independent from remote sources and grids. This would help the energy sector to produce reliable energy supply to the community of South Africa.

In academia, the study contributes to existing knowledge on renewable energy sources as clean and affordable energy sources that can help in reducing poverty in townships. The study would also allow the researcher to tease out and map the market and political cases for renewable energy approaches to chronic urban poverty reduction. The researcher would further gain new knowledge and understanding of the development of renewable energy as the poverty reduction strategy and also be able to formulate business plan in the renewable energy.

1.8 BRIEF RESEARCH DESIGN

Kanny (2013: 14) mentioned that research design addresses the planning of scientific inquiry in designing a strategy for finding out something. Moralesa and Ladhari (2011: 245) states that the knowledge claims, the strategies, and the method all contribute to a research approach that allows itself to be categorise as quantitative, qualitative, or mixed. Kanny (2013:45) argues that qualitative research is used to gain insight into people's attitudes, behaviours, value systems, concerns, motivations, aspirations, culture, or lifestyles. Quantitative research, by contrast, focuses on gathering numerical data and generalising it across groups of people. The mixed method research approach is defined by Creswell (2014) as research in which the investigator collects and analyses data, integrates the findings, and draws inferences using either qualitative and quantitative approaches or methods in a single study or program of inquiry.

Annan (2019: 34) offers the standard social scientific view of a survey as a research design in which a sample is selected from a population and studied to make inferences about the population. Surveys typically use questionnaires and interviews to determine the options, attitudes, preferences, and perceptions of persons of interest to the researcher. A survey or questionnaire is the main tool or instrument used to collect data in a descriptive survey research study (Lodico, Spaulding, and Voegtle, 2010: 204). This was supported by Junpath (2013: 51) who states that survey research is a method for collecting and analysing social data *via* highly structured and often very detailed interviews or questionnaires in order to obtain information from large numbers of respondents presumed to be representative of a specific population.

This study was conducted in two phases: the first phase focused on quantitative research, and secondary data sources, and the second phase focused on a qualitative research approach. Therefore, a mix method research approach was employed in this study. The reason for employing multi-method social scientific research approach is that it allowed the researcher to produce a case study of one South African neighbourhood within a township, to include quantitative and qualitative research approaches, to create breadth and depth in the study. The target population for this study included all residents of a specific Soweto neighbourhood who are 18 years of age and above and within these residents, 10 household units ‘families’ and 5 ‘industry’ expect were interviewed and studied. Only adults were allowed to participate in the study. For the purpose of this study, probability sampling technique was utilised. The researcher used a stratified random sampling method when choosing members of the population to participate in the study. The quantitative data gathering was analysed using the SPSS statistical package (latest version 29) and conducted appropriate statistical tests on the data, and thematic and narrative analysis technique was used for the analysis of qualitative data. The details of the research design are presented in Chapter 4 of the study.

1.9 DEFINITION OF TERMS

This section presents working definitions of terms that are key in the study.

Renewable Energy is the energy from a source that is not depleted when consumed, often referred to as clean energy and is derived from the natural resources such as sunlight, wind, the movement of water, biomass and geothermal heat.

Poverty alleviation is the means by which governments and various organisations both local and international seek to improve the standard of living of the poor and is referred to as a set of measures that are intended to permanently lift people out of poverty, for example the World Bank Poverty Alleviation Fund.

Empowerment is referred to as the process of gaining freedom, power, expansion of assets and capabilities of poor people to participate in, negotiate with, influence, control, and hold accountable institutions that affect their lives.

Economic growth is referred to as an increase of the national income per capita, and it involves the analysis, especially in quantitative terms, of this process, with a focus on the functional relations between the endogenous variables; in a wider sense, it involves the increase of the national wealth, including the production capacity, expressed in both absolute and relative size, per capita, also encompassing the structural modifications of economy.

Socio-economic refers to the field of study that examines social and economic factors, which is determined by a combination of social and economic factors such as income, education levels, occupation and place of residence, etc.

1.10 ORGANISATION OF THE STUDY

The study is presented in seven chapters as outlined below:

1.10.1 Chapter 1: Introduction and background of the study

Chapter one presents the introduction of the study and provides detailed background to the study. The rationale for the study is presented together with the research objectives and summary of the research design. The detailed history of the chosen study location or chosen township where the study is conducted is also discussed in detail. The structure of the thesis is also clarified in this chapter. Definitions of important terms are also presented in this chapter.

1.10.2 Chapter 2: Theoretical framework

Chapter two reviews the theoretical framework that was adopted to guide the study. The study adopted the Adopters Categories model as its main theoretical framework. Chapter two discusses and provide examples for the following theories: Adopters Categories model, the SWOT Analysis, PESTEL Analysis and Business Canvass Model. This chapter further present conceptual framework of the study.

1.10.3 Chapter 3: A review of energy supply in South Africa

Chapter three presents a critical review of related literature on the definitions, principles, policies, and practices with respect to electricity and renewable energy as the alternative source of energy.

Eskom as the energy utility and energy monopoly in South African is unpacked. The renewable energy is defined and renewable energy benefits, advantages were discussed in detail. The history of government policies towards the 'green economy, and green energy is discussed, and the literature on ‘greenism’ and renewable energy supply is selectively reviewed. This chapter also looks at 4 Sustainable Goals (SDGs) namely: no poverty; affordable and clean energy; decent work and economic growth and climate action, and at concepts like development, sustainability, and sustainable development. Renewable energy as an affordable and clean energy is one of the important 17 SDGs goals is also discussed. This chapter further unpack a history of government anti-chronic urban poverty policies, research on their effectiveness and draws on worldwide sources and contexts in relations to renewable energy as a poverty reduction strategy. This chapter also examines business or trade opportunities available in the context of renewable energy.

1.10.4 Chapter 4: Research design

Chapter four discusses the research design and methodology used in the study. Sections covered by the chapter include the research design, data collection methods and research instruments. The chapter also discusses data analysis processes, validity and reliability of the study and ethical considerations which have been considered in undertaking this research.

1.10.5 Chapter 5: Presentation of the results

Chapter five presents the research findings, analysis of the qualitative and quantitative data collected and interpretations of these results in accordance with the theory discussed in the literature review and the study research questions. Presentation is in the form of tables and graphs. Presentations begin with quantitative results collected from the participants in the questionnaire. These were categorised and presented based on the sections of the questionnaire. The last section of the chapter presents the qualitative responses obtained from interviews. Qualitative results were presented in the form of themes relating to the main variables of the study.

1.10.6 Chapter 6: Discussion of the study

Chapter six deals with the discussion of the data results and the interpretation of the research findings from the quantitative and qualitative data analysis. The chapter also discusses integrated results as part of answering research hypothesis and objectives. The discussion seeks to highlight the meaning of results obtained in chapter five in relation to the main variables. As such, the results are compared with conclusions from other scholars in the field. In addition, the discussions draw from and refer to the literature reviewed in order to attain the meaning from the findings.

1.10.7 Chapter 7: Conclusion and recommendations

Chapter seven presents the study summary, conclusions, and recommendations in line with study objectives. In addition, the chapter presents a renewable energy framework towards poverty reduction in South African townships. Furthermore, a renewable energy business framework is proposed in this chapter. The chapter then concludes with the scope for further research.

1.11 SUMMARY

The chapter provided introduction to the study and has set out the scope of the study and clearly stated the aim and objectives developed for the study. The background information on the history of South African townships and the location of the study was discussed. Soweto background as the chosen township for case study was examined together with the socio-economic status and electricity challenges that Soweto residents are facing. Research objectives and research hypotheses of the study were also specified. Significance, and contribution of the study to the body of knowledge were examined. Lastly, the definition of terms and structure of the study were also outlined.

The next chapter presents the theoretical frameworks that informed the study.

CHAPTER TWO

THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter reviews several theories towards proposing a conceptual framework to guide the study. As stated in the previous chapter, the study sought to develop a renewable energy framework that would reduce poverty in South African townships focusing on Soweto. It is for this reason that this chapter reviews several theories building into the conceptual framework adopted for the study. The theories include the Adopters Categories model, the SWOT Analysis, PESTEL Analysis and Business Canvass Model. The study adopted the Adopters Categories model as its main theoretical framework taken from the main theory, popularly known as the Diffusion of Innovations theory. In addition, the chapter discusses the relevant of the emerging conceptual framework.

2.2 THEORY 1: ADOPTER CATEGORIES COMPONENTS

Adopter categories can best be described as dividing product adopters based on the level of willingness and time with which they tried or would try the product or service. Adopter categories explains the consumer adoption journey over a period of time (Rogers, 1994; Rogers 2010; Rogers, Collins-Jarvis and Schmitz, 1994; Rogers, 1995; Martinez, Polo and Flavian, 1998). In its simplest terms, adopters are regarded as consumers who have already began making use of or exploring the product or service offerings. In this case, the product or service offering is renewable energy and consumers are Soweto residents. Adopter categories are discussed and described in relation to the Diffusion of Innovations Model. In line with these views, Rogers (1962) observes that understanding where these fit into the product-life cycle can undoubtedly enable selective marketing and design activities which are focused on tapping into these adopters' specific needs. In addition, Rogers further argues that this can increase a products or service’s chances of success.

In support of these views, Rogers, (1963) argues that when a new product or idea first surfaces in the market, it should be adopted by the different individuals that make up that particular market. Hence the identification of adopters is crucial for the development of proper and relevant marketing messages. It is important to address adopter category's values because it enables the maximisation of impact. If those who are tasked with the development of innovations or new ideas know that the path taken for adoption runs from innovator to laggard with three stops on the way, they can try to direct their marketing strategies to each relevant audience (Muller and Yogev, 2006; Escobar-Rodríguez and Romero-Alonso, 2014; Guttentag and Smith, 2020).

The consumer adoption patterns play a crucial role when it comes to understanding how organisations or individuals market their new products and services for adoption and/or consumption. In the absence of a clear understanding of what each type of adopter values it cannot be easy, if not impossible to target them through marketing. In his famous book, popularly known as the Diffusion of Innovations, Everett M Rogers, a well-known communication professor and sociologist, outlines five kinds of adopter categories for products and services and offers explanation into each of the categories. In simplifying the adopter categories, Rogers discusses a social system for adopters of recent innovation (Rogers, 1962). As depicted on figure 3.1 below, the adoption of innovation differs throughout the course of the product-life cycle (Gerpott, 2011; Laukkanen and Pasanen, 2008; Jacobsen, 2000; Agarwal, et al. 1998; Bennett III, 2004).

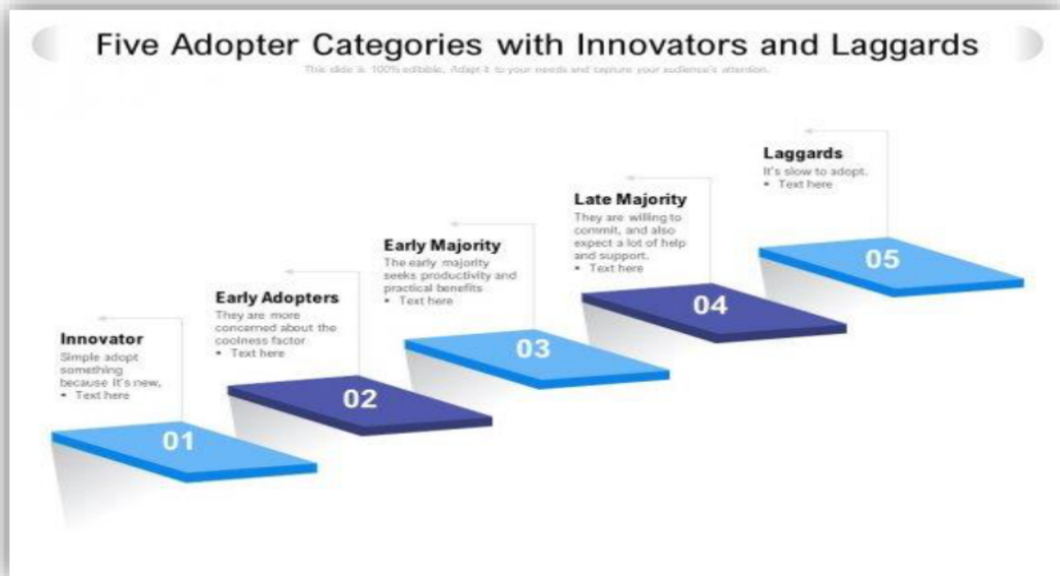


Figure 2.1: Adopter categories

Source: Adopted from Rogers (1962)

2.2.1 Characteristics of adopter categories

As depicted in figure 2.1 above, consumers are grouped into five adopter categories based on their behavioural values as well as patterns. Below are the five adopter categories listed according to their speed of uptake.

i. Innovators

Innovators can best be defined as risk-takers and who always seek for changes and new ways of doing things. More often than not, these are individuals who always come first when it comes to buying a new product or adopting a service. Some of the experts regard this group of adopters as trend setters as they are not sceptical to try the product or service while it still in its infancy and/or initial introduction phase. In his own point of view, Rogers (1963) describes innovators as individuals who are and will be crowding technological retailors such as Apple stores in order to buy an Apple watch. In support of the views above, Chesbrough and Crowther (2006) observe that innovators can be described as the first consumers to explore a new product or service. The latter authors add that innovators are always enthusiastic by the possibilities of new products and services, innovative ideas and new methods of doing things.

Generally, the products and services are likely to be more costly when they are released, and innovators are largely richer than other kinds of adopters. According to Chau and Hui (1998), in some instances innovators might decide to buy products and services in a thin field and dedicate most of their financial resources to that specific adoption. However, it is important to note that some products and services tend to disregard this trend. Bowers, et al. (2009) take these views further by stating that innovators are most likely to always have some degree of connection to the scientific discipline in which a new product or service is produced from and are most likely to socialise with other innovators in their selected product or service categories.

Chau and Hui (1998) add that innovators are well-known for their comfortability with the risks they take. Moreover, innovators are very much aware that some products or services that they procure might not produce the intended and promised benefits or might not be afforded to win the target audiences or market. According to Diederen, et al (2003), innovators will be the first group of adopters to be targeted for a product or service. This is the group of individuals that is expected to be identified by the marketing team very early during the product or service development. In this case, the marketing is done to gain the interest of these people in order to buy the product or use the service on offer hopping that involving them in early user trials will help to generally win their support. In line with these views, Bowers, et al. (2009) argues that from a design perspective, user research conducted with innovators tend to be very effective and helpful when it comes to developing prototypes before a mass market final product design.

ii. Early adopters

This refers to the individuals who begin to use a product or service immediately it becomes available or accessible. According to Chesbrough and Crowther (2006), this group of individuals is regarded as prestige-oriented opinion leaders as they hold a higher social status, education, and financial liquidity. Unlike innovators as stipulated above, early adopters prefer to use a product during its late introduction phase of its life cycle (Chau and Hui, 1998; Plötz, et al. 2014; Diederen, et al, 2003). Similarly, Diederen, et al (2003) provides an example of early adopters as individuals in countries such as India who have decided to adopt e-commerce in their business or consumers who have decided to procure goods and services through online platforms. According to Rogers (1963), early adopters are the second phase of product or service consumers after innovators. Furthermore, early adopters are regarded as highly influential individuals in their market space, and they tend to possess a degree of thought leadership for other prospective adopters.

In concurrence with the above views, Diederen, et al (2003) argues that early adopters are most likely to be always available online using different forms of social media and mostly producing reviews and other information relating to new products or services that they mostly prefer or do not like. Notwithstanding the fact that early adopters possess a reasonable access to money, actually beyond those of later adopters, and a sound approach to risk, they are most likely not taking as many risks as innovators. They are most likely to take numerous reasoned decisions with regard to whether or not to become involved in certain products or services. Early adopters tend to prefer to attain a lot of information compared to innovators with regard to the decision-making process (Chau and Hui, 1998; Plötz, et al. 2014; Diederen, et al, 2003). In support of the views above, Diederen, et al (2003) argues that early adopters are those who are targeted just after innovators.

In addition, Chau and Hui, (1998) further state that like innovators this group of adopters may also be approached prior to a product or service launch. The latter authors add that an emphasis will be placed on research into what this sector needs. Likewise, Plötz, et al. (2014) takes these views further by stating that marketers may choose to support early adopters with additional technical insights or behind the scenes perspectives of development to encourage them to share their thoughts with those who follow their thought leadership. This view is supported by Chesbrough and Crowther (2006) who argue that the mass market release of any product must be appealing and beneficial to early adopters if it is to convince those thought leaders to support further adoption of the product.

iii. Early majority

This group of adopters is regarded as the leading segment of the market, approximately one third of the target market (Mattila, Karjaluoto and Pento, 2003; Rogers, 1963; Chintalapati, 2021; Bowers, Ragas and Neely, 2009). The early majority group possess above average social status and they are not considered as opinion leaders. They tend to emerge in the buying process during the growth phase of the product or service (Mattila, Karjaluoto and Pento, 2003; Rogers, 1963; Chintalapati, 2021; Bowers, et al., 2009). For instance, Ram and Jung (1994) describe early majority as individuals who have adopted innovations such as cloud services. Based on Figure 2.1 in this chapter, it is clear that as the product or service starts developing mass market interest, the following step of adopter to arrive is the early majority.

According to Mattila, Karjaluoto and Pento (2003), this group of adopters is practically risk disinclined and prefers to be certain that their resources are wisely and safely used on products or services. However, the early majority are normally individuals who command and enjoy better than average social status and while not thought leaders in their own right they always prefer to be in communication with thought leaders and apply the views of these thought leaders when taking their decisions to adopt a product or service. In support of these views, Bowers, Ragas, and Neely (2009) are of the view that the early majority group is most likely to be targeted through more general marketing approaches and it is hoped that their connection with the early adopters will drive word-of-mouth sales. In addition, Chintalapati (2021) observes that designers may end up catering to the early majority through product iteration and offering improvements to the product.

Late majority

This group of adopters is regarded as followers of the early majority, usually doubtful about an innovation or new product or idea. In addition, late majority possess below average social status and have very little financial liquidity. This group of adopters represents approximately 36 percent of the prospect consumers. Moreover, late majority always prefer to try the product or service in its late growth and maturity phase (Hurlen, et al. 2010; Luckin, Shurville and Browne, 2007;

Bergström, 2015; Rogers, 1963). Likewise, Hurlen, et al. (2010) describes late majority as individuals who have just began making use of innovations such as debit and/or credit cards to virtually procure goods and services. In other words, late majority are potential consumers or individuals who are rather most doubtful regarding the adoption of a product or service compared to the first three groups of adopters. Basically, this group of adopters mostly prefers to put their own resources towards tried and tested solutions only and are risk averse.

Therefore, in a broad-spectrum, this group of adopters possess lower social status, little money and lesser amount of communication or engagement with thought leaders and innovators compared to the other adopters. The late majority infrequently provide any kind of thought leadership in a field (Mattila, Karjaluoto and Pento, 2003; Hurlen, et al., 2010; Luckin, Shurville and Browne, 2007; Bergström, 2015; Rogers, 1963). Similar views are shared by Luckin, Shurville and Browne (2007) who note that the late majority, will probably arrive as product differentiation occurs and the product has established itself in a particular niche in the market. The latter authors further state that marketing to this group is likely to be less aggressive in direct marketing and more based on special offers and promotions to incentivise a choice of one product over another in a competitive arena.

iv. Laggards

Laggards are known to be quite conservative, aversion to change-agents, and price conscious segment (Rogers, 1963; Essén and Östlund, 2011; Diederen, et al., 2003; Beukes, et al., 2018). These are older folks and most traditional individuals who always prefer to show their willingness to adopt the product or service in its late maturity phase and diminishing phase. Diederen, et al. (2003) describes laggards as individuals who would prefer to buy an Apple iPhone 4 while the latest iPhone in the market is iPhone 12. Basically, this group of adopters is described as a last group of people to reach at the adoption stage and their arrival is normally an indication that a product or service is reaching a decline phase. In other words, this group of adopters tend to value old-fashioned ways of doing things and mostly opposed to transformation, change and risk.

According to Essén and Östlund (2011), usually laggards have low socio-economic status and tend to occasionally source views or information outside of their own limited social scope.

Nonetheless, more often than not laggards are senior citizens who possess less technological competences compared to younger people. Similar to any generalisation, not all people of a category of adopters will conform to the common patterns of that particular class. For example, there might be high-income earners, risk-taking, high skilled, laggards including low-income, and poorly educated. There are numerous of senior citizens who are technological savvy. Hence Smith (2014) views these groups of adopters as helpful for generic planning for market entry and it would be regrettable if they are used to stereotype people. Similar sentiments are shared by Triguero, et al. (2016) who argues that it may be completely uneconomic to target laggards with direct marketing and it is likely that by the time they adopt a product, it is going into decline, and that pricing and general awareness of the product will most likely drive adoption from this group.

2.2.2 Relevance of the adopter's categories to the study

(i) Innovators

In the context of this study, renewable energy is regarded as an innovation because it is a new way of generating electricity. As already indicated above, innovators can best be defined as risk-takers and who always seek for changes and new ways of doing things (Muller and Yogev, 2006; Escobar-Rodríguez and Romero-Alonso, 2014; Guttentag and Smith, 2020). In the context of this study, innovators will be those individuals in society who have decided to use renewable energy to power their households or businesses. In addition, innovators in the context of this study could be the organisations that offer renewable energy. This is the first group of people to adopt renewable energy in the townships. Moreover, this is the group of community members or organisations that are expected to be identified by those who are promoting renewable energy in communities.

(ii) Early adopters

Early adopters are individuals who begin to use a product or service immediately it becomes available or accessible (Brown and Venkatesh, 2003; Ozdemir and Trott, 2009; Stafford, 2003; Zayim, Yildirim and Saka, 2006; Bowers, Ragas and Neely, 2009). In the context of this study, this group of adopters are those community members who are inclined in new ways of doing things. This is most likely to be community members who are employed. This group of individuals is regarded as prestige-oriented opinion leaders as they hold a higher social status, education, and financial liquidity. In addition, early adopters are regarded as highly influential individuals in their market space, and they tend to possess a degree of thought leadership for other prospective adopters. In the context of this study, this group of people refers to the household owners who have money and always play a significant role in the decision-making process within the household. They are so influential in the decision-making process such that they can decide whether to adopt renewable energy or reject it. Furthermore, this group of people in the township can also be refers to community leaders, political leaders, civil society leaders and community base organisation leaders.

(iii)Early majority

This group of adopters is regarded as the leading segment of the market, approximately one third of the target market. In addition, early majority possess above average social status and they are not considered as opinion leaders. This group of adopters is most likely to emerge in the buying process during the growth phase of the product or service. In the context of this study, this group of individuals refers to the community members who have had enough of power cuts and loadshedding currently experienced in South Africa. These are also individuals who are very much interested in new ways of doing things. In this case, these are community members who will not hesitate to adopt renewable energy. In addition, early majority are those individuals who have adopted innovations such as cloud services and have financial means to do so.

(iv) Late majority

Late majority are followers of the early majority, usually doubtful about an innovation or new product or idea. This group of adopters possess below average social status and have very little financial liquidity. This group of adopters represents approximately 34 percent of the prospect consumers (Mirthinti, 2023). In the context of this study, this group of adopters is regarded as community members who have very little to say in the decision-making process within the household. These are people who have very little money if nothing at all to be involved or decide in the decision to adopt or not to adopt renewable energy. Also, this group of people is always not inclined into the new ways of doing things and technology. They might question the significance of adopting renewable energy just for the sake of questioning. These are individuals who always prefer to try the product or service in its late growth and maturity phase. In the context of this study, this means that these people are most likely to adopt renewable energy if the majority of community members have already started using it. These are potential consumers or individuals who are rather most doubtful regarding the adoption of a product or service compared to the first three groups of adopters.

(v) Laggards

This group of adopters is well known to be quite conservative and aversion to innovations. In most cases, these are older people and most traditional individuals who always prefer to show their willingness to adopt the product or service in its late maturity phase and diminishing phase. In the context of this study, these are older women in the household who do not appreciate new ways of doing things. They prefer old ways of doing things because those are tried and tested methods of doing things. This group of adopters is described as a last group of people to reach at the adoption stage and their arrival is normally an indication that a product or service is reaching a decline phase.

2.3 THEORY 2: THE SWOT ANALYSIS

SWOT analysis is a framework for identifying and investigating an organisation's strengths and weaknesses, as well as the opportunities and threats the business is facing. SWOT is an acronym for strengths, weaknesses, opportunities and threats. Since, strengths and weaknesses are internal to an organisation and opportunities and threats external factors, SWOT analysis is sometimes called internal-external analysis. The primary goal of SWOT analysis is to enhance awareness of the influences that assist into making a business decision or establishing a business strategy. Nguza-Mduba (2020: 30) argues that SWOT analysis is one of the tools that are used by management when doing strategic planning as well as assessing the business for competitive advantage. Adom, Nyarko and Som (2016) mention that SWOT analysis is framework used to evaluate a company's competitive advantage and assist to formulate strategic planning.

According to Feder (2021), the strengths and weaknesses should not be taken as simple characteristics of a company, but more precisely as something that looks up against the competitors or that influences the customers' experiences. Feder (2021) added that as for opportunities and threats, these normally describe the shifts in the market, or in the broader world, that may take on a positive or negative risk for a business. On the other hand, Adom, et al., (2016) argue that there are opportunities and threats which an organisation cannot control but has to manage. Feder (2021) discusses the four elements of a SWOT analysis with examples of each element as follows:

(i) Strengths

Strengths are the things that a company does particularly well, or resources and assets that it owns that distinguish it from a competitor. It's important to know a company's strengths; they are what make the company thrive.

Examples of strengths:

- Solid financing
- A positive reputation
- Valuable intellectual property

(ii) Weaknesses

Weaknesses are internal attributes and resources that a company lacks. For business leaders, it's essential to know a company weakness because they make a business vulnerable. To identify the underlying cause of a company's weaknesses (or its strengths), Feder (2021) suggests using root cause analysis.

Examples of weaknesses:

- High levels of debt
- Low customer satisfaction
- Long delivery times

(iii)Opportunities

Opportunities are a set of external circumstances that, with the right decisions, can grow an organisation or position the company in a favourable strategic position.

Examples of opportunities:

- New trade agreement
- New environmental, social and corporate governance (ESG) reporting requirements can showcase a track record.
- Support for locally made products.

(iv)Threats

Threats are external forces that constitute a risk to a business. A company should be on the lookout for external obstacles; it will have to overcome them if it is to flourish. To analyse the threats (and opportunities) facing a business, Feder (2021) suggests one of the tools be a PESTLE analysis, which takes in the political, economic, sociological, technological, legal and environmental factors that influence an organization.

Examples of threats:

- New trade agreement which can bring increased competition.

- New ESG reporting requirements with possible heavier paperwork.
- Supply-chain problems.

As South Africa faces power failures as a result of load shedding, the demand and competition for renewable energy companies increases. As the competition heighten, the organisations operating in the power sector have to constantly scan the environment in order to determine both internal and external factors that affect their operations, favourably or unfavourably. The SWOT analysis tool is normally applied in four parameters in which managers often require and provide answers to questions to create important information for each parameter and determine their competitive advantage (Nguza-Mduba, 2020). This can assist the renewable energy businesses to be well informed of the changes in the market environment such as changes in customer preferences, attitudes, beliefs and values. It is, therefore, important that strengths and weaknesses match opportunities and threats in order to enable a company to have a strategic fit. Figure 2.2 below illustrates an example of a typical SWOT analysis framework of a renewable energy business.

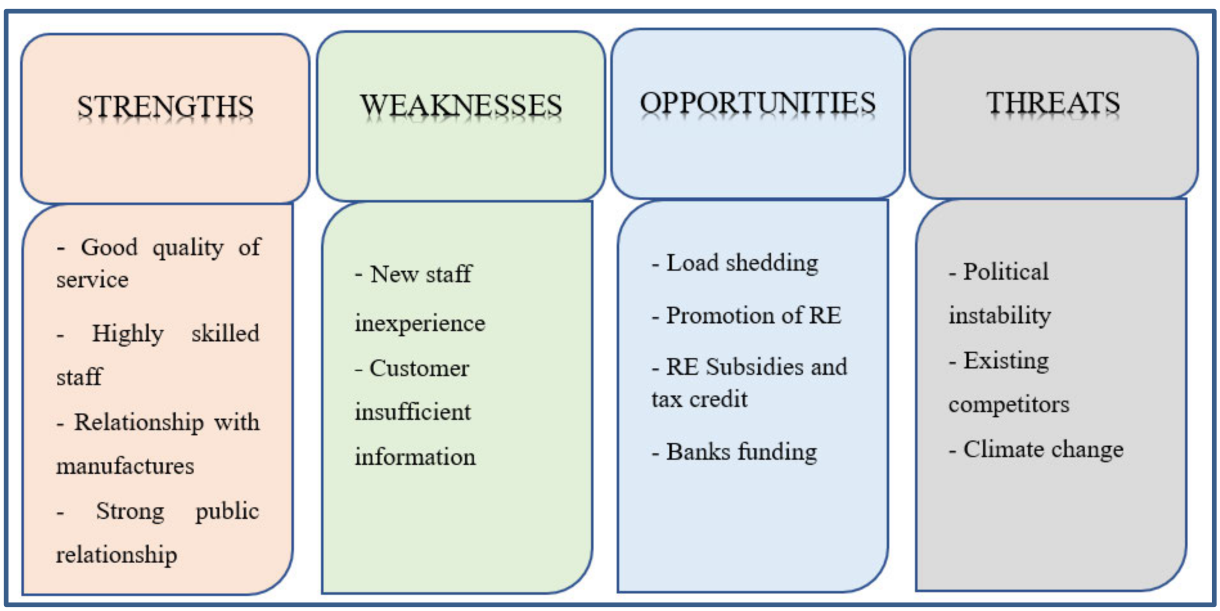


Figure 2.2: Typical SWOT analysis framework of a renewable energy business
Source: Researcher’s framework (2023)

The summary of the typical SWOT analysis framework of a proposed renewable energy business is discussed below:

2.3.1 Strength

Our core strength lies in the power of our team, our workforce. We have a team of certified and highly trained and experience solar panel installation, maintenance and repair engineers and technicians, a team with excellent qualifications and experience in various niche areas in the solar panel installation, maintenance and repair service industry. Aside from the synergy that exists in our carefully selected workforce, our services will be guided by best practices in the industry, and we offer our customers good quality of service. Our strong relationship with manufacturers and strong public knowledge distinguishes us from our competition.

2.3.2 Weakness

As a new solar panel installation, maintenance and repair company in South Africa, it might take some time for our organisation to break into the market and gain acceptance especially from top profile clients in the already saturated and highly competitive solar panel installation, maintenance and repair services industry; that is perhaps our major weakness.
Another weakness is that we may not have sufficient information or knowledge about our targeted customers. Our new and inexperience staff might take time to understand the markets trends.

2.3.3 Opportunities

No doubt, the opportunities in the solar panel installation, maintenance and repair services industry are massive considering the number of individuals and corporate organisations who are now switching over to alternative energy such as solar panel, as a results of load shedding and power failures that the country is experiencing. The promotion of renewable energy, bank funding, government subsidy and tax rebate offered by government will assist in attracting more clients to procure this service. As a solar panel installation, maintenance and repair company, we are ready to take advantage of any opportunity that is available in the industry.

2.3.4 Threat

Just like any other business, one of the major threats that we are likely going to face is economic downturn, climate change and political instability. It is a fact that economic downturn affects purchasing / spending power. Another threat that may likely confront us is the arrival of a new and existing solar panel installation, maintenance and repair company in same location where our target market exist and who may want to adopt same Business model like us. Continuous improvements in solar panels and batteries are also a threat to our company. Our company might not be able to keep up with the improvements made in the field of green energy which will put our company at a disadvantage.

It is recommended that a company perform a comprehensive analysis, using extensive data and looking at key industry players, every three to five years. The company can then spend a few hours doing a review of its initial assessment every year or every other year. Beyond those systematic analyses, a company can and should conduct a SWOT analysis on a smaller scale whenever it changes direction, and whenever it is facing a challenge on a more tactical level. A SWOT analysis can be very useful, for instance, if an energy business is underperforming or if the renewable energy company wants to gain a deeper understanding of its product mix. The next session presents another tool/framework that new solar organisations can utilise to scan the environment.

2.4 THEORY 3: THE PESTEL ANALYSIS

Mkude and Wimmer (2015) mention that globalisation and technology advancements have increased opportunities for organisations in public and private sectors to grow beyond national boundaries. Nevertheless, organisations have challenging tasks to manage the dynamic processes and their internal and external environments, in which they operate (Yüksel, 2009). In this regard, strategic planning is proven crucial for sustainable growth of the organisations. Strategic planning is defined as a long-term, future-oriented process of assessment, goal setting, and decision-making that maps an explicit path between the present and a vision of the future, relying on careful consideration of an organisation's capabilities and environment (Shahkooh et al., 2014). Buye (2015) argues that organisational environment comprises all factors and forces outside the organisation that affect and can be affected by the organisation. The internal setting consists of those relevant elements and factors within the boundaries of the organisation that influence organisational performance they include organisational members, physical infrastructure, organisational leadership, culture, systems and structure. Buye (2015) further states that the macro environment includes all the factors and forces that are part of the larger society and also affect the immediate environment. These factors are not directly under the control of the organisational but can have serious consequences on organisational performances. The factors can be categorised Political, Economic, Socio-Cultural, Technological, Environmental and Legal (PESTEL). The macro environment analysed using the PESTLE is congruently important as the micro-environment.

PESTEL (Political, Economic, Socio-cultural, Technological, Environment and Legal) analysis is a method used in strategic planning to analyse macro-environmental factors within which an organisation operates (Yüksel, 2009). The method is recognized in different fields as being suitable for strategic analysis of the dynamic parameters in long-term planning (Osborne and Brown, 2005; Yüksel, 2009). PESTEL was first conceived as ETPS (economic, technical, political and social) by Aguilar (1967) and has been modified since. For example, Richardson (2006) used a modified version called STEPE where another ‘E’ was added to include a scanning of environmental changes in other parameters to identify barriers and constraints in developing libraries. Katko (2006) used PESTEL to analyse political, economic, social, technical, ecological and legislative factors to assess the development of traffic safety in Finland, where an ‘E’ was added to the ETPS to analyse ecological factor and an ‘L’ was added to analyse legislative factor. According to Buye (2015), the PESTEL Analysis is one of the tools that is used to identify and analyse the key drivers of change in the organisational environment. Mkude and Wimmer (2015) believe that the PESTEL tool allows the assessing of the current environment and potential changes. It’s based on the premise that organisations that continuously scan their environment have competitive advantage because it helps in gathering, analysing, and using the information to improve organisational performance (Buye, 2015). More so it’s used in predicting and evaluating the future state of affairs. Buye (2015) explains the elements of PESTEL tool with examples as follows:

2.4.1 Political environment

PESTEL analysis is used to examine how organisations are affected by the political environment. For instance, the analysis can generate results on the political situations on whether there is political stability which is favourable to an organisation. On the other hand, an unfavourably political climate including war situation and uncertainty of governments can negatively affect the organisation. Identifying opportunities and dealing with threats in clean energy environment can greatly benefit the organisation.

2.4.2 Economic environment

The analysis using PESTEL generates data on economic situation in terms of taxes, tariffs, interest rates, economic growth, recession, inflation rate, exchange rate, minimum wage, wage rates, unemployment, the cost of living, working hours, credit availability, financing availability, and the level of economic growth. By providing results on the economic situation and how it might impact on the organisation helps it to respond appropriately. For example, economic recession can negatively affect the performance and continued existence of organisations. More so, interest rates affect a firm's cost of capital and therefore to what extent an organisation develops and expands. This implies that organisations, should use PESTEL to analyse the economic situation in its environment, where they operate in order to understand if the current economic environment presents opportunities or may pose threats.

2.4.3 Social dimension

The social environment includes the values, beliefs, attitudes, opinions, and lifestyles of stakeholders. Social beliefs, values and lifestyles influence clients. The analysis of demographic factors includes the study of the human population regarding size, geographic distribution, age, education levels and income distribution. By generating demographic data, it helps organisations to explain its probable market and relevant labour force.

2.4.4 Technological dimension

By generating information on technological advances, it enables organisations to be prepared to applicably change and operate using the most relevant technologies. New technologies identified would improve productivity and probably reduce cost of production depending on technological advancement. However, the changes identified in the technological environment may present opportunities or threats to the organisation. For example, the cost of acquiring new technologies may significantly increase the costs of the organisation, which in turn, might affect the organisational cost of production. PESTEL analysis enables organisations to update their own technology as it become obsolete.

2.4.5 Environment dimension

It also includes the nature and physical environment which consists raw materials, and other natural resources such as the land and physical space on which organisation operates. PESTEL analysis examines the natural environment to generate information on pollution, raw materials and government regulations on protection of natural resources. Pollution generated by the organisation or others can negatively affect its operation and reputation especially if its operations damage the environment. Hence, it’s important to generate data using PESTEL on environmental protection policies, pollution, waste management among others.

2.4.6 Legal dimension

The legal environment includes the laws and regulations of a country. PESTEL analysis generates data on government rules and regulations that will influence the way in which an organisation will produce and sell its products. Such laws can negatively or positively affect organisational operations. Organisations must analyse and identify those factors (legal environment).

Figure 2.3 below illustrates an example of a typical PESTEL analysis framework of a renewable energy business.

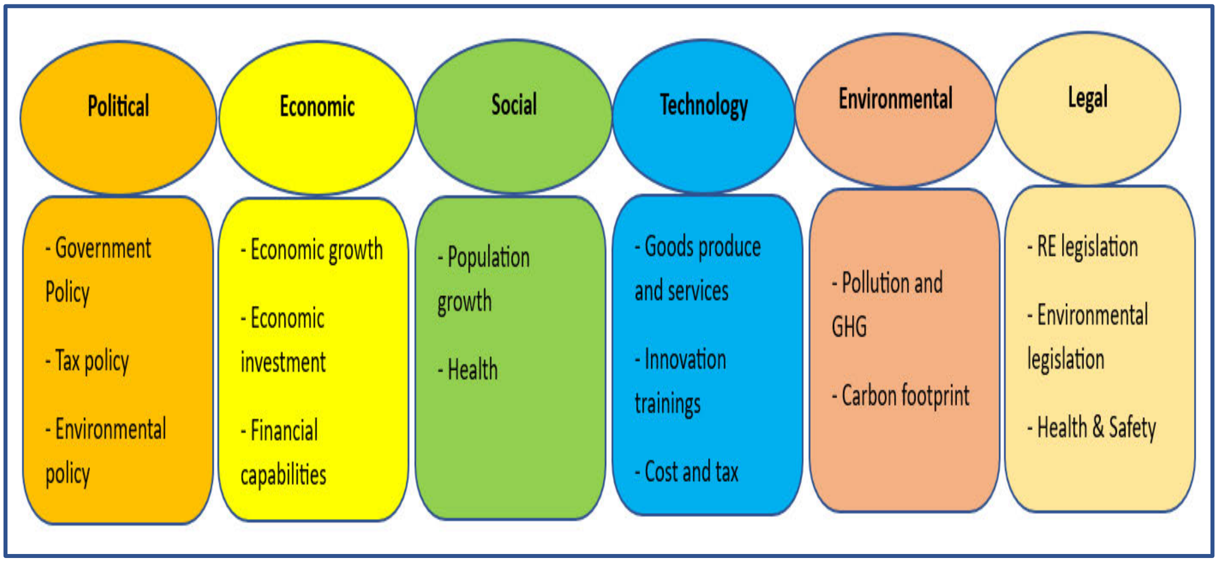


Figure 2.3: Typical PESTEL analysis framework of a renewable energy business
Source: Researcher's framework (2023)

The details of the typical PESTEL analysis framework of a renewable energy business are discussed in table 2.1 below:

Factors		Detail discussion
Political	Government policy	Policy to distribute RE at a subsided price households as part of the electrification program.
	Tax policy	Tax rebate on solar products to promote new installation of renewable energy
	Environmental policy	National Environmental policy which aims at defining specific actions to protect the environment in SA and ensure a sustainable growth to the country in the medium to long term.
Economic	Economic growth	Additional income generation for small business/farmers
	Economic investment	Need to foster income generating activities
	Financial capabilities	Need for innovative financing mechanisms to develop renewable energy
Social	Population growth	High rate in population growth
	Health	Improvement in health issues/ health centres
Technology	Goods produce and services	Increase in Technology could help produce more goods
	Innovation trainings	Low level of skills staff needs to be improved
	Cost and tax	Cost of equipment and reduction in taxation
Environmental	Pollution and GHG	Reduce pollution from thermal power stations, reducing pollution resulting from cooking with firewood
	Carbon footprint	Reduce amount of energy used, reduction in waste
Legal	RE legislation	Law on the promotion of electricity generation from renewable source
	Environmental legislation	framework law on the environment—this law sets the general legal framework for environmental management in South Africa
	Health & Safety	Improve health issues and safety of people, the renewable energy law applies to the safety, operation, storage, marketing, and security of renewable energy sources

Table 2.1: Discussion of renewable energy business PESTEL analysis framework

Source: Researcher's framework (2023)

The next session presents business canvass model/framework for new solar energy business.

2.5 THEORY 4: BUSINESS CANVASS MODEL

According to Haag (2013), creating a business plan is the key to secure financing, communicating, maintaining focus and helping to create preparations for unexpected events. Woertman (2019) states that the business plan is the entrepreneur's idea fully developed in a step-by-step analysis and steps to follow in order to reach the goal. It gives the entrepreneur the objectivity to approach the business unemotionally to see what the business really is. In addition, Woertman (2019) mentions there are two type of business plan structures, namely, the business description plan and business model canvas. Robinson (2016) defines the business model canvas as a visual framework for describing the different elements of how a business works. It can be used to design new models or to analyse current models. Breindahl, Egekvist, Edman and Hagen (2019) argue that the business model canvas is a strategic management and lean startup template for developing new or documenting existing business models. One advantage to the Business Model Canvas, according to Robinson (2016) is that it is not a linear description. This allows for the effects of alterations in one area to be clear, making it easier to play around with changes to current or potential models. The business canvas model consists of 9 elements or components. The next section presents an explanation of what components are in the business model canvas with a description on what contents should be within each specific paragraph (Woertman, 2019).

2.5.1 Customer Segments

Osterwalder and Pigneur (2020) defines the different groups of people or organizations an enterprise aims to reach and serve. Communication, distribution, and sales Channels comprise a company's interface with customers. Channels are customer touch points that play an important role in the customer experience. Osterwalder and Pigneur (2020) state that Channels serve several functions, including:

- Raising awareness among customers about a company's
- Products and services
- Allowing customers to purchase specific products and services.
- Delivering a Value Proposition to customers

- Providing post-purchase customer support

2.5.2 Value Propositions

Osterwalder and Pigneur (2020) state that value propositions describe the bundle of products and services that create value for a specific Customer Segment. The Value Proposition is the reason why customers turn to one company over another. It solves a customer problem or satisfies a customer need (Woertman, 2019). Each Value Proposition consists of a selected bundle of products and/or services that caters to the requirements of a specific Customer Segment. In this sense, the Value Proposition is an aggregation, or bundle, of benefits that a company offers customers (Osterwalder and Pigneur, 2020).

2.5.3 Channels

Channels describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition (Osterwalder and Pigneur, 2020). Channels are customer touch points that play an important role in the customer experience. According to Woertman (2019), channels are how entrepreneurs use entities to communicate to their segments but also through which entities they want to sell their products and/or services.

2.5.4 Customer Relationships

According to Osterwalder and Pigneur (2020), describes the types of relationships a company establishes with specific Customer Segments. A company should clarify the type of relationship it wants to establish with each Customer Segment. Robinson (2016) argues that customer relationships may be driven by the following motivations:

- Customer acquisition
- Customer retention
- Boosting sales (upselling)

2.5.5 Key Resources

Describes the most important assets required to make a business model work. Key resources according to Osterwalder and Pigneur (2020), allow an enterprise to create and offer a Value Proposition, reach markets, maintain relationships with Customer Segments, and earn revenues. Key resources can be physical, financial, intellectual, or human.

2.5.6 Key Activities

Osterwalder and Pigneur (2020) describes key activities as the most important things a company must do to make its business model work. These are the most important actions a company must take to operate successfully.

2.5.7 Key Partnerships

Describes the network of suppliers and partners that make the business model work. Robinson (2016) mentions that companies create alliances to optimise their business models, reduce risk, or acquire resources.

2.5.8 Cost Structure

Describes all costs incurred to operate a business model (Osterwalder and Pigneur, 2020). This building block describes the most important costs incurred while operating under a particular business model.

2.5.9 Revenue Streams

Represents the cash a company generates from each Customer Segment (costs must be subtracted from revenues to create earnings). A business model can involve two different types of Revenue Streams (Osterwalder and Pigneur, 2020):

- Transaction revenues resulting from one-time customer payments.
- Recurring revenues resulting from ongoing payments to either deliver a Value Proposition to customers or provide post purchase customer support.

The business model canvas has helped the entrepreneurs figure out what the best place to start a business. The business model canvas is the best business plan structure to provide guidance to prospect business start-up or entrepreneurs who seek to participant in the renewable energy business. The business model canvas provides a foundation for a subsequent business plan which is proposed in chapter 7 as a contribution of this study to promote renewable energy business that will help with poverty reduction. For the purpose of this study, the business name is called Gina Solar Energy (GSE) Pty Ltd. Figure 2.4 below presents a business model canvas for a renewable energy start-up business using business model canvas framework.

Key Partners	**Key Activities**	**Value Propositions**	**Customer Relationships**	**Customer Segments**
• Investors • Government • Suppliers • Transportation	• R&D • Installations & trainings • Evaluation	• Products and services that our company will deliver will be: Solar panels, installation, cleaning, repairs, and battery storage. • We offer storage of green energy from your own solar panels	• We want to offer long term relationships.	• Homeowners • Real estate Owners • Hotels • Schools • Small business • Large business
	Key Resources		**Channels**	
	• Solar panels • Batteries • Human capital • Materials		• Facebook • Instagram • Google • Advertising • TV & radio • website	

Cost Structure	**Revenue Streams**
• Staff salaries • Renting storage space • Procuring materials • Marketing • Transportation	• Solar panels and accessories • Battery storage • Installation • Repair and services

Figure 2.4: The business model canvas for start-up renewable energy business
Source: Researcher's framework (2023)

The nine elements of the conceptual framework for start-up renewable energy business are discussed in detail below.

i. Key partners

GSE key partners are as follows: Investors, government, suppliers and transportation.

- Investors - This is an institute that help South African entrepreneurs with financial injections to start a business and get ready for the future.
- Government – Government fundings available for renewable energy projects.
- Suppliers – These are manufacturer and distributors of solar panels and battery storage.
- Transportation – Transportation of our products and materials will be outsource to existing courier companies in South Africa.

ii. Key activities

GSE has a few key activities that are the most important for our business. These activities are as follows: Research and Development (R&D), Installations, trainings, and evaluation.

- R&D, as a solar power company Research and Development are crucial to remain in business. Developments in this market are rapidly developing which means that if the business does not keep evolving for better solar panels and services, there is no future for the company.
- Installations and trainings are important for the company to actually recognise the product for the customers and to get the revenue. The installation of solar panels is essential to our business for realising the income. We do not only install solar panels and battery storage, but we also provide trainings to our customers and explain to them how to take care of the products we sell.
- Before we install all the solar panels and battery storage, we evaluate to see how good the customer place for green energy. This will provide an insight to the customer in how much

they can expect to generate, how much they use during the days, and how much they will need to stay off the grid.

iii. Key resources

The key resources for GSE are mainly, solar panels, batteries, human capital, and materials.

- Solar panels are the core product for our business existence. We will receive solar panels that are ready without need to assemble and only need to get materials to install them on the roofs.
- Batteries are our unique selling point because we do not just want to sell the customers green energy, but we want to give them electricity freedom. These batteries will provide the customers with also energy in case of emergencies.
- Our human capital will install the solar panels and the batteries at home for the customers. The other aspect of human capital comes in the form of assembly and research and development.
- These materials will be procured from different companies, and we will make sure that they are well fitted together. These materials will include all the different parts needed for the installation and the set up for the solar panels.

iv. Value propositions

Our company will deliver the solution to customers. Solar power generated during the day can be saved by a large battery to store all excess green energy for a later use. For most households this will be a great solution because they will work during the day, when the energy is being generated and use the stored energy when they are at home. Products and services that our company will deliver will be: Solar panels, installation, cleaning, repairs, and battery storage. Depending on the size and the number of solar panels that can be placed, they can sustain them self freely without using the power grid.

v. Customer relationship

Customer relationship is important for our company. Our company wants to set up a customer relationship that if the customers are interested in our products, we can set up a meeting in order to survey the layout of the house and areas that we can work with. We want to offer long term relationships.

vi. Channels

The company considers reaching our customers through these channels: Facebook, Instagram, Google, advertising, TV, radio, pamphlets and website.

vii. Customer segments

Our customers segments include homeowners, real estate Owners, hotels, schools, small and medium-sized businesses, and large corporations looking to invest in solar panels.

viii. Revenue sources

Most of our revenues are transaction based. This means that we have a onetime customer which buys our solar panels and battery storage. Meaning that our biggest revenues are from the products we sell. We will provide additional services but that will not be for everyone. Installations and cleaning are secondary income sources after the biggest revenue transaction has occurred.

ix. Cost structure

As a new start-up business, financial statements are not available. Our cost structure will be mainly paying salaries to our employees, renting storage space, procuring materials, marketing spending and transportation of products.

The next section presents a conceptual framework applicable to this study which is developed to address the aim of the study.

2.6 THE CONCEPTUAL FRAMEWORK

This section of the study presents a proposed study conceptual framework for renewable energy as a poverty reduction technology tool. In view of the above theoretical frameworks, the study seeks to investigate the impact which the renewable, fair access to affordable renewable energy, have on variables such as poverty reduction and its associated factors such as economic growth, Socio-Economic status, environmental conditions and trade opportunities available as a result of the implementation of renewable energy in a selected South African township. Figure 2.5 below illustrates this interrelationship between variables.

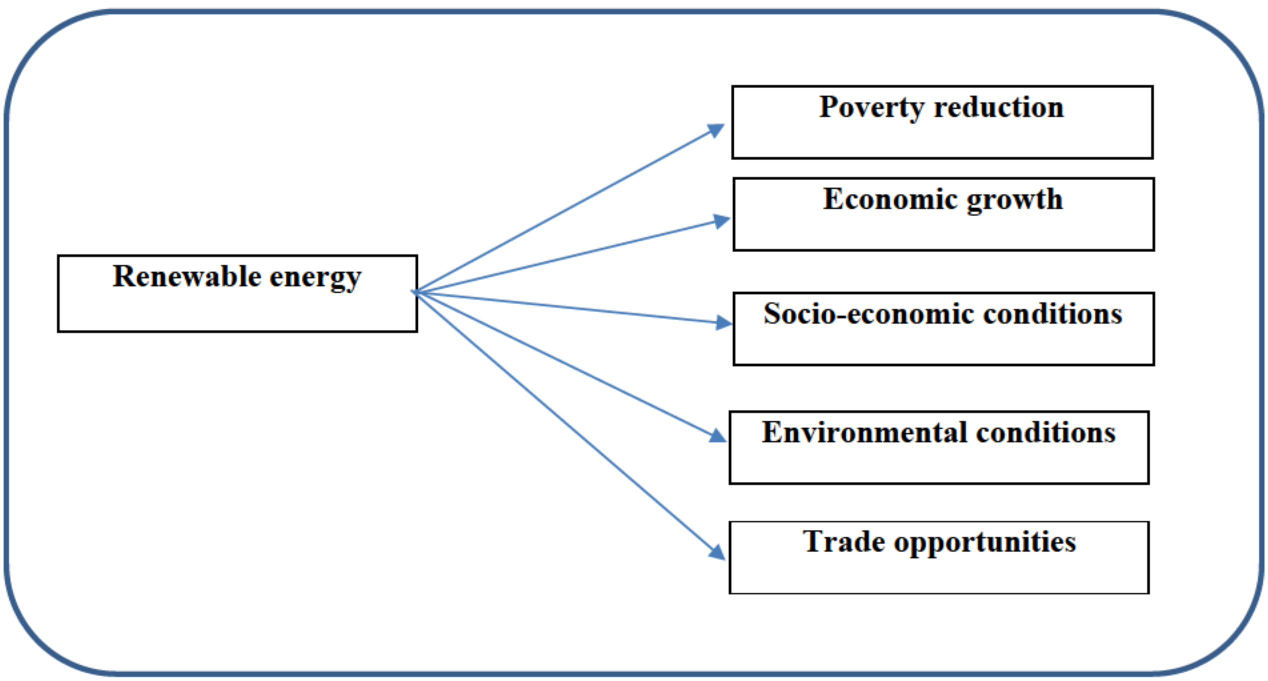


Figure 2.5: Proposed conceptual framework for renewable energy as a poverty reduction tool.
Source: Researcher's framework (2023)

The detail discussion and detail proposed conceptual framework for the study is discussed and presented in Chapter 7.

2.7 SUMMARY

This chapter has presented a theoretical framework that was adopted to guide the study. The study adopted the Adopters Categories model as its theoretical framework taken from the main theory, popularly known as the Diffusion of Innovations theory. Furthermore, this chapter discussed the relevance of the Adopters Categories elements to this study. This chapter also presented theoretical frameworks such as SWOT analysis, PESTEL analysis and business canvas model that seeks to address the aim of the study which is to develop a business plan. The chapter concluded by developing a conceptual framework applicable to the study.

The next chapter presents a critical review of energy related literature and further unpack sustainable development goals which informed the study dependent variables such as poverty, Socio-Economic, economic growth, climate change and trade opportunities.

CHAPTER THREE

A REVIEW OF ENERGY SUPPLY IN SOUTH AFRICA

3.1 INTRODUCTION

The previous chapter (Chapter 2) reviewed several theories from which the study draws giving birth to the conceptual framework that would form the basis of the study recommendations. This chapter focuses on the detail of energy supply by unpacking electricity background in South Africa. Different types of renewable energy are discussed and the benefits of using renewable energy are outlined in detail. Solar energy as a chosen type of affordable renewable energy source is also outlined. This includes the challenges involved in the implementation of small-scale embedded generation (SSEG) from rooftop solar photovoltaic (PV) and growing understandings of politics of electricity distribution in South Africa, as a contested space.

The chapter further examines the potential socioeconomic impacts of rooftop solar PV and the extent to which new affordable alternative energy source may either redress or reproduce the injustices of the current electricity system. This chapter also draws on an extensive desk-based analysis of policy and regulatory documents produced by institutions involved in South Africa's electricity governance, including national and municipal government, the state-owned utility Eskom, and the national energy regulator, as well as reports and publications by advocacy organisations. Furthermore, the concept of sustainable development is discussed, and sustainable development goals are examined in relation to dependent variables of the study. The dependent variables such as poverty, economic growth, climate change and trade opportunities are discussed in detail in relation to independant variable of the study i.e., renewable energy. The chapter concludes by unpacking the role of renewable energy as a poverty reduction strategy.

3.2 ELECTRICITY BACKGROUND IN SOUTH AFRICA

Numerous scholars and researchers have written extensively about renewable energy and solar power, for example (Kannan and Vakeesan, 2016; Sukhatme and Nayak, 2017; Kalogirou, 2013; Chen, 2011; Foster, Ghassemi and Cota, 2009; Tshehla, 2014; Walwyn, 2015). Various research studies were found focusing on the energy supply issues (Niu, Jia, Wang, He, Hu and Liu, 2013; Tacoli, 2012; Brazilian and Pielke, 2012; Janisch et al., 2012; Korsten, 2015; Mayr et al., 2015) but no research studies found which reflect electricity supply field in relation poverty reduction, socio-economic, economic growth and environmental impact. The quantitative study conducted by Singh, Wang, Mendoza and Ackom (2014) show that energy cuts across all dimensions of human activity and development. It lies at the core of the realisation of human well-being (i.e., economy, education, health, poverty, and socioeconomic status, etc).

The energy access requirements of rural populations have been much researched (Sokona et al., 2012; Singh et al., 2014; Christensen, Mackenzie, Nygaard, Pedersen, 2015; Broto, Stevens, Ackom, Tomei, Parikh, Bisaga, To, Kirshner and Mulugetta, 2017) and are the priority of many policies and global programmes (Brazilian and Pielke, 2012). Broto et al., (2017) in their mixed method study found that energy access is typically viewed as a problem for rural areas, but people living in urban settings also face energy challenges that have not received sufficient attention. However, Vieira and Ghisi (2016) in their case study argue that given rapid world urbanisation, energy poverty is no longer a rural only phenomenon. According to Singh et al., (2014), research study, more than half of the world's population live in urban areas, yet urbanisation is not necessarily accompanied by an equitable distribution of energy services. Niu et al., (2013) qualitative study found that if current trends continue, it is projected that by 2050 less and least developing regions will account for more than 80% of the world's urban population growth, raising concerns about increased urban poverty and the inability of national and city governments to provide services to the residents of their growing cities.

Baker and Philips (2019: 182) argue that access to electricity in South Africa, as with access to other basic services such as housing, education and water is paralleled by high levels of poverty and socio-economic inequality. According to IEA (2013), nearly 1.3 billion people continue to remain without access to electricity, and 2.6 billion do not have access to clean cooking facilities. The energy access needs of rural populations have been much researched and are the priority of many policies and global programmes (GNESD, 2015). However, more than half of the world's population lives in urban areas. GNESD (2015) report, argues that about 75% of the world's consumption of commercial energy contributes to urban areas, and many of those in direst need of access to modern energy systems are located in rapidly growing informal urban settlements throughout the developing countries. The Republic of South Africa is the southernmost country in Africa. The country is the 24th most populous nation in the world with about 59 million inhabitants. According to the general household survey of 2018, the percentage of households without electricity stands at 12.5%. The White Paper released by Eberhard (2003) reveals that the new electrical lights and machines that were developed in the late 19th century spread rapidly around the world and South Africa was amongst the early countries that adopted these revolutionary technologies.

The current electricity supply structure in South Africa is controlled by the monopolist, Eskom, the sole generator of electricity. The electricity supply industry in South Africa is managed and controlled by the state-owned monopoly utility, Eskom. Fourie (2001) reveals that Eskom is among the four largest state-owned enterprises (SOEs) with Telkom (telecommunications), Transnet (transportation), and Denel (defence production). Baker and Phillips (2019: 178) argue that in South Africa, the electricity system to date has been controlled by a state-owned entity, which owns the transmission grid and is responsible for 95 per cent of generation and 60 per cent of distribution. Municipalities meanwhile are responsible for the other 40 per cent. The electricity demand in South Africa comes from five sectors: industry, transport, agriculture, commerce and residential. Of these, industry has been the largest consumer of electricity (Department of Energy, 2009). In 2006, the industry sector accounted for 60% of the total energy demand.

According to Baker (2016), South Africa's electricity system has been historically determined by the country's abundant coal supplies, and complex interactions between its social, political, and economic institutions, networked infrastructures, and technological capabilities. Coal has been the dominant source of energy in the country. This was echoed by Musango, Amigun and Brent (2011) who argue that the electricity generation by fuel type shows the historical reliance on coal for electricity generation. The share of coal in electricity generation is more than 90% of the total electricity generated in South Africa (Republic of South Africa, 2009). This is because of its abundance and cheapness, which is regarded in the world as one of the lowest in terms of energy cost. Kohler (2013: 2) indicates that South Africa's electricity generation is 95 percent dependent on coal. An intensive investment in coal energy assets has historically been the country's electricity development path. Therefore, South Africa has historically relied primarily on coal for electricity generation, making the electricity sector one of the dominant greenhouse gas emitters (Musango, et. Al., 2011). Uhunamure and Shale (2021) argue that in 2016, apart from coal, which was the principal contributor to the total primary energy supply, other sources include nuclear, crude oil, gas, renewables, and waste energy as indicated in Figure 3.1 below. In 2012, more than 83% of SA energy was supplied by fossil fuel with the coal contribution of 69% in the total primary energy supply as seen in Figure 1, mainly because of the abundant coal reserves in the country, the mastery of technology and the infrastructure that has existed for years that promote good profitability (Kennedy, 2015).

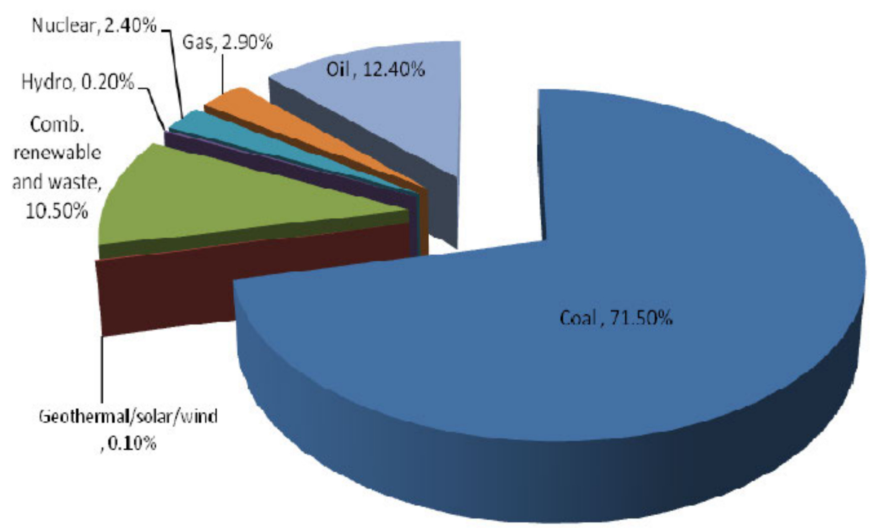


Figure 3.1: Total primary energy supply in South Africa

Source: Department of energy (2019)

In 1994 Nelson Mandela stated: by 2010 no community in South Africa will be without electricity, and the government' white paper on housing included electricity services in a commitment to provide basic services. The Reconstruction and Development Programme (RDP) set a target of electrifying 2.5 million households, 72% of the total, by the year 2000, which has been met. Removal of cross-subsidies has meant that domestic tariffs have increased whilst commercial consumers have experienced a cut in costs. Ateba and Prinsloo (2018) reveal that in the mid-1990s, the current government of South Africa led by the African National Congress (ANC) party implemented a rapid electrification programme which got 2.8 million households connected between 1994 and 1999. This led to electricity demand increasing by a large margin. The steady increase in population growth raised concerns for the electricity grid loading. Ateba and Prinsloo (2018) allude that these increases result in roughly 350 000 new South African households per year. The annual growth in household formation is a primary challenge on the electricity grid. While Hameed and Khan (2016) agree that there is a significant positive relationship between population growth and electricity consumption. The South African Energy Efficiency Report (2011: 2) points out that South Africa has high energy consumption per capita of 2.7 kWh, compared to the regular global consumption of 1.8 kWh. Energy consumption between 1990 and 2002 increased by 1.1% yearly; after 2002, increases have been at a very rapid rate of 4% yearly.

As a result of the above-mentioned population growth and rapid household's electrification programme, over the years the total electricity demand has been increasing and as a result, the electricity reserve margin has been declining. Odhiambo (2009) argues that the reserve margin declined from 25% in 2002 to 20% in 2004 and afterwards to 16% in 2006. Inglezi-Lotz and Blignaut (2011) also confirm that the demand for electricity in South Africa has been increasing since the early 1990. Since democratisation of the country in 1994, the economy has undergone significant structural changes. Among these structural changes was electrification for the poor rural areas. A study by Inglezi-Lotz and Blignaut (2011) reveals that during the apartheid era, about two-thirds of the nation lacked access to electricity and hence, provision for electricity to everyone was considered a crucial part of economic development post 1994. The electricity supply did not increase proportionately to the increase in demand.

3.3 SOUTH AFRICA STATE-OWNED UTILITY: ESKOM

Africa's leading electricity producer ranked eleventh in the world for installed capacity and the sixth-largest African company across all sectors (Jaglin and Dubresson, 2016: 1). Eskom Holdings SOC Ltd is a vertically integrated public monopoly, 100% owned by the South African state. Eskom is a major supplier of electricity with 95% of electricity generated consumed in South Africa and 38% of electricity generated consumed across Africa (Jaglin and Dubresson, 2016). Eskom owns the only nuclear power station in Africa. In South Africa, Eskom handles the transmission, but there are over 400 local companies (mostly municipal corporations) which distribute to customers. Baker and Phillips (2019: 183) set the scene: Eskom is responsible for 60 per cent of distribution, which is consumed by one third of South Africa's customers. The remaining two-thirds are supplied by municipalities, Eskom's largest customer category, accounting for just over 40 per cent of total Eskom sales of which 80 per cent goes to 12 municipalities, including the eight Metropolitan Municipalities in South Africa which have exclusive municipal and legislative authority in their areas: City of Tshwane, City of Johannesburg, Ekurhuleni, eThekwini, Manguang, Buffalo City, Nelson Mandela Bay and City of Cape Town (Wolpe and Reddy, 2016). Baker and Phillips (2019: 185) further argue that Municipalities are responsible for just over 40 per cent of electricity distribution in South Africa, purchasing electricity in bulk from Eskom at wholesale prices which they then mark up and sell on to the end user. Bolton and Foxon (2015) maintain that of 257 metropolitan, district and local municipalities, approximately 174 municipalities have been licensed by NERSA to serve as electricity distributors, a role which includes maintaining infrastructure, providing new connections, and setting minimum service level standards and pricing and subsidy levels for poor consumers (South African Local Government Association (SALGA, 2014).

Figure 3.2 below shows that the generation sector of electricity is controlled by Eskom and the transmission sector is also under full control of Eskom. The distribution sector is dominated by Eskom too, but some distributions are done by the municipalities. The challenge with this type of model is that it allows government intervention to utilise the funds earmarked for electricity industry infrastructure development, for their own interests or redirect to other projects not related to electricity. Khobai et al. (2017) argue that this model has cost South Africa its new path growth. For instance, from a study by Wait (2012), it was observed that the country loses between 3.3% to 3.5% gross domestic product (GDP) under the current electricity structure. The GDP growth would be higher if the electricity supply model was different to the current model. The government is proposing to separate generation and transmission, to privatise Eskom, and to rationalise the distribution industry into 6 regional distributors. In 1998, the White Paper on Energy Policy put forward the unbundling of South Africa's electricity sector into separate transmission, distribution and generation companies (Eberhard, 2007). The Government has approved the Eskom Conversion Bill, which will enable Eskom to become a limited liability company, open to private sector investment, through a public offering. According to Baker and Phillips (2019), the 2001 Eskom Conversion Act converted the utility from a statutory body to a public company and required that it pay tax and dividends for the first time.

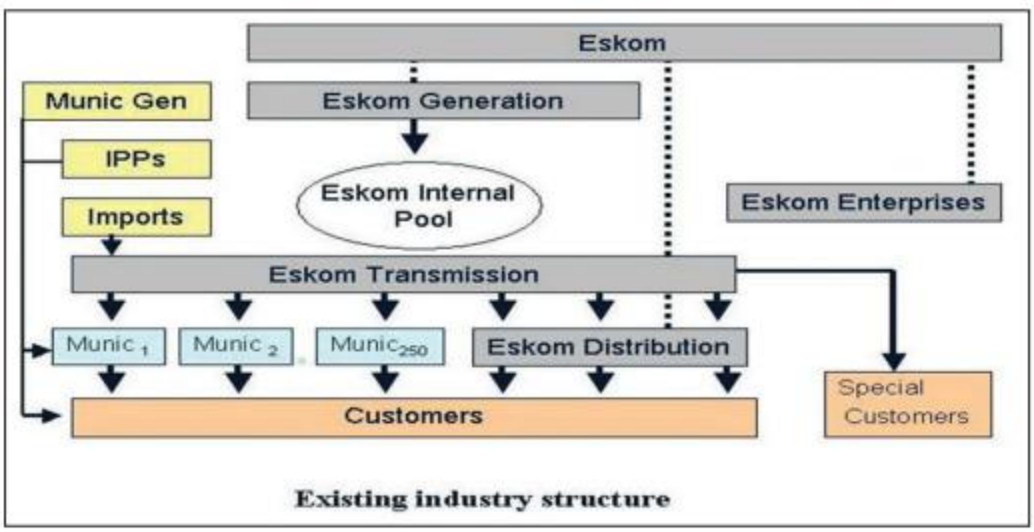


Figure 3.2: South Africa electricity supply structure
Source: Khobai et al., (2017)

In 2008, the electricity supply could not keep up with the increasing electricity demand and the country started to experience electricity power outages. Eskom (2014) reports that in 2013, the electricity supply reserve margins dropped badly and led to the first experience of power outages since 2008. South Africa is presently facing a serious electricity crisis. Factors contributing to this crisis include increase in the internal demand of electricity from the increased population, increased economic activity, growth in construction of housing for the disadvantaged communities by the Government, and lack of investment by the Government for the maintenance of the aging generation capacity and for expanding the generation capacity to meet the growing demand (Shilpi Jain et al., 2017). Bohlmann and Inglesi-Lotz (2021) argue that during October 2007 and February 2008, Eskom faced challenges in provisioning enough electricity for the country. Increasing electricity demand coupled with diminished reserve margins led to major electricity supply interruptions and the implementation of load-shedding to manage the energy shortage in South Africa (Eskom, 2018). Bohlmann and Inglesi-Lotz (2021: 3) confirm that the 2007/08 electricity crisis was a consequence of electricity demand estimations being lower than what they were which led to Eskom not making provisions for expanding its generation capacity on time; lack of electricity generation and a reduction in the quality of coal received which necessitated the burning of higher volumes of coal for the same output of electricity.

In order to improve electricity security and avoid total blackouts, there was a need to manage demand and supply through, respectively, demand side management strategies and electricity capacity expansion". As a last resort, the South Africa's national electricity utility, Eskom, intervened by embarking on load-shedding in order to better align the electricity generation with demand and at the same time maintain a reasonable electricity reserve margin (Odhiambo, 2009). Edkins et al. (2010) state that, this was followed by capacity expansion by Eskom, which included: (i) returning to service previous mothballed plants; and (ii) the start of construction of two coal-fired power plants (Medupi and Kusile) and a pumped storage scheme (Ingula). The installed capacity for these plants1 will be 4788 MW (for Medupi), 4800 MW (for Kusile) and 1.2 GW (for Ingula). The declining electricity reserve margin intensified in 2008 and the country experienced its worst blackouts with substantial economic losses. The electricity supply industry has been revolving between stages one and two of loading shedding in 2015. These stages indicate the amount of electricity to be saved. For instance, up to 1000 MW for stage one and up to 2000 MW for stage two of electricity that needs to be shed (Eskom, 2018). This is on account that despite the high increase in economic growth and electricity consumption, no worthwhile measures were taken to install new capacity for electricity generation (Edkins et al., 2010).

Electricity shortages have led to a fall in the production of the major sectors of the economy such as industrial, commercial, and mining industries. Bohlmann and Inglesi-Lotz (2021) reveal that after the 2007/2008 electricity crisis, the South African National Economic Development and Labour Council (NEDLAC) supported Eskom's application for a tariff increase for the 2007/2008 financial year, to set an electricity price that was cost reflective whilst also ensuring that the poor were protected and that they still have access to affordable electricity. Blignaut, Inglesi-Lotz, Weideman, (2015) state that since the 2007/2008 crisis, electricity prices in South Africa have increased at around 25 percent per annum. Again, the National Energy Regulator of South Africa (NERSA), the regulator of electricity prices in South Africa approved the price increases in June 2008 by increasing the average price of electricity by 27.5% for the 2008/2009 financial year (Eskom, 2018). Eskom (2012: 5) reports state that the South Africa pricing technique follows a multi-year price determination (MYPD), in which Eskom applies to NERSA for a periodic electricity price adjustment plan. However, Ateba and Prinsloo (2018) point out that there have been consistent debates as to whether South Africa's protocol for the consumer electricity price increase is effectively aligned to global standards.

South Africa's electricity policy has focused largely on supply rather than demand. The failure of Eskom as a monopolistic energy supply to meet the demand and local municipality model, resulted in the requirement of new energy forms. The Integrated Resource Plan (IRP) for electricity released in November 2016, proposes a generation mix to 2050 and allows for up to 17,600 MW for solar PV. According to Baker and Philiphs (2019), in recent years, South Africa has witnessed the rapid introduction of rooftop and ground-mounted solar PV by commercial, industrial, and high-income residential households. On the other hand, according to Uhunamure and Shale (2021: 2) there has been significant development in renewable energy sources as an alternative to fossil fuel. The government's Integrated Resource Plan 2010 to 2030 (IRP), which was promulgated in May 2011, puts a framework in place for the first time that sets out the scale and mix of the new electricity capacity required over the next two decades. The plan would more than double the capacity of the system, and change the energy mix, and the mix of players, dramatically. It envisages that dependence on coal would fall from 90% to 65% by 2030, while renewables increase their share of the mix from 0% to 9% and nuclear's share from 5% to 23%, and it sees the private sector coming in to build 30% of the new capacity.

The IRP provides the framework for the industry to diversify its energy mix to meet South Africa's objective to reduce its carbon footprint. The IRP sets ambitious targets for non-emitting new renewables and nuclear capacity, which together make up almost two thirds of the new capacity which the IRP sees being built by 2030. The substitution of clean fuels, and electricity, for traditional household fuels has health and environmental benefits. Musango, et al., (2011) argue that renewable energy and technologies have the potential to provide solutions such as greenhouse gas emission reduction, diversification of the energy mix, and job creation through manufacturing and industry development. The benefits of renewable energy consumption ranging from improved environmental quality to higher economic growth are well documented literature (Kahia et al., 2016; Salim et al., 2014; Ibrahiem, 2015; Khobai and Le Roux, 2017; Sebri and Ben-Salha, 2014 and Apergis and Danuletiu, 2014).

3.4 RENEWABLE ENERGY AS THE ALTERNATIVE SOURCE OF ENERGY

Sorenson (1979) defines renewable energy as energy that is converted from resources that are used at a rate no faster than that at which they are replenished:

> On a timescale of human relevance, they will not be exhausted, unlike the effectively limited stocks of fossil fuels (coal, oil, gas), which have been laid down over geological time and are not being renewed at the rate at which they have been consumed since the Industrial Revolution.

Numerous researchers and solar energy experts have written extensively on renewable energy. These researchers and experts include Kannan and Vakeesan (2016); Sukhatme and Nayak (2017); Kalogirou (2013); Chen (2011); Foster, Ghassemi and Cota (2009), to name but a few. These authors concur that renewable energy refers to the energy that is harnessed from renewable resources, which are naturally replenished on human timescale, such as solar, wind, biomass, tidal waves and geothermal heat. Numerous scholars and experts share similar sentiments that it is refers to the provision of energy via renewable resources which are naturally replenished as fast enough as they are being used (Twidell and Weir, 2015; Moriarty and Honnery, 2012; Quaschning, 2016; Panwar, Kaushik and Kothari, 2011). It is worth pointing out that renewable energy systems are rapidly becoming more efficient and cheaper. Similar views are shared by Sukhatme and Nayak (2017) who note that renewable energy can be defined as energy, which is derived from renewable natural resources, which are replenished at a human timescale, such as sunlight, wind, water, tides, rain, geothermal heat, and other naturally replenishing sources. According to Sager (2014), renewable energy are an option to address the energy problem in South Africa given the progress made in recent years in the manufacturing and low-cost installation of renewable electricity generation systems, progress made by the reduction in the cost of manufacturing and installing photovoltaic and windmills particularly, reaching prices almost equivalent to the prices of coal-fired plants.

Renewable energy supply is a sustainable and alternative energy supply option that can significantly reduce dependence on fossil fuels. According to Mutombo and Numbi (2019), renewable energy as an alternative is able to improve if not to sufficiently cover the energy needs of Africa and also reduce dependence on fossil fuel. One example of renewable energy, which has been developed recently is solar panels, Jacobs (2021) is of the view that solar energy can be harnessed in many different ways, with solar cells being an extremely efficient way to do this. He further argues that the word also covers biomass, which are also subject to some dispute, but whose carbon neutral profile is still under investigation. In addition, he states that other methods include thermal and nuclear energy sources. Similarly, Sukhatme and Nayak (2017) support above views by pointing out that renewable energy provides one of the most environmentally friendly sources of power available and is considered a renewable resource by the majority of countries around the world. The latter authors further argue that should one be able to continue to develop renewable energy sources that provide a sustainable energy supply, then it will become an even more important source of electricity, as fossil fuel becomes scarce, and prices increase. In addition, they note that this can help to reduce overall carbon footprint and therefore make it more cost-effective for humans to take responsibility for their own energy requirements. Kalogirou (2013) opines that one of the biggest issues in regard to renewable energy, however, is the difficulty of obtaining the right technology and materials, because they are not commercially available on a large scale.

In line with the sentiments above, Chen (2011) argues that renewable energy refers to the energy that is derived from natural sources. It is important to note that the phrase sometimes also encompasses biofuels, whose carbon neutral status remains in doubt (Chen, 2011; Lewis, 2007; Kabir, et al. 2018). Another point worth noting is that it is estimated that there may be up to one trillion barrels of oil and gas left on the Earth. Therefore, it is worth noting that by investing in renewable energy sources, environmental protection is supported. Similar views are shared by Sukhatme and Nayak (2017) who define renewable energy as the type of energy which is derived from the imperishable resources of nature. Likewise, numerous authors share similar sentiments that whenever thinking of renewable energy, most of the people think about solar and wind (Foster, Ghassemi and Cota, 2009; Crabtree and Lewis, 2007; Lewis, 2007; Kabir, et al. 2018). In line with the views above, Hernandez, et al. (2014) argues that renewable energy is a promising alternative to fossil fuel-based energy, but its development can require a complex set of environmental trade-offs. Similarly, Foster, Ghassemi and Cota (2009) observe that a recent increase in solar energy systems, especially large, centralised installations, underscores the urgency of understanding their environmental interactions.

Soliman (2012: 119) declares that continuously rising energy demand combined with increasingly limited natural resources are challenging energy suppliers, either for industry or consumers to rethink how we produce and use energy. Carley (2015: 289) states that renewable energy implies naturally replenished energy; it is energy which comes from renewable natural resources such as sunlight, wind, rain, tides, and geothermal heat. According to Hamilton (2015), the deployment of renewable energy technologies has seen remarkable growth in recent decades, supported by enabling policies and steep cost reductions. Thiam (2011) states that improved energy security, fewer adverse climate change impacts and broader energy access are widely viewed as motivations for this increase. Hamilton (2015) argues that the business case for renewable energy is further strengthened by the socioeconomic benefits it can offer. It is pointed out by Nanda (2015) that investments in the renewable energy sector can stimulate high capital spending flow through the economy and, consequently, can stimulate direct and indirect growth in other related sectors. Clearly, such direct and indirect economic growth in other sectors promotes employment as well (Nanda, 2015).

The increase of renewable energy deployment will contribute to job creation. The jobs created are likely to offset job losses in sectors such as fossil fuels because the sectors involved in the renewables supply chain are usually more distributed and labour intensive than the conventional energy sectors (Greenpeace, 2015). Therefore, substituting fossil fuels for renewables could lead to a higher number of jobs overall. Maradin et al. (2017) conclude by not only considering primarily the economic benefits, but also the environmental and social benefits of renewable energy technologies and their role in the growing energy security issues, the governments of certain national economies have issued many policies to boost the deployment of renewable energy. Renewable energy benefits as outlined by Hamilton (2015), therefore, play a critical role in informing policy decisions and tipping the balance in favour of low-carbon investments. With a view to contribute to this field of knowledge, the International Renewable Energy Agency (IRENA) developed a conceptual framework to analyse the environmental, social, and economic value from large-scale solar and wind energy deployment (IRENA and Clean Energy Ministerial, 2014). Its approach helps classify, quantify, aggregate, and compare socioeconomic effects in a holistic manner. This study may demonstrate that the benefits of scaling up renewable energy surpass cost competitiveness. According to Nanda (2015), increased deployment of renewable energy can meet the energy needs of a growing population, drive development and improve well-being, while reducing greenhouse gas emissions and increasing natural resource productivity.

Twidell and Weir (2015) state that renewable energy may replace or enhance fossil energy supply various distinct areas such as electricity generation, hot water/space heating, motor fuels, and rural (off-grid) energy services. According to the latter authors, one of the benefits of renewable energy is that manufacturing of its devices uses non-renewable resources such as mined metals and land surface. In his study, Quaschning (2016) vehemently argues that by mid-century, renewable energy must cover all of energy supply if one needs to phase out nuclear and successfully stop climate change. Panwar, Kaushi, and Kothari (2011) observe that renewable technologies are considered as clean sources of energy and optimal use of these resources minimize environmental impacts, produce minimum secondary wastes and are sustainable based on current and future economic and social societal needs. On the other hand, Moriarty and Honnery (2012) argue that world energy demand is projected to rise to 1000 EJ (EJ= 10 18 J) or more by 2050 if economic growth continues its course of recent decades. According to the National Development plan, as part of the energy mix, 18.2 GWof the electricity is expected to be generated from the renewable energy sources mostly from solar PV and wind energy, each at 8.4 GW respectively (Modise and Mahotas, 2018). Mutombo and Numbi (2019) argue that the local and global community is trying to gradually shift to renewable energy sources by changing their economic dependence greatly on renewable energy sources. Table 3.1 below indicates renewable energy production targeted by South Africa by 2030.

Sector/Technology	Targets
(Electricity)	18.2 GW
Solar PV	8.4 GW
Wind	8.4 GW
CSP	1 GW
Others	0.4 GW

Table 3.1: Set renewable energy target for South Africa

Source: Modise and Mahotas (2018)

3.5 BENEFITS OF RENEWABLE ENERGY

There seems to be numerous benefits of using renewable energy. For instance, Ellabban, Abu-Rub and Blaabjerg (2014) observe that electricity energy security is essential, yet the prohibitive cost and limited sources of fossil fuels, in addition to the need to reduce greenhouse gasses emission, have made renewable resources attractive in world energy-based economies. According to these authors the potential for renewable energy resources is enormous because they can, in principle, exponentially exceed the world's energy demand; therefore, these types of resources will have a significant share in the future global energy portfolio, much of which is now concentrating on advancing their pool of renewable energy resources. Similarly, Chen (2011) observes that fossil fuels are not renewable, and it is imperative that one does everything to extract and utilize them before they become too depleted. Chen (2011) further observes that some are extracted through petroleum exploration and production, while others must be found elsewhere in the world. These other sources include wood and agricultural residues, along with sewage sludge and coal, which have been burned and are now turning into fossil fuel (Chen, 2011; Fahrenbruch and Bube, 2012; Jacobs, 2021). In line with these view, Fahrenbruch and Bube (2012) observe that with the help of advances in technology, several different technologies and methods have been developed to produce various forms of energy, including the generation of electricity through solar panels or wind turbines, and even water heaters. They argue that the conversion of bio-fuels into electricity is still being perfected, and it is estimated that the process could take twenty to thirty years.

Likewise, Timilsina, Kurdgelashvili and Narbel (2012) argue that fossil fuel is a finite resource, so the use of other sources of energy would have to be taken over the long term to avoid our planet's depletion. They add that this would mean reducing use of fossil fuels and focusing instead on other forms of energy, especially those that are renewable. It is true that there are many types of renewable energy sources, from hydropower to geothermal and solar. However, it is highly advisable for individuals who are in the process of developing their own renewable energy source, they should first evaluate the viability of each resource, both for their needs and the environment (Timilsina, Kurdgelashvili and Narbel, 2012). The latter authors further observe that geothermal energy takes longer to generate than hydropower, but it is plentiful and can last longer than hydroelectricity, making it an ideal choice for use in home and small commercial facilities. Similar sentiments are shared by Sipahutar, Bernas, and Imanuddin (2013) as they argue that hydroelectricity and geothermal energy are the two most common forms of renewable energy sources today. However, Frey and Linke (2002) observe that although they are the oldest forms, they are also the most commonly used. Hence solar energy is considered to be the newest type of renewable energy source, as well as one of the least expensive (Frey and Linke, 2002). In modern days renewable energy is considered to be one of the safest types of usable energy (Sipahutar, Bernas and Imanuddin, 2013). As the world is focusing on sustainable development, as green energy, renewable energy is getting priority to the contemporary engineers (Frey and Linke, 2002).

When it comes to environmental benefits of renewable energy, Booth (2006) observes that renewable energy technologies are clean sources of energy that have a much lower environmental impact than conventional energy technologies. He adds that while renewable energy will not run out, other sources of energy are finite and will someday be depleted. In as far as jobs and the economy are concerned, Booth (2006) argue that most renewable energy investments are spent on materials and workmanship to build and maintain the facilities, rather than on costly energy imports. With regard to energy security, Booth (2006) observes that after the oil supply disruptions of the early 1970s, many countries have increased their dependence on foreign oil supplies instead of decreasing it. This increased dependence impacts more than just countries national energy policy (Booth, 2006).

3.6 BENEFITS OF USING RENEWABLE ENERGY

Numerous researchers have written extensively on renewable energy, including Alrikabi (2014); Malkina Pykh and Pykh (2002); Tietenberg and Lewis (2018); Booth (2006), to name but a few. In recent years there have been many advancements in green technology for the home, making today an exciting time for homeowners looking to greenify their homes. Alrikabi (2014) observes that the rapid increase in energy consumption particularly in the past several decades has raised fears of exhausting the globe's reserves of petroleum and other resources in the near future. In addition, Alrikabi (2014) argues that the huge consumption of fossil fuels has caused visible damage to the environment in various forms. He further contends that approximately 90% of energy consumption comes from fossil fuels. Thus, he further argues that due to industrializations and population growth, economy and technologies today largely depend upon natural resources, which are not replaceable. The literature shows that there are numerous world-wide studies that have been conducted on renewable energy. For instance, a study conducted by Malkina-Pykh and Pykh (2002) on sustainable energy resources established that the United States during that year was heavily relying on coal, oil, and natural gas for its energy. The latter authors further state that fossil fuels are non-renewable, that is, they draw on finite resources that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve. Sadly, it is worth noting that every year human activity dumps 8 billion metric tons of carbon into the atmosphere, 6.5 billion tons from fossil fuels and 1.5 billion from deforestation (Malkina-Pykh and Pykh, 2002).

Similar sentiments are shared by Tietenberg and Lewis (2018) who argue that the huge consumption of fossil fuels has caused visible damage to the environment in various forms. They argue that the huge consumption of fossil fuels creates a lot of environment problem and finally ecological cycle will be affected. In support of the views, Alrikabi (2014) observes that the energy industry needs to get more from existing fields while continuing to search for untapped resources. He further argues that due to technological advancement vehicles are made with improved fuel efficiency and also perfect hybrid vehicle are made. Moreover, he is of the view that the improvements are needed so that wind, solar and hydrogen can be playing more valuable sources in the energy field. In his earlier study, Booth (2006) notes that the many types of renewable energy resources-such as wind and solar energy-are constantly replenished and will never run out that is one benefit. He states that most renewable energy comes either directly or indirectly from the sun. He further states that sunlight, or solar energy, can be used directly for heating and lighting homes and other buildings, for generating electricity, and for hot water heating, solar cooling, and a variety of commercial and industrial uses.

According to Tietenberg and Lewis (2018), there are numerous benefits of using renewable resources. One of these benefits is that they can be distributed over a wide geographical area, ensuring that developing regions have access to electricity generation at a stable cost for the long-term future (Tietenberg and Lewis, 2018). The latter authors further observe that the sun's heat also drives the winds, whose energy, is captured with wind turbines. Consequently, the winds and the sun's heat cause water to evaporate. They state that when this water vapor turns into rain or snow and flows downhill into rivers or streams, its energy can be captured using hydroelectric power. In line with the sentiments above, Lund (2007: 912) observes that along with the rain and snow, sunlight causes plants to grow. He further states that the organic matter that makes up those plants is known as biomass. Similarly, Da Rosa and Ordonez (2021) note that biomass can be used to produce electricity, transportation fuels, or chemicals.

According to the latter authors the use of biomass for any of these purposes is called bio energy. In their study, Kaltschmitt, Streicher and Wiese (2007) state that hydrogen also can be found in many organic compounds, as well as water. They add that hydrogen is the most abundant element on earth. However, they argue that one of its glaring drawbacks is that it does not occur naturally as a gas. It is always combined with other elements, such as with oxygen to make water. It is a well-known fact that once separated from another element, hydrogen can be burned as a fuel or converted into electricity. Another point worth noting is that not all renewable energy resources come from the sun. For instance, Panwar, Kaushi, and Kothari (2011) observe that geothermal energy taps the Earth's internal heat for a variety of uses, including electric power production, and the heating and cooling of buildings. It is also correct to mention that the energy of the ocean's tides come from the gravitational pull of the moon and the sun upon the Earth. In fact, ocean energy comes from a number of sources (Panwar, et al., 2011). In addition to tidal energy, Walker and Devine-Wright (2008) state that there is energy of the ocean's waves, which is driven by both the tides and the winds. It is noted that the sun also warms the surface of the ocean more than the ocean depths, creating a temperature difference that can be used as an energy source. All these forms of ocean energy can be used to produce electricity (Tietenberg and Lewis, 2018).

Bull (2001: 1216) observes that energy is essential to society as it ensures that there is quality of life and to underpin all other elements of economies world over. He is of the view that renewable energy technologies offer the promise of clean, abundant energy gathered from self-renewing resources such as the sun, wind, earth, and plants. On the other hand, Twidell and Weir (2015) show that virtually all countries have renewable resources of one type or another. For instance, these authors are of the opinion that renewable resources currently account for about 10% of the energy consumed in the United States, most of this is from hydropower and traditional biomass sources. Another point worth noting is that wind, solar biomass, and geothermal technologies are cost-effective in an increasing number of markets and are making important steps to broader commercialisation (Twidell and Weir, 2015). They note that each of the renewable energy technologies is in a different stage of research, development, and commercialisation, and all have differences in current and future expected costs, current industrial base, resource availability, and potential impact on greenhouse gas emissions.

According to UCS (2017), renewable energy is providing affordable electricity across the country right now and can help stabilize energy prices in the future. Although renewable facilities require upfront investments to build, they can then operate at very low cost (for most clean energy technologies, the “fuel” is free). As a result, renewable energy prices can be very stable over time. Moreover, SEIA (2017) report mentions that the costs of renewable energy technologies have declined steadily and are projected to drop even more. For example, the average price to install solar dropped more than 70 percent between 2010 and 2017 (SEIA, 2017). The cost of generating electricity from wind dropped 66 percent between 2009 and 2016 (AWEA, 2017). Costs will likely decline even further as markets mature and companies increasingly take advantage of economies of scale. In contrast, fossil fuel prices can vary dramatically and are prone to substantial price swings. For example, there was a rapid increase in US coal prices due to rising global demand before 2008, then a rapid fall after 2008 when global demands declined (UCS, 2017). Likewise, natural gas prices have fluctuated greatly since 2000 (EIA. 2013). Using more renewable energy can lower the prices of and demand for natural gas and coal by increasing competition and diversifying energy supplies. UCS (2017) report argues that an increased reliance on renewable energy can help protect consumers when fossil fuel prices spike.

3.7 TYPES OF RENEWABLE ENERGY

It is worth pointing out that sustainable harvesting and use of renewable resources such as maintaining a positive renewal rate can reduce air pollution, soil contamination, habitat destruction and land degradation. According to Mutombo and Numbi (2019), renewable energy source is an alternative energy source that is continuously renew naturally so that it can be considered as inexhaustible on the scale of human lifetime. The literature shows that there are numerous and diverse types of renewable energy, namely: biomass, hydropower, geothermal energy, wind and solar. Several renewable resources have the potential to contribute significantly to South African energy supplies (Banks and Schäffler, 2006: 6). In particular:

- Solar thermal (for heating), solar thermal electricity generation and solar photovoltaic electricity generation. South Africa has an excellent solar resource.

- Wind electricity generation. South Africa has fair to reasonable wind resources by international standards.
- Biomass (heating, cooking, electricity and, in particular, liquid fuels for transport and cleaner cook stoves). Biomass already contributes between 9 and 14 percent to the total energy requirement, but it could be utilised more efficiently, and current use is not always sustainable.
- Hydropower. South Africa is not particularly well endowed with hydropower potential, but there is potential to import hydropower & to develop locally significant micro-hydro potential.
- Wave power. This is a new technology, but one from which South Africa could benefit, as there is an extensive coastline with high wave energy potential. Ocean currents, thermal gradients in the sea, and even ocean grown biomass could also play a future role.
- Other resources, such as geothermal, may play a lesser role.

3.7.1 Biomass energy

Biomass is regarded by many energy experts and enthusiasts as the most generic form of renewable energy that is widely used in the third world. According to Bar-On, Phillips and Milo (2018), biomass refer to biological material from living, or recently living organisms, most often referring to plants or plant-derived materials. Rosillo-Calle and Woods (2012) observe that the increasing importance of biomass as a renewable energy source has led to an acute need for reliable and detailed information on its assessment, consumption, and supply. On the other hand, McKendry (2002) argues that the use of renewable energy sources is becoming increasingly necessary, if one is to achieve the changes required to address the impacts of global warming. Similarly, Klass (1998) notes that biomass for renewable energy, fuels, and chemicals serves as a comprehensive introduction to the subject for the student and educator and is useful for researchers who are interested in the technical details of biomass energy production. Similar sentiments are shared by Demirbaş (2001) who states that biomass resources include wood and wood wastes, agricultural crops and their waste by products, municipal solid waste, animal wastes, waste from food processing and aquatic plants and algae.

Likewise, Klass (1998) observes that biomass energy is derived from six distinct energy sources: garbage, wood, plants, waste, landfill gases, and alcohol fuels. He further notes that historically, humans have harnessed biomass-derived energy since the advent of burning wood to make fire, and wood remains the largest biomass energy source today. In their study on indoor air pollution from biomass combustion and acute respiratory infections in the world, Ezzati and Kammen (2001) argue that low tech use of biomass, which still amounts for more than 10% of world energy needs may induce indoor air pollution in developing nations and results in between 1.5 million and 2 million deaths in 2000. A similar study by Ezzati, Saleh and Kammen (2000) established that acute and chronic respiratory diseases, which are causally linked to exposure to indoor air pollution in developing countries, are the leading cause of global morbidity and mortality.

The study concluded that efforts to develop effective intervention strategies and detailed quantification of the exposure-response relationship for indoor particulate matter require accurate estimates of exposure. Also, the results show that exposure during brief high-intensity emission episodes accounts for 31-61% of the total exposure of household members who take part in cooking and 0-11% for those who do not. In addition, Ezzati, Saleh and Kammen (2000) established that simple models that neglect the spatial distribution of pollution within the home, intense emission episodes, and activity patterns underestimate exposure by 3-71% for different demographic subgroups, resulting in inaccurate and biased estimations. Moreover, the latter study recommended that health and intervention impact studies should therefore consider in detail the critical role of exposure patterns, including the short periods of intense emission, to avoid spurious assessments of risks and benefits. Another similar study by Malla, et al., (2011) also established that indoor air pollution from burning solid fuels for cooking is a major environmental health problem in developing countries, affecting children and women. They further established that traditional household energy practices also contribute to substantial time loss and drudgery among households. The latter authors also found that while effective interventions exist, levels of investment to date have been exceptionally low, in part due to lack of evidence on economic viability.

It is important to note that between 2004 and 2007, different combinations of interventions, namely: improved stoves, smoke hoods and a switch to liquefied petroleum gas were implemented in poor communities in Nepal, Sudan and Kenya. Similar views are shared by Moturi (2010) who argues that exposure to indoor air pollution may be responsible for 2 million per year deaths in developing countries. In addition, Moturi (2010) further states that in Kenya for instance, it is among the factors linked to high morbidity, especially in children aged below five years. Moturi (2010) study found that state of housing and type of fuel used were found to be risk factors for indoor air pollution. The study concluded that the state of housing and fuel used in sampled households encourage indoor air pollution, which has been associated with various diseases (Moturi, 2010).

It is a well-known fact that women and girls are responsible for collecting fuelwood for cooking in most households, particularly in rural communities and in refugee camps. It has been observed that this increases their vulnerability to incidences of violence, including beating and bodily injury, assault, and rape (Balat and Ayar, 2005; Demirbas, 2008; Goldemberg and Coelho, 2004; Henrich, et al, 2015; Balat, 2009; van Swaaij, Kersten and Palz, 2015; Parikka, 2004). It is important to note that this time could be spent in more productive ways such as attending school or income production. Another point worth noting is that improved cook-stove interventions in refugee camps have shown significant decreases in fuelwood collection times reported by women (Balat and Ayar, 2005; Demirbas, 2008; Goldemberg and Coelho, 2004). Moreover, removing the need for women to collect fuelwood also significantly reduces reported rapes during firewood collection (Balat and Ayar, 2005; Demirbas, 2008; Goldemberg and Coelho, 2004).

In line with the views above, Balat (2009) observes that biomass energy plays a vital role in meeting local energy demand in many regions of the developing world. He further argues that biomass energy utilisation has gained particular interest in recent years due to the progressive depletion of conventional fossil fuels, which calls for an increased use of renewable energy sources. The gaining of interest is due to the fact biomass energy is more economical to produce and it provides more energy than other energy forms. It has been observed that biomass production is eight times greater than the total annual world consumption of all other energy sources (Balat, 2009). Similarly, Heinimö and Junginger (2009) argue that the markets for industrially used biomass for energy purposes are developing rapidly toward being international commodity markets. In addition, the latter authors further state that determining international traded biomass volumes for energy purposes is difficult, for several reasons, such as challenges regarding the compilation of statistics on the topic. On the other hand, Henrich, et al. (2015) observes that in a world without fossils, the limited biomass harvest is the only carbon source.

In his study that examined the importance of biomass energy sources for Turkey, Demirbas (2008) Established that various agricultural residue such as grain dust, crop residues and fruit tree residues are available in Turkey as the sources of biomass energy. In addition, his study found that among the biomass energy sources, fuelwood seems to be one of the most interesting because its share of the total energy production of Turkey is high at 21% and the techniques for converting it to useful energy are not necessarily sophisticated. Moreover, his study found that selection of a particular biomass for energy requirements is influenced by its availability, source and transportation cost, competing uses and prevalent fossil fuel prices. There is a wild held perception that utilisation of biomass is an attractive energy resource, particularly for developing countries since biomass uses local feedstocks and labour.

It is therefore important to note that electricity production from biomass has been found to be a promising method in the nearest future in Turkey (Demirbas, 2008). Likewise, in his study entitled Indoor air pollution and health in developing countries, Ezzati (2005) argues that biomass fuels and coal are vital to health and welfare in developing nations. Similarly, Ezzati, et al. (2004) is of the view that worldwide, almost 3 billion people use biomass such as wood, charcoal, crop residues, and animal dung, and coal as their main source of energy for cooking, heating, and other household needs such as food preservation. According to Dherani, et al. (2008) it is worth noting that combustion of biomass and coal emits mixtures of pollutants that have been associated, with varying degrees of evidence, as a cause of acute respiratory infections, chronic obstructive pulmonary disease, lung cancer, asthma, nasopharyngeal and laryngeal cancers, tuberculosis, and diseases of the eye. In addition, Dherani et al. (2008) further states that emissions are particularly high when solid fuels are used in open or poorly ventilated stoves, typical of most developing nations.

In their study entitled indoor air pollution in developing countries and acute lower respiratory infections in children, Smith et al (2000) established that studies of indoor air pollution from household biomass fuels are reasonably consistent and, as a group, show a strong significant increase in risk for exposed young children compared with those living in households using cleaner fuels or being otherwise less exposed. They further established that not all studies were able to adjust for confounders, but most of those that did so find that strong and significant risks remained. In their concluding remarks they indicated that the relative risks are likely to be significant for the exposures considered here. They further argue that since acute lower respiratory infection is the chief cause of death in children in less developed countries and exacts a larger burden of disease than any other disease category for the world population, even small additional risks due to such a ubiquitous exposure as air pollution have important public health implications. In the case of indoor air pollution in households using biomass fuels, the risks also are fairly strong, presumably because of the high daily concentrations of pollutants found in such settings and the large amount of time young children spend with their mothers doing household cooking (Smith, et al. 2000). One of the recommendations of their study was that given the large vulnerable populations at risk, there is an urgent need to conduct randomised trials to increase confidence in the cause-effect relationship, to quantify the risk more precisely, to determine the degree of reduction in exposure required to significantly improve health, and to establish the effectiveness of interventions (Smith, at al. 2000).

3.7.2 Hydropower energy

According to Yüksel (2010), hydropower energy is the most widely used form of renewable energy sources today, since it produces extraordinarily little waste, and it is extremely limited maintenance. In addition, Yuksel (2010) observes that in particular, dams built for hydropower production produce copious amounts of electricity. Numerous countries are using hydropower and one of them is Turkey. Yuksel (2010) notes that Turkey has a total gross hydropower potential of

433 GWh/year, but only 125 GWh/year of the total hydroelectric potential of Turkey can be economically used. It is worth pointing out that by the commissioning of new hydropower plants, which are under construction, 36% of the economically usable potential of the country would be tapped. Moreover, he states that Turkey has considerable renewable energy sources. He further argues that the most important renewable sources are hydropower, biomass, geothermal, solar and wind. According to Kannan and Vakeesan (2016), Germany is one of the world’s most prolific users of clean energy for power, heating, and transport. It has been observed that Germany has rapidly expanded the use of clean energy which now contributes almost one-fourth to the national energy mix.

It is important to note that Turkey's geographical location has several advantages for extensive use of most of these renewable energy sources. Yuksel (2010) is of the view that over the last two decades, global electricity production has more than doubled and electricity demand is rising rapidly around the world as economic development spreads to emerging economies. Another crucial point worth noting is that not only has electricity demand increased significantly, but it is also the fastest growing end-use of energy. Therefore, the technical, economic and environmental benefits of hydroelectric power make it an important contributor to the future world energy mix, particularly in the developing countries (Yuksel, 2010; Mekhilef, Saidur and Safari, 2011; Lewis, et al. 2005; Tiwari and Tiwari, 2016; Timilsina, Kurdgelashvili and Narbel, 2012). According to Sipahutar, Bernas and Imanuddin (2013), tropical rainforest regions have large hydropower generation potential that figures prominently in many nations’ energy growth strategies. In support of these views, Stickler, et al. (2013) observe that feasibility studies of hydropower plants typically ignore the effect of future deforestation or assume that deforestation will have a positive effect on river discharge and energy generation resulting from declines in evapotranspiration (ET) associated with forest conversion. Sipahutar, Bernas and Imanuddin (2013) take these views further by stating that forest loss can also reduce river discharge, however, by inhibiting rainfall. These authors further state that like other energy sources, hydropower plants present large social and environmental costs. They vehemently argue that their reliability as energy sources, however, must consider their dependence on forests.

In their study on hydropower as a renewable and sustainable energy resource meeting global energy challenges in a reasonable way, Frey and Linke (2002) note that central and state governments in many countries have enacted laws and regulations to promote renewable energy and to encourage sustainable technologies. These authors add that in doing so, countries had to define what they meant by renewable and sustainable, and they had to decide which particular technologies or organisations would be eligible for subsidies and tax concessions, and which others would be excluded. Not infrequently, a considerable amount of lobbying would precede the passage of such laws and regulations, and the resulting definitions of renewable and sustainable are often different than their original meaning (Frey and Linke, 2002). It is worth noting that if the dams are used effectively, they produce substantial amounts of power which are stored in storage devices, allowing for larger amounts to be generated. One of the advantages of hydropower is that it does not deplete the earth's freshwater supplies.

3.7.3 Geothermal energy

Van-Horn et al. (2020) state that geothermal energy is the world's most abundant continuous heat supply and is available worldwide. The geothermal energy as describes by Mutombo and Numbi (2019: 878) is the energy generated from the difference of temperature from the deep core of earth (4000 ◦C) to the surface of the earth (25 ◦C). Jouanne and Brekken (2017: 2147) argue that geothermal energy primarily comes from radioactive decay deep within the Earth and residual heat from the formation of the Earth. Heat from deep core of the earth heats the underground reservoir water that generates at the surface as steam or hot water. The steam runs the turbine that rotates a generator connected to it and electricity is generated. The geothermal energy like any other renewable energy presents benefits to the environment by low carbon dioxide emission, small physical full print and minimum environmental impact (Mutombo and Numbi, 2019). Sui, Langåker, and Yu (2017) state that Geothermal energy is a clean and sustainable energy resource with virtually unlimited supply. Van-Horn et al. (2020) later confirm that renewable geothermal energy systems generate clean, reliable, secure, and resilient electric power. The potential geothermal energy is estimated to be equivalent to 42 million MW of power and expected to last for billions of years (Sui et al., 2017).

Mutombo and Numbi (2019) argue that different geothermal power systems are developed, the most popular are the dry steam geothermal, the flash steam geothermal and the binary cycle geothermal. Based on the International Geothermal Association (IGA) report, this technology has reached the production of 11,700 MW produced in 2013 and the IGA projection for 2015 was 18,500 MW (G.E.A., 2010). South African scientists are optimistic about producing geothermal energy starting from low enthalpies from five regions (Richte, 2017). Mutombo and Numbi (2019) recommend that the regions of high geothermal potential energy are mostly located in the Cape Fold belt at the south of the country with a potential of 69m. Richte (2017) argues that the potential of geothermal energy in South Africa is 4.336 MW representing 63.13% of 6,868 MW of available geothermal energy.

3.7.4 Wind energy

Banks and Schäffler (2006) argue that wind energy is currently the fastest growing energy industry in the world, and large wind farms are being established on- and off-shore in several countries. According to Uhunamure and Shale (2021: 5), wind energy is indirectly related to solar energy. This is because energy from the sun drives the cyclical movement of air, water vapour as well as climatic pattern (Aliyu, Modu, and Tan, 2018). Mutombo and Numbi (2019) argue that Wind power is obtained by the conversion of air kinematic energy of the flowing air into electrical energy. Uhunamure and Shale (2021) further state that an electrical generator enables wind turbines to convert air kinetic energy into mechanical energy. The airflow rotates a wind turbine that converts the air kinematic energy into mechanical energy, the conversion of the mechanical energy into electrical energy is made possible by an electric generator (Mutombo and Numbi, 2019). According Uhunamure and Shale (2021: 5), the conversion of air kinetic energy from the flowing air into electrical energy generates wind power. Wind power according to Blaabjerg and Ma (2017), has become an important component of the modern energy supply. The cumulative wind power capacity from 2001 to 2020 is shown in figure 3.3 below; the installed capacity of wind power achieved 487 GW, with 54 GW added in 2016 alone. Wind power accounted for 55%

of the renewable power capacity globally, not including hydropower, and accounted for 3.7% of global electricity production by the end of 2015.

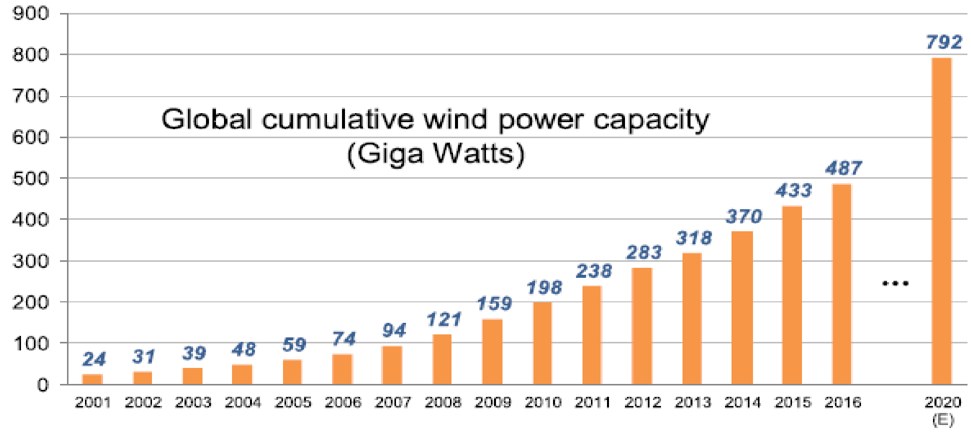


Figure 3.3: Global cumulative wind power capacity 2001 to 2020
Source: Blaabjerg and Ma (2017)

According to Wagner (2018), wind energy is a renewable energy source; therefore, it holds many advantages over the fossil fuels, which additionally have diminishing reserves. Effiom, Nwankwojike and Abam (2016) argue that wind energy has been widely accepted as an alternative energy to the fossil fuels and its derivate. Wind energy is clean with regard to toxic emissions. Therefore, it does not add to Global Warming or acid rain problems. The wind energy market has grown because of the environmental advantages of harnessing a clean and inexhaustible energy source and because of the economic incentives supplied by several governments (Effiom et al., 2016). However, wind energy is still one of the most important renewable energy resources for the future, because it can be harnessed in a clean and inexhaustible manner, through the application of technically advanced and efficient machinery (Wagner, 2018). Uhunamure and Shale (2019) argues that wind energy can be widely distributed and requires a small surface area for installation. Thus, the energy produced is considered to be environmentally friendly. Wind energy is advantageous because it produces energy which is considered free from greenhouse gas emissions in the course of operation, but emissions could be significant during turbine production and maintenance (Uhunamure and Shale, 2021).

Uhunamure and Shale (2021) state that in South Africa, many parts lie near the equatorial zone. Wind energy is also considered as one of the greatest prospects for energy generation in South Africa. Theoretically, wind energy potential in South Africa is estimated at 6700 GW. Shilpi, Jain and Iliso (2017) mention that over 80% of South Africa's land area has wind resources to support development of economic wind farms with annual load factors greater than 30% and total wind power potential of 6,700 GW, which is competitive with solar potential. South Africa requires 250 TWh/y energy which could all be generated from wind farms of a combined capacity of 75GW over 0.6% of the country's land area. Pegels (2010) state that the average wind speed in the country ranges from 7.29–9.70 m/s which was recorded in the Cape Agulhas. Generally, the potential of wind energy is good along the entire coastlines of the country, with some areas like the coastal promontories displaying a strong potential (DoE, 2015). Moderately, the inland areas are potentially noted such as the Eastern Highveld Plateau, the Drakensberg foothills in KwaZulu-Natal and Eastern Cape (DoE, 2015). Uhunamure and Shale (2021) state that so far, the implementation of about 3.366 GW of wind power is underway, with an envisioned addition of 5.034 GW capacity to be included by 2030.

3.7.5 Solar energy

Numerous researchers have written extensively about solar energy and they concur that it refers to the radiant light and heat from the sun that has been harnessed by humans since ancient times using a range of ever-evolving technologies (Sukhatme and Nayak, 2017; Kannan and Vakeesan, 2016; Kalogirou, 2013). Some experts and scholars are of the view that the importance of solar energy was recognized as early as 1911 in the Scientific American article, (Kannan and Vakeesan, 2016; Sukhatme and Nayak, 2017; Kalogirou, 2013; Chen, 2011; Foster, Ghassemi and Cota, 2009). In addition, it has been observed that solar radiation along with secondary solar resources account for most of the available renewable energy on earth (Chen, 2011; Kabir, et al. 2018; Tiwari & Tiwari, 2016; Lewis, 2016). In line with the views above, Almasoud and Gandayh (2015) define solar power as the energy from the sun that is converted into thermal or electrical energy. Similarly, Dickinson (2018) observes that solar energy is the cleanest and most abundant renewable energy source available. On the other hand, Creutzig, et al. (2017) argues that solar technologies can harness this energy for a variety of uses, including generating electricity, providing light or a comfortable interior environment, and heating water for domestic, commercial, or industrial use. In a nutshell, Lewis (2016) argues that solar is the most abundant source of energy on Earth. Hence, about 173,000 terawatts of solar energy strike the earth at any given time, more than 10,000 times the world's total energy needs (Mekhilef, Saidur and Safari, 2011; Creutzig, et al. 2017; Dickinson, 2018; Almasoud and Gandayh, 2015).

Moreover, Tiwari and Tiwari (2016) take these views further pointing out that by capturing the sun's energy and turning it into electricity for home or business, solar energy is a key solution in combating the current climate crisis and reducing our dependence on fossil fuels. Bahadori and Nwaoha (2013) observe that climate change due to greenhouse gases emission from fossil fuels has prompted several governments to channel resources in the commercial utilisation of renewable energy sources. Khatib, Mohamed and Sopian (2012) argue that solar energy is one of the renewable energy sources that are highly untapped and under utilised. Numerous researchers and green energy enthusiasts have written extensively on solar energy looking at its benefits. Some of these authors include Kannan and Vakeesan (2016); Sukhatme and Nayak (2017); Kalogirou (2013); Chen (2011); Foster, Ghassemi, and Cota (2009), to name but a few. For instance, Kannan and Vakeesan (2016) in their study established that world′s energy demand is growing fast because of population explosion and technological advancements. Hence, they suggest that it is important to go for reliable, cost effective and everlasting renewable energy source for energy demand arising in future. According to Sukhatme and Nayak (2017), solar energy, among other renewable sources of energy, is a promising and freely available energy source for managing long term issues in energy crisis. Kannan and Vakeesan (2016) share similar sentiments by stating that solar industry is developing steadily all over the world because of the high demand for energy while major energy source, fossil fuel, is limited and other sources are expensive. The latter authors further state that solar energy has become a tool to develop economic status of developing countries and to sustain the lives of many underprivileged people as it is now cost effective after long aggressive research done to expedite its development.

In their study, Kannan and Vakeesan (2016) conclude that the solar industry would definitely be a best option for future energy demand since it is superior in terms of availability, cost effectiveness, accessibility, capacity and efficiency compared to other renewable energy sources. Foster, Ghassemi and Cota (2009) are of the view that energy policy promoting sustainable development is transforming global energy markets. Kalogirou (2013) argues that solar power is the most abundant of all renewable resources. Similarly, Chen (2011) observes that solar power is crucial to greater achieving energy security and sustainability. Crabtree and Lewis (2007) weigh in by arguing that if solar energy is to become a practical alternative to fossil fuels, one has to have efficient ways to convert photons into electricity, fuel, and heat. In line with the views above, Lewis (2007) observes that at present, solar energy conversion technologies face cost and scalability hurdles in the technologies required for a complete energy system. Garg (2000) seem to possess knowledge on how radiation energy is created. Garg (2000) states that as a matter of fact all substances such as solids, liquids and gases, at temperatures above absolute zero, emit energy in the form of electromagnetic waves. Kabir, et al. (2018) observes that the development of novel solar power technologies is considered to be one of many key solutions toward fulfilling a worldwide increasing demand for energy. However, Kabir et al. (2018) argues that the rapid growth within the field of solar technologies is nonetheless facing various technical barriers, such as low solar cell efficiencies, low performing balance-of-systems (BOS), economic hindrances, and institutional obstacles.

Granqvist (2003) seems to be clued up about solar energy as he notes that solar energy materials have properties tailored to meet requirements set by the spectral distribution, angle of incidence, and intensity of the electromagnetic radiation prevailing in our natural surroundings. In support of the views above, Jacobs (2021) points out that not living in an off-the-grid house like an earth-ship, does not necessarily mean that one cannot live the eco-friendly lifestyle. He argues that this is mainly due to the fact that nowadays there are numerous modern green technologies available in the market that will make one's home greener. Jacobs further outlines these technologies to include smart lights to greener garden tools to smart thermostats and more. Likewise, Fahrenbruch and Bube (2012) observes that technology behind solar panels has been around since 1883, and solar panels akin to the ones used today have been in existence since 1954, but the use of solar energy is just starting to take off on the world stage. According to Jacobs (2021), the adoption of solar panels is being witnessed and found in at least more than 37 nations worldwide.

Jacobs (2012) further notes that the sun is a natural resource that will heat the planet for at least another many years to come. One of the positive aspects about the temperature is that it can be converted into electricity (Jacobs, 2012). It is true that solar panels are technological appliances that generate electricity by converting light energy into direct currents which are applicable for commercial and residential purposes (Jacobs, 2012). The advent of solar panels is a major progress in technology, providing the world with a more economically sustainable and reliable power supply for all applications (Jacobs, 2021). It is important to note that solar panels are an inevitable roof addition to install in order to cut electricity costs and contribute to the environment. Fahrenbruch and Bube (2012) observe that technology has become so advanced that panels nowadays can be almost unnoticeable or become a unique addition to the roofing system. Consequently, many people are continuing to use them in their properties motivated by quite a number of its advantages. Jacobs (2021) observes that it has become a well-known fact that solar panels are becoming more popular, more apparently among homeowners. He further notes that solar panels are transforming the way people live. One of the most glaring benefits of using solar panels is the fact that they have become so effective in making the world environmentally friendly. Jacobs argues that solar panels are becoming more proficient and inexpensive as the technology behind them gets perfected.

Similar sentiments are shared by Mekhilef, Saidur and Safari (2011) who observe that nowadays solar energy conversion is widely used to generate heat and produce electricity. They argue that a comparative study on the world energy consumption released by International Energy Agency (IEA) shows that in 2050, solar array installations will supply around 45% of energy demand in the world. Another point worth noting is that solar electricity is wildly applied in telecommunication, agricultural, water desalination and building industry to operate lights, pumps, engines, fans, refrigerators and water heaters (Mekhilef, Saidur and Safari, 2011). The latter authors further state that it is especially important to apply solar energy for a wide variety of applications and provide energy solutions by modifying the energy proportion, improving energy stability, increasing energy sustainability, conversion reduction and hence enhance the system efficiency.

Similar sentiments are shared by Lewis, et al. (2005) who argues that the world demand for energy is projected to more than double by 2050 and to more than triple by the end of the century. The latter authors further note that incremental improvements in existing energy networks will not be adequate to supply this demand in a sustainable way. They argue that finding sufficient supplies of clean energy for the future is one of society's most daunting challenges. It cannot be denied that sunlight provides by far the largest of all carbon-neutral energy sources. Looking at a brief history of solar energy, for instance in 2001, solar electricity provided less than 0.1% of the world's electricity, and solar fuel from modern biomass provided less than 1.5% of the world's energy (Lewis et al., 2005). It has been observed that the huge gap between present use of solar energy and its enormous undeveloped potential defines a grand challenge in energy research. There is no doubt that sunlight is a compelling solution to human's need for clean which is regarded as abundant sources of energy in the future (Lewis, et al, 2005). One of the benefits of solar energy is that it is readily available, secure from geopolitical tension, and poses no threat to the environment through pollution or to the climate through greenhouse gases (Lewis, et al, 2005).

In support of the views above, Tiwari and Tiwari (2016) observe that solar energy is clean, environmentally friendly and freely available over the planet earth. They further argue that life on earth also owes its existence to solar energy. Therefore, solar energy is used to produce thermal as well as electrical power (Tiwari and Tiwari, 2005). Likewise, Timilsina, Kurdgelashvili and Narbel (2012) are of the view that solar energy has experienced phenomenal growth in recent years due to both technological improvements resulting in cost reductions and government policies supportive of renewable energy development and utilization. However, they argue that even though the cost of solar energy has declined rapidly in the recent past, it still remains much higher than the cost of conventional energy technologies. They further observe that like other renewable energy technologies, solar energy benefits from fiscal and regulatory incentives, including tax credits and exemptions, feed-in-tariff, preferential interest rates, renewable portfolio standards and voluntary green power programs in many countries. Another point worth noting is the fact that the emerging carbon credit markets are expected to provide additional incentives to solar energy deployment. Despite the huge technical potential, the development and large-scale deployment of solar energy technologies world-wide still has to overcome a number of technical, financial, regulatory and institutional barriers (Timilsina, Kurdgelashvili and Narbel, 2012). The continuation of policy supports might be necessary for several decades to maintain and enhance the growth of solar energy in both developed and developing countries (Timilsina, et al. 2012).

3.8 ADVANTAGES OF SOLAR ENERGY

Synthesizing literature by numerous scholars, researchers, as well as renewable energy enthusiasts it is clear that solar energy has numerous benefits. For instance, Hernandez, et al. (2014) argues that renewable energy is a promising alternative to fossil fuel-based energy, but its development can require a complex set of environmental trade-offs. On the other hand, Foster, Ghassemi and Cota (2009) observe that a recent increase in solar energy systems, especially large, centralised installations, underscores the urgency of understanding their environmental interactions. In support of the views above, Adenle (2020) notes that renewable energy sources like solar energy have a key role to play towards the implementation of the 2030 agenda and Sustainable Development Goals (SDGs) in Africa. The latter author further adds that while renewable energy was not stated as one of the technologies for the achievement of the Millennium Development Goals (MDGs), it played an indirect role towards meeting MDG targets especially in the areas such as household application, health, education and poverty reduction in Africa. However, Adenle (2020) further states that renewable energy's impacts including solar energy technologies were not quantified, and lack of performance assessment could be in part attributed to the weak implementation of solar energy projects in the developing world including countries in Africa.

Likewise, Kabir, et al. (2018) argue that the development of novel solar power technologies is considered to be one of many key solutions toward fulfilling a worldwide increasing demand for energy. However, the latter authors argues that the rapid growth within the field of solar technologies is nonetheless facing various technical barriers, such as low solar cell efficiencies, low performing balance-of-systems (BOS), economic hindrances such as high upfront costs and a lack of financing mechanisms, and institutional obstacles to include inadequate infrastructure and a shortage of skilled manpower. On the other hand, Amankwah-Amoah (2015) argues that for decades, Africa was perceived as the dumping ground for obsolete technologies. He further states that in recent years, technological leapfrogging, which is associated with the newly industrialised economies in Asia, has transpired in some key industries. Amankwah-Amoah (2015) argues that despite the promising opportunities of this industry, a number of factors such as high up-front capital costs and limited end-user financing schemes have limited the technological process. However, Zawilska and Brooks (2011) maintain the view that renewable energy's role as an alternative to fossil-based power is growing in the developing world. They further observe that the city of Durban, South Africa, is an example of a rapidly expanding urban center which can benefit from the implementation of solar energy technologies.

Fluri (2009) conducted a study that explored all provinces of South Africa with a good potential for the implementation of large-scale concentrating solar power plants which were identified using geographic information systems (GIS). He found that all the areas are assumed suitable if they get sufficient sunshine, are close enough to transmission lines, are flat enough, their respective vegetation is not under threat and they have a suitable land use profile. According to Mekhilef, Saidur and Safari (2011), it is important to note that solar energy conversion is widely used to generate heat and produce electricity. These authors further state that a comparative study on the world energy consumption released by International Energy Agency (IEA) shows that in 2050, solar array installations will supply around 45% of energy demand in the world. Their study actually established that solar thermal is getting remarkable popularity in industrial applications. They define solar thermal as an alternative to generate electricity, process chemicals or even space heating. Moreover, they further observe that it can be used in food, non-metallic, textile, building, chemical or even business-related industries. Similarly, solar electricity is wildly applied in telecommunication, agricultural, water desalination and building industry to operate lights, pumps, engines, fans, refrigerators and water heaters (Diabate, Blanc and Wald, 2004).

According to Mekhilef, Saidur and Safari (2011), it is particularly important to apply solar energy for a wide variety of applications and provide energy solutions by modifying the energy proportion, improving energy stability, increasing energy sustainability, conversion reduction and hence enhance the system efficiency. Similar views are shared by Kumar, et al. (2019) who argues that lanterns, homes systems, hot water systems and micro-grids based on small-scale solar have become prominent ways to address the energy access challenge. In addition, Kumar et al. (2019) notes that the diverse ways in which solar provides energy access is a function of the flexibility/fixity of the socio-technical assemblage and the de/centralisation of agency. He further observes that energy access is fluid and ever changing and people need fluid, easily maintainable, locally modifiable assemblages. Tomei and Gent (2015) maintain that providing access to affordable, reliable, sustainable and modern energy for all is regarded as central to development and enshrined as one of the Sustainable Development Goals (SDG).

South Africa is a leader of solar power, especially because Africa, as a continent, has a long duration of sunshine. According to Amankwah-Amoah (2015), Africa receives many more hours of bright sunshine during the course of the year than any other continent of the Earth, with many of the planet's sunniest places being situated here. Solar energy is one of the most readily accessible resources in South Africa, as the country's solar-equipment industry is developing. Similarly, Kumar, et al. (2019) is of the opinion that this source of energy is a cleaner, and an often cheaper, variant of power that once deployed, provides South African institutions with an excellent opportunity to thrive. In their study, Zawilska and Brooks (2011) found that within South Africa, homeowners are also choosing to move to solar panels compared to other energy sources. They add that this is due to the increasing affordability and the wide range of benefits they offer. In line with these views, Fluri (2009) argues that the only cost associated with the use of solar energy is the manufacture and installation of the components, which means that despite the large initial investment, there are no additional costs associated with their use. The latter author further notes that renewable, non-polluting and available planet-wide, solar power contributes to sustainable development and job creation where it is installed.

South Africa has been particularly quick in turning to solar power as an energy alternative. It is also correct to mention that based on the government's energy policy and The South African Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), the aim has been to diversify away from coal (figure 3.4) and imported crude oil, helping to reduce climate change and save money (Kumar, et al. 2019; Zawilska and Brooks, 2011; Fluri, 2009). These authors further state that every aspect of social and economic policy in South Africa is being re-examined, reformed and redrafted, setting the country on a path of growth with redistribution (Kumar, et al. 2019; Zawilska and Brooks, 2011; Fluri, 2009). Energy policies are already responding to pressures to reduce emissions as energy investments are subject to greater environmental scrutiny.

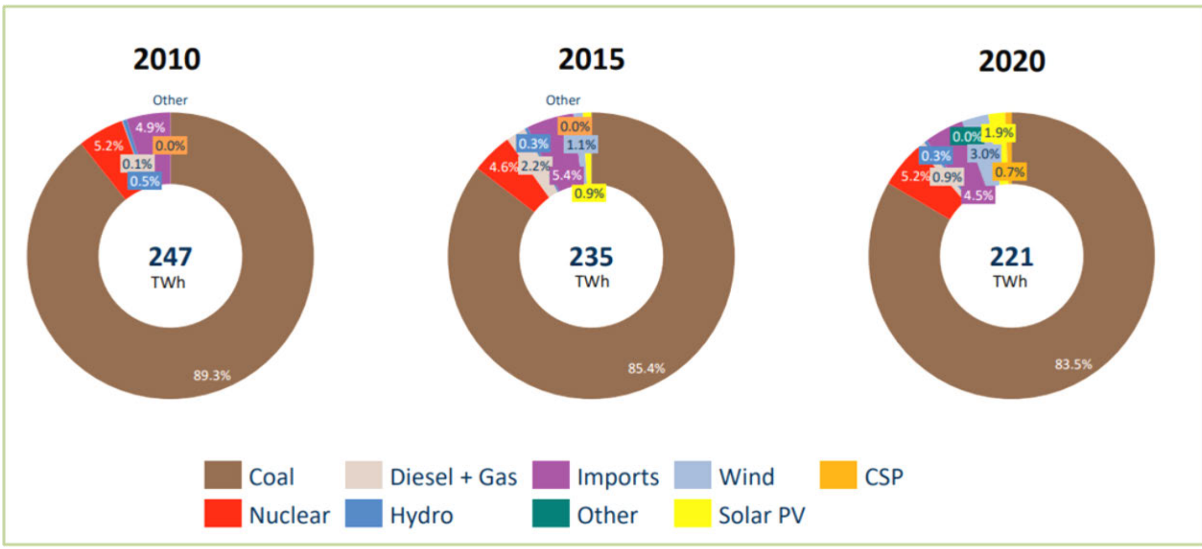


Figure 3.4: Total evolution of energy mixes over the past 10 years in South Africa
Source: Calitz and Wright (2021)

As a result, South Africa has committed to an energy generation infrastructure development plan for 2010 to 2030, which is known as the Integrated Resource Plan (Kumar, et al. 2019; Zawilska and Brooks, 2011; Fluri, 2009). This plan shows the country's aim to achieve 9600 MW of solar power capacity by 2030. Solar plants are now being developed throughout, which is an exceptional financial and environmentally solution for power. The next upcoming tender would be Round 5 which is expected 2019/2020 (Kumar, et al. 2019). It is also correct to note that across the country, and worldwide, solar energy has been increasingly more affordable compared to a few years ago when only large companies could justify the expense. It has been observed that the drop of the prices of solar power can be attributed to many factors, such as a rise in demand and a drop in production costs. Across the entire global market, the cost of renewables, for solar energy, in particular, are constantly falling (Kumar, et al. 2019; Zawilska and Brooks, 2011). This rapidly declining cost is a sign that the world may be on the verge of a dramatic change in how buildings and vehicles are powered.

Edkins et al., (2010) state that the major financial barrier was overcome in South Africa with the publication of the Renewable energy feed-in tariff (REFIT) in 2009. According to Brodski (2009), renewable energy generators are assured a rate per kWh for electricity fed into the grid for specific technologies. The REFIT was part of a number of energy actions implemented in the wake of the load-shedding experienced in South Africa in 2008 (Edkins et al., 2010: 15). The REFIT regulatory guidelines published on the 26 March 2009 present tariffs of R 1.25 per kWh for wind and R 2.10 per kWh for concentrating solar power, in addition to tariffs published for small hydro and landfill gas (NERSA, 2009a). In October 2009 NERSA approved the addition of tariff for CSP without storage (R 3.14/ kWh), large-scale (>1 MW) grid connected PV systems (R3.94/ kWh) and CSP Tower with storage of six hours per day (R 2.31/ kWh) (NERSA, 2009b) (see Table 3.2).

REFIT Phase	*Technology*	*R/ kWh*
Phase I	CSP	2.10
	Wind	1.25
	Small hydro	0.94
	Landfill gas	0.90
Phase II	CSP trough without storage	3.14
	Large-scale grid-connected PV systems (≥1MW)	3.94
	Biomass solid	1.18
	Biogas	0.96
	CSP tower with 6 hours per day storage	2.31

Table 3.2: REFIT tariffs published by NERSA.

Source: Edkins et al., (2010)

According to Schmidt, Matsuo, and Michaelowa (2017: 99) argue that fossil fuel subsidies are a key barrier for economic development and climate change mitigation. Numerous researchers are of the view that most of the power generated in South Africa is produced using fossil fuels, which emit tons of carbon dioxide and other pollution every second which dilutes the environment (Sampaio and González, 2017; Carpaneto, Lazzeroni and Repetto, 2015; O'Gallagher, 2008; Johnston, 2007; Selinsky, et al. 2013; Chu and Meisen, 2011). More importantly, the sad reality is that fossil fuel will eventually run out. In line with these views above, Chu and Meisen (2011) argue that in order to make the development of our civilisation sustainable and cause less harm to the environment, people are looking for new source of substitute clean energy. It has been observed that due to the increasing demands in clean energy, the solar energy industry has been one of the fastest growing forces in the market. According to Sampaio and González (2017), it is worth noting that nowadays there are several major directions for solar technology development. For instance, photovoltaic systems directly convert the solar energy into electrical energy while concentrated solar power systems first convert the solar energy into thermal energy and then further convert it into electrical energy through a thermal engine (Sampaio and González, 2017; Carpaneto, Lazzeroni and Repetto, 2015; O'Gallagher, 2008; Johnston, 2007; Selinsky, et al. 2013; Chu and Meisen, 2011).

3.9 ADVANTAGES OF SOLAR PANELS

The main benefit of solar energy is visibly, access to inexpensive electric power in remote areas that are not connected to the grid and/or national electricity supply network. It is worth noting that the education sector is benefit a lot in solar energy. For instance, schools in remote areas in particular can make use of electronic media as a result of this technology. It cannot be denied that most of updated and recent educational resources and/or content are stored in online platforms that require constant electricity to access them. The gadgets that are used to access online content require electricity. Therefore, solar energy plays a significant role in this case, more especially in areas where electricity is not available (Kumar, et al. 2019; Zawilska and Brooks, 2011). One of the most glaring benefits of using solar power is that it is renewable, clean and has no direct emissions, compared to other traditional methods of power production. Musango, et al. (2011:

127) describe solar power as a renewable energy that taps the sun's energy to produce electricity through a solar thermal system or by photovoltaic systems. In South Africa, there is an enormous potential for the development of solar energy since the country has 24% of the world's best winter sunshine area (figure 3.5 below), as well as some of the best annual irradiation (Kumar, et al. 2019; Holm *et al.*, 2008; Fluri, 2009). This was also supported by Fouché and Brent (2019: 1) who argue that South Africa has the third largest solar resource in the world, with an average of more than 2500 h of sunshine per year and average solar radiation levels ranging between 4.5 and 6.5 kWh/m2 in one day.

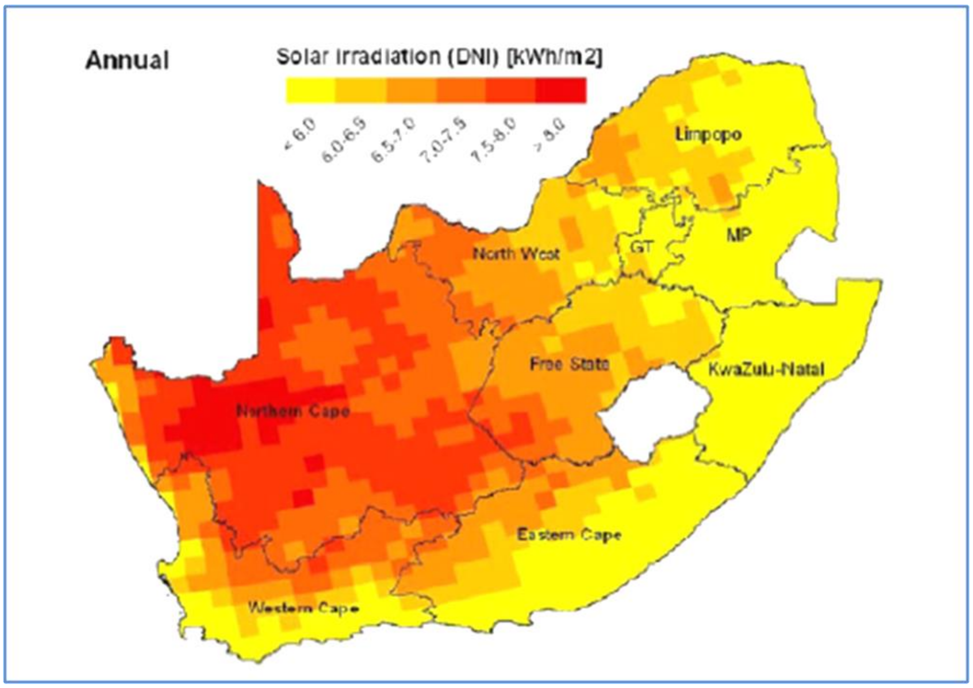


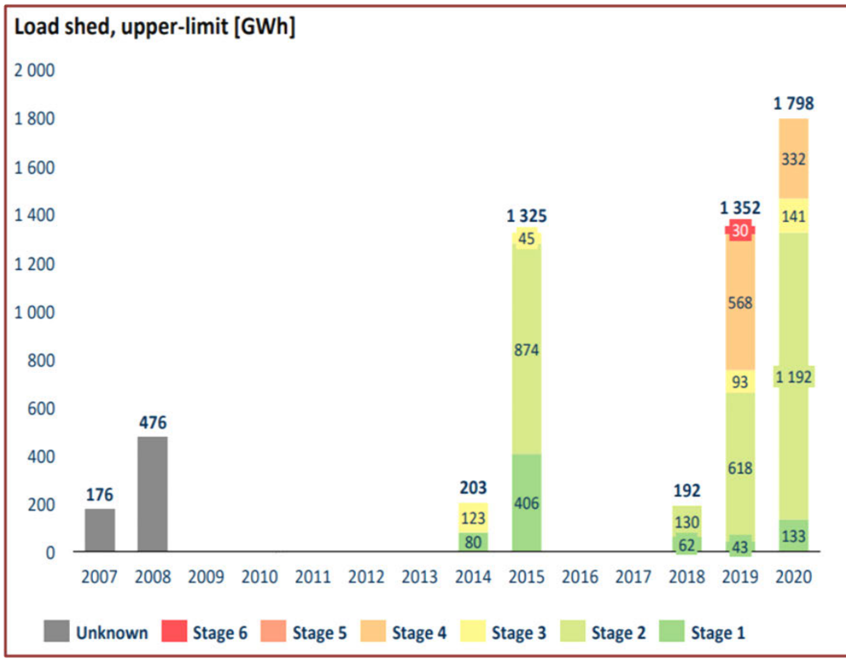
Figure 3.5: The average daily direct normal irradiation in South Africa for the whole year
Source: Musango, et al., (2011)

3.9.1 Cost savings

Solar systems are rapidly reducing in cost, while grid electricity has been ever more expensive (Kumar, et al. 2019; Zawilska and Brooks, 2011; Fluri, 2009). The beauty about this is that power is guaranteed provided that you have batteries installed. In 2016 power generated from solar and wind sources was already 40% cheaper than power generated from coal (Kumar, et al. 2019; Zawilska and Brooks, 2011; Fluri, 2009). It is also important to note that the installation of a solar system, consumers does not get affected by electricity price hikes. Moreover, consumers who installed solar power they have an opportunity to recoup the installation cost within several years, and after that they generate their own free power (Kumar, et al. 2019; Zawilska and Brooks, 2011; Fluri, 2009). It is noted that one does not need to buy noisy and polluting generators when power failures happen. The most important benefit in this is that with a grid-interactive system one can actually feed power back into the grid and receive credits for doing so (Kumar, et al. 2019; Zawilska and Brooks, 2011; Fluri, 2009). It has been observed that one increases the value of his/her property and benefits from SARS deductions. Another glaring benefit of using solar energy is that solar power qualifies for savings on CO2 (carbon) tax (Kumar, et al. 2019; Zawilska and Brooks, 2011; Fluri, 2009).

3.9.2 Guaranteed power supply

Guaranteed power supply is regarded as one of the key benefits of solar energy. This is mainly due to the fact that one is still has power even when load shedding and power failures occur (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova and Sultonov, 2019; Fluri, 2009). Figure 3.6 below illustrates the energy interruption as a results of load shedding over a period of 10 years (2007 to 2020). Consequently, those who have implemented solar power are assured of reliable electricity for at least 25 years, if not more. Sunny South Africa's free and constant supply of bright light will generate power for those using solar energy even on overcast days. This is mainly due to the fact that with a sunworx inverter and deep-cycle batteries as part of the system, solar energy users will be able to store solar power for when it is needed at night or during power failures (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova and Sultonov, 2019; Fluri, 2009).



Year	Duration of outages (hours)	Energy shed (GWh)
2007	-	176
2008	-	476
....	....	....
2014	121	203
2015	852	1325
2016	-	-
2017	-	-
2018	127	192
2019	530	1352
2020	859	1798

Figure 3.6: Duration of outages and energy shedding over 10 years (2007 to 2020)
Source: Calitz and Wright (2021)

3.9.3 Clean, responsible power

Another glaring advantage of solar power emanates from the fact that solar power is silent and simple to install anywhere. This is because solar energy is clean and renewable. Thus, it is important to note that with solar power one is able to contribute to a healthy and sustainable environment (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova & Sultonov, 2019; Fluri, 2009). In addition, solar power affords its users an opportunity to reduce their carbon footprint. Consequently, one will have the satisfaction of being socially and environmentally responsible (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova and Sultonov, 2019; Fluri, 2009).

3.9.4 Promoting development.

Solar energy has played a significant role in promoting development in a sense that remote communities can enjoy electric lighting and television off the grid. It is also important to note that solar power makes it possible for under-resourced schools to use electronic media and the internet to learn (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova and Sultonov, 2019; Fluri, 2009). Furthermore, it has been observed that the health sector has not been left behind in as far as the benefits of solar energy are concerned. For instance, it has been observed that solar energy benefits patients in rural areas by enabling clinics in such remote and far-flung areas to operate without grid or generator power (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova and Sultonov, 2019; Fluri, 2009).

3.9.5 Peace of mind

It has been observed that solar energy provides peace of mind to its users. For instance, numerous researchers have reported that sunlight is free and inexhaustible, and Africa is blessed with plentiful sunshine (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova and Sultonov, 2019; Fluri, 2009). They further point out that sunworx ensures faultless installation and maintenance. This is attributed to the fact that even cloudy days provide enough light for energy generation (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova and Sultonov, 2019; Fluri, 2009).

3.10 SOLAR ENERGY: GLOBAL VIEW, AFRICA AND SOUTH AFRICA

When it comes to carbon emission and environmental pollution, countries such as Germany, USA, China and Russia are at the forefront as being the main polluters. On the other hand, Africa is discovered as a continent with extraordinary resources. There are corporates and governments that work together with communities in order to find solutions of combating economic drifts and carbon emissions. Research has shown that South Africa is one of the African countries that is making good use of the solar power to generate renewable energy, for local electrification and pumping of water (Kaur, et al., 2016; Kalogirou, 2004; Oisamoje and Oisamoje, 2013; Naspolini, Militão and Rüther, 2010; Ploetz, Rusdianasari and Eviliana, 2016; Liu, 2017; Jaloliddinova and Sultonov, 2019; Fluri, 2009). According to Musanga, et al. (2011: 27), the IRP also allocates a large portion of grid-connected electricity generation from solar. The planned allocations for solar technologies are 8400 MW by 2030 for large-scale photovoltaic (PV) and 1000 MW for concentrating solar power (CSP) by 2030 (Department of Energy, 2011). Thus, photovoltaic (PV) is expected to play a key role at a utility scale in South Africa. The study conducted by Edkins (2010) discuss that Photovoltaic technologies are not only applicable at utility scale, but also have a potential at small scale such as household and industry systems. Small-scale PV has been used for electricity generation for telecommunications, electronic media and lighting in remote areas that are far from the grid (Musango, et al., 2011).

Another study conducted by Bahadori and Nwaoha (2013) confirms that Australia has the highest average solar radiation per square metre of any continent in the world. The latter study focused on the need to improve solar energy utilisation in Australia, challenges facing it and the future benefits. In addition, their study found that successfully storing and transferring solar energy ensures that solar energy makes a significant contribution to Australia's electricity grid supply and Australia will be well positioned to assist in meeting its growing clean energy demand. Likewise, in their study, Lakatos, Hevessy and Kovács (2011) found that in Hungary, the use of solar energy for water heating, taking a bath, shower, and drying crops has had a tradition for a long time. In addition, the latter study found that there are particularly good possibilities for common use of solar energy and wind-power in Hungary.

In developing countries, industries and manufacturing sectors consume a major portion of the total consumption of energy (Table 3.3 below), where most of the energy is used for low, medium or high temperature heat generation to be used for process applications known as process heat

(Farjana, et al. 2018). Farjana, et al. (2018) further states that the necessity to commercialise clean, cheap and efficient renewable sources of energy in industrial applications emerges from increasing concerns about greenhouse gas emissions and global warming and decreasing fossil fuel use in commercial sectors. It has been observed that as an abundant source of energy, solar energy technologies have proven potential. In addition, it has been reported that few industries are employing solar energy in industrial processes to generate process heat while replacing fossil fuels (Farjana, et al. 2018). The latter author further argues that solar thermal power generation is already very well-known and getting popular in recent years while other potential applications of the concentrated heat from solar radiation are little explored.

Sector	GWh	%
Industry	116631	60.0
Transport	3480	1.8
Agriculture	5841	3.0
Commerce	28833	14.8
Residential	39671	20.4

Table 3.3: Main electricity consumer in 2006

Source: Department of Energy (2009)

In line with these views, Solangi (2011) observes that to overcome the negative impacts on the environment and other problems associated with fossil fuels have forced many countries to inquire into and change to environmentally friendly alternatives that are renewable to sustain the increasing energy demand. He further notes that solar energy is one of the best renewable energy sources with least negative impacts on the environment. As a result, different countries have formulated solar energy policies to reducing dependence on fossil fuel and increasing domestic energy production by solar energy. Moreover, it has been observed that FIT, RPS and incentives are the most beneficial energy policies implemented by many countries around the world. These policies provide significant motivation and interest for the development and use of renewable energy technologies (Solangi, 2011). Rabaia, et al. (2021) report that the annual increases in global energy consumption, along with its environmental issues and concerns, are playing significant roles in the massive sustainable and renewable global transmission of energy. In addition, he observes that solar energy systems have been grabbing most attention among all the other renewable energy systems throughout the last decade. However, he argues that even renewable energies can have some adverse environmental repercussions. Hence, he suggests that further attention and proper precautional procedures should be given.

3.11 RENEWABLE ENERGY POLICY

Policy makers according to Pachauri, Scott, and Shepherd (2013), are trying to balance the demands of three broad objectives in the energy sector; energy security to ensure economic stability and growth; reducing energy poverty, by ensuring access to electricity and clean-combusting fuels and equipment for the poor; and managing greenhouse gas emissions from energy. Brew-Hammond (2013) argue that South Africa, Botswana, Ghana, and Zimbabwe have implemented policies and strategies to give poor households greater access to electricity and to make the use of electricity more affordable. South Africa had the political will, the financial resources, and the capacity to implement the National Electrification Programme and increase electricity access from 36% in 1995 to 75% in 2007 (Niez, 2009). According to Mosdell (2016), South Africa is a signatory of the Kyoto Protocol and the United Nations Framework Convention on Climate Change and, as such, has an obligation to mitigate climate change. Fouché and Brent (2019: 1) adds that the policy landscape enables the implementation of renewable energy technologies and promotes ecologically sustainable development and the use of natural resources.

Fouché and Brent (2019) argue that the Energy White Paper of 1998 state that many of the policies presented can be seen as drivers of renewable energy deployment in South Africa. Edkins et al (2010: 13) state that one of the main goals in the White Paper is to create energy security by diversifying the energy supply, thereby giving support towards the deployment of renewable energy supply. Another key feature of the White Paper is the recognition that not all of South Africa’s power needs should be met by Eskom, the single operator, but rather that 30% of the power should be met by independent power producers (Edkins et al., 2010). Besides encouraging the inclusion of IPPs in South Africa’s electricity generation, it highlighted the areas which needed to be addressed to create the appropriate enabling environment for the promotion of renewable energy, including financial and legal instruments, technology development and awareness raising, capacity building and education (Edkins et.al, 2010). Winkler (2009) suggest that investment in renewable energy and energy efficiency is important to reduce the negative economic, social and environmental impacts of energy production and consumption in South Africa. Edkins et al., (2010) further argue that the White Paper furthermore identifies four strategic areas that need to be addressed to create the appropriate enabling environment for the promotion of renewable energy, including financial and legal instruments, technology development and awareness raising, capacity building and education. Access to modern forms of energy such as renewable energy is a key element in poverty alleviation and an indispensable component of sustainable human development. Universal access to modern forms of energy is one of the most urgent objectives of energy policies in the coming decades (AGECC, 2011).

The above mentioned was also supported by Bazilian, Nussbaumer, Haites, Levi, Howells and Yumkella (2014) who describe that it is inextricably linked to improved welfare because energy services have a direct impact on human needs, productivity, health, education, and communication. Brew-Hammond (2013) argue that lack of access to modern forms of energy such as renewable energy and the related lack of access to energy services contribute to and are a consequence of poverty, constrain the delivery of social services, limit opportunities, and often erode local environmental sustainability. It will help address environmental challenges, guarantee adequate levels of health, increase energy security, and promote economic development (Bazilian, et al., 2014). According to Saghir (2012), renewable energy policies should be consistent with policies on employment, income, foreign affairs, institutional structure, social objectives, environment, science and technologies, regional development, financing, to name a few. General policies influence the feasibility and effectiveness of sector policies, such as energy.

There must be complementarity between energy strategies and other cross-cutting policies, other sector policies, and general development policy (Bazilian, et al., 2014). They cannot be developed in isolation. Brew-Hammond (2013) state that for policy to be effective, they should include specific definitions of interventions and of the system as a whole. Bazilian, et al., (2014) recommend that for a policy's failure to obtain the expected results is due to one or more of the following: failure of diagnosis through lack of information, failure to identify the barriers to be overcome or the main problems that the policy should address, or inadequate strategies, instruments, and measures to address the problems and barriers. Of course, lack of political will and government commitment to prioritise investment in energy should also be considered as a failure, or a short-term view of the energy system (Saghir, 2012).

Williams (2011) argues that for billions of people struggling with poverty, access to affordable energy services such as renewable energy is of higher priority than climate change. Saghir (2012) suggests that increasing energy access to poor people would entail a small increase in the level of emissions. Given that the priority objective is poverty alleviation through access to modern forms of energy, it would be more useful to look for synergies and convergence with global objectives of climate change and clean energy (Williams, 2011). GNESD (2008) summarise some key findings in policy papers. These include:

- Diversifying energy generation sources, with a wider mix of energy sources.
- Promoting proven renewable energy technologies for electricity generation; and
- Setting renewable energy targets in the energy mix.

Such measures could be a major contribution to reducing vulnerability to climate change and at the same time improve access to energy (GNESD, 2008).

According to Fouché and Brent (2019: 2), the 2003 White Paper on Renewable Energy, this is the founding document aimed at promoting renewable energy development in South Africa and the 2011 National Climate Change Response White Paper Policy set out the goals and commitment from government to ensure that renewable energy forms a significant part of the South African energy portfolio. Fouché and Brent (2019) add that the Western Cape province's Green Economy Strategy Framework further highlights that investing in renewable energy technologies is one way of fulfilling the obligation to decrease carbon emissions in South Africa. The Integrated Resource Plan (IRP) of South Africa is a Department of Energy existing plan, which models different policy scenarios and South Africa future energy mixes.

The latest draft IRP 2018 sets a target to produce a total of 20,000 MW of renewable power (solar PV, wind and concentrated solar power) by 2030, while achieving Socio-economic and environmentally sustainable growth (DoE, 2018). Rennkamp, Haunss, Wongsa, Ortega, and Casamadrid, (2017: 216) argue that National policy to support renewable energy was only implemented in 2011 when the government hosted the international climate change negotiations in Durban (COP17). Previous efforts to generate electricity from renewable energy sources that had been formalised under the Renewable Energy White Paper and the Renewable Energy Feed-In Tariff (REFIT) failed because of the lack of political support for their implementation (DoE, 2016).

Müller, Stampfli, Dold, and Hammer (2011) argue that implementing renewable energy solutions at a local governmental level could potentially be the start of energy self-sufficiency, which could hold many benefits, such as reduced transport distances for energy resources through decentralised systems, security of energy supply and protection from future price increases, local job creation, and local economic growth. Fouché and Brent (2019) state that the Government of South Africa, in Section 151(3) of the Constitution, gives municipalities the autonomy to govern the local affairs of their communities within the parameters of national and provincial legislation. Mosdell (2016) state that the three white papers on energy, renewable energy and climate change response contain numerous policy directives in favour of sustainable development and ensuring energy security through a diversified supply mix. Fouché and Brent (2019) concludes that municipalities can justify renewable energy implementation initiatives that will drive sustainable development or diversify their supply mix, because they are aligned to national policy directives.

3.11.1 Formulate and implement policies for renewable energy expansion.

According to Rennkamp et al. (2017), energy policies and renewable energy projects need to be designed, financed, constructed, and integrated into energy systems considering human rights and social implications, especially on vulnerable populations that are living in the township. Müller et al. (2011) considers that creating the right conditions for equitable access to clean and renewable energy, while protecting and promoting human rights and mitigating climate change for all will require the creation of a broad mix of policies, including fiscal policy, trade and investment policy, research and innovation policy, industrial policy, labour policy, and renewable energy policy. Mosdell (2016) mentions that policy planning and action must take place at all levels, from local to global, and with the active participation of a wide range of stakeholders including governments, utilities, international development agencies and financial institutions. National policymakers must be willing to promote renewable energy and new facilitating technologies on a much wider scale among all actors in society, from consumers to economic enterprises (Mosdell, 2016). States, as primary duty-bearers, should play a leading role in formulating policies to ensure the creation of a conducive climate for a just transition to renewable energy (Müller et al., (2011).

3.11.2 Monitoring and evaluation of policies and measures

The International Energy Agency (IEA, 2018) report that improved data is particularly important for assessing the progress under strategies and action plans, as well as assessing the effectiveness of specific policies and measures. Evaluations can help ensure that renewables deployment is as cost effective as possible and does not impose unnecessary burdens on any sectors (IEA, 2018). Government should therefore:

i. Designate an appropriate institution to monitor progress against targets on a regular basis.
ii. Develop metrics for performance against targets and cost effectiveness.
iii. Carry out regular evaluations for specific policy instruments.
iv. Be prepared to adjust policies in response to the outcome of evaluations.

3.12 RENEWABLE ENERGY BEST PRACTICE STRATEGIES

Mosdell (2016) argues that target setting is an important first step towards higher renewables deployment. How the targets are to be achieved needs to be set out in strategies and action plans. These plans should be regularly updated. According to Rennkamp et al. (2017), best practice strategies and action plans for renewable energy should:

i. Be formulated based on long-term scenarios to provide a clear trajectory towards the achievement of the targets.

ii. Identify barriers and measures to overcome them.
iii. Be clearly linked to the overall national energy strategy to meet strategic goals such as energy security and CO_2 emission reduction targets.
iv. Involve all relevant levels of governance (e.g., national government and local authorities).
v. Ensure renewables and energy efficiency policies are well-aligned.

These best practices should provide a roadmap for deployment, based on an assessment of resources and acknowledging the current status of technology development and deployment in the country (Mosdell, 2016).

3.13 LINKING RENEWABLE ENERGY AND SUSTAINABLE DEVELOPMENT GOALS (SDGs) 2030

This section of the chapter will look at what is the Sustainable Goals (SDGs) and why member states of the United Nations (UN) adopted a new sustainable development agenda, in September 2015. Concepts like development, sustainability and sustainable development will be defined and the 4 SDGs namely: no poverty; affordable and clean energy; decent work and economic growth and climate action, out of the 17 SDGs that are relevant to this study will be highlighted. These 4 SDGs mentioned are dependent variables of the study. Renewable energy as an affordable and clean energy is one of the important 17 SDGs goals.

3.13.1 What is the Sustainable Development Goals (SDGs)

Sustainable Development Goals (SDGs) for peace, prosperity for people and planet, now and in the future with the call to all countries and all stakeholders to act in collaborative partnership to implement this plan (UN, 2015). According to Haywood, Funke, Audouin, Musvoto and Nahman (2019), the SDGs adopted by the United Nations General Assembly consist of 17 goals to be achieved by 2030 to make the world a more sustainable and equitable society for all. These Sustainable Development Goals (SDGs) was entitled Transforming our World: The 2030 Agenda for Sustainable Development (UN, 2015). The 2030 Agenda for Sustainable

Development is a plan of action for people, planet and prosperity and it seeks to strengthen universal peace in larger freedom and is aimed to transform our world (UN, 2015). Haywood et al., (2019) cited The World Health Organisation (WHO) statement that the SDGs aims to transform our world and made a call to action to end poverty and inequality, protect the planet, and ensure that all people enjoy health, justice, and prosperity. According to UN (2015), the goals and targets will stimulate action over the next fifteen years in areas of critical importance for humanity and the planet based on the role of the 5 p's namely: people, planet, prosperity, peace, and partnership. The WHO outlined what the determining role of the 5 p's are:

- **People**: We are determined to end poverty and hunger in all their forms and dimensions and to ensure that all human beings can fill their potential in dignity and equality and in a healthy environment.
- **Planet**: We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change so that it can support the needs of the present and future generations.
- **Prosperity**: We are determined to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature
- **Peace**: We are determined to foster peaceful just and inclusive societies which are free from fear and violence. There can be no sustainable development without peace and no peace without sustainable development without no peace and without sustainable development.
- **Partnership**: We are determined to mobilise the means required to implement this Agenda through a revitalised Global Partnership for Sustainable Development based on a spirit of strengthened global solidarity focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries all stakeholders and all people.

In order to ensure that the lives of all are profoundly improved and our world will be transformed for the better it is significantly important to realise the purpose of the new Agenda (UN, 2015). At this point the concepts development, sustainability and sustainable development will be discussed.

3.13.2 Concept of Development

According to Mensah (2019), development as a concept, has been associated with diverse meanings, interpretations and theories from various scholars. He defines development as 'an evolutionary process in which the human capacity increases in terms of initiating new structures, coping with problems, adapting to continuous change, and striving purposefully and creatively to attain new goals. Todaro and Smith (2006) as cited in Diale (2013) states that development is both a physical reality and a state of mind in which society has secured the means for obtaining a better life. According to Reyes (2001), as cited in Mensah (2019), development is understood as a social condition within a nation, in which the needs of its population are satisfied by the rational and sustainable use of natural resources and systems. Another definition of development by Todaro and Smith (2006) as cited in Mensah (2016) is that development can be seen as a multidimensional process that involves major changes in social structures, attitudes, and institutions, as well as economic growth, reduction of inequality, and eradication of absolute poverty. Diale (2013) explains that it is important to mention that development is not only about releasing human potential, but also about increasing human potential as well as increasing institutional capacity to control resources. Rabie (2016) summarises that development is basically an economic concept that has positive connotations; it involves the application of certain economic and technical measures to utilize available resources to instigate economic growth and improve people's quality of life.

3.13.3 The concept of Sustainability

The concept of sustainability is defined as a capacity to maintain some entity, outcome or process over time and further apply the concept to anticipate improving and sustaining a healthy economic, ecological, and social system for human development (Mensah, 2019). Stoddart (2011) as cited in Emas (2015) defines sustainability as the efficient and equitable distribution of resources. Ben-Eli (2015), views sustainability as a dynamic equilibrium in the process of interaction between the population and the carrying capacity of its environment. Such that the population develops to express its full potential without producing irreversible adverse effects on the carrying capacity of the environment upon which it depends (Mensah 2019). From this standpoint Thomas (2015) as cited by Mensah (2019) continues that sustainability brings into focus human activities and their ability to satisfy human needs and wants without depleting or exhausting the productive resources at their disposal. According to Hearn (2018), sustainability is a concept that has the objective of dealing with the immediate and future ‘needs’ of society while attempting to take the ‘limitations’ imposed by the ecological damage into account.

3.13.4 What is Sustainable Development (SD)?

Rabie (2016) defines sustainable development (SD) as the ability to meet the needs of the present while contributing to meeting the future generations' needs. Therefore, SD could be defined as a pattern of economic growth in which resource are used more efficiently (Rabie, 2016). According to The International Institute for Sustainable development (2019), Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development, therefore according to Kumar (2020), always encourages to conserve and enhance resources, by gradually changing the manners in which we develop and use technologies. Emas (2015) concurs that SD is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It provides a mechanism through which society can interact with the environment while not risking damaging the resource for the future (Mensah, 2019). Ben-Eli (2015) also mentions that SD is away to enhance the long-term economic, social, and environmental well-being of people and communities. So, for Emas (2015), the overall goal of SD is the long-term stability of the economy and environment; this is only achievable through the integration and acknowledgement of economic, environmental, and social concerns throughout the decision-making process.

In summary, SDGs aims to balance the economic, social, and ecological dimensions of sustainable development, and place the fight against poverty and sustainable development on the same agenda for the first time (UN, 2015). The SDGs also makes a call to all countries to meet their basic needs of employment, food, energy, water, and sanitation (UN, 2015). The South African Constitution states that every citizen has the right to a healthy, safe, and clean environment and that all people also have a responsibility to protect and use the environment in a way that will protect it for us, our children, and our grandchildren. (South Africa Constitution, 1996).

Below is the list of 17 SDGs adopted in 2015:

Figure 3.7: Sustainable Development Goals

Source: UN (2015)

This section of the study put the focus on the 4 SDGs and its role link to renewable energy. The SDGs that will receive attention and will form part of the discussions are SDG 1: No poverty, SDG 8: Decent work and Economic growth, SDG 13: Climate Action, SDG 7: Affordable and clean energy.

3.14 NO POVERTY

Goal 1 (SDG1): No Poverty aims to end poverty in all its forms everywhere and by achieving SDG 1 would extremely end poverty, which would be referred to as chronic poverty for the purpose of this study, globally by 2030 (UN, 2015). UN (2015) recognise that eradicating poverty in all its forms and dimensions, including chronic poverty, is the greatest global challenge and an indispensable requirement for sustainable development. Goal 1 centre on ending poverty; protecting the natural environment; and ensuring inclusive, just and peaceful societies, with prosperity for all (UN, 2015). The researcher of the study will define poverty, investigate the cause and effects of poverty, explains why chronic poverty is one of the greatest challenges in achieving SDG1 and the SA government strategies to reduce poverty.

3.14.1 What is poverty?

According to Chen (2022), poverty is a state or condition in which a person or community lacks the financial resources and essentials for a minimum standard of living. The definition given by The Economic Times (2022) is as follows Poverty is a state or situation in which a person or a group of people don't have enough money or basic things they need to live. Saar and Plotnik (2011) define poverty as barely begin able to cover expenses for housing, food, and wealth in other words as the ability to afford pretty much anything. Chen (2022) also explains that poverty means that the income level from employment is so low that basic human needs cannot be met, and that poverty-stricken people and families might go without proper housing, clean water, healthy food, and medical attention. South Africa's legacy of apartheid has created deeply entrenched racial characteristics of the country's poverty rates and distributions of income inequality (Francis, 2006).

3.14.2 Causes and Effects of poverty.

In South Africa specifically the major causes of poverty, is precipitated by a history of apartheid, involve disparities in the distribution of resources, coupled with poor educational opportunities (Francis 2006). Poverty is often affected by a person's race, gender, socio-economic status, and where they live. Others may fall into poverty because of bad economic conditions, natural disasters, rising living costs, drug addiction, depression, or issues with their mental health (The Economic Times, 2022). According to Chen (2022), access to good schools, healthcare, electricity, safe water, and other critical services remains elusive for many and is often determined by socio-economic status, gender, ethnicity, and geography. In the SA context some of the main causes of poverty are the lack of education and marketable skills, poor health, and a lack of employment opportunities (Ramnath 2015). For Seeking (2007), the proximate causes are clear persistent unemployment and low demand for unskilled labour, strong demand for skilled labour, an unequal education system, and a social safety net that is unusually widespread but nonetheless has large holes.

The income poverty is one of the measure causes of poverty that need to address. The study conducted by Hall (2022) shows that the number and share of children living in households that are income-poor. Hall (2022) argues that money is needed to access a range of goods and services, income poverty is often closely related to poor health and nutrition, reduced access to education and Early Childhood Development (ECD) facilities, and physical living environments that compromise health and personal safety. Grinspun (2016) states that international law and the Constitution recognise the link between income and the realisation of basic human rights and acknowledge that children have the right to social assistance (social grants) when families cannot meet children's basic needs. Bassier, Budlender, Zizzamia, Leibbrandt and Ranchhod (2021) mention Income poverty measures are therefore important for determining how many people need social assistance, and for evaluating the state's progress in realising the right to social assistance.

3.14.3 Chronic poverty

The UN (2015) recognises that chronic poverty remains prevalent in low-income countries, particular those affected by conflict and political upheaval. Chronic poverty in the SA context is the result of address the legacies of apartheid which is economic inequality, social inequality, and political inequality (Francis 2006). According to Alliber (2001), chronic poverty can be a function of an individual's characteristics (for example, elderly, disabled), or of the environment (for example, sustained periods of high unemployment, landlessness), or of a combination of the two. Hulme and Shepherd, (2003) cited in Ramnath (2015) states that the term 'chronic poverty' has received considerable attention in South Africa, as well as globally and that this type of poverty is deep-rooted, where individuals live in poverty as a result of multiple deprivations over extended time periods. For Alliber (2001), households or individuals are understood to be in chronic poverty when their condition of poverty endures over a period. He further explains that chronic poverty can be understood as the inability of households or individuals, perhaps due to the lack of opportunity, to better their circumstances over time or to sustain themselves through difficult times. For Shepherd (2015), chronically poor people experience deprivation over many years, often over their entire lives, and frequently pass poverty on to their children. Ramnath (2015) agrees by citing Alliber (2003) that chronic poverty occurs if individuals are trapped in poverty over a long period of time.

Alliber (2001) agrees by stating that chronic poverty is sometimes conceptualised as inter-generational poverty, meaning that children from poor households are likely to become poor adults, whose children will in turn risk remaining in poverty. Chronic poor, which is defines as those who experience poverty for extended periods of time or throughout their entire lives, whose children are also likely to remain poor, and who have benefited least or are likely to benefit least from economic growth and national and international development initiatives (Du Toit, 2005). It is therefore clear that chronic poor are those people who are leading constant lives of poverty and who are normally poor but may have a small amount of money with them (for example, casual workers) are classified collectively as the chronic poor (Shepherd, 2015). Alliber (2001) makes a statement that South Africa's poor are chronically poor. Ramnath (2015) states that the term 'chronic poverty' has received considerable attention in South Africa, as well as globally. In other words, this type of poverty is deep-rooted, where individuals live in poverty as a result of multiple deprivations over extended time periods (Francis, 2006). The sensitivity of poverty rates to changes in social assistance is in large part because, first, South Africa's poor have such low incomes, relative to the rich, and second, there are many poor people just below (as well as just above) any of the widely used poverty lines, so that quite small changes in incomes can raise people above the lines (Seeking, 2007). Chronic poverty in SA is according to Du Toit (2005) not a residue, but the by-product of incomplete growth and modernisation and that the chronic poor are not simply those 'left behind' or 'not reached 'by growth or excluded by too-rigid labour laws.

3.14.4 Poverty reduction

South Africa's post-apartheid government has developed numerous poverty reduction strategies since 1994 but yet after 21 years of democracy, more than 50% of the population is still poor, and income inequality is among the highest in the world (Ramnath, 2015). Hulme and Shepherd (2003) as cited in Ramnath (2015) states that a major concern in modern day is that poverty reduction is trying to decrease poverty in an age of globalisation; and integrating the poor into the global economy, where the chronically poor are likely to be neglected. South Africa's post-apartheid government embarked on various poverty reduction strategies in order to address poverty and inequality in the country (Ramnath, 2015). Furthermore, Ramnath (2015) mentions that in order for poverty reduction strategies to be effective, the major causes of poverty, namely the lack of marketable skills, poor health and unemployment need to be properly addressed. According to Hlongwane (2022) reducing South Africa's high inequality will also require improving education and spatial integration to provide the poor with skills that are required to meaningfully participate in a capital and skills intensive economy.

3.15 SOCIO-ECONOMIC CONDITIONS

Hlongwane (2022) states that SA despite its natural wealth, faces a number of Socio-Economic challenges, which include high unemployment, poverty, social inequality, and limited access to public services. Socioeconomic status has been operationalised in a variety of ways, most commonly as education, social class, or income (Darin-Mattsson, Fors, and Kåreholt, 2017). This means that Socio-Economic factors include occupation, education, income, wealth and where someone lives (Darin-Mattsson et al., 2017). These difficulties continue to engulf South Africans and have an impact quality of life and economy collectively (Hlongwane, 2022).

The most recent Momentum Unisa household financial wellness index has revealed that South Africans are living beyond their means (Rajgopaul, 2023). According to the index, close to 70% of financially distressed households find it challenging to pay monthly expenses and pay bills. However, Nel (2023) argues that financially well households are also finding it difficult to cover their expenses. According to DebtBusters' Q4 2022, debt index shows that South African consumers are under increasingly high levels of financial pressure, with spending power among the middle class taken away by the rising cost of living (BusinessTech, 2023). Rajgopaul (2023) states that the ability of South Africans to keep up with the rising cost of living was outpaced leading up to the end of 2022, which led to many people taking measures to live within their means as well as the restrictions of the current economic reality. Nel (2023) mentions that growing inflation and increased interest rates put many South Africans under pressure and make achieving their financial goals more difficult. On average, South Africans are spending 63% of their take-home pay servicing debt (BusinessTech, 2023).

According to Nel (2023), when the interest rates began to rise in late 2021, consumers started to feel the increased burden of servicing asset-linked debt. The average interest rate for a bond went from 8.3% in Q4 2020 to 10.8% in Q4 2022 (BusinessTech, 2023). The toll on everyday consumers was illustrated in a recent report by Eighty-Twenty that noted (BusinessTech, 2023):

- **Vehicle asset financial (VAF)**: the middle class holds 25% of all vehicle asset financing loans; these are set to default in quarter (Q1) of 2023, up by 21% while average instalments have increased by 11% year-on-year (R525).
- **Bond**: for those without a mortgage, their average bond instalment is up 15% (R452) on last year, with balances newly in default up 19%.

Manyike (2023) advises that people should only make purchases and enter new contracts that suit their affordability, not their social media profile. According to Nel (2023), only paying the minimum payments due on credit agreements and taking longer to pay off these agreements generally indicates a problem. Nel (2023) also advises that people to only buy what they can afford and avoid credit altogether. An indication of poor financial planning is whereby an individual is living pay cheque to pay cheque and not having money left at the end of the month. Manyike (2023) states that people should be constantly reviewing their budget plans and understand how the money that they are receiving is distributed to aid their financial plan. According to Nel (2023), a budget is a backbone of health financial and setting up a budget should always be a priority.

3.16 DECENT WORK AND ECONOMIC GROWTH

Goal 8 (SDG 8): Decent work and Economic growth seeks to promote inclusive economic growth, full and productive employment, and decent work for all (UN, 2015). Focusing on the South African context Leibbrandt, Woodland, McEwen and Koep (2010) argue that creating jobs and reducing unemployment are key economic and social challenges. This is the result of the labour market demanding an increasingly skilled and productive workforce and the weakness of our human capital policies continues to leave those who were particularly disadvantaged by apartheid poorly equipped to face this future (Leibbrandt et al 2010).

3.16.1 The concept of decent work

Dharam (2008) states that decent work is defined by the International Labour Organization (ILO) as productive work for women and men in conditions of freedom, equity, security and human dignity. Decent Work called for quality jobs, dignity, equality, a fair income, and safe and healthy working conditions and environments; it strived to put people at the centre of development and create a future that is inclusive and sustainable (Rantanen, Muchiri and Letitinen, 2020). According to the International Labour Organization (ILO), decent work involves opportunities for work that are productive and deliver a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration, freedom for people to express their concerns, organise and participate in the decisions that affect their lives and equality of opportunity and treatment for all (Dharam , 2008; Rantanen et al., 2020). Decent work defined according to the International Labour Organization, refers to the overall aspirations of people in their working lives. It consists of four pillars: job creation, rights at work, social protection, and social dialogue, with gender equality as a cross-cutting objective (UN World Youth Report, 2011).

3.16.2 The concept of Economic growth

Roser (2021) states that economic growth is measured as an increase of people's real income which means that the ratio between people's income and the prices of what they can buy is increasing: goods and services become more affordable, people become less poor. The Oxford Dictionary definition is that Economic growth is the increase in the production of goods and services per head of population over a stated period of time. Roser (2021) agrees by stating that economic growth can be described as an increase in the quantity and quality of the economic goods and services that a society produces and consumes. The Cambridge Dictionary defines economic growth as an increase in the economy of a country or an area, especially of the value of goods and services the country or area produces. There is a clear connection between economic growth and human capital. Ramnath (2015) shows this connection by stating that economic growth is for poverty response as it aids in employment growth if the economic growth absorb labour. Daile (2013) connects economic growth and development by mentioning that economic growth might bring material gain to the people, but development is much more about enrichment of lived of all the people in the society. Economic growth is the most powerful instrument for reducing poverty and improving the quality of life in developing countries.

Economic growth is viewed as a significant instrument for reducing unemployment, poverty and to help improve the living standards of people (Makaringe and Hlalefeng, 2018). Osinubi (2005) as cited in Makaringe et al., (2018) observed that although economic growth is of significant importance in reducing unemployment and poverty alleviation, however it is not sufficient since economic growth alone cannot overcome all the critical factors that contribute to poverty and unemployment. At this point it is important to mention that governments should adopt policies that would focus on job creation, acceleration of economic growth, eradicate poverty and employment as well as working towards transition to the introduction of renewable energy.

3.16.3 Addressing unemployment through Decent work and Economic growth.

Makaringe et al., (2018) makes a statement that unemployment is a major contributor to widespread poverty and income inequality. Hlongwane (2022) concurs by highlighting that high unemployment remains the key challenge for South Africa and the country struggles to generate sufficient jobs. Young people today face a difficult process in seeking to enter the world of work. The global recession has left its mark and, after falling for some years, youth unemployment rates are once again on the increase (UN, 2015). Some of the young work seekers to according to Yu (2013) are not well educated and dropped out of school early, this is due to reasons such as poverty and an inability to cope with studies. It is also pointing to the fact that economy demands highly skilled labour due to capital deepening and technological advancements, and therefore an incomplete secondary education is insufficient to guarantee employment (Yu, 2013). Unless productive employment is at the heart of macroeconomic and social policies and the aggregate demand for labour is expanding, it is not possible to have successful programmes to integrate disadvantaged young people into the labour market (ILO 2022). An alarming issue is the unemployment of 22 percent of youth in 2019. When addressing youth unemployment, it means finding solution with and for young people who are seeking a decent and productive job.

Youth employment is not just about jobs; youth employment can be decent only if it incorporates the other three dimensions of decent work as well: rights, protection, voice and representation (ILO, 2022). The high unemployment rate in South Africa is largely attributed to the high number of individuals who are unskilled or semi-skilled, the considerable unemployment among the youth and the shrinking formal sector employment (Ramnath, 2015). It is evident according to Hlongwane (2022) that SA had focused on building an economy of high skills and high wages, while ignoring the reality of unskilled and inexperienced jobseekers and that as a country we need an environment that encourages businesses to make and sell goods and services with the workforce they currently have, not the workforce they wish they had. The World Bank (2012) points out that employment creation is instrumental in the redistribution of income and the attainment of Socio-Economic development, and that employment is the cornerstone of development.

Employment is major driver in poverty eradication. The creation of employment is therefore high on the agenda of most governments. The transition of young people into work marks a critical period in the life cycle. It signifies a crucial stage of independence, the application of academic learning, and social and economic productivity, as well as sets the stage for an individual's potential in terms of earning capacity, job options and the possibility of advancement (UN, 2011). Ramnath (2015) cites the UNDP (2014) and The World Bank (2015b) views that there is a general consensus amongst economists that high rates of economic growth are essential for poverty reduction and that increased economic growth (measured by rising per capita incomes), would mean that a country's poverty levels will fall. With relation to the issue of employment it is important to mention that given the major role played by the formal labour market in the profile of poverty and inequality in South Africa, there is a central emphasis on job creation and growth in the alleviation of poverty (Du Toit, 2005).

3.16.4 Township economic development: Soweto economy

According to Kaziboni (2017), South Africa's highly concentrated core economy may seem far removed from the challenges confronting township entrepreneurs, but in fact, the wider economy frames the competitive context in which they operate, with direct consequences for the nature of opportunities in township economies. The report produced for Cities Support Programme (CSP) by Philip (2018) state the aim of township economic development strategy as to enhance incomes from economic activity taking place in townships. This includes better returns to entrepreneurs, better wages for workers and better choices for consumers, that allow their incomes to go further. Township economy' generally refers to all economic activities occurring in townships. McGaffin et al., (2015: 12) defines township economies as the microeconomic and related activities taking place within areas broadly defined as 'townships', whereby a township refers to a formally promulgated urban area. 'Township economy' refers to enterprises and markets based in the townships. According to the report by Gauteng Township Economy Revitalisation Strategy (2014), These are enterprises operated by township entrepreneurs to meet primarily the needs of township communities and therefore can be understood a 'township enterprises' as distinguished from those operated by entrepreneurs outside the townships.

Township enterprises are involved in wide and diverse economic activities, ranging from spaza shops, street vending, hair salons, shebeens, minibus taxis, to mechanical services, manufacturing, burial societies, stokvels and childcare services. These are largely micro-enterprises with low capital and low skills base (GTERS, 2014). Ledger (2016) states the objectives of township economy strategies as:

- To **create jobs** in the township.
- To **create opportunities** for existing township entrepreneurs to expand, and for new entrepreneurs to emerge.
- To increase the **income returns** from economic activity – including for workers employed in such enterprises.
- To increase **asset creation** – and the better use of existing assets to create value.
- To augment these approaches with the **more effective use of public employment** (through Expanded Public Works Programme - EPWP and the Community Work Programme) given the significant

Philip (2018) argues that the social and economic importance that the goods and services that township enterprises provide have an important economic and social importance to communities they serve – for example:

a) Minibus taxis, in the absence of the adequate public transport system, have played and continues to play an essential role in daily commuting of millions of townships working class to and from work and shopping routines at affordable rates and employing more than 70,000 people in Gauteng.
b) Spaza shops - This is a R7 billion sector that has historically played a role of a micro convenient grocery store providing basic necessities to township residents within a walking distance.
c) In response to the need for decent and dignified funeral, thousands of burial societies were born to provide an informal funeral insurance cover at affordable rate - to an estimated 12.5 million members and their dependents. This economic activity is valued at R25 billion; and

d) Stokvels - These are traditional rotating schemes that have played a role in funding education of black children and providing credit to township entrepreneurs. stokvels members in Gauteng alone contribute more than R25 billion annually.

In the context of Soweto, there is no shortage of economic activity happening in Soweto streets, backyards, and houses. There are spaza shops on every corner, metal fabricators spilling sparks out of garages, hair-braiding on the sidewalk, rooms for rent and a shisanyama and a beer are never far away. According to the report by CSP (2018), the most economic activity in Soweto is trapped within a narrow band of informal activities. The single biggest category of activity is retail, made up mainly of street-traders, spazas and shebeens: many operating from homes on a very small scale (Philip, 2018). Hardware and building supply stores are also found. In the services sector, the taxi industry thrives and is the backbone of related service activities, from tyres repair to car washes (CSP, 2018). The rest of the service sector, however, tends to focus on personal and social services, including food preparation, hair salons, and Early Childhood Development Centres.

Soweto is also the site of high levels of urban poverty and unemployment, particularly for youth. Hunters (2018) mentions that the lack of jobs locally means many people depend on economic opportunities far away. For workers, this adds hugely to the costs of commuting, eroding the value of their wages and invading on the time they have available outside of work (Philip, 2018). These factors raise the cost of labour and reduce productivity, with economy-wide impacts. The costs of work-search activities are often simply unaffordable for unemployed. (Kaziboni, 2017).

3.17 ENVIRONMENTAL CHANGE vs CLIMATE CHANGE

Goal 13 (SDG 13): Climate action aims to take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy.

3.17.1 Environmental impact

An environmental impact is defined as any change to the environment, whether adverse or beneficial, resulting from a facility's activities, products, or services which could be interpreted as the effect that people's actions have on the environment (Ayers, 2010). The key environmental problems highlighted are global warming and climate variability, loss of biodiversity, deforestation, desertification-land degradation, waste and littering, population growth, urbanization, pollution, poverty and health hazards (Darkoh, 2009). These problems according to Darkoh, 2009) present a challenge to governments and other players within and outside Southern Africa to seek for long-term solutions by addressing the root causes of these problems. Identifying environmental aspects and impacts as well as environmental goal setting and measurement may be among those responsibilities (Ayers, 2010). At this point it would make sense to look at what Environmental impact Assessment (EIA) is and what role does it play. According to Hearn (2018), EIA is an established legal (both domestically and internationally) process governing the inclusion of Socio-Economic development requirements and environmental considerations into the decision-making activity. Ayers (2010) explains that EIA can broadly be defined as a study of the effects of a proposed project, plan or program on the environment. These impacts can include all relevant aspects of the natural, social, economic, and human environment (Ayers, 2010).

3.17.2 Climate change

Climate change refers to long-term shifts in temperatures and weather patterns (UN, 2015). It further states that human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas since the 1800's. According to Scholes and Engelbrecht (2021), there is no scientific doubt that the climate of Southern Africa is becoming warmer, the atmospheric concentration of greenhouse gases is increasing and the sea level surrounding the continent is rising. They agree with the UN (2015) that human activities are by far the largest cause of these changes. Major results of global warming have been intermittent droughts, reduced agricultural yields, and persistent droughts and South Africa has become more susceptible to floods. Southern Africa is particularly vulnerable to climate change because of its geographical location and socioeconomic development state. It is an already warm and dry region, projected to become warmer and drier, and has many demands on its institutions and finances in addition to climate change (Scholes et al., 2021).

Zhou, Shoko, Sibanda and Nhundu (2022) mention that South Africa's rural and urban areas face several challenges related to climate change and that these challenges highlight a vulnerability to climate change in rural and urban settings. Both the urban and rural areas in South Africa are exposed to extreme events, particularly droughts, floods, heatwaves, cold spells, and hailstorms (Zhou et al., 2022). UN (2015) notes that climate change can affect our health, ability to grow food, housing, safety and work and Zhou et al., (2022) states that poverty has been listed as the greatest limitation in adapting to climate change. Adapting to climate change protects people, homes, businesses, livelihoods, infrastructure and natural ecosystems and adaptation will be required everywhere but must be prioritised now for the most vulnerable people with the fewest to cope with climate hazards (UN, 2015). This lack of understanding about how vulnerability to climate change varies from rural to urban environments (especially in SA) leads to a deficiency in supportive policies and frameworks needed to enhance climate adaptation processes (Zhou et al., 2022). Climate change poses a massive threat to human development and in some places, it is already undermining the international community's efforts to reduce extreme poverty and hunger (Darkoh, 2009).

3.18 BUSINESS AND TRADE OPPORTUNITY OF RENEWABLE ENERGY

Goal 7 (SDG 7): Affordable and clean energy aims to ensure access to affordable, reliable, sustainable and modern energy. The World Trade Organisation (2015), notes that international trade is beneficial to countries that are involved in supplying affordable and clean energy and the demand for energy will go up. Trade in Renewable Energy equipment will scale up as most nations engage in the purchase of RE-related equipment (Mugodzva, 2019). According to Merven, Ireland, Hartley, Arndt, Hughes, Ahjum, McCall and Caetano (2018), the contours of the global power sector are changing rapidly, due to ongoing technological advance, particularly in the renewable energy space. They also mention that South Africa has a coal-based energy system, which has been a source of abundant and cheap energy. Merven et al., (2018) acknowledges that this system is ageing and, that taking into account climate and environmental concerns, there are good reasons for South Africa to embark on a clean-energy transition. According to Gorjian (2017), renewable energy, simply put, is a kind of energy that is sourced from an unlimited natural resource that can be replenished in a short period of time which are generated from natural resources such as sunlight, wind, rain, tides and geothermal heat.

The solar power generation is becoming popular among South Africans who are frustrated by load shedding. Spencer (2023) mentions that solar energy is the most affordable way of getting off the grid as the country faces heavy stages of loadshedding. Duba (2023) argues that solar panels and batteries can be used as the long-term investment being the most affordable option, the average cost of electricity it produces is the lowest of any of the technologies that are available. Spencer (2023) states that solar energy is the kind of mitigating measure against the load shedding that has exploded over various parts of corporate South Africa and private individuals. Many businesses i.e., small to large business and households have opted to invest in roof top solar panel installations in order to avoid never stopping load shedding and also for business to ensure business continuity, which most of the businesses have suffered severely and led to some businesses shutting down. The immediately solution to rescue the current situation of load shedding is to add thousands of megawatts from various players including renewable energy from the private sector and procuring excess power from neighboring countries (Mkhwanazi, 2023). The increase in demand for roof top solar installations by corporate and individual households will result in more business opportunity becoming available to entrepreneurs who are interested in trading in the renewable energy space.

3.18.1 Renewable energy as an affordable and clean energy

At this point the study looks at the impact of Renewable Energy (RE) on South Africa's social welfare, global trade and employment in South Africa as well as poverty reduction. It also briefly discusses what is needed by the SA government in developing Renewable Energy Technologies

(RETs) that will result in a more sustainable energy supply for the economy According to Mugodzva (2019), the South African economy has been affected by energy problems relating to its supply and cost and that most of the time, demand has been outstripped by supply, resulting in load shedding being implemented in most places. South Africa faces severe electricity and infrastructure constraints, labour problems (strikes and absenteeism), high youth unemployment, among other issues, and these have had an adverse effect on economic growth and poverty levels (Ramnath 2015). Access to energy has further been hampered by issues of affordability and that a lack of access to energy is linked to poverty, hunger, and limited access to water and the delivery of education and health (Gets and Mhlanga 2013 as cited in Mugodzva 2019). The above-mentioned statement highlights problems associated with the provision of electricity in South Africa. According to Daly and Cobb (1989) as cited in Mugodzva (2019), sustainable energy is important in placing the economy on a developmental trajectory. The International Energy Agency and World Bank (2015) note that energy access plays an important role in analysing welfare. Access to reliable, cost effective and environmentally sustainable energy can have a multiplier effect on development according to Mugodzva 2019. Kumar (2020) states that RE is going to be an important source for power generation in the near future, because we can use it again and again to produce useful energy.

These effect on development as mentioned by Mugodzva (2019) mentions is reduction of ill-health, improvement of livelihoods, poverty alleviation, job creation, gender equality and enhanced access to water and food. Kumar (2020) agrees in mentioning that local employment, better health, job opportunities, job creation, consumer choice, improvement of life standard, social bond creation, income development, demographic impact and community development can be achieved by proper usage of RE systems. Due to the above statements this builds a strong case for finding alternative sources of electricity which are cheaper and sustainable (Mugodzva 2019). It is of utmost importance that the SA government makes a commitment to implement renewable energy to deal with the energy crisis facing the country which has caused inaccessibility of electricity to the rural and remote area dwellers, and the problem of environmental degradation from over dependence on coal (Jain & Jain 2017). They go further to suggest that South Africa should adopt enabling policies framework to increase the share of renewable energy in the national energy mix.

Implementing RE has various benefits which includes the following:

- Substitution of imported energy sources in favour or indigenous sources, which are cheaper and more readily available.
- Local energy production will result in increased energy security. Many countries in the Sub-Saharan region rely on imported energy.
- The availability of electricity will enable countries to meet the growing demand for various goods and services (Mugodza 2019).

3.19 THE ROLE OF RENEWABLE ENERGY IN POVERTY REDUCTION AND SUSTAINABLE DEVELOPMENT

Thorough search of literature suggests that numerous scholars have written extensively on the impact of renewable energy in poverty reduction. Some of these authors include Wirawan and Gultom (2021) who conducted a study to investigate the potential role of renewable energy-based rural electrification to reduce poverty in remote non-grid villages and outermost islands, through the use of the renewable energy-based village-grids (RVGs) program in Indonesia. Their study found that as a matter of fact, renewable energy-based village grid electrification offers a promising solution to energy poverty in remote areas. For example, these authors note that the RVG electrification roll-out significantly decreased the number of welfare recipients in remote areas in Indonesia. They further argue that the potential intermediary mechanism of the effects is the growth of small-scale industries.

In addition, Wirawan and Gultom (2021) study investigated the effect of renewable energy-based plants in 217 remote villages in Indonesia by comparing outcomes for treated and untreated villages within one sub-district where the remote villages are located. Their study found that the program has significantly reduced the number of poor and vulnerable people in the treated village by 91 people. Furthermore, the aforementioned study highlights the importance of an off-grid renewable energy-based electrification roll-out in reducing poverty in remote areas and outer islands of Indonesia. In their study, Bhide and Monroy (2011) observe that after the establishment of how access to energy enhances development and the achievement of the millennium development goals, energy poverty has become a major issue. In India there is a great interest in addressing the subject of energy poverty, in order to reach development goals, set by the Government. In a climate of change and environmental consciousness, sustainable alternatives must be considered to address these issues (Bhide & Monroy, 2011).

A study conducted by Karekezi, et al. (2005) found that high poverty levels especially in rural areas are a significant challenge that faces East Africa. In addition, the latter study found that efforts to reverse poverty trends have been inadequate, as poverty levels continue to rise. For instance, in some countries such as Tanzania, poverty is more prevalent in rural areas relative to urban areas. Despite the role of energy in poverty reduction being widely recognised, energy services for productive purposes in agricultural, small-scale agro-processing and small and medium enterprises (SME) are yet to be adequately addressed. They further argue that the limited access that rural people have to adequate, affordable and convenient energy sources possibly ranks amongst the greatest impediments to their social and economic well-being and development (Karekezi, et al., 2005). It has been observed that renewable energy technologies (RETs) can play an important role in poverty reduction in rural areas in the region (Karekezi, et al., 2005). According to these authors, a growing number of energy analysts perceive non-electrical renewable energy options as important for productive uses and poverty reduction (Karekezi, et al., 2005).

In a similar study conducted by Thiam (2011) notes that the desire to increase energy access remains a strong driving force for poverty alleviation in rural areas of developing countries. In addition, he argues that the supply of modern energy facilitates the improvement of human living conditions and the productivity of sectors. He further observes that modern energy contributes by reducing the time spent, mainly for women and children, in collecting biomass and therefore can provide an opportunity for an increase in the education level of children and for women empowerment. Thiam (2011) states that policies promoting the adoption of clean technologies in developing countries such as Senegal could be considered as being the main components on the agenda of poverty reduction. Similarly, Yadoo and Cruickshank (2012) conducted a study looking at the advantages and disadvantages of using renewable energy technologies for rural electrification in developing countries. They concluded in their study that renewable mini grids are a valuable climate change and poverty reduction strategy. In addition, their study found that renewable mini grids can be cheaper than diesel on a levelized basis and offer grid level service. However, they argue that awareness about mini grids should be raised, and institutional frameworks improved. They concluded that financing mechanisms should be developed to encourage private sector investments.

According to the World Bank (2019), it is worth noting that despite significant progress in recent years, the world is falling short of meeting the global energy targets set in the United Nations Sustainable Development Goals (SDG) for 2030. Ensuring affordable, reliable, sustainable, and modern energy for all by 2030 remains possible but will require more sustained efforts, particularly to reach some of the world's poorest populations and to improve energy sustainability (The World Bank, 2019). It is important to note that notable progress has been made on energy access in recent years, with the number of people living without electricity dropping to roughly 840 million from 1 billion in 2016 and 1.2 billion in 2010. India, Bangladesh, Kenya and Myanmar are among countries that made the most progress since 2010 (The World Bank, 2019). However, without more sustained and stepped-up actions, 650 million people will still be left without access to electricity in 2030 (The World Bank, 2019). Nine out of 10 of them will be living in sub-Saharan Africa (The World Bank, 2019).

It has been observed that great efforts have been made to deploy renewable energy technology for electricity generation and to improve energy efficiency across the world (The World Bank, 2019). The latter document further states that access to clean cooking solutions and the use of renewable energy in heat generation and transport are still lagging far behind the goals (The World Bank, 2019). Therefore, maintaining and extending the pace of progress in all regions and sectors will require stronger political commitment, long-term energy planning, increased private financing and adequate policy and fiscal incentives to spur faster deployment of new technologies (World Bank, 2019). A study by the World Bank (2019) found that the global electrification rate reached 89 percent and 153 million people gained access to electricity each year. However, the biggest challenge remains in the most remote areas globally and in sub-Saharan Africa where 573 million people still live in the dark (World Bank, 2019). It is important to note that to connect the poorest and hardest to reach households, off-grid solutions, including solar lighting, solar home systems, and increasingly mini grids, will be crucial. Another important worth noting is that globally, at least 34 million people in 2017 gained access to basic electricity services through off-grid technologies (World Bank, 2019). When it comes to clean cooking, it has been observed that almost three billion people remain without access to clean cooking in 2017, residing mainly in Asia and Sub-Saharan Africa. Sadly, this lack of clean cooking access continues to pose serious health and socioeconomic concerns.

It is therefore crucial to note that under current and planned policies, the number of people without access would be 2.2 billion in 2030, with significant impact on health, environment, and gender equality (World Bank, 2019). In as far as renewables are concerned, it is important to note that they accounted for 17.5% of global total energy consumption in 2016 versus 16.6% in 2010 (World Bank, 2019). The latter study also found that renewables have been increasing rapidly in electricity generation but have made less headway into energy consumption for heat and transport. It further concludes that a substantial further increase of renewable energy is needed for energy systems to become affordable, reliable, and sustainable, focusing on modern uses (World Bank, 2019). It is argued that as renewables become mainstream, policies need to cover the integration of renewables into the broader energy system and take into account the socio-economic impacts affecting the sustainability and pace of the transition (World Bank, 2019).

According to the World Bank (2019), 840 million people lack access to electricity global and it is projected that 650 million people, primarily in sub-Saharan Africa, will still lack access to electricity in 2030. In addition, to end poverty, it is crucial to connect the poorest and hardest to reach households, off-grid solutions, including solar lighting, solar home systems, and increasingly mini grids. However, as efforts to expand energy access accelerate, groups working on the issue also have to contend with the looming climate crisis. It is important to note that efforts to equip communities with electricity can't lead to more greenhouse gas emissions that exacerbate climate change (World Bank, 2019). The use of solar energy has proven to be effective as a method of alleviating poverty in the past (World Bank, 2019). For example, in China, solar energy has provided power to more than 800,000 families living in poverty, and in one county, solar installations provided families with an additional annual income of over $400 (World Bank, 2019).

In support of these views, it has been observed that spreading solar energy can reduce greenhouse gas emissions and pull people and communities out of poverty (Global Citizen, 2021). It is important to note that Goal 1 of the United Nations' Sustainable Development Goals is No Poverty, while clean and affordable energy is Goal number 7 (Global Citizen, 2021). Another crucial point worth noting is that bringing electricity to remote and impoverished communities is more than providing a pathway to modernity, it is a matter of basic human rights (Global Citizen, 2021). It is argued that nobody can really adequately address global poverty unless and until they take on energy poverty as well (Global Citizen, 2021). This is attributed to the fact that the world's poorest people suffer most from the climate crisis, despite contributing the least to the problem. Sadly, the effects are already being felt worldwide, from failed crops to flooding (World Bank, 2019).

According to Jairaj, et al. (2017), India launched a massive renewable energy project in 2014 which was regarded as a strong move that aimed at bringing electricity and jobs to poor, rural communities across the country. In addition, Jairaj, et al. (2017) notes that many of the jobs aimed at providing steady incomes, healthcare benefits and skill-building opportunities for unskilled and semi-skilled workers. He further argues that for India's rural poor, especially women, clean energy jobs offer an alternative to subsistence farming. In addition to improving energy security, enhancing energy access, and mitigating climate change, renewable energy may be able to help reduce poverty, by creating good jobs that poor people can perform (Jairaj, et al. 2017). Some studies have looked at the impact of renewable energy on employment, but few have looked at the quality of jobs (Jairaj, et al. 2017). Even less attention has been given to the types of skills and employment opportunities that can be created along the supply chain of renewable energy development (Jairaj et al., 2017).

3.20 SUMMARY

This chapter has presented the literature review on the background of electricity in South Africa, the state utility: Eskom and renewable energy. On renewable energy, the chapter started by conceptualising the term renewable energy followed by the benefits of renewable energy. The chapter went further to discuss about solar energy and its advantages to society. In addition, the chapter presented a funnel approach that focused on the global view, Africa, and South Africa in as far as renewable energy is concerned. The chapter concluded by unpacking renewable energy policy and renewable energy best practices.

The next chapter presents the research design, process and methods adopted to conduct the study.

CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

This chapter outlined the research design and methodology followed in conducting this research study. Thus, the chapter discussed the research design and methodology adopted to carry out the study. The chapter commenced by providing an overview of the research methods followed by the research design, research paradigm, and research strategy. The chapter proceeded to discuss the research methods, the research parameters with a focus on population, sampling techniques, and sample size. Further, the chapter discussed the data collections instruments which include the questionnaire survey and interviews. Other sections discussed include data analysis tools for the quantitative and qualitative data, aspects of validity and reliability, ethical considerations as well as the limitations of the study.

4.2 AN OVERVIEW OF RESEARCH METHODOLOGY

Numerous researchers recently defined a research methodology (Snyder, 2019; Gupta, 2022; Kilani & Kobziev, 2016; Mohajan, 2018; Singh, 2021) including Wilkinson (2002) who defines research methodology as the specific procedures or techniques used to identify, select, process, and analyse information about a topic. Wilkinson (2002) adds that the methodology section allows the reader to critically evaluate a study's overall validity and reliability. Jose (2015) states that the methodology section answers two main questions: How was the data collected or generated? How was it analysed? On the other hand, Rajasekar, Philominathan and Chinnathambi (2013) describe research methodology as a systemic way to solve a problem. Jose (2015: 36) adds that research methodology helps the researcher to understand how research should be undertaken together with the theoretical and philosophical assumptions upon which the research is based and the implications of these for the method or methods adopted. It is important for the researcher to have some understanding of this in order to make an informed choice about the research (Saunders et al., 2009: 3). Hernold (2018: 126) presents an argument on two types of research, i.e., fundamental, basic research and applied research. Bajpai (2011) states "that fundamental research is mainly concerned with generalisations and with the formulation of a theory and defines applied research as a type of research that aims at finding a solution for an immediate problem facing a society, or an industrial/business organisation.

The above choice can be explained using the research onion as illustrated in Figure 4.1 below, which is used to compare the various layers of research processes (Saunders et al., 2009: 108). There are six layers of the research onion. All the layers are equally important to successful research; these layers are research philosophy, research approach, research strategy, research choice, research technics and procedures.

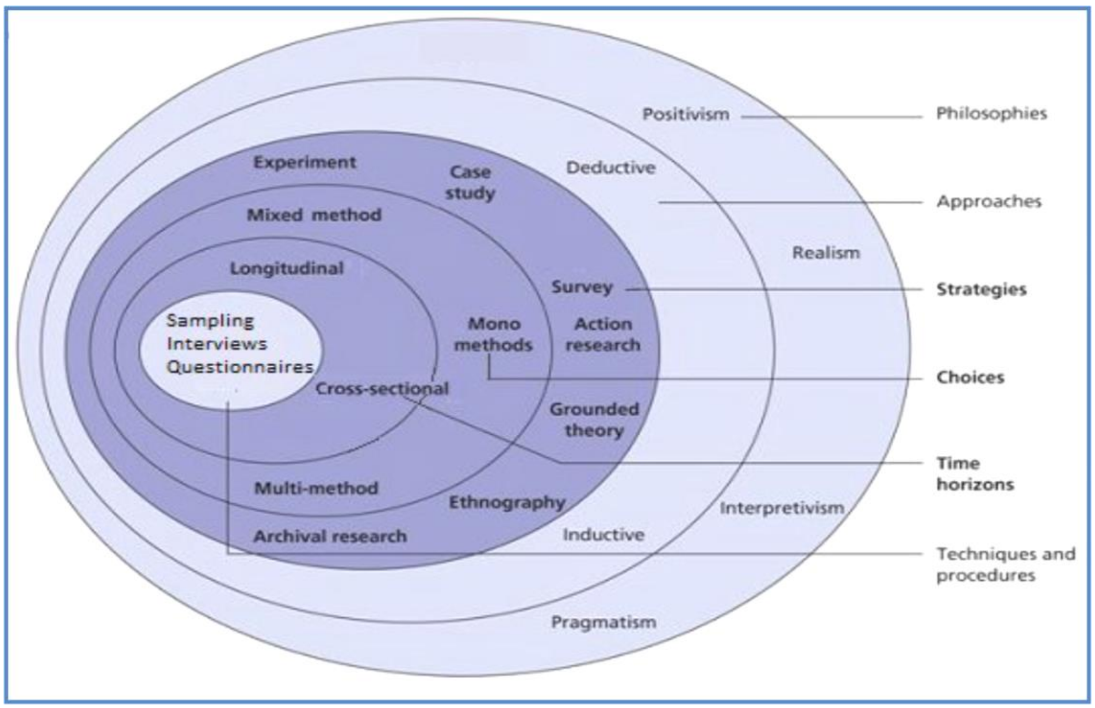


Figure 4.1: Saunders's Research Onion source

Source: Saunders et al (2009: 108)

4.3 RESEARCH DESIGN

This section presents the paradigm of the study, and the design that was employed to conduct the study. According to Gonyora (2021: 134), research design is the process of guiding issues involved in designing and developing a research strategy. De Vaus (2001) defines a research design as the overall strategy that the researcher chooses to integrate the different components of the study in a coherent and logical way, thereby, ensuring he/she will effectively address the research problem. Sekaran and Bougie (2013) describe a research design as a blueprint for the collection, the measurement as well as the analysis of data which would be based on the research questions of the study. In addition, De Vaus (2001) states that research design constitutes the blueprint for the collection, measurement, and analysis of data. Later Neuman (2014) and Bryman (2016) viewed the process of research design process as a blueprint used when conducting a study. Willard (2020: 117) regards research design as the overall plan which connects conceptual research problems to the pertinent empirical research. Research design is also a procedure and plan for research that extends pronouncements from wide-ranging notions to comprehensive data collection methods (Gonyora, 2020). Willard (2020) further argues that research design is a product with a background that guides and links to the world's expectations and characteristics that advocate that design determine the research paradigm.

According to Bryman and Bell (2015), research design is the structure that shows how to collect and analyse data. Edmond and Kennedy (2013) argue that research design can be thought of as the logic or master plan of a research study and it throws light on how the study is to be conducted. Quwe (2020: 105) adds that it is a technique that the researcher utilises to organise a research project. The study conducted by Mtetwa (2019: 85) suggests that research design also ensures that the evidence obtained enables the researcher to address the research problem logically and as unambiguously as possible. The design would articulate on which data is required, the methods for collecting and analysing the data as well as on how the research questions are to be answered (Van Wyk and Toale, 2015). Gorard (2015) further add that, research design presents plans, methods and procedures that clearly specify how to collect and analyse data. It involves combining inquiry strategies, philosophical assumptions and detailed techniques (Creswell & Zhang, 2009).

Clow and James (2014); Mtetwa (2019); Quwe (2020) mention different types of research design; exploratory, explanatory, descriptive, and causal research approach. Willard (2020) adds that studies can either be exploratory, explanatory, descriptive or causal by nature. The nature of the study as depicted by Willard (2020), depends on the stage at which knowledge of the study would have advanced to.

According to Mtetwa (2019), exploratory studies focus on new research areas with the aim of developing a clear understanding of problems. Exploratory studies according to Gonyora (2020), mainly focuses on obtaining understanding knowledge within a subject matter for further rigorous investigation. Sekaran and Bougie (2009) point out that these studies are essential when additional evidence is required to develop a viable theoretical framework. Hence such an approach is a crucial component during these rigorous investigations. Saunders et al. (2015) clarify that the explanatory research design is a controlled research design, which associates properly with quantitative research approach. According to Mtetwa (2019), explanatory studies are mainly concerned with establishing relationships between variables. Gorard (2015) further explains that this approach, describes the reasons for phenomena through the use of theories and derived hypotheses. The purpose of choosing explanatory research design is to minimise expenditure, enable smooth scaling, collect suitable data and technique, provide blueprint for plan, and give direction (Quwe, 2020). In the descriptive stage there is an attempt in describing characteristics of the phenomena to which interest centres (Willard, 2020). Descriptive research identifies and classifies the elements or attributes of phenomena in existence (Collis and Hussey, 2009). According to Saunders et al., (2009) descriptive studies are used to show the exact summary of people, incidences, or circumstances. It ascertains and describes the attributes of pertinent issues since it examines the problem in more depth than exploratory research does (Gonyora, 2020). Jankowicz (2005) states that the goal of descriptive studies is to describe the features of an organization or situation under investigation and describe the features and issues that arise as accurately as possible. Edmonds and Kennedy (2013) opine that the analyses for descriptive research tend to be simple inferential statistics that enable one to summarise the obtained means of central tendency and estimate values for the population generalised. Willard (2020) argues that in the causal studies there is an examination of whether respective relationships have been substantiated. Causality is said to be at the centre of the scientific approach to research. The approach tests whether variables would cause another to change or not. A descriptive research design underpins this research thesis with an explanatory sequential mixed-methods approach. The design chosen for this study is both explanatory research approach, carried out through a comprehensive literature review and qualitative interviews and descriptive research approach carried out through quantitative surveys. This procedure is two-phased with quantitative data collected during phase one from the chosen population of Soweto residents; the results were analysed and then used to consolidate phase two, qualitatively conducted from selected interviews of ten families chosen from Soweto township and five energy industry expects. The goal of this method is for qualitative data to assist in explaining the details of the initial quantitative results (Gonyora, 2020).

4.4 RESEARCH PARADIGM

Coetzee (2019) argues that the term paradigm originated from the Greek word *paradeigma* which means *pattern*. According to Thomas (2010) the term paradigm was first used by Thomas Kuhn (1962) to denote a conceptual framework shared by a community of scientists which provided them with a convenient model for examining problems and finding solutions. The term paradigm was discussed by Khun (1970) in his book titled The Structure of Scientific Revolutions (Msomi, 2018). Creswell and Clark (2007) indicate that paradigm denotes a set of beliefs or suppositions which are embedded in the research design in collecting, analysing and reporting findings. The study conducted by Msomi (2018: 90) defines a paradigm as the entire constellation of beliefs, values, and techniques that members of a community share. While Moloi (2019: 131) mentions that it is critical to understand the meaning of paradigm in pursuit to a journey of finding a solution to the research problem. Coetzee (2019) depicts that the choice of paradigm sets down the intent, motivation and expectations for the research. A paradigm therefore implies a pattern, structure, flow or framework of scientific and academic ideas, values and assumptions (Olsen, Lodwick and Dunlap, 1992). Saunders (2011) explains that the paradigm encompasses the qualitative and quantitative research. According to Nguza-Mduba (2020: 134), a research paradigm and/or worldview are different philosophical assumptions connected by the perspectives of a particular survey. Johannesson and Perjons (2014) explain a research paradigm as a set of commonly held beliefs and assumptions within a research community about ontological, epistemological, and methodological concerns. On the other hand, Schwandt (2001) describes research paradigm as a Shared world view that represents the beliefs, and values in a discipline and that guides how problems are solved. Morgan (2007) clarifies that there are various forms of paradigms, namely: positivist, post-positivism, constructivist, participatory and pragmatist. Msomi (2018) also supported the above and argues that various paradigms are found in social science research and these are tabulated in Table 4.1 below. These forms of paradigms vary in relation to states of being in general because they are normally perceived as worldviews, epistemologies, and ordinary answers to existing challenges or generally accepted norms and values of a particular discipline (Nguza-Mduba, 2020). These worldviews thus vary in respect to their philosophical components which may be ontology, methodology, as well as epistemology (Creswell and Plano-Clark, 2011). Msomi (2018) also mentions that there is a framework of assumptions that underlies social science research, namely: Ontological, epistemological, and methodological assumptions are the assumptions related to social science research. These are assumptions are explained briefly in the paragraphs that follow.

According to Msomi (2018), ontological assumptions often refer to materialism, contra-idealism, or positions in between. Höijer (2008) discusses the unproven assumptions about reality, such as the question of whether or not we have order or chaos in the world. This is viewed as the discovery of life within the real world. Nguza-Mduba (2018: 136) opines that the ontological perspective contributes that pragmatism accepts objective reality (post-positivism), and it rejects that reality can be ascertained as truth in a normative sense. Msomi (2018) cited the study conducted by Bryman (2011) who argues that ontological assumptions have concern for human beings and the nature of the world in a social context. It is about probing questions about real issues in life. On the other side Msomi (2018), further cited Usher (1996), argues that epistemological assumptions seek to determine and distinguish between knowledge and non-knowledge. Epistemological assumptions are associated with the ways in which to acquire and perceive knowledge (Bryman, 2011). Epistemological assumptions focused on the issues of seeking to know the relationship between two people and to further understand how this relationship really work. Epistemology argues that a claim to know needs to be justified based on the way in which one arrived at that claim (Msomi, 2018). There is an argument that knowledge claims have the same status, so the determination of their status lies with epistemology (Usher, 1996). Nguza-Mdunga (2020: 135) adds that pragmatism favours perspectives that epistemology matters are present on a continuum not dichotomy of objectivity and subjectivity which are apparently two conflicting views. Tuli (2011) states that methodological assumption is about enquiring the process of doing things. Msomi (2018) cites Cohen et al., (2001) who mentions methodological assumptions as an analysis approach used for acquisition. A quantitative approach is used to control the social setting when undertaking actions and a qualitative approach is used to observe the changes that occur after the actions (Rahmawati, 2008).

Research Paradigm	Description
Positivist	There is an assumption that social reality encompasses attitudes, behaviours, beliefs, and the measurement of satisfaction can be achieved objectively through the employment of traditional scientific methods by independent observers (those who are outside). The positivist paradigm is a truth-seeking paradigm.
Post-positivism	This is in opposition to the positivist paradigm as it indicates that reality, or the truth, is dependent on the observer.
Constructivist	The way in which people learn. It is based on scientific study and observation. Constructs are complicated and not relatively true.
Participatory	Action research. The participatory is normally motivated by political views and interests, and thus usually connected with qualitative research methods (Nguza-Mduba, 2020: 133)).
Pragmatist	This acknowledges and accepts different methods (both knowledge identified as objective, along with subjective) in deploying effective actions which address research problems (Green, 2008; Creswell and Plano-Clark, 2011). This accepts practicality founded upon approaches which work to address the research problem as more critical from an epistemology point of view instead of being limited to a single approach and/or method (Nguza-Mduba, 2020).

Table 4.1: Research paradigms

Source: Adapted from Msomi (2018: 90)

Creswell and Plano-Clark (2011) argue that the research design can influence the study's associated paradigm. The authors also contributed that paradigm assumptions assist to create mixed methods constructs along with processes. According to Nguza-Mduba (2020), the post-positivist, which is connected with quantitative approaches, assists in variable selection which can be practically observed and quantified. While on the other hand, the constructivist (qualitative) view assists to draw out multiple meanings from participants and develop a deeper understanding of the phenomena, which differs from the quantitative approach which generates and conceivably creates a theory or trends of responses which define quantitative outcomes (Zandvanian and Daryapoor, 2013). Worldview discussions which were prevalent have been addressed through the emergence of schools of thought which support that combining quantitative and qualitative approaches is appropriate to answer problems stated by the study (Teddlie and Tashakkori, 2009; Zandvanian and Daryapoor, 2013).

Numerous researchers have supported the practice of triangulation, that is using both quantitative and qualitative approaches, simultaneously, so that greater comprehension of variables under study can be achieved (Venkatesh, et al., 2013; Zandvanian and Daryapoor, 2013; Coetzee, 2019; McMillan and Schumacher, 2010). Thus, according to Nguza-Mduba (2020), numerous researchers confirm that multiple paradigms can coexist harmoniously in a study inquiry. Pragmatism is advocated through many perspective attributes of mixed method techniques that contribute that multiple worldviews may be employed, although their utilization requires it to be explicit (Brewer and Hunter, 2006; Agerfalk, 2010). Nguza-Mduba (2020) explains that pragmatism treats most of the concerns linked with mixed method research design. According to Agerfalk (2013), pragmatism philosophy is ascertained to ideally serve as integration of both quantitative along with qualitative methods (mixed-method research design). In this regard, the researcher, using a pragmatist paradigm, may choose both quantitative and qualitative methods in which they would apply deductive approaches (quantitative) and inductive approach inferences (qualitative) to address the study’s research questions in the research cycle (Teddlie and Tashakkori, 2009). Heale and Twycross (2015) add that pragmatism focuses on external validity, the ability to transfer findings along with ideographic statements which are constituent elements considered when generalising the study results.

With the above as reference, it is therefore important to note that this study adopted a pragmatist paradigm. The philosophy used in the methodology is known as pragmatism, a deconstructive paradigm that advocates the use of mixed methods in research (Coetzee, 2019). Pragmatism is not committed to any one system of philosophy and reality and offers an academic foundation for carrying out mixed methods research (McMillan and Schumacher, 2010). Within the paradigm of pragmatism, the research design utilised for this study was a mixed-methods approach, focusing on both quantitative and qualitative research methods. The mixed-methods approach is suited to this study as it takes advantage of the differences between quantitative and qualitative methods and combines the two methods for the benefit of the research. The reason for using quantitative research was linked to the controlling of a phenomenon, while the primary rational for qualitative research was to understand a social situation from participants' perspectives. The following section discusses the approach determined to be appropriate for this study.

4.5 RESEARCH STRATEGY

A research strategy refers to the general plan of how a researcher answer the research questions (Saunders et al., 2009: 600). Jose (2015) mentions that the most commonly used research strategies are as follows: Experiment, Survey, Case Study, Action Research, Grounded Theory, Ethnography, Archival Research. All these strategies are equally important, and they have their advantages and disadvantages. Mathews and Ross (2010: 116) state that **experiment** emphasis on scientific research and it involves the study of materials and cases which can be manipulated by the researcher in some way so that some change or difference can be measured. According to Blumberg et al., (2011: 308), experiments are studies involving intervention by the researcher beyond that required for measurement. Experiment is not an appropriate strategy to conduct this research as this research strategy is best suitable to conduct a social and scientific research where participants meet each other and share their views.

On the other side Saunders et al., (2009) declare that the **survey** method is feasible and fit for an inductive approach and it is popular method in business and management research. Jose (2015) confirms that it is the most frequently used to answer who, what, where, how much and how many questions. It is used for exploratory and descriptive study. Survey method enables the researcher to learn about opinions, attitudes, expectations, and intentions of the participants. Blumberg et al., (2011: 207) made an example that information about past events such as the services of field engineers during home visit can be obtained accurately through surveying. Survey method give the researcher more control over the research process. The survey method also enables to collect a large amount of data in an economical way (Jose, 2015). In this study, the survey method was adopted in the form of self-administered questionnaires distributed to residents of Soweto township, NGO and community base organisations.

Mathews and Ross (2010: 128) define case study as a single case or a small number of cases which is explored in detail and great depth. The subject of the case may be a person, an organisation, a situation, or a country. According to Burns (2000: 460), a case study must involve the collection of very extensive data to produce understanding of the entity being studied. This clearly says that case study is different from other research approaches, and it usually takes a broader view on a problem (Jose, 2015). The researcher might conduct a survey to understand the different aspects of research problem whereas a case study generally focuses on one entity which can lead to bias in data collection. Jose (2015) cited Burns (2000: 443) who explains action research as the application of fact-finding to practical problem-solving in a social situation with a view to improving the quality of action within it. Burns (2000) further argues that the focus in action research is on a specific problem in a defined context. Action research is situational, collaborative, participatory and self-evaluative. Mathews and Ross (2010) cited in Glaser and Strauss (1967) state that grounded theory is systematic research which generates theory from data. Grounded theory starts with the data, not with a theory or even predefined research projects. The researcher never reads the existing and previous literature on the topic and does not even conduct interviews or talk with others about the emerging theory during the research process (Jose, 2015). According to Blumberg et al., (2011: 300), this is to eliminate any influence of preconceptions that distract the researchers from the data collected. This research strategy clearly is not suitable for this study.

Jose (2015) cites Burns (2000: 393) who states that ethnography compasses any study of a group of people for the purpose of describing their socio-cultural activities and patters. Ethnographical study involves the relationship of the researcher and the data that is collected. Mathews and Ross (2010: 135) argue that the researcher spends time (sometimes a number of years) immersed within the research context, seeing and hearing the data at first hand. This research strategy utilised for this study as this research strategy is time-consuming wherein the researcher needs to be absorbed in the social world as much as possible. According to Saunders et al., (2009: 150), archival research makes use of administrative records and documents as the principal sources of data. Jose (2015) states that this method of research allows answering the research questions which focus upon the past and which is changing. Archival research allows the researcher to extract the evidence from original archival records (Jose, 2015). Archival research is different in terms of scope and methods, so it was not suitable for this study. Jose (2015) concludes that it is crucial to choose a research strategy that correlates with interpretivism, inductive and qualitative method in order to bring out the truth. Therefore, the researcher utilised the quantitative (survey) and qualitative methods in order carry out this research. Thus, the multi-method social scientific research approach was employed.

4.6 RESEARCH METHODS

This part of the chapter outlines the selection of respondents, the instrument used for the collection of the data and steps that were employed to analyse the data. Vogt (2011) defines research methods as tools that researchers adopt to do conduct study. In addition, Vogt (2011) notes that these can either be qualitative or quantitative or mixed. The fourth layer of the research onion as depicted in Figure 4.1 defines the type of research methods that a researcher can adopt. A research method is defined by Cooper and Schindler (2014) as a procedure that is used to collect data using different instruments. Quwe (2020: 107) argues that the instrument used to collect data is guided by the type of research method used in specific research. According to Cooper and Schindler (2014), there are three types of research methods, namely: mono research method, multiple research method and mixed research methods. A mixed research method was chosen for this study.

This study was conducted in three phases:

- The first phase focused on quantitative research method with participants from Dobsonville neighbourhood, community-based organisation members.

- The second phase focused on a qualitative research method form 10 families living in Dobsonville neighbourhood.
- The third phase focused on qualitative research method from the industry expects which included participants working with electricity whether from the Municipality, Eskom and organisations that are an advocate of electricity.

Therefore, the mix method research approach was employed in this study. The reason for employing multi-method social scientific research approach was that it allowed the researcher to produce a case study of one South African township, to include quantitative and qualitative research approaches, to create breadth and depth in the study. Furthermore Lancaster (2012) explains that, both methods of data collection and data analysis are determined by whether or not the researcher was interested in qualitative or quantitative data. One method is not better than the other. Both the methods are important when it comes to the data collection and data analysis of the research (Jose, 2015: 38).

4.6.1 Quantitative research (positivist) method

Annan (2019: 30) states that positivism evolves around the use of numerical measurements and statistical analyses of measurements to examine social phenomena. Positivist research is generally quantitative in nature. According to Jose (2015), quantitative research method basically deals with the data collection techniques or procedure that uses numeric data. This was supported by Kabir and Rashid (2017) who state that quantitative data is numerical in nature and can be mathematically computed. It includes graphs, charts and statistics that help the researcher to examine, analyse, describe, and interpret relationships and trends without the data (Saunders et al., 2012: 472). The most used quantitative research method is the survey. Furthermore, Kabir, Aziz and Jahan (2018) argue that quantitative use a systematic standardised approach and employ methods such as surveys and ask questions. Trigueros, Sandoval and Occidente (2017: 5) mention that in a quantitative research method, the researcher may use a short answer responses or dichotomous questions, multiple choice answers, paragraph, check boxes, drop down, linear scale, multiple choice grid and more. It is important to note that quantitative methods examine numerical data and often requires the use of statistical tools to analyse data collected (Vogt, 2011). This mainly permits for the measurement of variables and relationships among them.

Kabir et al., (2018) add that typical quantitative data gathering strategies include:

- Experiments/clinical trials.
- Observing and recording well-defined events (e.g., counting the number of patients waiting in emergency at specified times of the day).
- Obtaining relevant data from management information systems.
- Administering surveys with closed-ended questions (e.g., face-to face and telephone interviews, questionnaires etc).
- In quantitative research (survey research), interviews are more structured than in Qualitative research. In a structured interview, the researcher asks a standard set of questions and nothing more. Face-to-face interviews have a distinct advantage of enabling the researcher to establish rapport with potential participants and therefore gain their cooperation.
- Paper pencil questionnaires can be sent to a large number of people and saves the researcher time and money. People are more truthful while responding to the questionnaires regarding controversial issues in particular due to the fact that their responses are anonymous.

Quantitative data measure uses different scales, which can be classified as nominal scale, ordinal scale, interval scale and ratio scale (Basias 2018; Creswell, 2009; Kothari, 2004). Saunders et al., (2012) state that the techniques used in quantitative research include random selection of research participants from the study population in an unbiased manner, the standardised questionnaire or intervention they receive, and statistical methods used to test predetermined hypotheses regarding the relationship between specific variables. According to Nzeru (2020: 119), the data generated in quantitative research is processed using distinctive statistical software. Quantitative approaches have the advantage that they are cheaper to implement, are standardised so comparisons can be easily made, and the size of the effect can usually be measured (Kabir and Rashid, 2017). Nzeru (2020) states that, advantages of quantitative research approach have been found as: (a) the output is numerical and thus the research might not get influence from personal feelings in representing the research and facts, (b) the approach would simplify the processing of a huge amount of data, (c) allows for easier data comparison and (d) enables the development of quantitative valuation indicator.

Kabir, et al., (2018) argue that quantitative data collection methods rely on random sampling and structured data collection instruments that fit diverse experiences into predetermined response categories. They produce results that are easy to summarise, compare, and generalise. If the intent is to generalise from the research participants to a larger population, the study employed probability sampling to select participants (Annan, 2020). The study maintained an impartial approach throughout the process when gathering, analysing and interpreting data. For this study, the responses from questionnaire were numerical (Likert scale), and the data generated from the sample were subjected to statistical analysis techniques, with the inference on the broader population.

4.6.2 Qualitative research method

Qualitative Approach according to Jose (2015), basically deals with any data collection techniques or methods that use non-numeric data. Kabir et al., (2018) argue that qualitative data are mostly non-numerical and usually descriptive or nominal in nature. Earlier mentioned by Vogt (2011) who states that qualitative data is non-numerical and focuses on establishing patterns. This means the data collected are in the form of words and sentences. Often (not always), such data captures feelings, emotions, or subjective perceptions of something (Kabir and Rashid, 2017). Qualitative methods include focus groups, group discussions and interviews. Saunders et al., (2012: 546) state that it includes interviews, face to face interviews, and telephonic interviews. Qualitative approaches are good for further exploring the effects and unintended consequences of a program. They are, however, expensive and time consuming to implement (Kabir and Rashid, 2017). Kabir, et al., (2018) add that, the findings cannot be generalised to participants outside of the program and are only indicative of the group involved. The qualitative methods most commonly used in evaluation can be classified in three broad categories, namely: in-depth interview, observation methods and document review.

Worthen and Sanders (1987: 50) characterise qualitative inquiry as a research approach that is generally conducted in natural settings, utilising the researcher as the chief instrument in both data gathering and analysis. According to Annan (2019: 30), subjective researchers argue that the world is a social construct, and that science is driven by human interests and that the researcher, as a subjective entity, is part of the world they are observing.

- Objectivity is an impossible aim.
- The findings often have greater validity and less artificiality as the process of observing phenomena in a natural, real-life setting.
- It often allows researchers to develop a more accurate understanding of those phenomena.
- It often reveals depth of understanding and richness of details.

Kabir and Rashid (2017) reveal that qualitative data collection methods play an important role in impact evaluation by providing information useful to understand the processes behind observed results and assess changes in people's perceptions of their well-being. Furthermore, Jose (2015) reasons that qualitative methods can be used to improve the quality of survey-based quantitative evaluations by helping generate evaluation hypothesis, strengthening the design of survey questionnaires and expanding or clarifying quantitative evaluation findings. Kabir, et al., (2018) mention that these methods are characterised by the following attributes:

- They tend to be open-ended and have less structured protocols (i.e., researchers may change the data collection strategy by adding, refining, or dropping techniques or informants).
- They rely more heavily on interactive interviews; participants may be interviewed several times to follow up on a particular issue, clarify concepts or check the reliability of data.
- They use triangulation to increase the credibility of their findings (i.e., researchers rely on multiple data collection methods to check the authenticity of their results).

- Generally, their findings are not generalizable to any specific population, rather each case study produces a single piece of evidence that can be used to seek general patterns among different studies of the same issue.

In qualitative method, the researcher needs to record any potentially useful data thoroughly, accurately, and systematically, using field notes, sketches, audiotapes, photographs, and other suitable means (Kabir and Rashid, 2017). Jose (2015) mentions that the benefits of qualitative methods are embedded in its emphasis on thick description, i.e., obtaining real, rich, deep data which illuminates everyday patterns of action and meaning from the perspective of those being studied. The data collection methods must observe the ethical principles of research.

The qualitative method taken to conduct this study was through field and telephone interviews. This research method offered interpretative explanations based on the literature review and primary data where the researcher conducted in-depth interviews with ten (10) families living in Soweto, Dobsonville neighbourhood, and five (5) industry expects on their experience of current energy system and further ascertain their understanding preferences of renewable energy. During the qualitative phase, the researcher conducted semi-structured interviews (designed following an analysis of the questionnaire data) with residents, utility providers, NGO's or pressure groups, local businesses in Soweto neighbourhood, adding depth and detail to the quantitative data. Anonymity was granted to those that participated in the research. The social anthropological dimension to the qualitative work was the in-depth study of ten families, and the building of a critical incident index, based on 'shocks' to their livelihoods.

4.6.3 Mixed research method

Edmonds and Kennedy (2013) highlight that mixed method allows the researcher to assess the qualitative data from well-established quantitative findings. This assessment helped to interpret the new quantitative results using qualitative data (Gonyora, 2021). According to Maphosa (2017: 123), mixed methods research refers to the use of quantitative and qualitative methods as shown in its definition as research in which the investigator collects analyses data integrates findings and draws inferences using both qualitative and quantitative approaches and methods in a single study or program or program of enquiry". The study conducted by Mertler (2013: 103) argues that a mixed-methods approach is the combination of both types of data trends to provide a better understanding of a research problem than one type of data isolation.

Denscombe (2014: 146) states that mixed methodology approach bears three key qualities that differentiates it from other techniques in social research. These include:

- The use of both qualitative and quantitative data in the same study so as to bring together elements that are treated as bipolar variables.
- Its centrality on triangulation. It emphasises and explains the role of triangulation.
- It is a pragmatist approach. In other words, mixed methodology has a problem- solving orientation and gives attention to the research problem and research questions. Proponents of mixed-methods approach suggest that it is an important process in deciding which methods to use. There is an advantage in using methods with different paradigm grounding. However, only if the use of these methods comes up with practical findings addressing the statement of the problem.

The study by Maphosa (2017) highlights that, when using mixed methodology and having started with quantitative research proceeding to qualitative research, the utility of qualitative research is to explain the findings and outcomes of the quantitative study, to gain understanding and interpret particular progression in responses or behaviour as highlighted by the questionnaire, to find out why and how these behaviours and perceptions come about and, finally, to contextualise the behaviour under study. Maphosa (2017) further states that mixed methodology is a complicated approach to employ because both qualitative and quantitative methodology have different paradigms from which they operate, appropriate for particular settings and research purposes.

In this study, mixed methodology is utilised, moving from quantitative research to qualitative research. The multiple research method provided a richer approach to data collection, analysis, and interpretation. The combination and systematically integration of quantitative and qualitative methods in this study to helped to obtain a fuller picture and deeper understanding of the phenomenon using the mixed method research. The phases of the multiple methods research design and research approaches incorporating the pilot test is reflected in Figure 4.2 below. Quantitative data was collected from the survey questionnaires, administered by the researcher from the residents of Soweto, Dobsonville neighbourhood who use electricity, NGO's and industry experts.

In order to gain better understanding of the community's experience on energy, a survey questionnaire was also distributed to NGO's, utility representatives (Municipality and Eskom employees) and community base organisations in Soweto. The researcher further conducted qualitative research with selected 10 families from Soweto in Dobsonville neighborhood and 5 industry expects (officials from Municipalities and Eskom). Hennick, Hutter and Bailey (2011: 55) analyse that, when using mixed methodology and having started with quantitative research proceeding to qualitative research, the effectiveness of qualitative research is to explain the findings and outcomes of the quantitative study, to gain understanding and interpret particular progression in responses or behaviour as highlighted by the questionnaire, to find out why and how these behaviours and perceptions come about and, finally, to contextualise the behaviour under study.

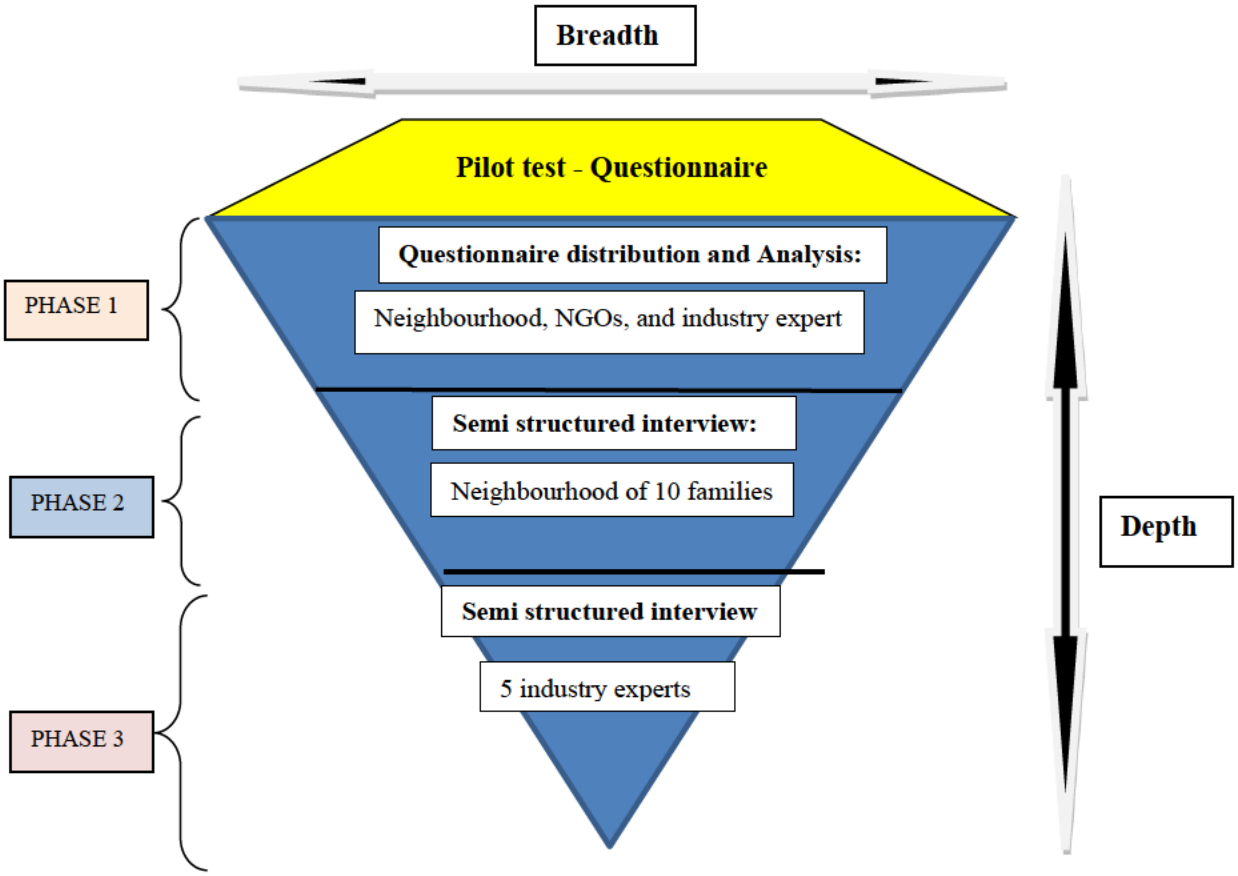


Figure: 4.2: Multiple methods research design

Source: Own source (2022)

4.6.4 Triangulation

Collis and Hussey (2014: 71) defines triangulation as the use of multiple sources of data, different research methods and/or more than one researcher to investigate the same phenomenon in a study. Jick (1979) was of the view that this can reduce bias in data sources, methods and investigators. Collis and Hussey (2014: 71) cited the work of Denzin (1978) who argues that the use of different methos by a number of researchers studying the same phenomenon should lead to greater validity and reliability than a single method approach, providing they all reach the same conclusion.

Easterby-Smith, Thorpe and Jackson (2012) state four main potential elements of triangulation in research studies, namely:

- **Triangulation of theories** – A theory is taken from one discipline (i.e., psychology) and used to explain a phenomenon in another discipline (i.e., accounting).
- **Data triangulation** – Data are collected at different times of from different sources in the study of a phenomenon.
- **Investigator triangulation** – Different researchers independently collect data on the same phenomenon and compare the results.
- **Methodological triangulation** – More than one method is used to collect and analyse the data, but it is important to choose them from the same paradigm (i.e., exploratory interviews to identify key issues and provide insights into the issues before conducting a questionnaire survey).

i. The benefits of using triangulation.

Denscombe (2014) state that "the rationale for using triangulation in social research is that by viewing something from more than one viewpoint the researcher can get a better knowledge of it, and this better knowledge can take two forms:

- **Improved accuracy** (a means of validation). This use of triangulation focuses on the validation of the findings in terms of their accuracy and authenticity. The alternative methods are used as confirmation, a check on one another in terms of the corroboration of findings.

- **Fuller picture** (a source of complementary data). This approach focuses on producing complementary data that enhances the completeness of the findings. Researchers can use triangulation to get a fuller version or a version that incorporates different facets of the thing being studied. Or triangulation can be used to develop a line of enquiry, building on findings produced by a different viewpoint. In this sense, the triangulation is used to complement information from other sources.

Whether the aim is to get improved accuracy or to get a fuller picture, the use of triangulation can give the researcher added confidence in his/her research data and findings (Easterby-Smith, Thorpe and Jackson, 2012). Collis and Hussey (2014) mention that the opportunity to corroborate findings and the chance to see things from a different perspective can enhance the validity of the data. According to Maphosa (2017), it can bolster confidence that the meaning of the data has some consistency across methods and that the findings are not too closely tied up with a particular method used to collect the data. Data analysis becomes more complex when using triangulation. Not only does the researcher need to use more than one kind of analysis, but there is also the need to compare, contrast and integrate the findings in a way that is more demanding (Denscombe, 2014). In many cases this would involve the combination of quantitative and qualitative findings, a task that is more challenging than sticking with just one method.

For the purpose of this study, the three sources of data were placed at the points of a triangle, where each data source provided a philosophical starting point for the other data sources. The three data sources employed in this study, and how they were triangulated, are depicted figure 4.3 below.

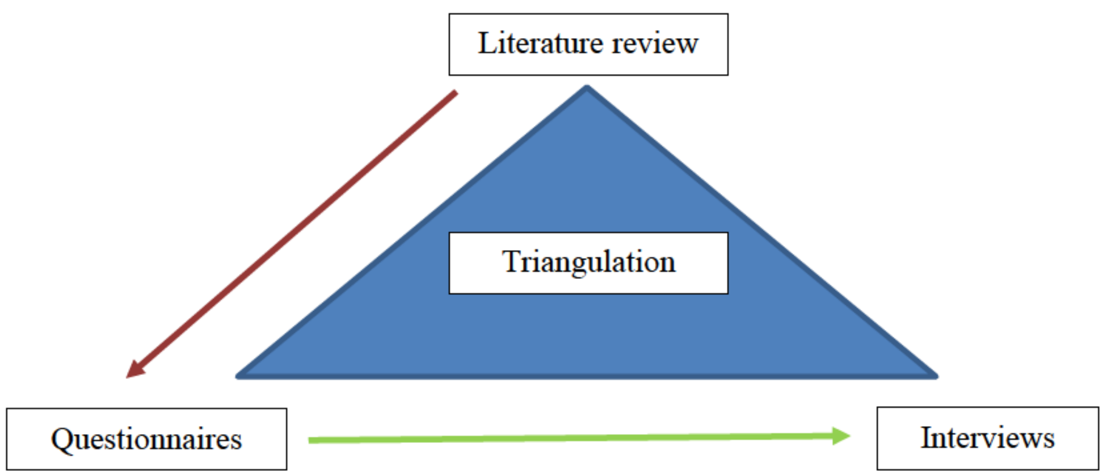


Figure 4.3: Triangulation of data sources

Source: adopted from Singh (2018)

There were three data sources used in this study, namely: literature review, questionnaires and interviews. The literature review was used to provide secondary data which assisted the researcher to formulate questions for the questionnaires. The findings from the analysed questionnaire informed the types of questions which were included in the interview schedule for participants.

For the purpose of this study, only three types of triangulations were utilised, namely: data triangulation, theory triangulation and methodological triangulation. Data triangulation concerns itself with the use of various data sources, and in this study, interviews, questionnaires, and an in-depth literature review were conducted from different people in different times. Chapter 3 of the study evaluated different theoretical frameworks that are relevant to the study. Methodological triangulation concerns itself with the use of both qualitative and quantitative methods in the same study.

4.7 RESEARCH PARAMETERS

4.7.1 Research area

The research investigates the link between modern, affordable, and clean renewable energy access as an alternative source of energy and chronic poverty reduction strategy in South African townships. In part, the findings and recommendations of the study are applicable to all South African townships. The study focused on building a case study of a neighbourhood within a South-Western Township (Soweto) situated in Gauteng province, mainly due to the uniqueness of this area, in the context of a broader discussion of the evidence we have about energy and utility transformations in supply and demand and chronic urban poverty worldwide. Soweto is made up of 32 different neighbourhood, clustered together, with a vibrant mix of cultures and tribes. It is one of the hubs of economic development targeted by the South African government. According to Fiil-Flynn, McDonald and Bond (2001: 9), Soweto is one of the oldest, largest, and most politically important townships in South Africa. Soweto serves as a useful indicator of township experiences and attitudes and a useful case of the state of electricity provision in the country (IOL, 2022). Soweto was selected because of its diverse citizenry and there has been calls for the implementation of renewable energy to the very same township.

4.7.2 Target population

According to Annan (2019: 39), a population is the full arrangement of components from which an example is drawn. A population is defined as a group of individuals, with at least one common characteristic which distinguishes that group from other individuals (Best and Kahn, 2006). Population is the whole group of people that the researcher wishes to investigate (Sekaran and Bougie, 2016). According to Burns and Grove (1997: 236), the target population for a survey is the entire set of units for which the survey data are to be used to make inferences. Hence, the target population defines those units for which the findings of the survey are meant to generalise (Burns & Grove, 1997: 236). The target population can best be defined as the total group of individuals from which the sample might be drawn. A populace component is the single unit of the example from which estimations and perceptions are drawn. Neumann (2011:89) argues that population is the abstract idea of a broader group of many research subjects from which a sample is drawn and further, to which the findings from a sample are to be generalised. While Jose (2015) explains the population as the full set of cases from which a sample is taken.

Masango (2019: 110) observe that target population relates to a group of elements or objects possessing the required facts and evidence sought in a study from which conclusions are drawn.
Population is further described by many researchers as the entire lot under study, to which the objectives of the research study has been specified for (Efron and Ravid, 2013; Leedy and Ormrod, 2014; Banerjee and Chaudhury, 2010). Gonyora (2021: 154) stated that the bigger pool from where the study draws sampling elements and generalise findings is the target population. Population can also refer to the entire targeted respondents or research subjects from where select research elements are drawn for sampling (Saunders, Lewis, and Thornhill, 2012:109). Goodenough and Waite (2012) additionally argued that the target population emanates from the cosmos of elements. Saunders (2011) concurs by upholding that the target population is the complete instances of the sample. The population of any research is intended to denote the total amount of individuals from

which a sample can be identified and from which data is required to answer research questions (Naidoo, 2018: 100). The population would firstly, be too large for a study of this limited scope and secondly, too diverse to be able to generalise the findings. It is for this reason that it is necessary to have a research population.

The study targeted residents from Dobsonville section in Soweto Township. Soweto is the largest township in South Africa, with over 1.272 million people (StatsSA, 2011). The targeted population is all residents of Soweto who are adults from the age of 18 years and above and who are somehow impacted or affected by energy. The population also included members of the utility providers, NGO's or pressure groups and local small businesses in Soweto. The study focused on building a case study of a neighbourhood within Soweto in the context of a broader discussion of the evidence we have about energy and utility transformations in supply and demand and chronic urban poverty worldwide.

4.7.3 Sampling technique and sample size

According to Jose (2015) a sample is composed of a group of some members that are selected from a whole population to provide the researcher the ability to describe conclusions about the population studied. Annan (2019) study argues that sampling is a procedure of methodically choosing targets for consideration in a research project. On the other hand, a sample can be best be defined as the group of people who take part in the investigation (Frerichs, 2008). Kumar (2011) describe sampling as the process of selecting a few (a sample) from a bigger group (the sampling population) to become the basis for estimating or predicting the prevalence of an unknown piece of information, situation or outcome regarding the bigger group. A sample is a subgroup of the population the researcher is interested in studying. Sample size is described as a sub-section of the population, which is selected to participate in a study (Polit & Hungler, 1995:279).

Sampling is related with the selection of a subset of individuals from within a population to estimate the characteristics of whole population (Singh and Masuku, 2014: 3). The essential point according to Jose (2015), is that by choosing a portion of the components in a populace and concentrating research consideration on this limited group, the specialist may apply the discoveries of the investigation to the entire populace of interest. In the view of Moyo (2019: 53), a sample examines a portion of the target population, and the portion must be carefully selected to represent that population. This process of selecting a sample from the total population has advantages and disadvantages (Kumar, 2011). The advantages are that it saves time as well as financial and human resources. However, the disadvantage is that the researcher does not find out the information about the population's characteristics of interest, but only estimate or predict them. The study conducted by Kumar (2011) found that the selection of a sample in quantitative and qualitative research is guided by two opposing philosophies. In quantitative research an attempt is made to select a sample in such a way that it is unbiased and represents the population from where it is selected. However, in qualitative research, number considerations may influence the selection of a sample such as: the ease in accessing the potential participants; your judgement that the person has extensive knowledge about an episode, an event or a situation of interest to you; how typical the case is of a category of individuals or simply that it is totally different from the others. Kumar (2011) further argues that the determination of sample size in quantitative and qualitative research is based upon the two different philosophies. Quantitative research is guided by a predetermined sample size that is based upon a number of other considerations in addition to the resources available. Qualitative research does not have a predetermined sample size but the data collection phase proceeds until a point of data saturation is reached. According to Singh and Masuku (2014: 3), the two main advantages of sampling are the faster data collection and lower cost. Annan (2019: 41) argues that the two extensive categories of sampling designs are probability sampling and non-probability sampling. Probability sampling is based on the concept of random selection, a selection procedure that ensures that each element of the population is given a known chance of selection. Whereas non-probability sampling is non-random, purposive and subjective because the researcher may select the sample using criteria other than those associated with randomness of selection. According to Annan (2019: 42), there are four commonly used types of probability sampling design, and these are, namely: simple random sampling; stratified random sampling; systematic sampling and cluster sampling. Similarly, Kumar (2011) mentions that there are five commonly used non-probability sampling designs, namely: quota sampling; accidental sampling; judgmental sampling or purposive sampling; expert sampling; and snowball sampling.

For the purpose of this study, probability sampling technique was utilised. Stratified random sampling method was used to choose members of the population to participate in the study. The stratum units to study comprised of Soweto neighborhood residents, NGO's, industry experts (utility providers) and local small businesses. This sampling method covered maximum population, as the researcher had a complete charge over the strata division. A questionnaire was distributed to a stratified random sample of 384 respondents for quantitative study. Further to that, a stratified random sample of 15 units were study in depth for the qualitative study.

4.7.4 Stratified Random Sampling

Singh and Masuku (2014: 4) defined stratified random sampling as where the population embraces a number of distinct categories, the frame can be organised by these categories into separate strata. Each stratum is then sampled as an independent sub-population, out of which individual elements can be randomly selected. Singh and Masuku (2014) argue that stratified random sampling is useful method for data collection if the population is heterogeneous. In this method, the entire heterogeneous population is divided into a number of homogeneous groups, usually known as Strata, each of these groups is homogeneous within itself, and then units are sampled at random from each of these stratums (Singh and Masuku, 2012). The sample size in each stratum varies according to the relative importance of the stratum in the population. The technique of the drawing this stratified sample is known as Stratified Sampling. In other words, according to Hitesh (2011), stratification is the technique by which the population is divided into subgroup/strata. Groves (2010) states that sampling would then be conducted separately in each stratum. Strata or Subgroup are chosen because evidence is available that they are related to outcome.

4.7.5 Determination of sample size

Singh and Masuku (2014) state that sample size determination is the technique of electing the number of observations to include in a sample. Hitesh (2011) argues that the sample size is an important feature of any study or investigation in which the aim is to make inferences about the population from a sample. Kaur (2017) argues that in terms of quantitative research, sample size determination is the mathematical estimation of the number of subjects/units to be included in a study. A sample size generally depends on five study design parameters: minimum expected difference or also known as the effect size, estimated measurement variability, desired statistical power, significance criterion, and whether a one- or two-tailed statistical analysis is planned (Singh and Masuku, 2014: 8). There are many approaches to determining the sample size (Glenn 1992, Rao 1985 and Sudman 1976, Singh and Masuku 2013). These include using:

- **Using a Census for Small Populations -** A census eliminates sampling error and provides data on all the individuals in the population. In addition, some costs such as questionnaire design and developing the sampling frame are fixed, that is, they would be the same for samples of 50 or 200. Therefore, entire population would have to be sampled in small populations to achieve a desirable level of precision.
- **Using a Sample Size of a Similar Study -** Another approach is to use the same sample size as those of studies similar to the plan. Without reviewing the methods used in these studies may run the risk of repeating errors that were made in determining the sample size for another study.
- **Using Published Tables -** published tables provide the sample size for a given set of criteria. Sample sizes that would be necessary for given combinations of precision, confidence level and variability.

The formula for determining sample size, of the population has virtually no effect on how well the sample is likely to describe the population and as Fowler (2002) argues, it is most unusual for it (the population fraction) to be an important consideration when deciding on sample size (Fowler, 2002). Table 4.2 present sample size that would be necessary for given combinations of precision, confidence levels, and a population percentage or variability of 50% (the figure which many researchers suggest maximising variance). Based on Table 4.2 below, Soweto population is over 1 million, therefore the targeted sample size for this study at 5% Precision Levels where Confidence Level is 95%, is 384 participants.

	Variance of the population P=50%		
	Confidence level=95% *Margin of error*		
Population Size	5	3	1
50	44	48	50
75	63	70	74
100	79	91	99
150	108	132	148
200	132	168	196
250	151	203	244
300	168	234	291
400	196	291	384
500	217	340	475
600	234	384	565
700	248	423	652
800	260	457	738
1000	278	516	906
1500	306	624	1297
2000	322	696	1655
3000	341	787	2286
5000	357	879	3288
10000	370	964	4899
25000	378	1023	6939
50000	381	1045	8057
100000	383	1056	8762
250000	384	1063	9249
500000	384	1065	9423
1000000	384	1066	9513

Table 4.2: Sample size based on Desired accuracy with Confidence Level of 95%

Source: Gill et al., (2010)

4.8 PILOT STUDY

According to Annan (2019: 50), the researcher must test the instruments with a small pilot group, inspecting the ease of use, accuracy, and sufficiency of the information to be used in the actual research study. Anything that needs improvement can then be dealt with prior to commencing the study. The significance of a pilot study in any research study cannot be over emphasised. According to Arnold (2010), it is important to note that a pilot study is crucial when conducting a research study. Arnold (2010) went further to define it as a small study for helping to design a further confirmatory study. However, the pilot study collection method should follow the same way the main collection method is going to follow (Quwe, 2020: 121). Howes (2018) state that pilot study of a questionnaire is conducted during the process of gathering the data to detect weaknesses in the design and instrumentation of the questionnaire. Gonyora (2021: 171) mentions that the pilot study aimed to pre-test the instrument and to provide the present research with a practical approach to testing the questionnaire and ensure that it reflected the theoretical model developed and the epistemological approach adopted. Hair et al. (2011) assert that the administration of a questionnaire occurs after testing for the accuracy and consistency of the responses.

Cooper and Schindler (2014) argue that having constructed a research instrument, whether an interview schedule or a questionnaire, it is important to test it out before using it for actual data collection. The study conducted by Howell (2013) found that, pre-testing a research instrument entails a critical examination of the understanding of each question and its meaning as understood by a respondent. A pre-test should be carried out under actual field conditions on a group of people similar to the study population (Quwe, 2020). Cooper and Schindler (2014) confirm that the purpose of conducting a pilot is not to collect data but to identify problems that the potential respondents might have in either understanding or interpreting a question. Furthermore, the aim of conducting a pilot according to (2010), is to identify if there are problems in understanding the way a question has been worded, the appropriateness of the meaning it communicates, whether different respondents interpret a question differently, and to establish whether their interpretation is different to what you were trying to convey. If there are problems, a researcher needs to re-examine the wording to make it clearer and unambiguous.

In this study, a pilot study was conducted with ten community members in Soweto Township. These 10 pilot participants did not take part in the main study, as they were only selected to assist with the pilot study. The results from the pilot study were used to strengthen the main research instrument for the study. The purpose of the pilot study in this research was to determine the feasibility of the study; to test the reliability and validity of the instrument and trustworthiness of respondents for data collection in the main study; to establish how appropriate, understandable and practical the instrument is; to address any problems prior to the main study; and to check the time required for the completion of the questionnaire. The pilot study demonstrated that the questionnaire did not contain any confusing items and the responding participants found it easy and quick to complete.

4.9 DATA COLLECTION INSTRUMENT

The literature shows that numerous research has described data collection instruments. One of these authors is Pierce (2009: 159) who defines it as a survey, questionnaire, test, scale, rating or tool designed to measure the variable(s), characteristic (s), or information of interest, often a behavioral or psychological characteristic. According to Denscombe (2010: 110), there is not a particular method of data collection that is claimed to be unique to grounded theory. Though Strauss (1987: 1) indicates that, 'very diverse materials (interviews, transcripts of meetings, court proceedings; field observations; other documents, like diaries and letters; questionnaire answers; census statistics; etc.) provide indispensable data for social research.' Kabir (2018) argues that data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes. Data collection is one of the most important stages in conducting research. Kabir (2017) earlier mentions that the goal for all data collection is to capture quality evidence that then translates to rich data analysis and allows the building of a convincing and credible answer to questions that have been posed.

Kumar (2011) mentions pre-requisites for data collection, before the researcher starts obtaining information from potential respondents it is imperative that the researcher make sure of their:

- **Motivation to share the required information:** It is essential for respondents to be willing to share information with the researcher. The researcher should make every effort to motivate potential respondents by explaining clearly and in simple terms the objectives and relevance of the study, either at the time of the interview or in the covering letter accompanying the questionnaire and/or through interactive statements in the questionnaire.
- **Clear understanding of the questions:** Respondents must understand what is expected of them in the questions. If respondents do not understand a question clearly, the response given may be either wrong or irrelevant, or make no sense.
- **Possession of the required information:** The third prerequisite is that respondents must have the information sought. This is of particular importance when the researcher is seeking factual or technical information. If respondents do not have the required information, they cannot provide it.

The most used primary data collection methods are the survey, questionnaire and the interview (Annan, 2019). All research is generally concerned with obtaining answers to questions.

For this study, organised and closed ended questions were employed. The following procedures and techniques were utilised: primary and secondary source analysis, statistical survey procedures, such as, a questionnaire and interviews as the research measuring instrument. In this research study, data collection instruments were structured questionnaire and in-depth interviews. The questionnaire and interviews were data collection instruments that enable the researcher to pose questions to participants in search of information on the research topic. Furthermore, Annan (2019) argues that each of these instruments has distinct features that enable the researcher to decide which is the correct and appropriate one for the specific data collection purpose.

4.9.1 Questionnaire

According to Kabir (2018), the questionnaire was invented by Sir Francis Galton (1822 - 1911). A questionnaire can easily be described as pre-defined set of questions, assembled in a pre-determined order (Williams, 2003). Annan (2019:51) states that questionnaires are most widely used in surveys with a descriptive or exploratory purpose. Questionnaire is a systematically prepared form or document with a set of questions deliberately design to elicit responses from respondents or research informants for the purpose of collecting data of information, which provided insight into the nature of the problem under study (Annum, 2016: 1). According to Annan (2019), the questions included on the questionnaire should individually and collectively provide the data required for successful achievement of the research objectives. A well-constructed questionnaire also has a range of question categories, each consisting of small number of related questions, intended to elicit information of a particular type relating to the research topic. Kabir (2018) mentions that questionnaires have advantages over some other types of surveys in that they are cheap, do not require as much effort from the questioner as verbal or telephone surveys, and often have standardized answers that make it simple to compile data.

According to Kabir (2017), advantages of questionnaires are: -

- Large amounts of information can be collected from a large number of people in a short period of time and in a relatively cost-effective way.
- Can be carried out by the researcher or by any number of people with limited affect to its validity and reliability.
- The results of the questionnaires can usually be quickly and easily quantified by either a researcher or through the use of a software package.
- Can be analysed more scientifically and objectively than other forms of research.
- When data has been quantified, it can be used to compare and contrast other research and may be used to measure change.
- Positivists believe that quantitative data can be used to create new theories and / or test existing hypotheses.

Annan (2019: 51) states that the appropriateness of questionnaires as research tools must, however, be carefully examined in the context of each study. Saunders et al. (2003: 280) maintain that it is generally good practice not to rely solely on questionnaire data but to use the questionnaire in conjunction with at least one other data collection instrument. For example, a questionnaire designed to establish customers' attitudes can be complemented by semi-structured interviews to explore and understand the basis of these attitudes. In this study, semi-structured questionnaire was adopted as a data collection instrument (suitably adapted for literacy standards and cultural practices), which was distributed to a neighbourhood sample of Soweto residents, private and state utility providers (the suppliers) in order to initially describe the territory of the research in terms of key stakeholders, to define the market conditions for energy and the social situation of the consumers. The questionnaire was divided into following sections:

Section I: Socio-Economic Status (SES) Questions (To be administered to all participants)

Section II: Poverty alleviation (To be administered to all participants)

Section III: Economic Growth (To be administered to all participants)

Section IV: Environmental conditions / Climate change (To be administered to all participants)

Section V: Renewable energy trade opportunities (To be administered to all participants)

Section VI: Only for NGO's, Civil Society Organisations and Utility Organisations (To be administered to only organised organisations)

The questionnaire was designed to collect data pertaining to respondent's experiences in relation to variables of the study (Refer to Appendix D).

4.9.2 Survey

According to Annan (2019: 34), the survey is a research design in which a sample is selected from a population and studied to make inferences about the population. Saunders et al. (2009) argue that the survey method is feasible and fit for an inductive approach and it is popular method in business and management research. It is most frequently used to answer who, what, where, how much and how many questions and is used for exploratory and descriptive study (Jose, 2015: 40). Annan (2019) state that surveys typically use questionnaires and interviews in order to determine the options, attitudes, preferences and perceptions of persons of interest to the researcher. Kabir (2018) believes that survey research is often used to assess thoughts, opinions, and feelings. Survey research can be specific and limited, or it can have more global, widespread goals. Survey method enables the researcher to learn about opinions, attitudes, expectations and intentions of the participants (Jose, 2015). A good sample selection is key as it allows one to generalize the findings from the sample to the population, which is the whole purpose of survey research (Kabir, 2017).

A survey consists of a predetermined set of questions that is given to a sample. According to Jose (2015) survey method enables the researcher to collect a large amount of data in an economical way. Annan (2019) mentions that in well-designed surveys, the sample can be carefully selected to ensure that it is a representative of a larger population; it is possible to use statistical techniques to assess the applicability and generalisability of the findings to the large population. Kabir (2018) reveals that with a representative sample, that is, one that is representative of the larger population of interest, one can describe the attitudes of the population from which the sample was drawn. Further, one can compare the attitudes of different populations as well as look for changes in attitudes over time. According to Trigueros (2018: 13), there are several types of surveys as: telephone survey, online surveys also known as internet surveys, in-person surveys or face-to-face surveys, and mobile surveys. Denscombe (2010) also mentions other types of surveys as namely: postal surveys, group-administered surveys, observational surveys, and document surveys. Annan (2019) argues that the researcher must clarify the reason for the survey to the participants before they answer the questionnaire and should include a covering letter with the questionnaire which also explains the reasons for the study. In addition, the survey itself should have an opening segment that clarifies the essential point of the examination and the significance of the participants' involvement in the study. So, keeping in mind the nature of this research study, the survey method that was adopted, was in the form of telephone survey, online survey and face-to-face survey, conducted with residents of Soweto, Dobsonville neighbourhood.

4.9.3 Interviews

Interviewing is a commonly used method of collecting information from people. According to Annan (2019: 55), the interview is a form of data collection that is very common in descriptive research such as surveys and can be used to collect valid and reliable data in other types of research. According to Burns (1997: 329), an interview is a verbal interchange, often face to face, though the telephone may be used, in which an interviewer tries to elicit information, beliefs or opinions from another person. Interviews involve a set of assumptions and understandings about the situation which are not normally associated with a casual conversation (Denscombe, 2010: 172). It is an interaction in which oral questions are posed by the interviewer to elicit oral response from the interviewee. This was supported by Trigueros et al, (2017: 2) who states that an interviewing involves asking questions and getting answers from participants in a study. Kumar (2011) mentions that any person-to-person interaction, either face to face or otherwise, between two or more individuals with a specific purpose in mind is called an interview. Annan (2019) argues that the interview is unique because it involves the collection of data through direct verbal interaction (often face-to-face).

- The interview enables the researcher to follow up verbal leads and thus obtain more data and greater clarity.
- The interview situation also permits much greater depth than other methods of collecting data.

There are various types of interviews, namely (Kumar, 2011; Annan, 2019; Kabir, 2017):

- **In-depth interview:** An In-depth interview is the one that takes place when the researcher interviews the studied population (individually or in groups) so that it freely expresses any idea, feelings and motivations about the topic being studied (Oxman, 1998: 9).
- **Face to face interview:** A face to face interview is a version of an in-depth interview. It is useful for targeting detailed perceptions, opinions, and attitudes (Trigueros et al, 2017).
- **Structured Interviews:** The interviewer asks each respondent the same series of questions. Questioning is standardized and the ordering and phrasing of the questions are kept consistent from interview to interview (Kabir, 2017).
- **Semi-structured Interviews:** The interviewer develops and uses an ‘interview guide’. This is a list of questions and topics that need to be covered during the conversation, usually in a particular order. (Kabir, 2017). Semi-structured interviews elicit people’s

own views and descriptions and have the benefit of uncovering issues or concerns that have not been anticipated by the researcher (Trigueros et al, 2017).

According to Annan (2019), most interviews include composed content or some likeness thereof with differing dimensions of adaptability structured into the interview plan (the organisation, composed posting of the inquiries or subjects). Interviews are among the most challenging and rewarding forms of measurement. They require a personal sensitivity and adaptability as well as the ability to stay within the bounds of the designed protocol (Kabir, 2018). Kumar (2011) state that the process of asking questions can be either very flexible, whereby the interviewer have the freedom to think about and formulate questions as they come to mind around the issue being investigated, or inflexible, where the interviewer must keep strictly to the questions decided beforehand, including their wording, sequence, and the manner in which they are asked. In this study, a semi-structured interviews were conducted with 10 families from Soweto and five energy industry expects in order to obtain depth and breadth (Refer to Appendix C).

4.10 DATA ANALYSIS

According to Jose (2015: 45), data analysis involves reducing the accumulated data to a manageable size, developing summaries, looking for patterns, and applying statistical techniques. Annan (2019: 77) mentions that the objective of data analysis is to establish a connection between what one knows and what one finds out about a research problem through an audit of relevant literature and assembling essential information from people and the different components of both quantitative and qualitative research strategies. quantitative research uses numbers as the unit of analysis, while qualitative research uses words or visual images as the unit of analysis (Denscombe, 2014). Furthermore, quantitative research is associated with the production of numerical data that are ‘objective’ in the sense that they exist independently of the researcher and are not the result of undue influence on the part of the researcher himself or herself. Denscombe, (2010) believes that qualitative research, by contrast, tends to place emphasis on the role of the researcher in the construction of the data.

Creswell (2014) state that quantitative data alludes to all information that can be deduced in numerical qualities, going from the numerical recurrence of event to complex introduction of information in terms of diagrams and graphs. Collecting and analysing information with quantitative systems incorporates understanding the relationship among factors using clear and inferential statistics (Annan, 2019). While the analysis of quantitative data depends on implications, qualitative data focuses on implications communicated through words and analysis is conducted using conceptualisation. Saunders, Lewis and Thornhill (2003) stated that the nature of qualitative data has implications for both its collection and its analysis. According to Annan (2019), there are three related elements in the analysis of qualitative data:

- Reducing the data to condense the material in some systematic way to make it more manageable.
- Structuring data in terms of themes, patterns and interrelationships
- Decontextualizing the data by converting extended text into more manageable forms such as summaries, charts, diagrams and illustration.

Mixed method data analysis according to Onwuegbuzie and Combs (2010), involves the use of both quantitative and qualitative analytical techniques within the same framework, which is guided either a priori, a posteriori, or iteratively (representing analytical decisions that occur both prior to the study and during the study). Onwuegbuzie and Combs (2011, 3) further argue that, in mixed method data analyses, either the qualitative or quantitative analysis strands might be given priority or approximately equal priority as a result of a priori decisions (i.e., determined at the research conceptualisation phase) or decisions that emerge during the course of the study (i.e., a posteriori or iterative decisions).

In this study, quantitative data was analysed using descriptive statistics with the help of the Statistical Package for Social Scientist (SPSS version 29) software. In addition, Microsoft Excel was employed to develop graphs and tables. Bendat and Piersol (2011) describe data analysis as breaking up the data into manageable themes, patterns, trends, and relationships. Qualitative data was analysed using a conceptualisation and interpretation of data recorded during data collections. The thematic analysis was the process used to identify patterns or themes within qualitative data.

This method of data analysis is not tied to an epistemological or theoretical perspective, though it has its intellectual roots in social anthropology.

4.11 VALIDITY AND RELIABILITY OF THE STUDY

Hlongwane (2015) states that the principles of validity and reliability are fundamental cornerstones of any scientific method and together they are at the core of what is accepted as scientific proof. Leedy (1997:32) argues that validity is concerned with the soundness of a study. Put rather simply, validity refers to the effectiveness of the measuring instruments. Likewise, Neuman (1997:141) argues that reliability and validity of the study is mainly concerned with the precision with which an instrument measures the problem being investigated. On the other hand, Moss (1994: 44) defines reliability as the consistency of our measurements or the degree to which an instrument measures the same way each time it is used the same conditions with the same subjects. Naicker (2018: 120) refers to reliability as the degree to which the instrument can be depended upon to yield consistent results if used repeatedly over time on the same person, or if used by two researchers. Similarly, Hlongwane (2015) argues that validity encompasses the entire experimental concept and establishes whether the results obtained meet all of the requirements of the scientific research method. Msomi (2018: 104) affirms that for a quantitative study, reliability and validity are important for minimising any errors that might arise. According to Creswell (2013), validity is an important mechanism to determine the merits of a data collection instrument. Validity is defined as the extent to which a data collection tool yields accurate measurements of what it is intended to measure. Validity indicates whether the conclusions of the study are justified based on the design and interpretation (Ram, 2013). Similarly, if a data collection instrument is deemed valid then it should yield the same outcomes when it is used on different groups under various circumstances (Louis et al., 2011). Joppe (2000) provides the following explanation of what validity is in quantitative research by stating that validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. Crewell (2003) describes the validity of quantitative research as 'construct validity'. The construct is the initial concept, notion, question or hypothesis that determines which data is to be gathered and how it is to be gathered (Hlongwane, 2015).

To ensure validity, the researcher conducted pre-testing of the questionnaires. Neuman (1997: 141) notes that the validity of the questionnaire that was aligned to the study objectives as outlined in chapter one of this study. In this process, the researcher ascertained that each question is checked to determine whether it contributes to the study objectives (Neuman, 1997:141). With qualitative research, validity is about the accuracy and credibility of what is reported (Msomi, 2018). Trustworthiness and honesty are important for ensuring credibility. In this study, the researcher established a relationship with the participants by being honest with them, as people mostly treat you the way you treat them. These relationships were built in the hope that the participants would provide honest feedback.

4.12 ETHICAL CONSIDERATION

According to (Saunders et al., 2009), there is a strong possibility of ethical issues arising while planning the research. Jose (2015: 44) believes that ethical consideration could be related to seeking access to organisations, collect, analyse and report the data. As a matter of principle, ethical consideration is critical for any research study to commence; consequently, it is vital for every researcher to take cognisance of the ethical considerations. Bryman and Bell (2015) suggest that ethics represent the standards, principles, moral and values that govern the way individuals and groups perform their activities. It basically means the behaviour of the researcher in relation to the right of those who become the subject of the work (Jose, 2015). Hlongwane (2015: 217) sates that there are three major ethical considerations to consider when undertaking research. These are how the information is collected, how the information is processed, and lastly, how the findings are used. Furthermore, Hlongwane (2015) argues that it is important for the researcher to be honest and open with the respondents when dealing with the first ethical consideration on how the information is collected and to keep respondents anonymous and their response confidential. Quwe (2020) mentions that it is the responsibility of the researcher to ensure that the research is conducted within the ethical framework. This means that the researcher has to ensure that the research should be designed keeping in mind the morality and security of all those who are involved.

There are number of ethical issues arise at different stages of the research project. These relate to the: privacy of participants, voluntary nature of participation, consent and possible deception of participants, data confidentiality, reactions of participants, attitude and behaviour of you as researcher (Saunders et al., 2009). With the above sentiments as a reference, ethical clearance to conduct this study was obtained from the UKZN Ethics Committee (Refer to Appendix A). In addition, informed consent was obtained from all the respondents in the study to ensure that they understood what they were doing and to verify their willingness to participate in the study. The respondents were informed of their rights, including the right of consent; protection from disclosure of information; and respect for their privacy. In line with the information above, the researcher ensured that respondents were not exposed to risk or embarrassment, unusual stress or any demeaning treatment. Therefore, anonymity and confidentiality were granted and maintained.

4.13 LIMITATIONS OF THE STUDY

The major limitations of the research were that research collection was scheduled to happen during coronavirus disease 2019 (COVID-19) period where there were restrictions and rules set in the country, depending on the lockdown alert level scheduled. Since the beginning of the pandemic, like many other countries, South Africa imposed varying restrictions in response to the pandemic. According Chitiga-Mabugu, Henseler, Mabugu and Maisonnave (2021), South Africa recorded its first case on the first of March 2020 and by 12 March 2020, the number of confirmed cases had risen to 16. Burger and Coetzee (2020) state that a National State of Disaster was declared on the 15 March 2020, and the country was put under a hard lockdown on the 26 March 2020 for five weeks, closing of schools and prohibiting gatherings of more than 100 people, among other measures". Chitiga-Mabugu et al., (2021) mention that the virus was spreading locally predominantly through community infection and subsequently a state of lockdown for 21 days was imposed on the economy. On that date, a total of 927 active cases had been confirmed in all the nine provinces. The lockdown was stringent and restricting mobility to essential travel only, prohibiting the sale of alcohol to take pressure off the health system, and making no allowances for non-essential activities outside the home (Burger and Coetzee, 2020). Most economic functions across the country came to an immediate halt, apart from a set of essential services including healthcare, security, agriculture, and the transport of selected goods (Chitiga-Mabugu et al., 2021). Burger and Coetzee (2020) argue that most of the world, among them South Africa's trading partners, also implemented some form of lockdown which included the closure of borders, and no non-essential trade and travel.

The study was not executed entirely as planned because of restrictions on the study design caused by COVID-19. It was difficult to reach out to participants during this period. As a result of the COVID-19, some respondents were reluctant to participate in the study, more especial during qualitative data collection. When interviews were conducted, the respondents and the research were both wearing face masks which made it difficult for the researcher to read facial expression from the respondents, which would have presented another perspective in the study. During quantitative data collection, the researcher had to find an alternative way to ensure that questionnaires were distributed and collected to potential respondents without problems. It was for this reason that an electronic method of distributing and collecting questionnaires was utilised. Some respondents were e-mailed questions to complete and return to the sender which was the researcher. The qualitative part of the study, as planned whereby the researcher targeted to collect primary data with an in-depth study of 50 units and their past, present and expectations about their future well-being in the context of the main themes of the study, this could not be executed due to COVID-19. The researcher could not carry out multiple face-to-face interviews and could not visit and spend time with families building a profile of their socio-economic experience. The researcher was unable to travel easily in Soweto to build a community profile because of COVID-19 travel restrictions, neither could build the scales. So, the result of this study is largely quantitative, with limited qualitative data. Nonetheless, the researcher was able to address the central research questions, using the data presented in chapter 5 and study discussions in chapter 6. Regarding the unwillingness to participate in the study, the researcher took the time to explain appropriately the purpose of the study and always guaranteed all respondents of the anonymity. Another concern was that some respondents complained about the short duration required from them to complete the questionnaire. This was addressed by allowing them enough time to complete the questionnaire.

4.14 SUMMARY

This chapter presented the research methodology that was employed to conduct the study. In this chapter, the researcher discussed philosophical paradigm and the research approach. The chapter gave details on which methodology was used in this study. A probability sampling technique was used to collect data using stratified sample of 384 targeted respondents. The participants respondent to the questionnaire distributed were 252 respondents for quantitative data collection method. Furthermore, 10 families and 5 industry experts were interviewed for qualitative data collection method. As already discussed in this chapter, the study adopted a mixed method approach and collect data using a questionnaire and semi-structured interviews.

The next chapter presents the data analysis and interpretations.

CHAPTER FIVE

PRESENTATION OF THE RESULTS

5.1 INTRODUCTION

The previous chapter presented the research design and methodology employed by the study. This chapter presented the results of the study. Since the study employed a mixed method approach, the presentation of results was in two parts: the first part covering the quantitative, and the second covering the qualitative results. Sections covered include descriptive statistic on demographic information for the quantitative study, followed by sections aligned to the study objectives.

5.2 DESCRIPTIVE STATISTIC RESULTS: QUANTITATIVE DATA ANALYSIS

The respondents were asked to indicate their personal details namely: gender, age, living condictions, house hold structure, famiy size and financial income. This information was critical in determing whether the respondents' demographic profile had or did not have any influence on their perception about renewable energy.

5.2.1 Gender of the respondents

The respondents were asked to indicate their gender. This was to ascertain whether or not "the gender of respondents had any bearing on their perception about renewable energy and more particularly solar energy. The results are presented on the figure below.

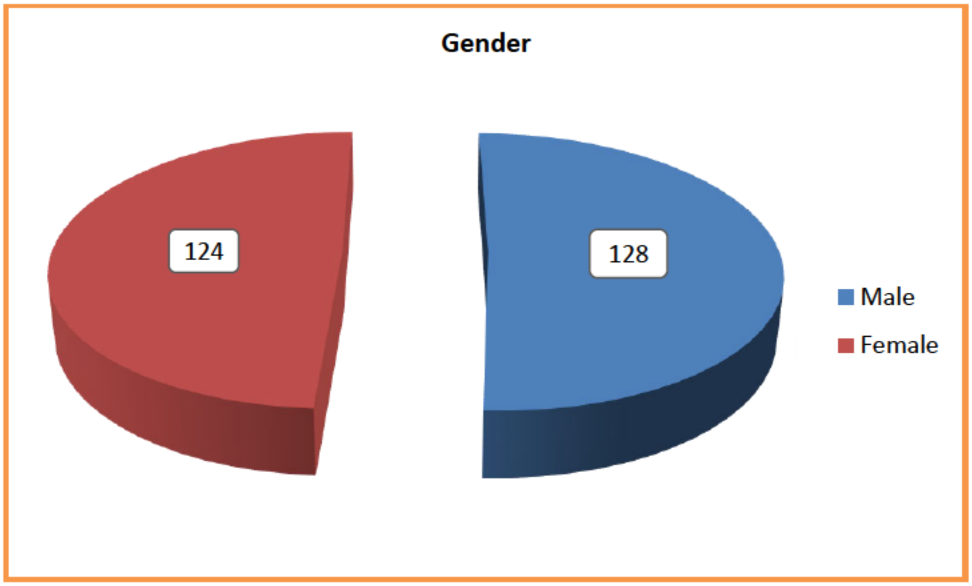


Figure 5.1: Gender (n = 252)

The results on the figure 5.1 shows that the majority of the respondents (128; 51%) are males, while 124 (49%) are females. There are no respondents who prefer not say their gender. The data shows normal distribution in a country where majority of the populace are females. This is an affirmation of the consistency of the process followed to investigate the current study. This can also assist the authorities to know where to focus attention for their poverty reduction in urban areas of South Africa.

5.2.2 Age of respondents

The respondents were asked to indicate their age. This was to ascertain whether or not the age of respondents had any bearing on their perception about renewable energy and more specifically solar energy. The results are presented on the figure below.

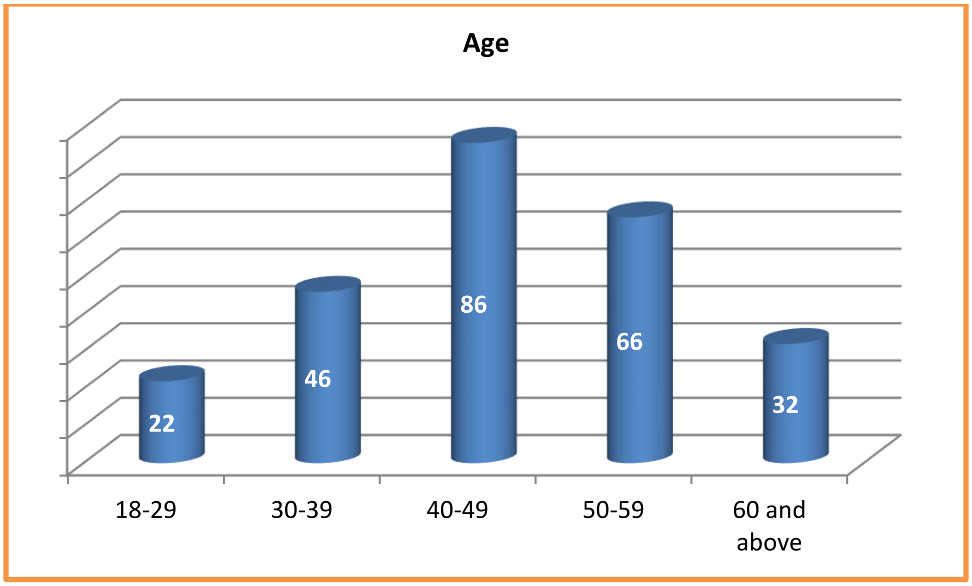


Figure 5.2: Age of respondents (n = 252)

Data displayed on figure 5.2 shows that most of the respondents (86; 34%) were between 40-49 years old, followed by those who were between 50-59 (66; 26%). In addition, the figure depicts that 46 (18%) of the respondents were between 30-39 years old, while 32 (13%) were 60 and above. Moreover, the figure shows that only 22 (9%) of the respondents were between 18-29 years old.

5.2.3 Living conditions

The living condition of the respondents were also investigated so as can enable a follow up analysis to know how poverty reduction in the urban areas of South Africa was successful when the before and after situational analysis is compared. The respondents were asked to indicate their living conditions. Possible living conditions were provided for the respondents to choose from. The graph below summarises the results.

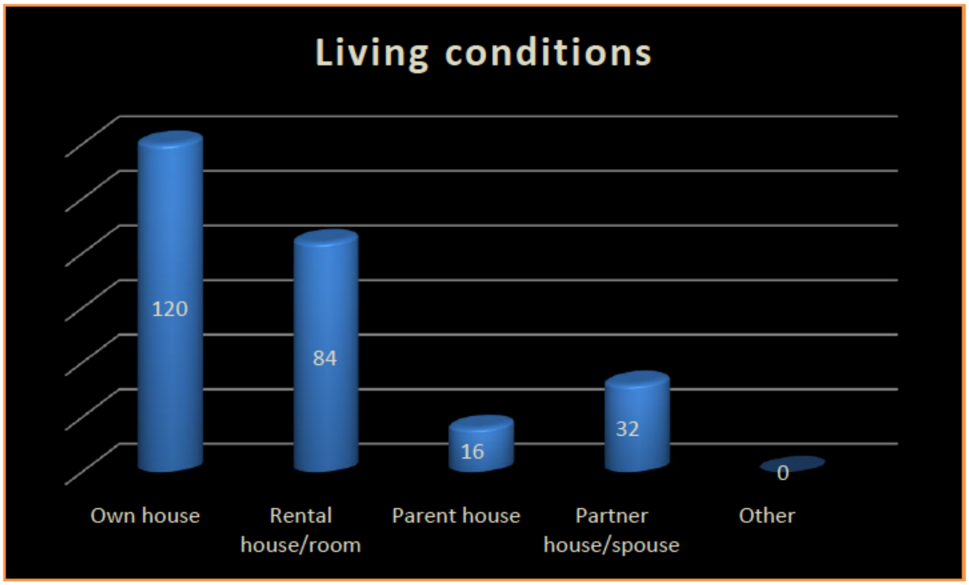


Figure 5.3: Living conditions (n = 252)

The results on figure 5.3 shows that most of the respondents (120; 48%) were living in their own houses, followed by those who were renting a house or a room (84; 33%). In addition, the results show that those who were living in the partners' or spouse' house were 32 (13%), while only 16 (6%) were living in their parents' house.

5.2.4 Household structure

The respondents were asked to indicate their household structure. This was to ascertain whether or not their household structure had any influence on their perception about the use of solar energy. Further, the household size can give the indication of the houses and their relative poverty levels. Possible house structures were provided to the respondents to choose from. The results are presented on the figure below.

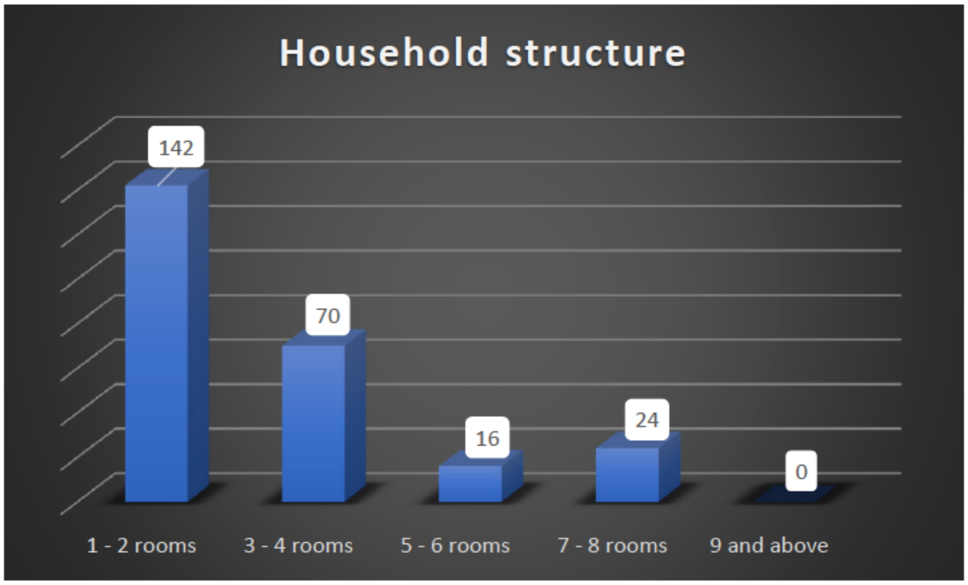


Figure 5.4: Household structure (n = 252)

It can be noted on the figure 5.4 that the majority of the respondents (142; 56%) were living in a 1-2 room, followed by those who were living in a 3-4 room house (70; 28%). In addition, the results show that 24 (10%) of the respondents were living in a 7-8 room house, while only 16 (6%) were living in a 5-6 room house and none of the respondents were living in a 9 room and above house.

5.2.5 Family size

The respondents were asked to indicate their size of the family. This was important to determine the amount of the electricity being utilised. Possible family sizes were provided to the respondents to choose from as was applicable to them. The results are presented on the figure 5.5 below:

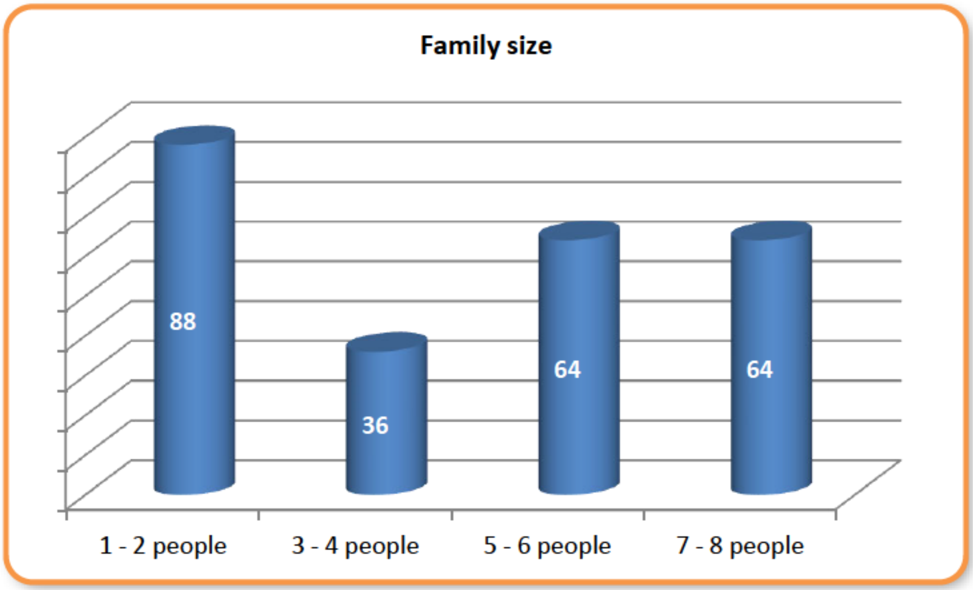


Figure 5.5: Family size (n = 252)

As displayed on figure 5.5, most of the respondents (88; 35%) were a family of 1-2 members, followed by those who were 5-6 family members (64; 25%), 7-8 members (64; 25%). In addition, the figure depicts that 36 (15%) 3-4 respondents were in a family of 3-4 members. There were no participants from a family of 9 and above.

5.2.6 Source of income

The respondents were asked to indicate their source of income. The rationale behind asking this question was to ascertain whether the respondents' source of income had any influence on their perception about the use of solar energy and assist in understanding participants poverty levels resulting from less to no income. Possible sources of income were provided to the respondents to choose from as was applicable to their situations. The figure 5.6 below presents the results.

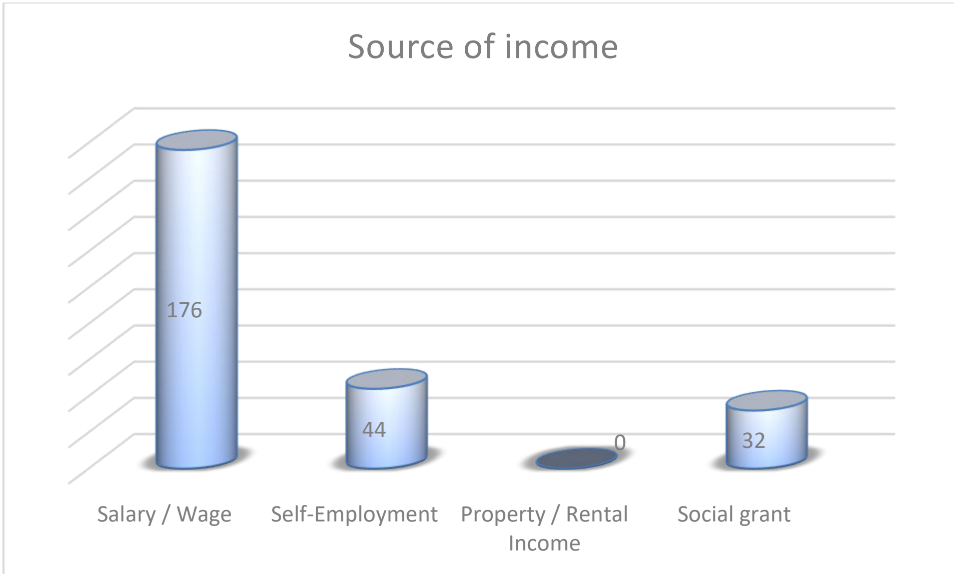


Figure 5.6: Source of income (n = 252)

The results on the figure 5.6 show that majority of the respondents (176; 70%) were employed getting a salary, followed by those who were self-employed (44; 17%). In addition, only a significant number of the respondents (32; 13%) were receiving social grants. There were no participants who earned an income from renting a property and other income source.

5.2.7 People working in the household.

The respondents were asked to indicate the number of people who were employed in the household. This was to determine whether or not households were able to pay for the electricity. Possible numbers of people working in the households were provided to the respondents to choose from as was applicable to their situations. The results are summarised on the figure 5.7 below.

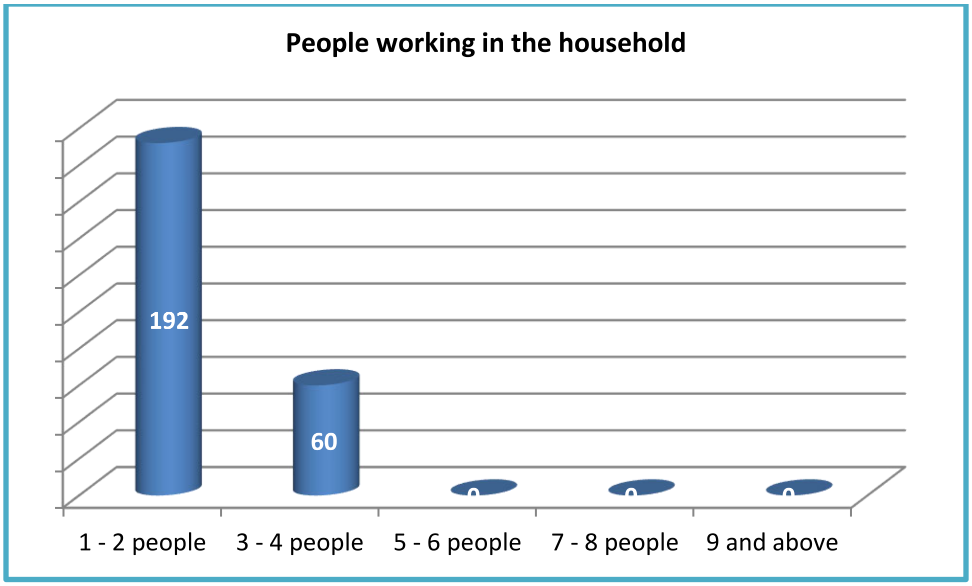


Figure 5.7: People working in the household (n = 252)

The results on figure 5.7 depict that the majority of the respondents (192; 76%) indicated that 1-2 people were working in the household, followed by those who said 3-4 people were working in the households (60; 24%). In addition, the study found that none of the respondents 5 and above people in the household.

5.2.8 Household income per month

The respondents were asked to reveal the amount of income they were receiving on a monthly basis. This was to determine if their income was insufficient or sufficient for them to buy electricity whenever they needed to. To measure their responses, a list of possible household income was provided for them to choose from as it was applicable to them. The results are presented on the figure below.

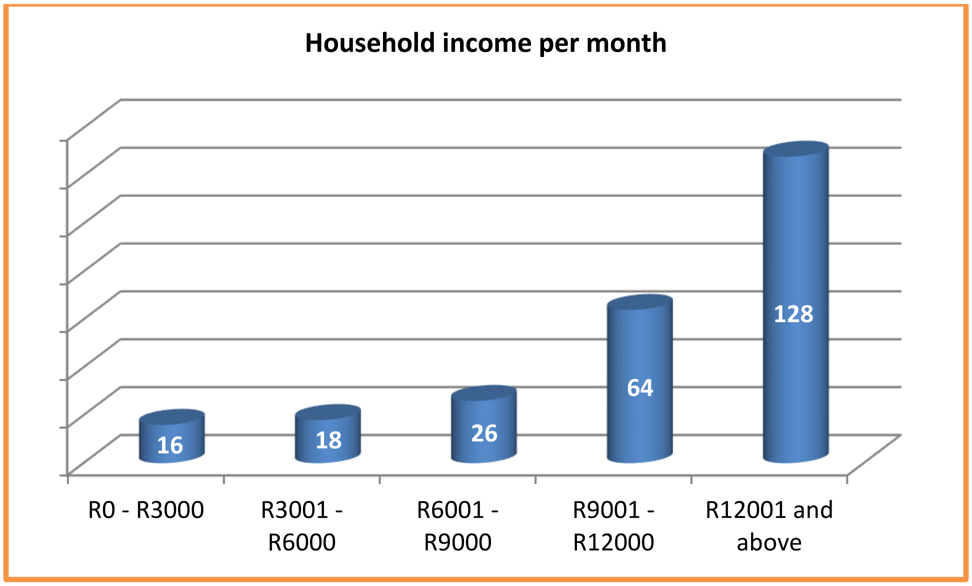


Figure 5.8: Household income per month (n = 252)

Data displayed on figure 4.8 shows that the majority of the respondents (128; 51%) indicated that the monthly income in the household was between R12,001 and above, followed by those who said it was between R9,001 –R12,000 (64; 25%). Moreover, the results show that 26 (10%) of the respondents said the monthly income was between R6,001-R9,000. Additionally, 18 (7%) of the respondents said that the monthly income was between R3001-R6000, while only 16 (6%) said the monthly income was between R0-R3,000.

5.2.9 Awareness of alternative energy

The respondents were asked whether they were aware of renewable energy. This was to determine if their awareness of renewable energy or lack thereof had any bearing on their decision to use or not to use this technology. A binary choice of yes or no was used to measure their responses. The results are presented on the figure 5.9 below.

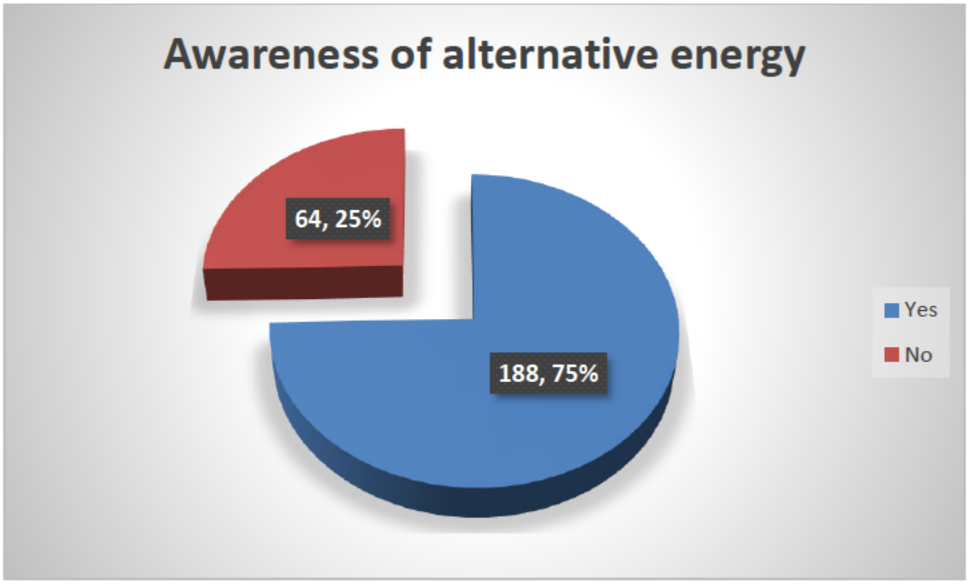


Figure 5.9: Awareness about alternative energy (n = 252)

Data displayed on figure 5.9 illustrates that the majority of the respondents (188; 75%) revealed that they were actually aware, while 64 (25%) said they not aware of renewable energy.

5.2.10 Usage of alternative/other energy source

The respondents were asked to indicate the type of alternative energy they are using as a substitute to the current grid energy. A list of alternative energy types was provided to them to choose from as was applicable to their situations. The results are presented on the figure 5.10 below.

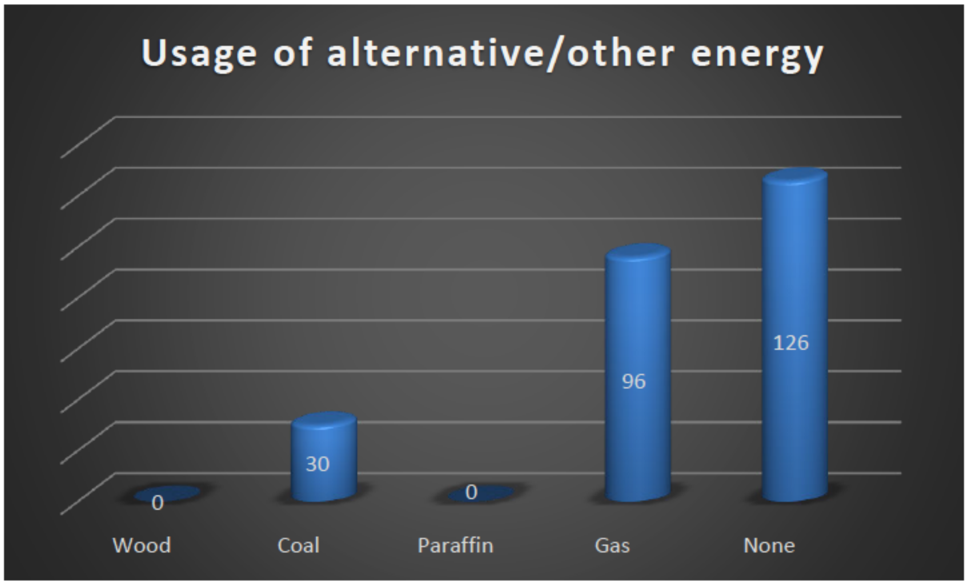


Figure 5.10: Usage of alternative/other energy source (n = 252)

The results on the figure 5.10 shows that the majority of the respondents (126; 50%) they are not using alternative energy in their households, followed by those who are using gas (96; 38%). In addition, the results show that 30 (11%) are using coal, while none of them are using wood and paraffin.

5.2.11 Method of access electricity in the household

The respondents were asked to indicate the method they were using to access electricity. This was to ascertain what method participants were accessing their electricity. A list of possible methods of accessing electricity was provided to the respondents to choose from as was applicable to their situations. The results are presented on the figure below.

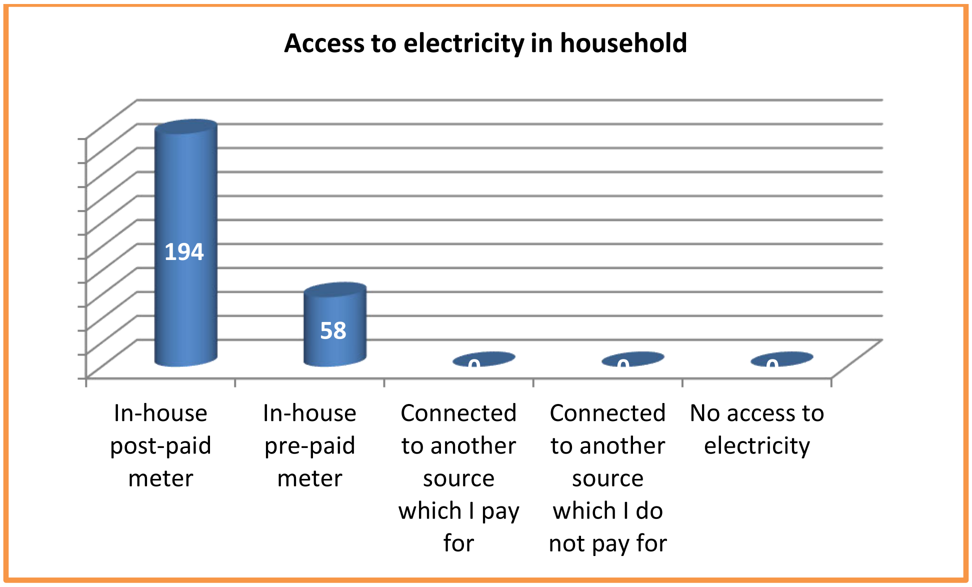


Figure 5.11: Method of access electricity in the household (n = 252)

The data on figure 5.11 demonstrates that the majority of the respondents (194; 77%) were accessing the electricity through an in-house post-paid meter, while 58 (23%) were using an in-house pre-paid meter system. None of the respondents were using other forms of systems to access the electricity.

5.2.12 Type of energy supply

The respondents were asked to indicate their electricity supplier. A list of possible suppliers was provided to the respondents to choose from as was applicable to their situations. The results are summarised below.

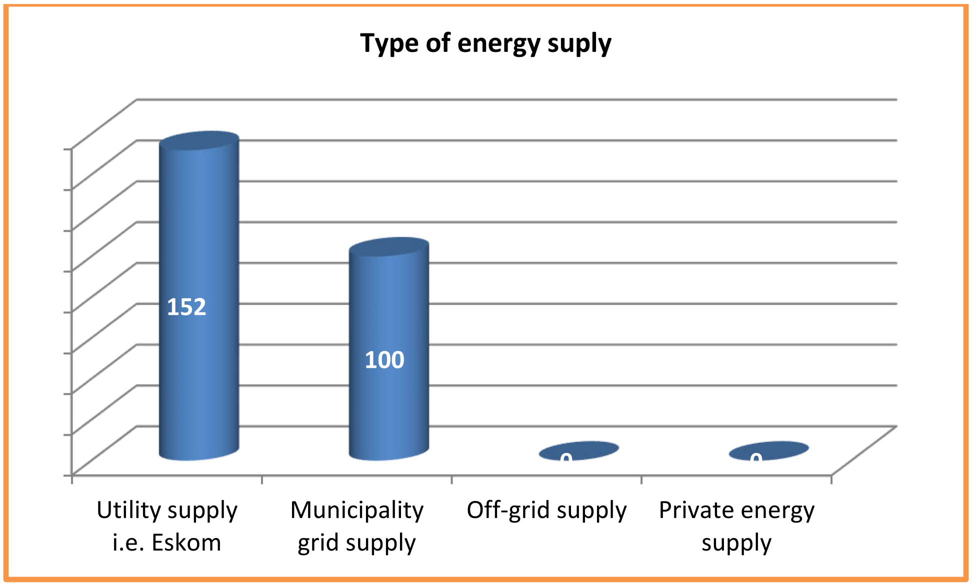


Figure 5.12: Type of energy supply (n = 252)

The results on the figure 5.12 shows that the majority of the respondents (152; 60%) were receiving their electricity from Eskom, while 100 (40%) were receiving electricity from the municipality. In addition, the study found that none of the respondents were receiving the electricity from private energy suppliers, off the grid and other sources.

5.2.13 Average monthly electricity bill

The respondents were asked to indicate the amount of money they were spending on electricity on a monthly basis. This was to ascertain if using solar energy as an option would be cheaper than the cost they were spending on electricity. A list of possible monthly bills was provided for them to choose from as was applicable to their situations. The results are presented on the figure below.

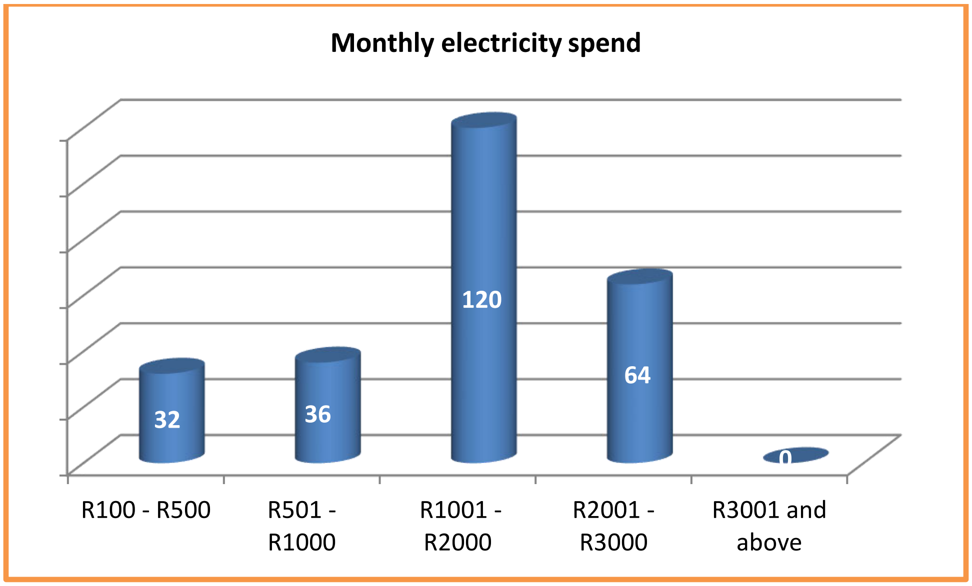


Figure 5.13: Average monthly electricity bill (n = 252)

Data displayed on figure 5.13 shows that the majority of the respondents (120; 48%) were spending R1001 – R2,000 to buy electricity on a monthly basis, followed by those who spent R2001 –R3000 (64; 25%). In addition, the results show that 36 (14%) of the respondents spent R501 – R1000 per month, while 32 (13%) spent as little as R100-R500 on a monthly basis. Moreover, the study found that none of the respondents were spending R3001 and above on electricity.

5.2.14 Money spent on electricity monthly.

The respondents were asked to rate on a Likert scale the amount of money they were spending on electricity on a monthly basis whether it was too high or too low. A Likert scale of far too high through to do not know was used to measure their responses. The figure below summarises the results.

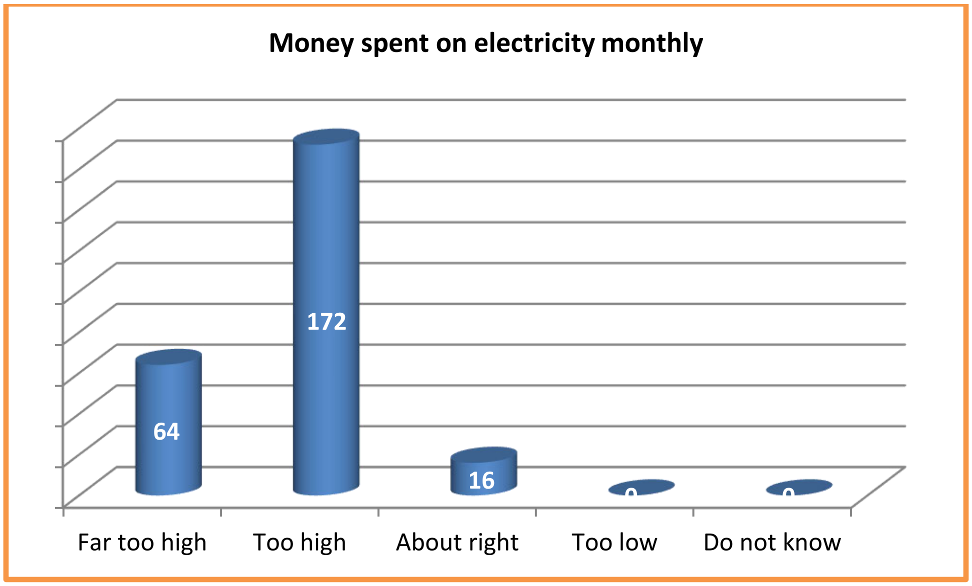


Figure 5.14: Money spent on electricity monthly (n = 252)

The results on the figure 5.14 suggest that the majority of the respondents (172; 68%) felt that they were spending too much money on electricity on a monthly basis, followed by those who said it was far too high (64; 25%). In addition, the study found that only 16 (6%) said it was about right, while none of them said it was too low or did not know.

5.2.15 Level of satisfaction with electricity

The respondents were asked to rate their level of satisfaction with regard to the electricity provision in their households. A Likert scale of very satisfied through very dissatisfied was used to measure their responses. The results are presented on the figure below.

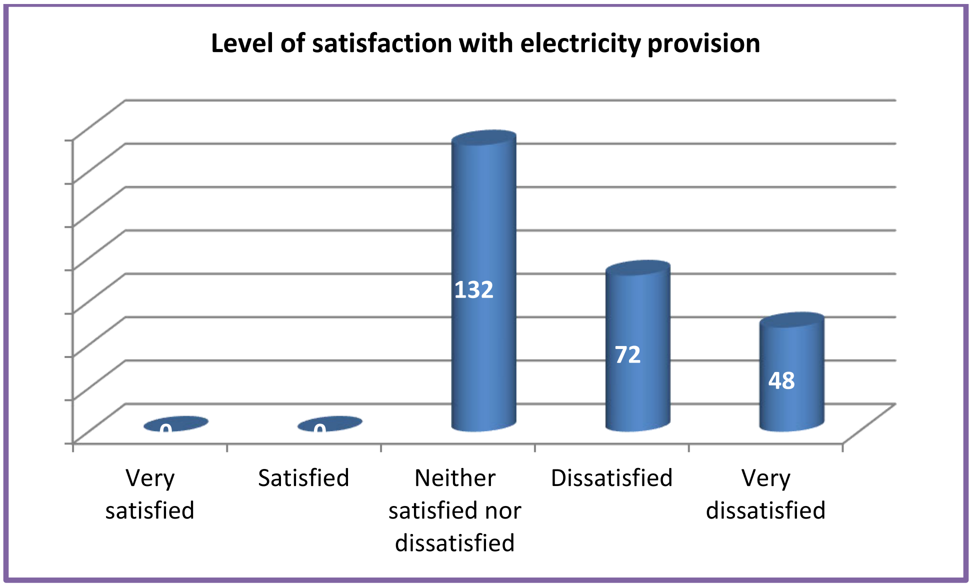


Figure 5.15: Level of satisfaction with electricity (n = 252)

It can be seen on the figure 5.15 above that the majority of the respondents (132; 52%) were neither satisfied nor dissatisfied with the provision of electricity in their households. In addition, the results show that 72 (29%) of the respondents were dissatisfied, while 48 (19%) were very dissatisfied. The results further show that none of the respondents said they were very satisfied and satisfied with the provision of electricity in their households.

5.2.16 Reaction to electricity hike

The respondents were asked to indicate their reaction to the electricity hike that occurs time and again in South Africa. The results are presented on the figure below.

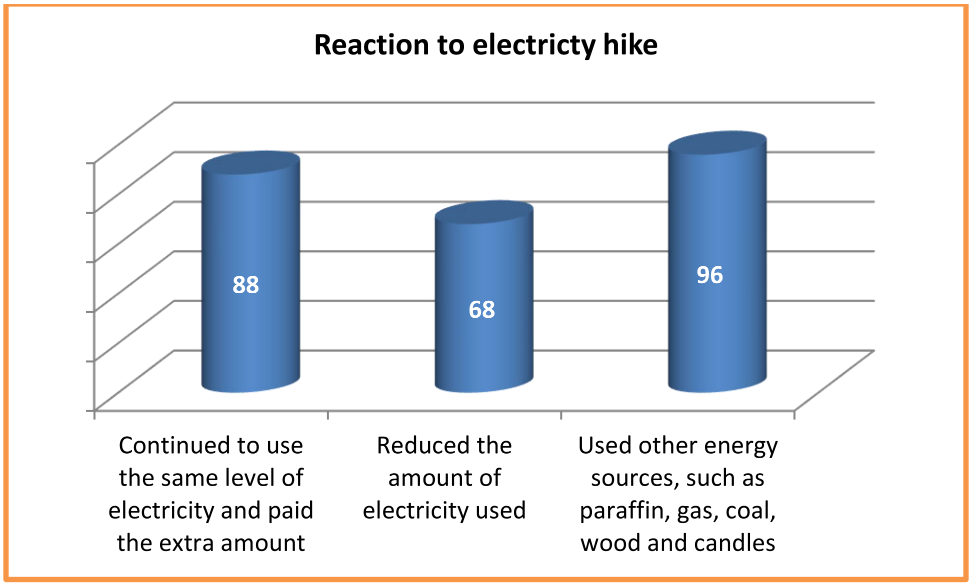


Figure 5.16: Reaction to electricity hike (n = 252)

The figure 5.16 shows that a significant number of the respondents (96; 38%) said they use other energy sources such as paraffin, gas, coal, wood and candles, followed (88; 35%) by those who said they continued to use the same level of electricity and paid extra amount of money. In addition, the figure shows that 68 (27%) said they reduced the amount of the electricity used. Furthermore, none of the respondents used energy-efficient appliances and other sources.

5.2.17 Cut back on spending on electricity.

The respondents were asked to indicate whether in the last 12 months their household had cut back on spending on energy for lighting, cooking or heating in order to make ends meet. A Likert scale of ‘very often’ through to ‘never’ to measure their responses. The figure below presents the results.

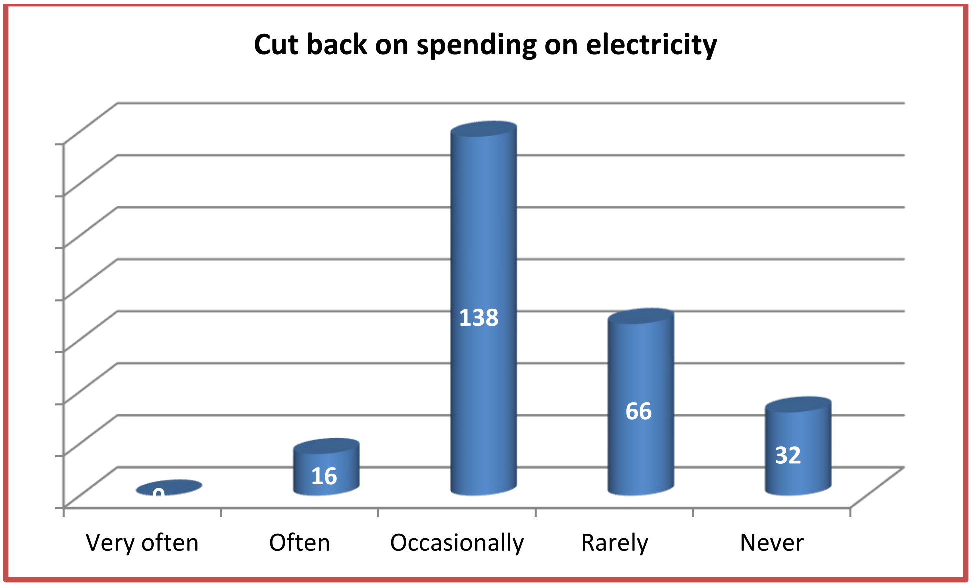


Figure 5.17: Cut back on spending on electricity (n = 252)

The results on the figure 5.17 shows that the majority of the respondents (138; 55%) in the last 12 months in their households they had occasionally cut back on spending on energy for lighting, cooking or heating in order to make ends meet. In addition, the results show that 66 (26%) of the respondents said they rarely cut back on spending, while 32 (13%) said never and 16 (6%) said they often cut back on spending. None of the respondents cut back on spending very often.

5.2.18 Load-shedding in the area

The respondents were asked to indicate whether they experienced load-shedding in their area of residence. A Likert scale of 'very often' through to 'never' was used to measure their responses. The results are presented on the figure below.

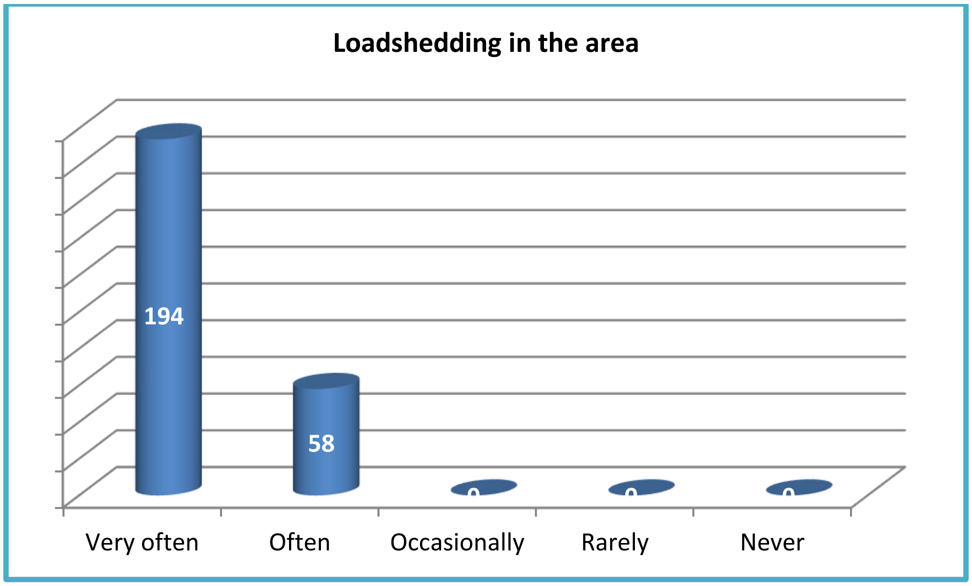


Figure 5.18: Load-shedding in the area (n = 252)

The results on the figure 5.18 demonstrates that the majority of the respondents (194; 77%) said they very often experienced load-shedding in their area of residence. In addition, 58 (23%) said they often experienced load-shedding, while none of the respondents said they never, rarely and occasionally experienced load-shedding in their areas.

5.2.19 Knowledge of renewable energy

The respondents were asked to indicate if they were had knowledge or aware of renewable energy. A binary choice of yes and no was used to measure their responses. The results are presented on the figure below.

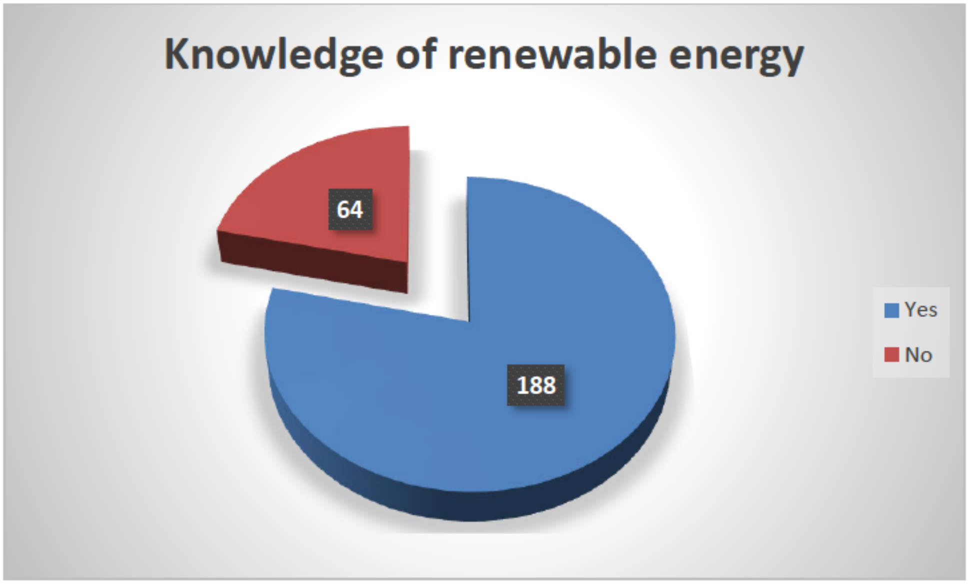


Figure 5.19: Knowledge of renewable energy (n = 252)

The data on figure 5.19 illustrates that majority of the respondents (188; 75%) said they knew about renewable energy, while only 64 (25%) said they were not aware of renewable energy.

5.2.20 Renewable energy on electricity bill reduction

The respondents were asked to indicate their perceptions on whether renewable energy can play a significant role in reducing the electricity bill in households. A Likert scale of 'strongly agree' through to 'strongly disagree' was used to measure their responses. The results are presented on the figure below.

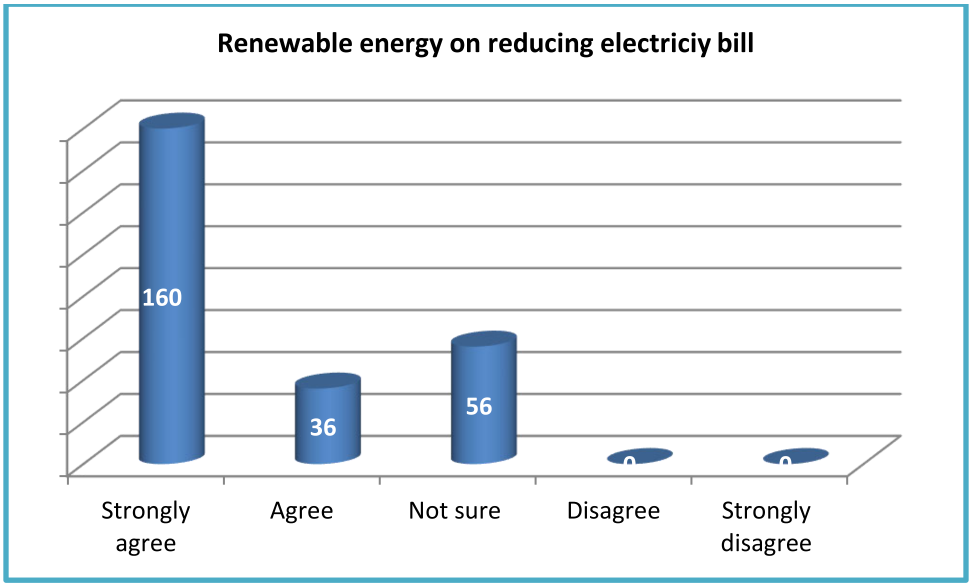


Figure 5.20: Renewable energy on electricity bill reduction (n = 252)

The results on the figure 5.20 shows that majority of the respondents (160; 63%) strongly agreed that renewable energy does reduce the electricity bill in the households. In addition, the results show that 36 (14%) agreed, while 56 (22%) were not sure. Notable, none of the respondents disagreed or strongly disagreed with the statement.

5.2.21 Already using renewable energy.

The respondents were asked to indicate if they were already using the renewable energy in the households. A binary choice of yes and no was used to measure their responses. The results are presented on the figure below.

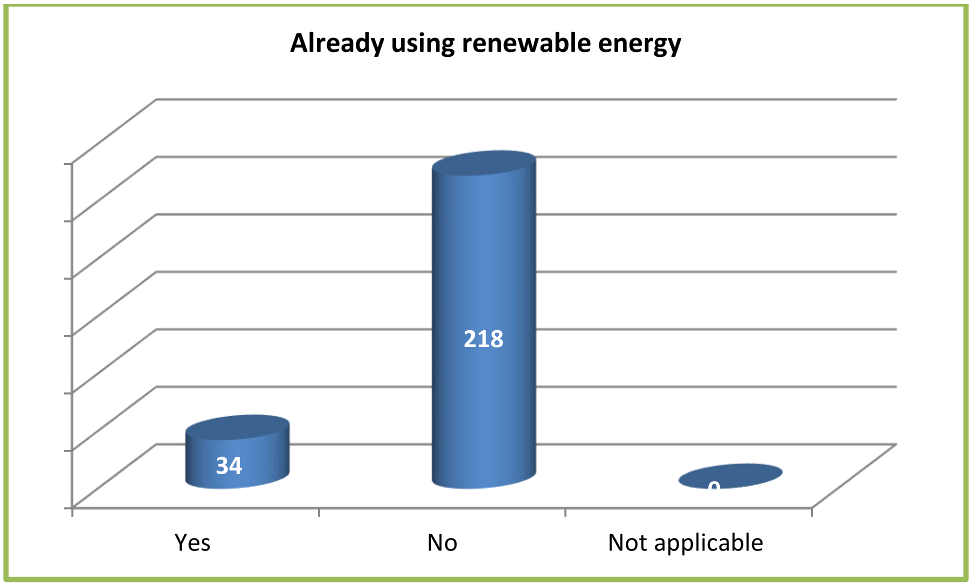


Figure 5.21: Already using renewable energy (n = 252)

The results on figure 5.21 indicates that the majority of the respondents (218; 87%) said they were not using renewable energy, while only 34 (13%) said they were already using renewable energy in the households.

5.2.22 Period spent using renewable energy.

The respondents were asked to indicate the period in which they have been using renewable energy. A list of possible years was provided to the respondents to choose from as was applicable to their situation. The results are presented on the figure below.

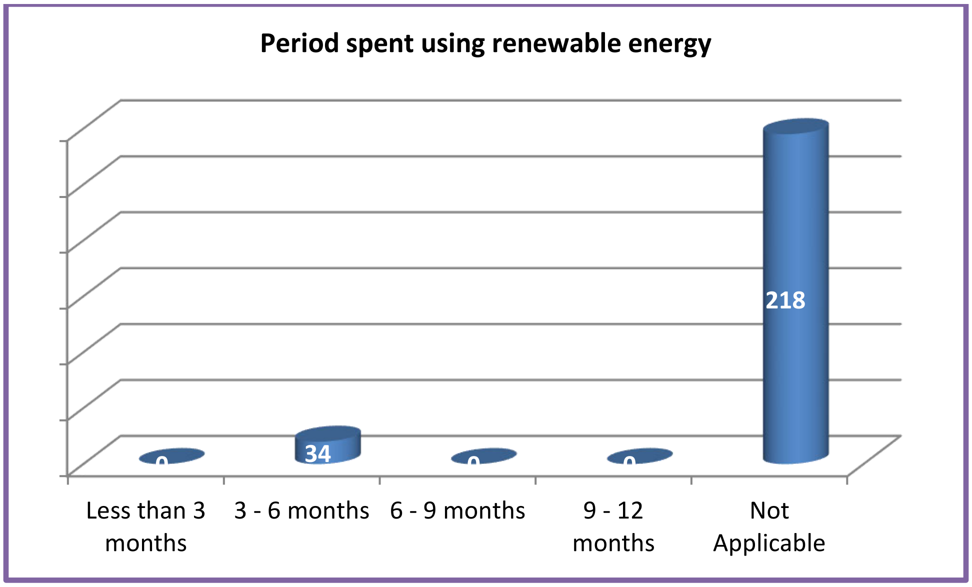


Figure 5.22: Period spent using renewable energy (n = 252)

The results on the figure 5.22 shows that the majority of the respondents (218; 87%) indicated that the statement was not applicable to them. This means that they were not using any renewable energy technologies. In addition, the figure 5.22 depicts that 34 (13%) of the respondents had spent 3-6 months using renewable energy. Furthermore, figure 5.22 shows that none of the respondents had used renewable energy for more than 6 months.

5.2.23 Level of satisfaction with the use of renewable energy

The respondents were asked to indicate their level of satisfaction when it comes to the use of renewable energy. A Likert scale of 'very satisfied' through to 'very dissatisfied' was used to measure their responses as was applicable to their situations. The results are presented on the figure below.

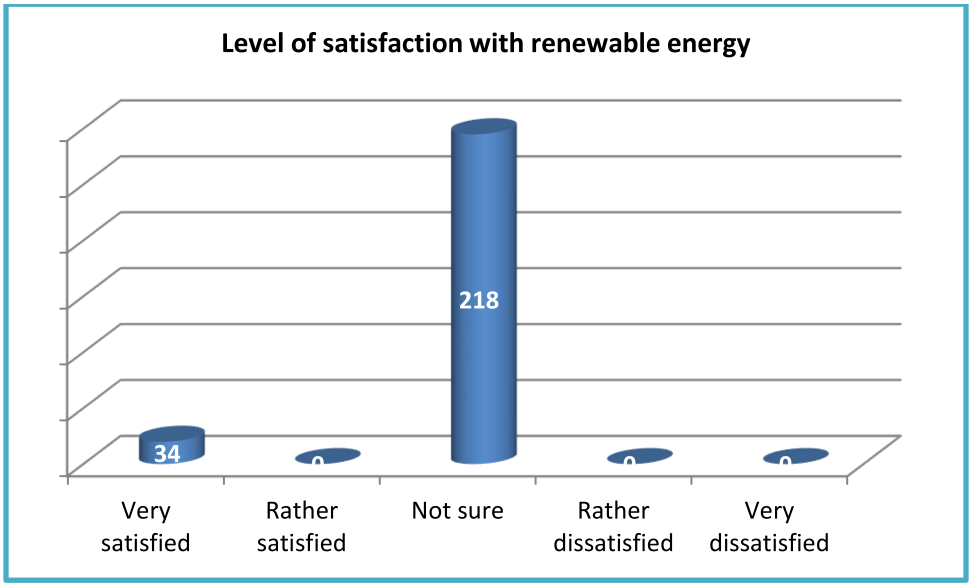


Figure 5.23: Level of satisfaction with the use of renewable energy (n = 252)

It can be seen on the figure 5.23 above that the majority of the respondents (218; 87%) were not sure of their satisfaction level with the renewable energy. In addition, the results show that 34 (13%) of the respondents were very satisfied with using renewable energy. Moreover, the figure depicts that none of the respondents revealed that they were rather satisfied, rather dissatisfied, or very dissatisfied with their level of satisfaction with renewable energy.

5.2.24 Reasons for not using renewable energy.

The respondents were asked to indicate their reasons for not using renewable energy. A list of possible reasons and/or factors to the obstacles of using renewable energy were provided to the respondents to choose from was applicable to their situations. The results are presented on the figure below.

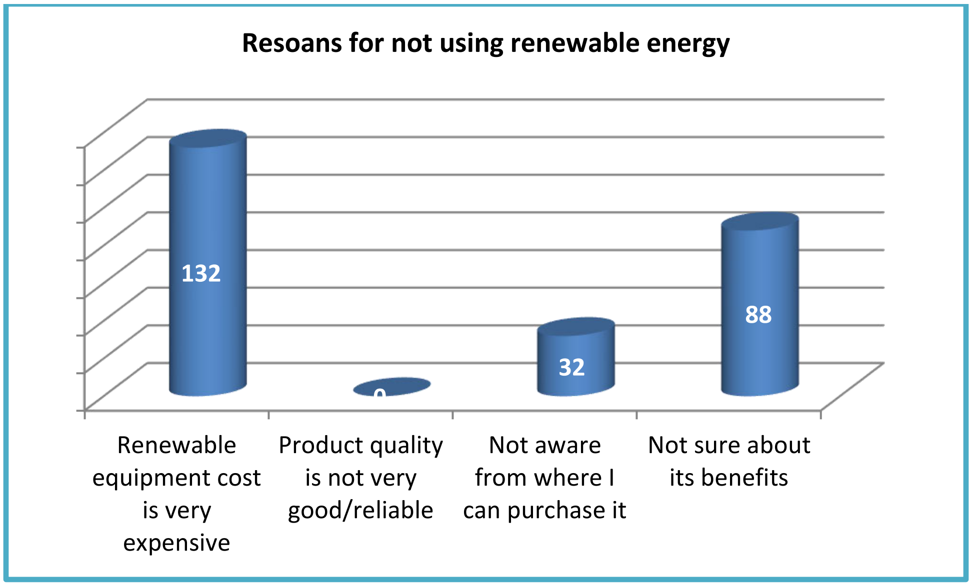


Figure 5.24: Reasons for not using renewable energy (n = 252)

It can be seen on the figure 5.24 above that a significant number of the respondents (132; 52%) indicated that the reason they not using renewable energy is because renewable equipment is very expensive. In addition, the results show that 88 (35%) it is because they were not sure of the benefits, while only 32 (13%) said they were not aware of the place where they can purchase it. None of the respondents indicated that product quality is not very good / reliable.

5.2.25 Renewable energy on household economic growth

The respondents were asked to indicate if they believe that affordable renewable energy technologies will promote better standard of living in a household. A Likert scale of 'strongly agree' through to 'strongly disagree' was used to measure their responses. The results are presented on the figure below.

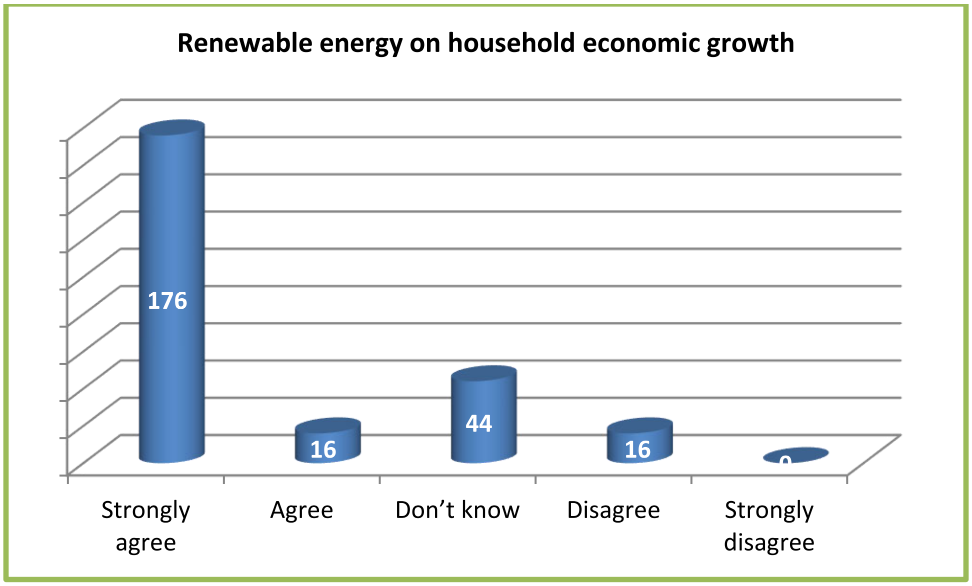


Figure 5.25: Renewable energy on household economic growth (n = 252)

The results on the figure 5.25 shows that the majority of the respondents (176; 70%) strongly agreed that they believe that affordable renewable energy technologies will promote better standard of living in their household. In addition, the results show that 44 (17%) of the respondents said they do not know, while 16 (6%) disagreed, and other 16 (6%) agreed. Moreover, the results show that none of the respondents strongly disagreed.

5.2.26 Knowledge of climate change

The respondents were asked to indicate if they had knowledge of climate change, meaning whether they knew what it is all about. A binary choice of 'yes' and 'no' was used to measure their responses. The results are presented on the figure below.

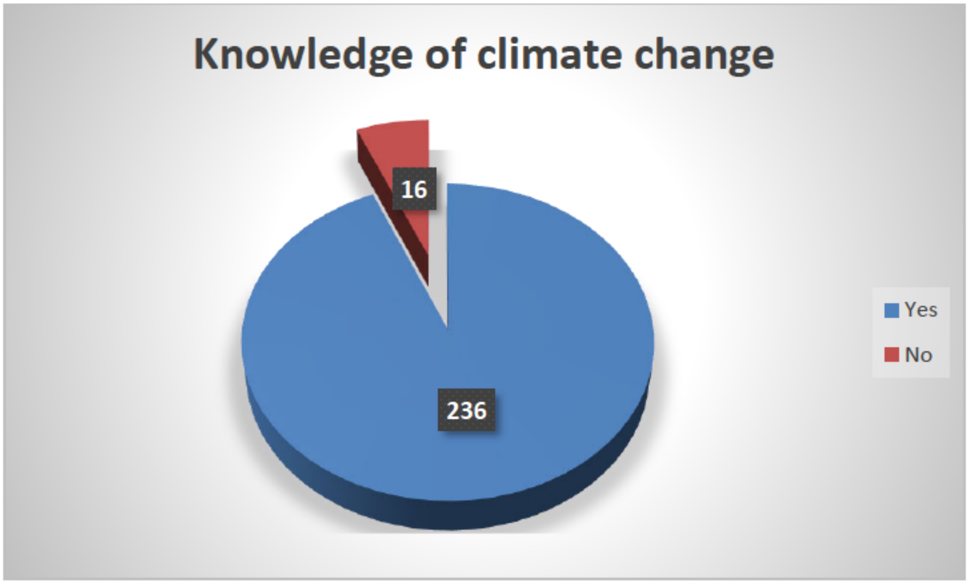


Figure 5.26: Knowledge of climate change (n = 252)

The data on figure 5.26 shows that majority of the respondents (236; 94%) said they had knowledge of climate change, meaning that they knew what it is all about. In addition, the figure depicts that only 16 (6%) of the respondents had no knowledge of climate change.

5.2.27 Importance of global warming

The respondents were asked to indicate how important is the issue of global warming to them. A Likert scale of much less important than other issues through much more important than other issues was used to measure their responses. The results are presented on figure 5.27 below.

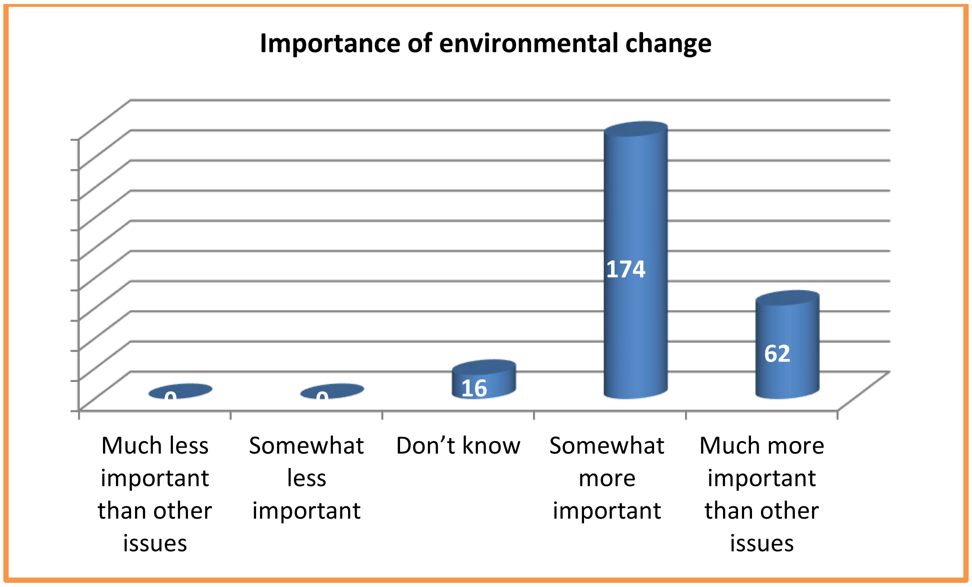


Figure 5.27: Importance of global warming (n = 252)

The results on the figure 5.27 shows that the majority of the respondents (174; 69%) said the issue of global warming was somewhat more important to them. In addition, the figure depicts that 62 (25%) of the respondents said global warming issues are much more important than other issues, while only 16 (6%) said they have no idea. Notably, none of the respondents said global warming issues are much less important to them.

5.2.28 Climate change impact on quality of life

The respondents were asked to indicate if environmental change / climate change will have direct negative effect on quality of life. A Likert scale of 'strongly agree' through 'strongly disagree' was used to measure their responses. The results are presented on the figure below.

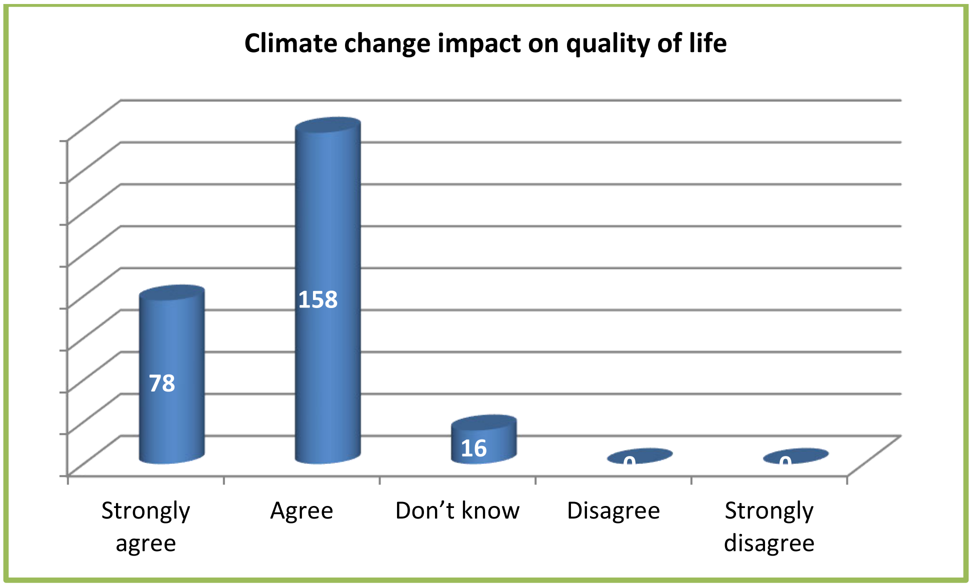


Figure 5.28: Climate change impact on quality of life (n = 252)

It can be seen on the figure 5.28, that majority of the respondents (158; 63%) agreed that environmental change / climate change will have direct negative effect on quality of life. In addition, 78 (31%) of the respondents strongly agreed, while 16 (6%) indicated they do not know. Furthermore, the results demonstrated that none of the respondents disagreed.

5.2.29 Individual and climate change adaptation

The respondents were asked to indicate their view with regard to every individual doing something to adapt to environmental change. A Likert scale of 'strongly agree' through to 'strongly disagree' was used to measure their responses. The results are presented on the figure below.

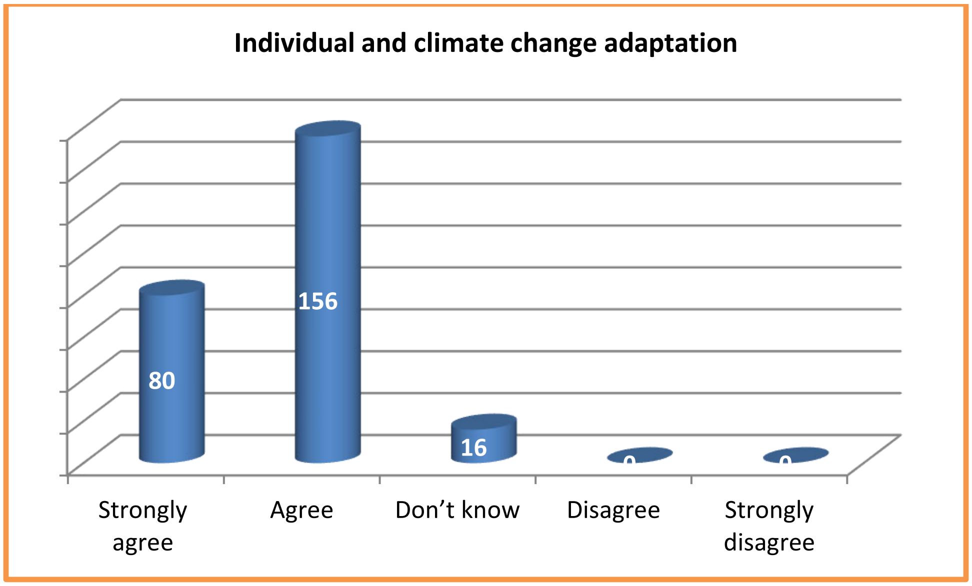


Figure 5.29: Individual and climate change adaptation (n = 252)

The results on figure 5.29 shows that the majority of the respondents (156; 62%) agreed that every individual has to do something to adapt to environmental change. In addition, the result on the figure 5.29 depicts that 80 (32%) of the respondents strongly agreed, while only 16 (6%) did not know. Notably, the results show that none of the respondents disagreed.

5.2.30 Grid energy supply effect on climate change

The respondents were required to indicate their perception on whether the grid energy supply has a direct negative effect on climate change. A Likert scale of 'strongly agree' through to 'strongly disagree' was used to measure their responses. The results are presented on figure below.

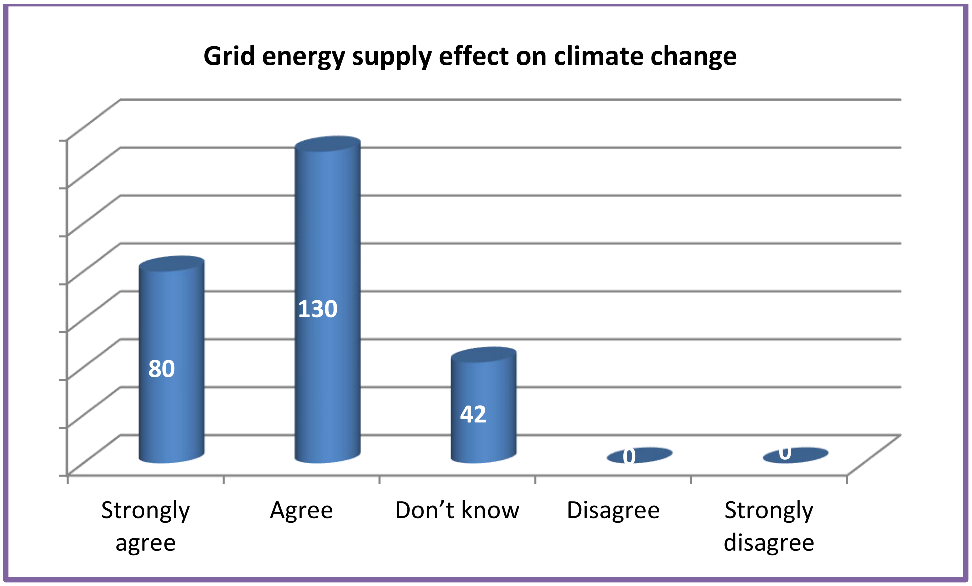


Figure 5.30: Grid energy supply effect on climate change (n = 252)

The results on the figure 5.30 shows that the majority of the respondents (130; 52%) strongly agreed that the grid energy supply has a direct negative effect on climate change. In addition, the results show that 80 (32%) of the respondents strongly agreed, while 42 (17%) said they have no idea. Furthermore, the results show that none of the respondents disagreed and strongly disagreed.

5.2.31 SA Government campaigns on saving environment.

The respondents were asked to indicate whether the South African government should spend money on campaigns to encourage people to save the environment. A Likert scale of 'strongly agree' through to 'strongly disagree' was used to measure their responses. The figure below summarises the results.

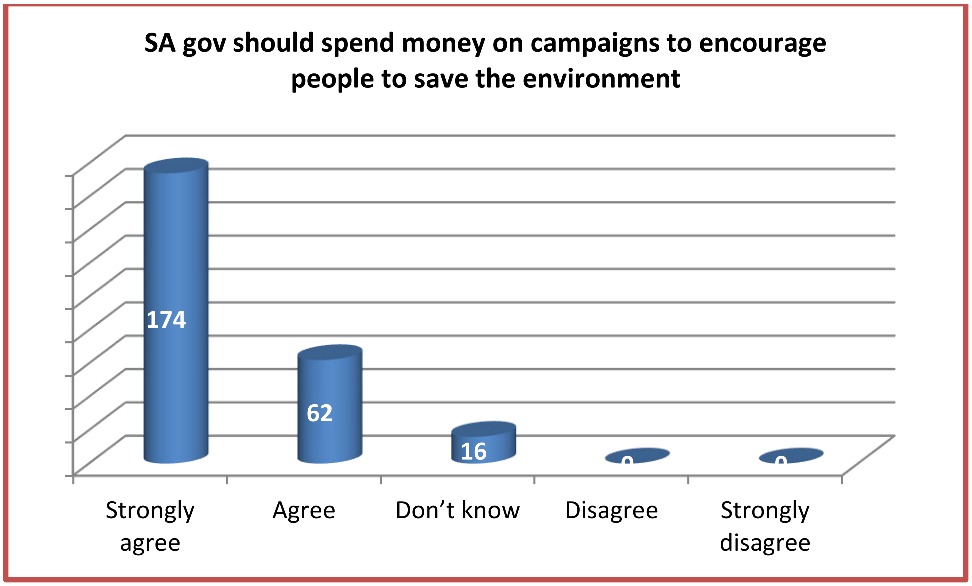


Figure 5.31: SA Government campaigns on saving environment (n = 252)

It can be seen on figure 5.31 that the majority of the respondents (174; 69%) strongly agreed that the South African government should spend money on campaigns to encourage people to save the environment. In addition, the results on the figure above show that 62 (25%) agreed, while only 16 (6%) indicated they have no idea. Notably, none of the respondents disagreed and strongly disagreed.

5.2.32 Renewable energy in saving environment.

The respondents were asked to indicate whether clean and cheap renewable energy supply can help to save the environment. A Likert scale of strongly agree through 'strongly disagree' to establish if the use of renewable energy can help to save the environment was used to measure their responses. The results are presented on the figure below.

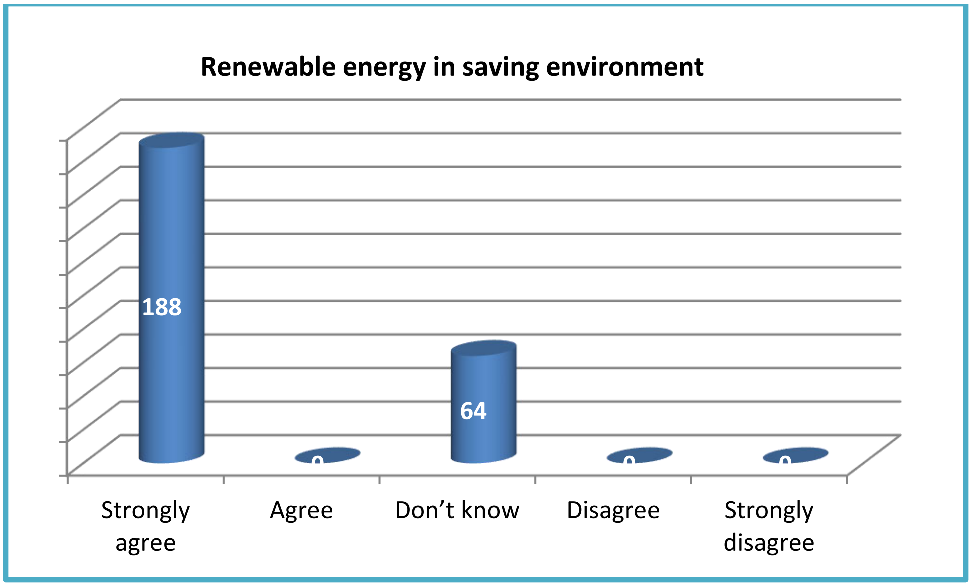


Figure 5.32: Renewable energy in saving environment (n = 252)

The results on the figure 5.32 illustrates that most respondents (188; 75%) strongly agreed that clean and cheap renewable energy supply can help to save the environment. In addition, the figure 5.32 further shows that 64 (25%) said they do not know whether clean and cheap renewable energy supply can help to save the environment. Furthermore, the results show that none of the respondents agreed, disagreed, and strongly disagreed.

5.2.33 Cost effectiveness of renewable energy

The respondents were asked to indicate what they thought of the affordability of the present sources of renewable energy. A list of possible answers was provided to them to choose from as was applicable to their situations. The results are presented on the figure below.

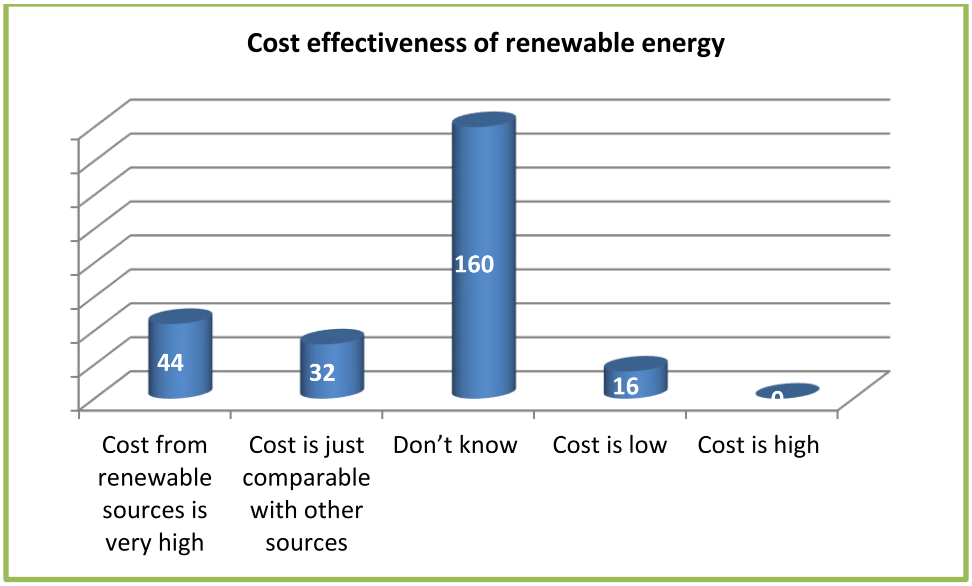


Figure 5.33: Cost effectiveness of renewable energy (n = 252)

It can be seen on figure 5.33 that the majority of the respondents (160; 64%) said that they do not know anything about the cost effectiveness of the present sources of renewable energy. In addition, the results on the figure 5.33 further demonstrates that 44 (17%) of the respondents said the cost of renewable sources is very high. Furthermore, the results show that 32 (13%) of the respondents said that cost is just comparable with other sources. Moreover, 16 (6%) of the respondents said that the cost of renewable energy is low, while none of the respondents said the cost is high.

5.2.34 Preferred renewable energy supply

The respondents were asked to indicate types of renewable energy supply they prefer as their source of energy. A list of renewable energies was provided to them to choose from as was applicable to their situations. The results are presented on the figure below.

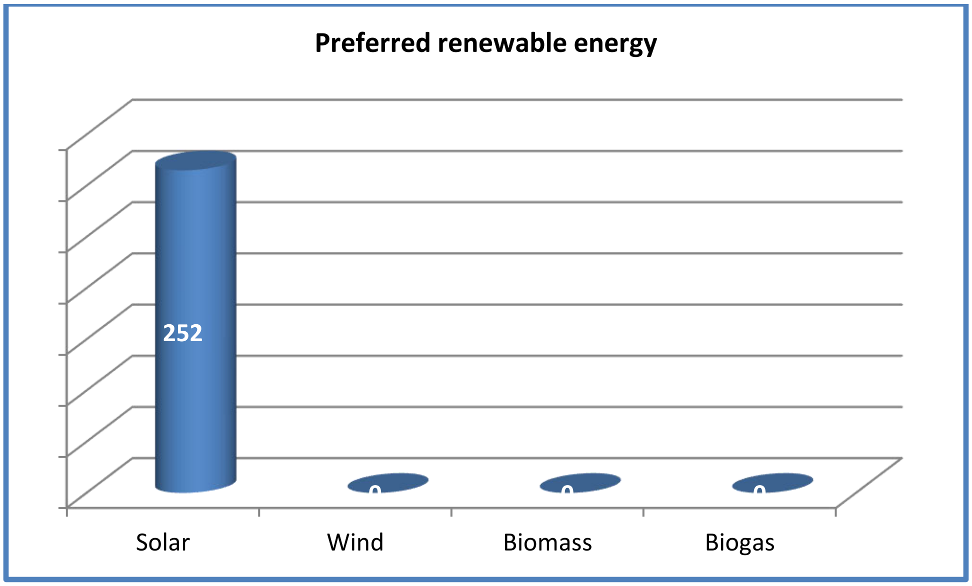


Figure 5.34: Preferred renewable energy supply (n = 252)

It can be seen on the figure 5.34 that all the respondents (252; 100%) said they preferred solar as their source of renewable energy.

5.2.35 Making renewable energy affordable.

The respondents were asked to indicate what should be done to make renewable energy supply more affordable. A list of possible things that can be done to make renewable energy supply more affordable was provided to the respondents to choose from as was applicable to their situation. The results are presented on the figure below.

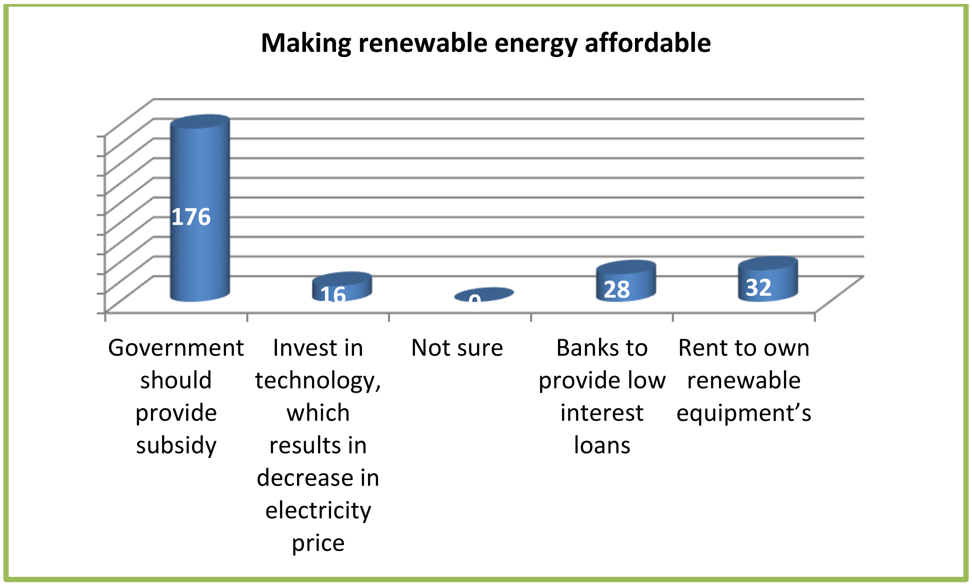


Figure 5.35: Making renewable energy affordable (n = 252)

The results on figure 5.35 shows that the majority of the respondents (176; 70%) said that government should provide subsidy to community who deserve it. In addition, the results on the figure 5.35 shows that 16 (6%) of the respondents said that one needs to invest in technology which results in decrease on the electricity price. Furthermore, 28 (11%) of the respondents suggested that banks should provide low interest loans. Moreover, 32 (13%) of the respondents said that people should be allowed to rent to own renewable equipment. Notably, none of the respondents said were not sure.

5.2.36 Government subsidy of renewable energy

The respondents were asked to indicate whether the South African government should subsidies clean and cheap renewable energy supply. A Likert scale of 'strongly agree' to 'strongly disagree' was used to measure their responses. The results are presented on the figure below.

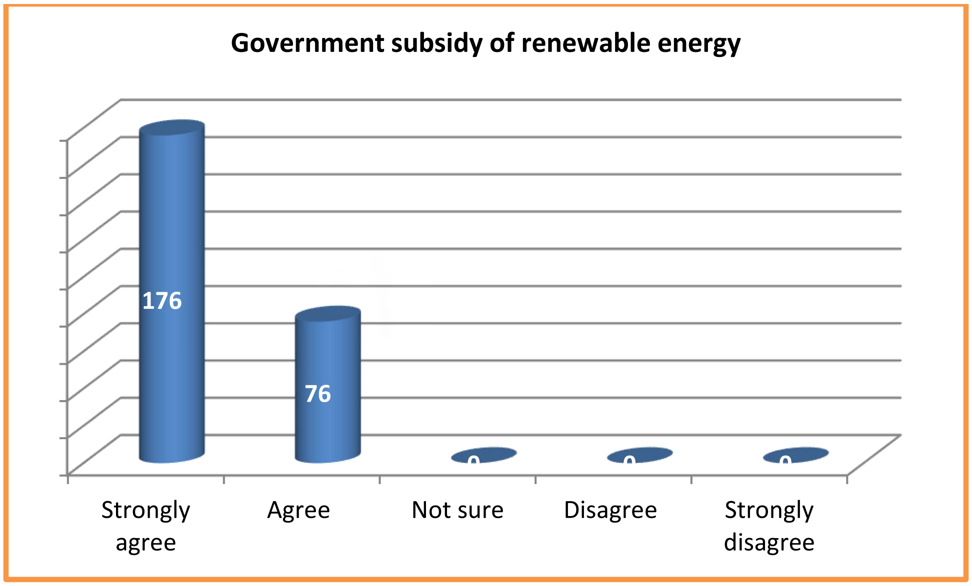


Figure 5.36: Government subsidy of renewable energy (n = 252)

The data on figure 5.36 demonstrates that the majority of the respondents (176; 70%) strongly agreed that the South African government should subsidies clean and cheap renewable energy supply. In addition, the results show that 76 (30%) of the respondents agreed that the South African government should subsidies clean and cheap renewable energy supply. Furthermore, the figure above shows that none of the respondents disagreed, strongly disagreed and not sure.

5.2.37 Government on replacing grid energy with renewable energy.

The respondents were asked to indicate if the South African government should spend money to replace grid energy with clean and cheap renewable energy supply. A Likert scale of ‘strongly agree’ through to ‘strongly disagree’ was used to measure their responses. The figure summarises the results below.

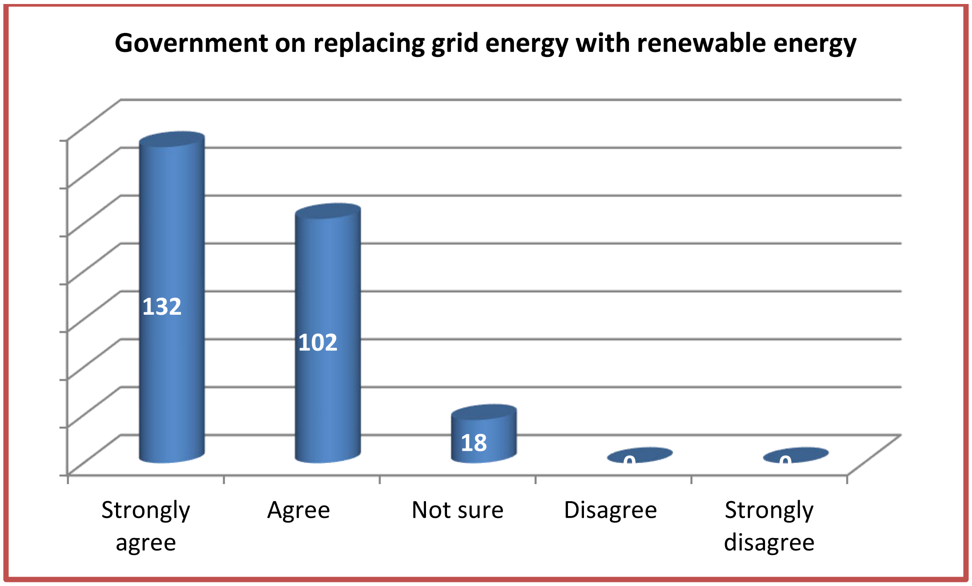


Figure 5.37: Government on replacing grid energy with renewable energy (n = 252)

The results on figure 5.37 above show that the majority of the respondents (132; 52%) strongly agreed that the South African government should spend money to replace grid energy with clean and cheap renewable energy supply. In addition, the results further show that 102 (40%) of the respondents agreed, while 18 (8%) were not sure. In addition, the results show that none of the respondents disagreed and strongly disagreed.

5.2.38 Shifting to off grid renewable energy.

The respondents were asked to indicate if they would be willing to shift to off grid renewable energy supply if a local bank were to provide loans with attractive interest rate in addition to the government subsidy. A Likert scale of ‘strongly agree’ through to ‘strongly disagree’ was used to measure their responses. The results are presented on the figure below.

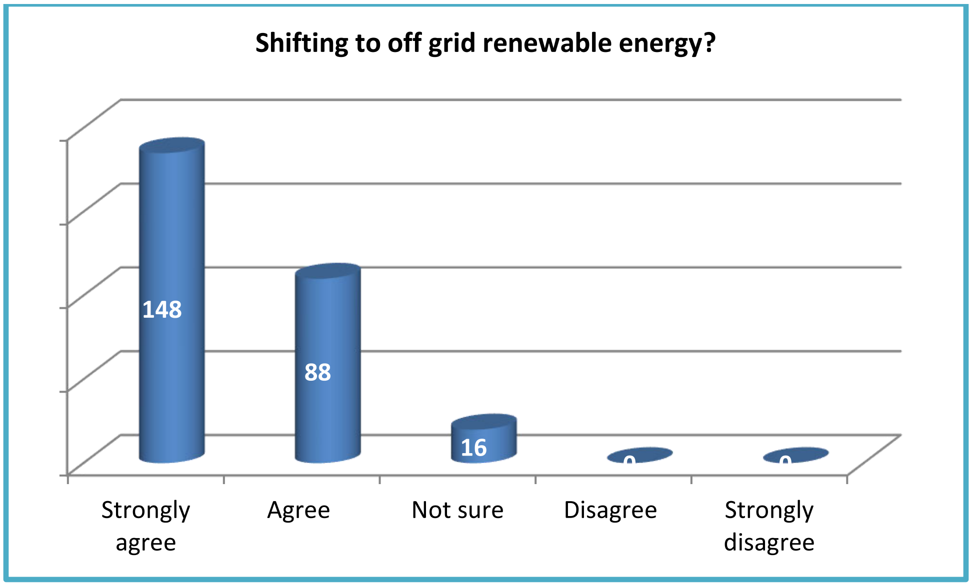


Figure 5.38: Shifting to off grid renewable energy (n = 252)

The results on the figure 5.38 show that majority of the respondents (148; 59%) strongly agreed that they would be willing to shift to off grid renewable energy supply if a local bank were to provide loans with attractive interest rate in addition to the government subsidy. In addition, the results show that 88 (35%) of the respondents agreed, while only16 (6%) said they were not sure. Moreover, the results show that none of the respondents disagreed and strongly disagreed.

5.2.39 Government priority to clean and cheap renewable energy

The respondents were asked to indicate if the South Africa government should give priority to clean and cheap renewable energy in order to meet its future energy needs and demands. A Likert scale of ‘strongly agree’ through to ‘strongly disagree’ was used to measure their responses. The results are presented on the figure below.

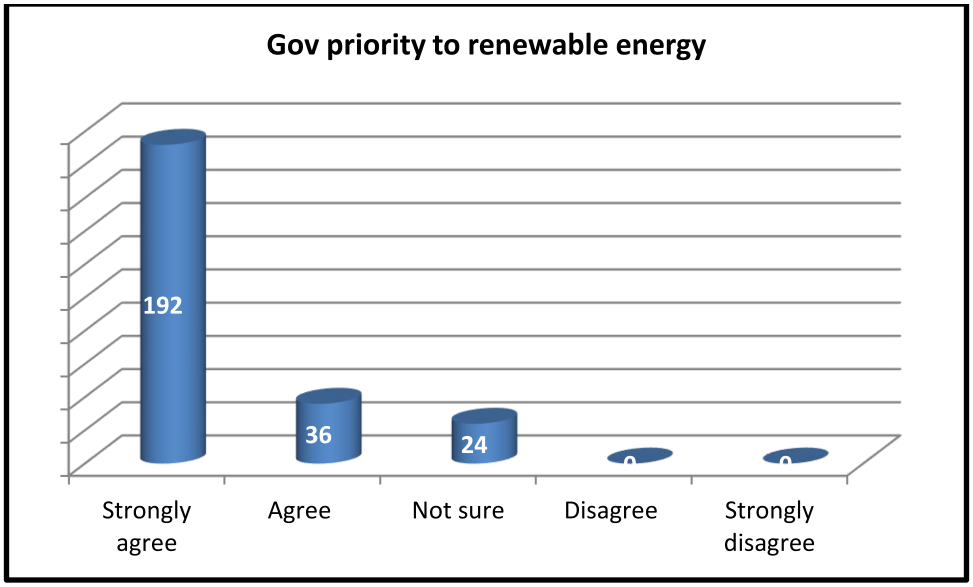


Figure 5:39: Government priority to renewable energy (n = 252)

The data on figure 5.29 demonstrates that the majority of the respondents (192; 76%) strongly agreed that the South Africa government should give priority to clean and cheap renewable energy in order to meet its future energy needs and demands. In addition, the figure depicts that 36 (14%) of the respondents agreed, while 24 (10%) were not sure, and none of the respondents disagreed and strongly disagreed.

5.3. Objectives based hypothesis for quantitative analysis.

In addressing the study`s questions, the quantitative research took on an explanatory purpose with the following null hypotheses (H), whether:

H_1: There is no relationship between access to affordable renewable energy and poverty reduction in urban areas.

H_2: There is no relationship between access to affordable renewable energy and economic growth in urban areas.

H_3: There is no relationship between access to affordable renewable energy and Socio-Economic conditions in urban areas.

H_4: There is no relationship between access to affordable renewable energy and environmental conditions in urban areas.

H_5: There is no relationship between access to affordable renewable energy and trade opportunities in urban areas.

These were meant to address the study`s objectives as follows:

(i) Establish renewable energy practices towards poverty reduction in Soweto.

(ii) Establish if an increase of renewable energy improves energy access, therefore reducing urban poverty architecture, improves socio-economic status and increase economy.

(iii) Identify trade opportunities in green energy power and the renewable energy sector for community sectors.

(iv) Develop a renewable energy framework that will reduce poverty, thereby improving economic growth and better socio-economic status of the people living in the South African townships.

This led to the distribution of a questionnaire to a stratified random sample of 252 respondents based on the calculation for determining the minimum sample size for categorical data (Saunders, Lewis and Thornhill, 2016) as follows:

- First, the study determined the satisfactory boundary of error, say +/- 5% = e%
- Then established the confidence level of 95%
- It settled on the z-value at a 95% confidence level = 1.96
- Assessed the split, for example, a 50/50, as the quantity going to the sample = p%, and those not = q%, to the quantified group.

$n = q\% \times p\% \times (z/e\%)^2$ $n = 50\% \times 50\% \times (1.96/0.05)^2$ $n = 385$

This was altered since the sample size was <10 000 a lesser sample can be used devoid of precision lost, thus:

n^1 = adjusted minimum size sample n = calculation as per formula above N = total sample $n^1 = n/1+(n/N)$

$n^1 = 300 / (1+(300/5201)) = 284$

Grounded on these least returned sample sizes the data normality was distributed as table 5.1 for validity of the study sample.

Name	Mean	Median	Scale min	Scale max	Observed min	Observed max	Standard deviation	Excess kurtosis	Skewness	Cramér-von Mises p-value
Gender	1.493	1.000	1.000	2.000	1.000	2.000	0.500	-2.013	0.028	0.000
Age	3.102	3.000	1.000	5.000	1.000	5.000	1.148	-0.692	-0.131	0.000
Living Condit	1.873	2.000	1.000	4.000	1.000	4.000	1.023	-0.192	0.990	0.000
House Size	2.680	3.000	1.000	4.000	1.000	4.000	0.746	0.017	-0.427	0.000
Family Size	2.433	3.000	1.000	4.000	1.000	4.000	1.207	-1.563	0.025	0.000
Source of Income	1.549	1.000	1.000	4.000	1.000	4.000	0.983	1.756	1.763	0.000
Hsehold Workers	1.239	1.000	1.000	2.000	1.000	2.000	0.427	-0.496	1.228	0.000
Hsehold inco/mth	4.011	5.000	1.000	5.000	1.000	5.000	1.260	0.172	-1.145	0.000
S1Q9	1.250	1.000	1.000	2.000	1.000	2.000	0.433	-0.657	1.161	0.000
S1Q10	4.243	4.000	2.000	5.000	2.000	5.000	0.972	0.816	-1.337	0.000
S2Q11	1.236	1.000	1.000	2.000	1.000	2.000	0.425	-0.439	1.251	0.000
S2Q12	1.394	1.000	1.000	2.000	1.000	2.000	0.489	-1.824	0.435	0.000
S2Q13	2.831	3.000	1.000	4.000	1.000	4.000	0.942	-0.456	-0.597	0.000
S2Q14	1.880	2.000	1.000	4.000	1.000	4.000	0.727	2.732	1.295	0.000
S2Q15	3.655	3.000	3.000	5.000	3.000	5.000	0.783	-1.038	0.693	0.000
S2Q16	2.415	2.000	1.000	4.000	1.000	4.000	1.309	-1.702	0.228	0.000
S2Q17	3.430	3.000	2.000	5.000	2.000	5.000	0.795	-0.274	0.507	0.000
S2Q18	1.229	1.000	1.000	2.000	1.000	2.000	0.420	-0.318	1.298	0.000
S3Q19	1.250	1.000	1.000	2.000	1.000	2.000	0.433	-0.657	1.161	0.000
S3Q20	1.588	1.000	1.000	3.000	1.000	3.000	0.828	-0.952	0.895	0.000
S3Q21	1.856	2.000	1.000	2.000	1.000	2.000	0.351	2.154	-2.035	0.000
S3Q22	4.687	5.000	2.000	5.000	2.000	5.000	0.825	5.027	-2.542	0.000
S3Q23	2.782	3.000	1.000	3.000	1.000	3.000	0.558	4.736	-2.466	0.000
S3Q24	2.310	1.000	1.000	4.000	1.000	4.000	1.385	-1.841	0.199	0.000
S3Q25	1.630	1.000	1.000	4.000	1.000	4.000	1.004	-0.001	1.235	0.000
S4Q26	1.067	1.000	1.000	2.000	1.000	2.000	0.250	10.219	3.485	0.000
S4Q27	4.197	4.000	3.000	5.000	3.000	5.000	0.540	-0.072	0.106	0.000
S4Q28	1.746	2.000	1.000	3.000	1.000	3.000	0.568	-0.426	0.046	0.000
S4Q29	1.754	2.000	1.000	3.000	1.000	3.000	0.565	-0.392	0.027	0.000
S4Q30	1.842	2.000	1.000	3.000	1.000	3.000	0.671	-0.800	0.198	0.000
S4Q31	1.391	1.000	1.000	3.000	1.000	3.000	0.610	0.646	1.314	0.000
S4Q32	1.500	1.000	1.000	3.000	1.000	3.000	0.866	-0.657	1.161	0.000

S5Q33	2.585	3.000	1.000	4.000	1.000	4.000	0.850	-0.301	-0.821	0.000
S5Q34	1.028	1.000	1.000	2.000	1.000	2.000	0.165	31.095	5.734	0.000
S5Q35	1.930	1.000	1.000	5.000	1.000	5.000	1.511	-0.353	1.197	0.000
S5Q36	1.303	1.000	1.000	2.000	1.000	2.000	0.459	-1.264	0.863	0.000
S5Q37	1.479	1.000	1.000	3.000	1.000	3.000	0.619	-0.161	0.931	0.000
S5Q38	1.472	1.000	1.000	3.000	1.000	3.000	0.619	-0.113	0.959	0.000
S5Q39	1.349	1.000	1.000	3.000	1.000	3.000	0.651	1.331	1.652	0.000

Table 5.1: Data normality for the quantitative data

The normalcy of this study`s data, having been assessed with the sign analysis generated the above (table 5.1) results. The mean and standard deviations (Std Dev), along with display variables, excess kurtosis and skewness are displayed in the table for inspection. Out of the total organised measurement model instances, 39 met the validity criteria and these were used for the quantitative analysis. Even though non-normal circulation of data might cast some questions on the outcome of an examination, Boomsma, Hoogland, Cudeck, du Toit, and Sörbom (2001: 14) aimed out that, the concept of typical chance just functions well under functional non-normality. Optimum possibility services are durable to skewness with just little impacts on the specification estimate as well as standard errors (Jaccard and Wan, 1996).

Let it be enough by keeping in mind that the PLS-SEM covariance evaluation, which was used in this research study, does not call for generally dispersed information to execute evaluation (Gefen, Straub and Boudreau, 2000; Henseler, Hubona and Ray, 2016). This as a result removes the outcome of this research from any kind of information misconception or uncertainty. Considering that the regulation of data normality needs kurtosis and skewness to drop within the variety +/- 1.0 (Lomax and Schumacker, 2004), the dataset measurements are given for the interested viewers in table 5.1. The proportion of 1:15 recommended by this study pertaining to sample dimension in connection manifest variables, specifically because of the covariance matrix, once more removes this study from any kind of question due to its sample dimension of n = 252.

5.4 Inferential statistics

According to Mtetwa (2019: 116), tests from inferential analysis are aimed at extending generalisations made from a sample to the entire population from which it was selected. Kuhar (2010) mention that inferential statistics are often used to compare the differences between the treatment groups. Inferential statistics allows the researcher to draw conclusions based on extrapolations and is in that way fundamentally different from descriptive statistics that merely summarize the data that has actually been measured (Chin and Lee, 2008). it uses measurements from the sample of subjects in the experiment to compare the treatment groups and make generalisations about the larger population of subjects (Kuhar, 2010). Inferential statistics were executed to corroborate relationships between the variables of this research and to establish the variances between group means.

5.4.1 Validity and reliability test

The questionnaires' strength in this study is displayed through convergent and also discriminant legitimacy steps (Hair, Sarstedt, Ringle, and Mena, 2012). The convergent credibility was analysed utilising: reliability of the questions, composite consistency of the hypotheses, and variance extracted by the theories (Fornell and Larcker 1981). Discriminant legitimacy was examined by observing at connections amongst the concerns (Fornell and Larcker 1981) in addition to differences and also covariances amongst the hypotheses (Igbaria et al. 1994).

These were done by a method known as confirmatory factor analysis (CFA) to develop whether the commonly approved requirements for reliability as well as sincerity were fulfilled. The examination of reliability is the level to which elements, gauged with a numerous product range, mirror true ratings on the aspects about the error (Aibinu and Al-Lawati, 2010). Through the measurement of internal uniformity, the composite reliability was estimated. To approximate the consistent of the respondents to this study, to the products within the range, composite reliability (CR) was made use of (Shin, 2009). CR uses a retrospective technique of general integrity procedure of a factor in a survey and approximates uniformity of the factor itself together with security as well as equivalence (Suki, 2011). From Table 5.2, all the values of CR and also Cronbach's alpha were above 0.7. This suggests excellent dependability for the variables used in this study (Henseler et al. 2009; Bagozzialso, Yi, 2012).

	Cross Loading	Mean	Std dev	VIF	Cronbach's alpha	CR	AVE
ARE					0.634	0.843	0.729
S3Q19	0.896	0.170	0.329	1.274			
S4Q26	0.809			1.274			
ECON GROWTH		0.000	1.000		0.703	0.723	0.753
S3Q20	1.000			1.000			
ENV COND		0.000	1.000		0.618	0.796	0.566
S4Q28	0.740			**1.222**			
S4Q29	0.727			**1.206**			
S4Q31	0.789			**1.240**			
SOC ECON STATUS		0.000	1.000		0.822	0.890	0.916
S1Q4	0.947			1.951			
S1Q5	0.892			1.951			
TRADE OPP		0.000	1.000		0.724	0.725	0.845
S5Q37	0.813			1.457			
S5Q38	0.796			1.409			
S5Q39	0.799			1.409			
POV REDT		0.000	1.000		0.890	0.734	0.845
S2Q13	1.000			1.000			

Table 5.2: Item loadings, cross-loadings and reliability estimations

The model was again tested for validity. This was done to assess whether it really measured what it was meant to measure (Raykov, 2011), by two processes: convergent validity and discriminate validity. Convergent validity was expected to display the extent to which the pieces of the factor represented the factor. This was achieved through a standardised factor loading of 0.5 and above (Fornell and Larcker, 1981). As seen in Table 5.3 below, values in brackets were higher than 0.5 on their respective factors to provide evidence of acceptable convergence validity. The discriminate validity indicated the extent to which the questionnaires' given factor was truly distinct from other factors (Suki, 2011). According to Fornell and Larcker (1981), to pass this test, the AVE which determines the amount of variance that a factor captures from its measurement items must be greater than the square root of the inter-factor correlations (Fornell and Larcker 1981; Henseler et al. 2009). Once again, table 5.3 shows that the AVE values and the correlations among factors, with the square root of the AVE in bold on the diagonal (values), exceeded the inter-factor correlations. This infer that discriminate validity was acceptable for the current study.

	ARE	ECON GROWTH	ENV COND	POV REDT	SOC ECON STATUS	TRADE OPP
ARE	**0.854**					
ECON GROWTH	0.761	**1.000**				
ENV COND	0.695	0.341	**0.752**			
POV REDT	0.045	0.037	0.032	**1.000**		
SOC ECON STATUS	0.003	0.027	0.008	0.782	**0.920**	
TRADE OPP	0.678	0.368	0.645	-0.007	-0.025	**0.803**

Table 5.3: Fornell-Larcker criterion of validity and reliability test

5.4.2 Heterotrait-monotrait

A new-found measure of discriminant validity test that has proven to be more reliable is that of the Heterotrait-monotrait measure. In other words, a brand-new discovered step of discriminant validity examination that has confirmed to be much more reputable is that of the Heterotrait-monotrait action which keeps that discriminant legitimacy need to be <0.85 among the square origin of the inter-factor relationships when it is calculated. From the examination results given in table 5.4, evidence that this standard was met the exemption of the relationship between the ARE, ECON GROWTH, ENV COND, POV REDT, SOC ECON STATUS and TRADE OPP (0.955) also failed this test. These are highlighted in the table. It is for that matter not doubtful that the factors in the research study questionnaire are absolutely distinct from each other (Henseler et al., 2016).

	ARE	ECON GROWTH	ENV COND	POV REDT	SOC ECON STATUS	TRADE OPP
ARE						
ECON GROWTH	0.918					
ENV COND	1.167	0.433				
POV REDT	0.056	0.037	0.053			
SOC ECON STATUS	0.047	0.034	0.126	0.841		
TRADE OPP	1.057	0.433	0.955	0.016	0.051	

Table 5.4: Heterotrait-monotrait ratio (HTMT) – Matrix

5.4.3 Structural model and the Hypothesis testing

As a rule of thumb, after assessing the validity and reliability of a questionnaire, the next step is to evaluate the fitness of the structural model of a study. This was done with the help of the SmartPLS 4.0 version. The hypothesised theories of the study were modelled as a causal relationship with the endogenous factor and estimated. The variance (R^2) of each dependent factor indicated how well the model fitted the data of the study as R^2 shows the amount of variance in a dependent factor that is explained by a model (Cornell and Berger, 1987). Each of the hypotheses (H_1 to H_5) corresponded with a path on the structural model for the dataset. Therefore, both the R^2 and path coefficients indicated the models` fit (effectiveness) to demonstrate how well the model performed (Hulland, 1999).

This overall fit and explanatory power of the structural model examination, together with the relative strengths of the individual causal path is displayed in figure 5.40 as a proof of the experimental test in the laboratory. A backing for any of the stated hypothesis is determined, by inspecting the sign (+/-) together with the statistical importance of its equivalent link. Figure 5.40 displays the empirical result of testing the deduced hypothesis on the renewable energy framework towards poverty reduction in South African township, as experimented in the laboratory with the SmartPLS structural equation modeling. Table 5.5 shows the summary result of the outcome of the hypothesis test on the nomological net (Figure 5.40).

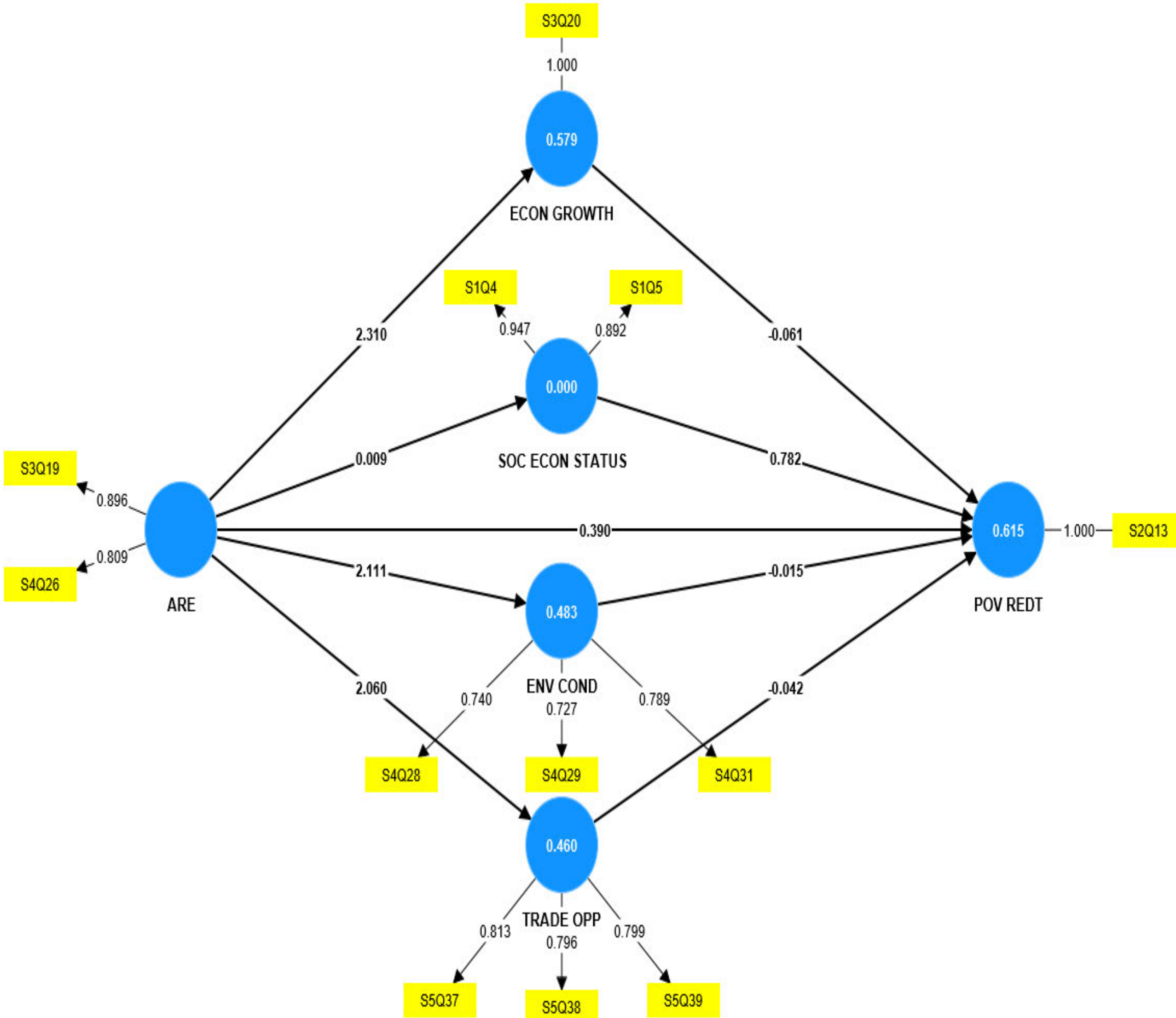


Figure 5.40: Empirical result of testing a renewable energy framework towards poverty reduction in South African township

From Figure 5.40, it could be seen that the effect of affordable renewable energy (ARE) on poverty reduction (POV REDT) through economic growth (ECON GROWTH) was (β= -0.061, p=0.159) which is not significant. Nevertheless, when the same variable was tested directly on the POV REDT, the effect was (β= 0.390, Table 5.5). The negative effect of the ECON GRWOTH is hence to be blamed on this low performance in the former. Similar scenario is seen throughout the model which calls for a careful evaluation of the direct and indirect effects of the ARE policy on POV REDT. Table 5.5 provides a summary of the complete result of hypothesis testing and their statistical importance.

	Original sample (O)	Sample mean (M)	Std deviation (STDEV)	T-statistics (|O/STDEV|)	P-values
ARE -> ECON GROWTH	2.310	2.330	0.142	16.229	0.000***
ARE -> ENV COND	2.111	2.100	0.100	21.082	0.000***
ARE -> POV REDT	0.390	0.401	0.278	1.407	0.159 ns
ARE -> SOC ECON STATUS	0.009	0.012	0.209	0.041	0.968 ns
ARE -> TRADE OPP	2.060	2.050	0.106	19.345	0.000***
ECON GROWTH -> POV REDT	-0.061	-0.065	0.062	0.987	0.324 ns
ENV COND -> POV REDT	-0.015	-0.013	0.058	0.257	0.797 ns
SOC ECON STATUS -> POV REDT	0.782	0.783	0.022	36.231	0.000***
TRADE OPP -> POV REDT	-0.042	-0.042	0.064	0.659	0.510 ns

Note: SE (standard error), ns (not significant), *p<0.05, **p<0.01, ***p<0.001 (two-tailed t-tests)

Table 5.5: Summary of the result of hypothesis testing - Path coefficients, Mean, STDEV, T-values, p-values

As expected, the effect of ARE on the dependent variables were in the hypothesised paths were significant at various levels, and insignificant at others due to the presence of mediating factors.

5.4.4 Correlations matrix analysis

Connection coefficients are made use of in scientific research to evaluate the level of organisation between two variables, elements, or information collections. It is an analytical action of the power of a straight partnership between two variables. Its values can vary from -1 to 1. A connection coefficient of -1 defines an ideal unfavorable or inverted, relationship, with values in one collection increasing as those in the various other decreases, and vice versa. A coefficient of 1 reveals an ideal favourable relationship, or a straight correlation. A relationship coefficient of 0 stands for a zero straight connection.

From the current study, The ARE variable perfectly and positively correlates with itself and positively with ECON GROWTH (0.761), ENV COND (0.695), POV REDT (0.045), SOC ECON STATUS (0.003), and TRADE OPP (0.678). There is no negative correlation with this variable and any other variable. Thus, the policy of the affordable renewable energy is a viable venture which must be encouraged. Table 5.6 summarises the outcome of the correlation matrix for this study.

	ARE	ECON GROWTH	ENV COND	POV REDT	SOC ECON STATUS	TRADE OPP
ARE	**1.000**	0.761	0.695	0.045	0.003	0.678
ECON GROWTH	0.761	**1.000**	0.341	0.037	0.027	0.368
ENV COND	0.695	0.341	**1.000**	0.032	0.008	0.645
POV REDT	0.045	0.037	0.032	**1.000**	0.782	-0.007
SOC ECON STATUS	0.003	0.027	0.008	0.782	**1.000**	-0.025
TRADE OPP	0.678	0.368	0.645	-0.007	-0.025	**1.000**

Table 5.6: Correlation's matrix

5.4.5 Goodness of fit evaluates.

The benefits of fit reviewed the disparity in between the empirical connection matrix as well as the model-implied connection matrix: the lower the values of this action, the better the fit between the suggested model and the information (Bollen and Long, 1993). Generally, the standardised root mean residual (SRMR) value must be less than 0.080 for the suggested version and the data (Bollen and Long, 1993).

From the table 5.7, the standardised root mean residual (SRMR) is the standard distinction between the observed covariance as well as the forecasted covariance. A value of absolutely no shows (0) indicates best fit, and when it comes to bigger sample dimensions a value less than 0.08 is thought about as a great fit (Bollen and Long, 1993). As shown in table 5.7, this was not the case with the current study because the data size was less than 500 (Ullman, 2001). However, both the Squared

Euclidean Range (d_ULS) and the geodesic range (d_G) were all much less than absolutely zero to back the model.

For models with between 75 and 200 situations, the Chi-square examination is a practical procedure. The Chi-square examination is impacted by the dimension of the connections in the design, where the bigger the relationship the poorer the fit. The situations in the present research study were less than 500 for the data; for this reason the values seen in the Table 5.7 are not encouraging. The normed fit index (NFI) specifies the void design as a model in which every one of the connections or covariance are absolutely zero. A value between 0.90 and 0.95 serves, and over 0.95 is excellent. NFI values listed below 0.80 show a requirement to re-specify the model. This can, however, be impacted by a little sample dimension (Ullman, 2001). Because the design's fit of SRMR, d_ULS and d_G (one of the most vital ones) are all within the appropriate array, given the size of the data for this quantitative analysis, the design must be thought about as an excellent suitable for the information gathered (Benitez-Amado, Henseler and Castillo, 2017).

	Saturated model	Estimated model
SRMR	0.109	1.479
d_ULS	0.931	170.713
d_G	0.591	n/a
Chi-square	794.543	1494.575
NFI	0.585	0.220

Table 5.7: Mode Fit summary

From table 5.5, hypotheses 1, 2 and 4 turned out to be statistically insignificant as follows: H_1: ARE -> SOC ECON STATUS (0.968^{ns}), H_2: ECON GROWTH -> POV REDT (0.324^{ns}) and H_4: ENV COND -> POV REDT (0.797^{ns}). This prompted the study to further investigate these with interviews and qualitative analysis as the literature shows that there could be positive correlations between them.

5.5 QUALITATIVE DATA ANALYSIS

Qualitative data analysis conducted in this study assisted as a basis for ensuring that the qualitative data collected through the interview procedure or schedule were systematised and thematically organised to institute part of the collective data and triangulated with the quantitative data collected through the questionnaire. The study utilised a quota sample of fifteen (15) participants made up of (5) industry experts and 10 Soweto families for an in-depth qualitative analysis. The ensuing questions were asked: First, to ten (10) Soweto residents for their general comments, then, to five (5) industry experts to get their views as energy experts.

The interview questions and responses from 10 Soweto families were as follows:

1. Who is the electricity provider in the neighbourhood and how are you connected?

Some of the following responses emerged from the participants in the interviews when the question about electricity service provider in the neighbourhood was asked:

> *R2F1: Our electricity pre-paid meter is supplied by Eskom.*
> *R3F1: Eskom prepaid meter supplied in our neighbourhood.*
> *R5F1: Our home is with City Power, and we have a prepaid meter install.*
> *R9F1: We have a pre-paid from City Power*

It is noted that majority of the participants (9 of 10) interviewed were using pre-paid meters and only 1 of 10 had a post-paid meter installed. In additional, all residents were part of the interview, were connected to the grid source. Furthermore, (5 of 10) of the participants that were interviewed were receiving their electricity from Eskom and another (5 of 10) received from City Power which is the utility service provider for City of Johannesburg metro Municipality.

2. In your opinion, do you believe the quality of electricity supply in the neighbourhood is good?

When the question about quality of electricity supply was asked during interviews, some of the following responses were recorded:

> *R1F2: The quality of electricity supply is very bad; we are having constant power cuts in our neighbourhood.*
>
> *R4F2: We were without electricity supply in our street for almost 2 weeks which shows the type of supply quality.*
>
> *R5F2: Quality of electricity supply in our township is bad.*
>
> *R7F2: I cannot even explain how bad quality of electricity supply in this country.*

All participants (10) who participated in the interviews were not satisfied with quality of electricity supply in their neighbourhood. It has been established from the interviews that community members are extremely unhappy with the quality of electricity supply. One of the participants (*R6F2)* mentioned that *…Electricity quality supply in South Africa is terrible in all areas of the country….* This is the clear indication of poor service provided by Eskom as the only utility provider of electricity in South Africa.

3. Do you believe that the price paid for electricity in your neighbourhood is fair?

When participants in the interviews were asked about the fairness of electricity price they are paying, some of the following comments were captured:

> *R1F3: For a small size of our home, the price we are paying for electricity is very high.*
>
> *R8F3: Electricity price in South Africa is supposed to be cheap but it is not.*
>
> *R10F3: We are continuing to be poor because of expensive electricity.*

All participants (10) who were interview, agreed that the price paid for electricity in South Africa is very high. One of the participants (*R9F3*) mentioned that *…Current government promised us* *free electricity for all, but we are getting opposite of that….* This high cost of electricity requires government interventions. Consumers of electricity in South Africa are becoming poorer as a result of ever-increasing cost of electricity.

4. What did your household do as a result of the increase in electricity prices in the last 12 months?

During interviews, participants were asked about what they did in their households in order to survive the electricity price increase. Some of the responses were as follows:

> *R1F4: Electricity rate has ever been increasing as a result, we have to reduce money to buy food in order to manage our electricity bill.*
> *R10F4: We replaced our lights with energy saving lights and also change some of the appliances to energy saving appliances.*
> *R9F4: We had to cut on spending money eating out so that we can keep our lights on all the time.*

The participants had some creative ideas to survive electricity price increases. These ideas are ranging from changing to energy saving appliances, change to gas stoves, replaces geyser with solar geyser and changing all light bulbs to energy saver bulbs. One of the family, indicated that they had to reduce money for buying food, in order to keep the lights on and be able to pay their electricity bill. Some families remain in poverty because of the ever-increasing electricity bills in South Africa.

5. In your area, how often have you experience electricity cut-off because of either load shedding, power cut or equipment failure?

The participants were asked about how often they are experiencing power cut-off as a result of load shedding, power cut or equipment failure. Some of the following feedback were recorded:

R1F5: Load shedding is very bad in our neighbourhood. We are experiencing power cuts at least 3 to 4 times a week.

R4F5: The entire street in our neighbourhood was without electricity for almost 2 weeks due to cable theft which happened during loadshedding.

R5F5: Depending on the stage of loadshedding as scheduled by Eskom, we are without power 2 - 4 times a day.

There is a serious challenge with electricity cut-offs in South Africa. Many times, this is caused by the load shedding crisis faced by many South African societies / communities. One of the participants (*R9F5*) added: *…We had a transformer catching fire and it took 2 weeks for City Power to replace and get us back on….* Load shedding is further causing many electricity equipment's failures.

6. How have power cuts / load shedding impacted or affected your normal life?

The participants in the interviews were asked about the impact of load shedding / power cuts in their normal life. Some of the following responses were captured from the interviews.

R3F6: Our fridge broke down due to loadshedding. When power came back after loadshedding, our home fridge did not switch back on

R2F6: We have a small family food business in the township and loadshedding has led to our family business having to let go of 3 workers because we are losing productive due to loadshedding and if continue like this, we will eventually close down our family business.

R1F6: The continuous power cuts as a result of loadshedding has had bad negative impact in our normal life. When power came back, our microwave did not switch on. So, this loadshedding is damaging our appliances.

The effect of load shedding in people life is very bad. Many families are experiencing their electrical appliances breaking down due to load shedding. This is caused by high electrical spark when power is switch back on, after loadshedding. One of the participants (*R5F6*) added that *…When there is loadshedding, street traffic lights are not working, and we are experiencing traffic on our roads of which sometimes results in road accidents…* During peak hours, motorists are experiencing high traffic and high accidents when there is load shedding due to traffic lights not working.

7. Do you think that the use of renewable energy supply can help to reduce your electricity bill?

The participants were asked if renewable energy can help them in reducing their electricity bills. Some of the following responses were recorded:

> *R3F7: Solar panels are very expensive to install and will require subsidy from government in order for household to realise a reduction in electricity bill.*
> *R7F7: Electricity bill can only be reduced if renewable energy supply is subsidies.*
> *R10F7: Only if roof solar panels are funded, they can reduce electricity bill.*

The majority of people who participated in the study, believes that renewable energy can only reduce electricity bill if supply and installation of roof top solar panels is subsidies by government and funding is provided to execute such project roll out. One of the participants (*R5F7*) added that*...I don't think renewables will reduce electricity bill because installation of solar panels is expensive...* Some people understand that roll out of renewable energy requires an upfront investment which many households in the township cannot afford.

8. Do you believe that SA government should spend money to promote the use of alternative energy sources such as renewables?

The question about South African government spending money to promote the use of alternative energy sources such as renewables was asked in the interview session. Some of the responses that were received are as follows:

R1F8: Yes, government should promote the use of renewable energy source, maybe that will help with loadshedding that is happening all the time.

R8F8: There are too many challenges with electricity in South Africa, government need to introduce renewables as an alternative source.

R10F8: Renewable energy source is the way to go, and government should promote the use of this source of electricity.

Even though many participants in the interviews agreed with the statement of government promoting the use of renewable energy sources as the alternative energy source to the current existing coal energy generation. One of the participants (*R9F8*) added that: *…Yes, government need to promote renewable energy but not kill base load of electricity generation such as coal generation….*

9. Do you believe that using clean and cheap renewable energy sources will help to improve your household social and economic status?

The question was asked to participants in the interviews whether the use of clean and cheap renewable energy sources such as solar roof top, can help in the improvement of household social and economic status. Below are some of the responses that were mentioned by participants:

R1F9: Yes, it will help improve our social and economic status because socially we will nor experience loadshedding and economically, we will save on our monthly electricity bills.

R4F9: Renewable energy will help with household social status because it can work as a supplement when grid supply is failing.

R5F9: Yes, renewables can help with household social and economic status.

It is noted that majority of responses from the participants in the interviews believes that renewable energy in a form of solar roof top panels will have a positive impact on household social status and will improve economic status of the household. However, there were those that differ in their response and alluded that renewable equipment's are expensive *R9F9…I will not be able to confirm improvements of household economic status because renewable energy equipment's requires large amount of investment….* One of the respondents (*R7F9*) mentioned the challenge of weather status in solar energy generation to produce reliable energy supply *…Solar panels for electricity generation are weather dependents and may not be able to produce consistent electricity supply if weather is bad for days…*

10. If renewable energy (i.e., Roof top solar panels) is made cheap and subsidised, would you shift to installation of renewable energy in your house?

General household participants were asked if they will move to install renewable energy in their houses, if renewable energy in a form of roof top solar panels were made affordable and subsidised. Some of the responses received from interview participants are below:

> *R1F10: If roof solar panels are to become affordable, I will definitely install in my house.*
>
> *R4F10: Electricity charge is very expensive in South Africa; subsidy of roof top solar panels will bring peace of energy supply and we will support it.*
>
> *R6F10: Making solar electricity affordable and subsidise, we will support and convert our home to solar.*

All participants in the interview vowed to support installation of roof top solar panels in their houses, if this is made affordable and subsidised. One of the participants (*R7F10*) who supported the install of roof top solar panels, mentioned the advantage of installing solar in their household *…We cannot doubt the advantages that solar will bring to our house, if made affordable we will support it because we will not feel the pain of load shedding that is happening very often…*

The second segment of interview questions were directed to industry experts. The five industry expects were interviewed and the following five (5) interview questions were asked to the participants:

1. Type of organisation you are working for.

The industry expects who participated in the interviews were asked to state the organisation they are working for. The outcome of the industry expects interview revealed that (2 of 5) participants are working for Municipality. While (1 of 5) is working for Eskom utility. Participants that are working for energy related community-based organisation and non-profit organisation, were (1 of 5) and (1 of 5) respectively.

2. Do you or your organisation believe the quality of electricity supply is good?

The question about quality of electricity supply was asked to the industry expects and some of the following responses were captured from interviewed participants:

> *R1E2: Our Municipality try to deliver good service to electricity supply to the neighbourhood, but Eskom is letting us down with never ending loadshedding which take place almost every week.*
>
> *R2E2: Eskom is facing major challenges with generation of electricity which in turn have a negative impact with quality of electricity supply.*
>
> *R4E2: Our organisation has no trust and believe in quality of electricity supply to the community because of too much power cuts and loadshedding experienced by the community of Soweto.*

The industry expects who participated in the study also confirmed that the quality of electricity supply received by the communities in South Africa is not good. One of the participants (*R3E2*) in the study mentioned that *...The quality of electricity supply is not good due to never stopping* *loadshedding and power cuts due to equipment's failure and cable theft….* This is the indication of Eskom failure to meet up with the ever-increasing energy demands in the South Africa.

3. Do you or your organisation believe the price paid for electricity is fair?

The industry expects were asked if they believe the price paid for electricity by the society or community is fair. The energy industry expects responded with the following answers:

> *R2E3: The generation of electricity in South Africa is very expensive which result in increase of electricity tariffs. Therefore, makes electricity not to be affordable.*
>
> *R3E3: The price paid for electricity is South Africa is not fair. Electricity paid by members of the society is very expensive.*
>
> *R4E3: We do believe that the electricity price paid by our community is too high and not reliable.*

As mentioned above by majority of the industry expects who participated in the study, the price paid for electricity in South Africa is very high. The high electricity price paid by communities in South Africa, further subjecting them to high poverty levels.

4. Do you or your organisation believe that SA government should spend money to promote the use of alternative energy sources such as renewables?

The question about South African government spending money to promote the use of renewable energy as the alternative source of energy was asked to energy industry expects to express their opinions. The following responses were received from participants in the interviews:

> *R1E4: South Africa has excessive sun which makes it more convenient for solar panel electricity generation. I believe SA government should focus on investments to add renewable energy generation in the energy mix.*
>
> *R2E4: Eskom grid energy generation is overpowered, investing in alternative*

energy sources such as renewables will easy and free over loaded grid energy generation.

R3E4: South African government should invest and promote the use of renewable energy in order to assist the ever-breaking electricity equipment's and ensure reliable electricity supply.

The majority of energy industry participants believed that South African government should invest money in promoting the use of renewable energy as the alternative source of electricity supply. One of the participants (*R5E4*) mentioned that *…Our society is highly impacted by loadshedding, and we will support any initiatives of government to promote renewable energy as an alternative source of electricity supply so as to reduce the challenges faced by the population of South Africa….* The views are that renewable energy will reduce the challenge of loadshedding faced by the larger society in South Africa.

5. Do you or your organisation believe that using clean and cheap renewable energy sources helps to improve household social and economic status?

Lastly, the question was asked to industry expects if their organisation(s) believe that using clean and cheap renewable energy sources will help to improve household social and economic status. The following responses were captured from the interviews:

R3E5: Renewable energy will not only improve household social and economic status, but it will also assist to save the environment which over polluted by the traditional electricity generation i.e. coal.

R4E5: Our organisation believes in the positive benefits that will come with the rollout of renewables in the community. Our organisation is a promoter of green energy supply and therefore believes in the benefits of renewable energy in the environment.

R5E5: We agree to the benefits of renewable energy in the larger society of South Africa. We believe sources such as renewable energy will help improve *household social status and economic status and also brings about stability in the electricity supply.*

The above responses from the energy industry expects, confirmed the urgent need and requirement for an alternative energy supply in order to aid the current challenges of power cuts and load shedding experience by larger society in South Africa. One of the interviewed participants (*R2E5*) was very sure of the positive impacts for rolling out renewable energy and mentioned that *…Definitely, renewable energy supply will help to improves household social and economic status….*

The study further did the analysis by generating word cloud to point out the outstanding categories of responses that mostly surfaced from the interviews to theme the general comments from the discussion. These word frequencies (Figure 5.41 and Figure 5.42) from the open-ended questions above helped with Eclectic Coding (Saldaña, 2021). It also gave a hint of the general issues among the respondents.

For example, from the question 1 of the interview guide the following question was posed:

Who is the electricity provider in the neighbourhood and how are you connected?

The participants had the following to say:

Our service provider for electricity is City Power Municipality and we are connected to the grid via electricity prepaid meter	Participant 1
Our electricity pre-paid meter is supplied by Eskom	Participant 2
Eskom prepaid meter supplied in our neighbourhood	Participant 3
We have City Power pre-paid meter	Participant 4
Our home is with City Power, and we have a prepaid meter install	Participant 5
City Power, pre-paid meter	Participant 6
Eskom pre-paid meter	Participant 7
We are connected with Eskom prepaid meter	Participant 8
We have a pre-paid from City Power	Participant 9

Our pre-paid meter if from Eskom Participant 10

These comments generated the following word cloud as shown in figure 5.41 below.

Figure 5.41: Word cloud (comments) frequency by Soweto residents: general respondents

From the comments, the word meter was the most pronounced, followed by prepaid to answer Q1. These were followed by power, city and Eskom among various questions. The frequency of the words denotes the concerns of the respondents regarding those words expressed in their responses.

For clearer visualisation of these comments a word count was measured and converted into a bar chart as displayed in figure 5.42 below.

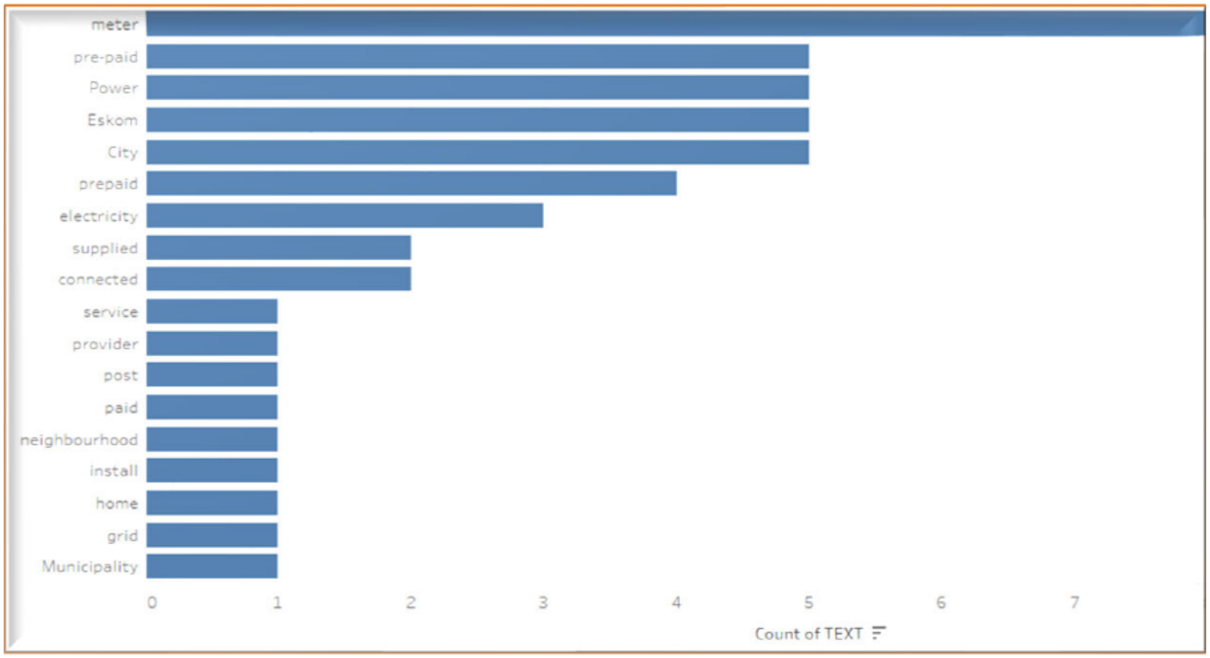


Figure 5.42: Word count from by general respondents

The comments generated were as shown in figure 5.43 below:

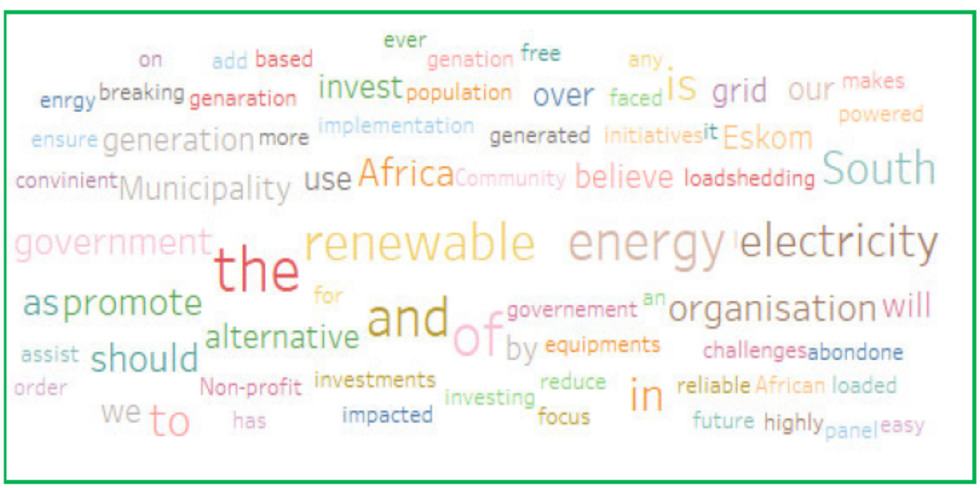


Figure 5.43: Word cloud frequency Interview comments by expert respondents

From this word cloud the word energy was the most pronounced, followed by renewable, then electricity and so on. The word count frequency was transformed into a bar chart and shown in figure 5.44 below. This aligns the word relations and associations between the key variables investigated in the interviews, the importance of available renewable energy and their word cluster analysis. The key associations from the word cluster analysis showed distinct word associations and relationships as follows:

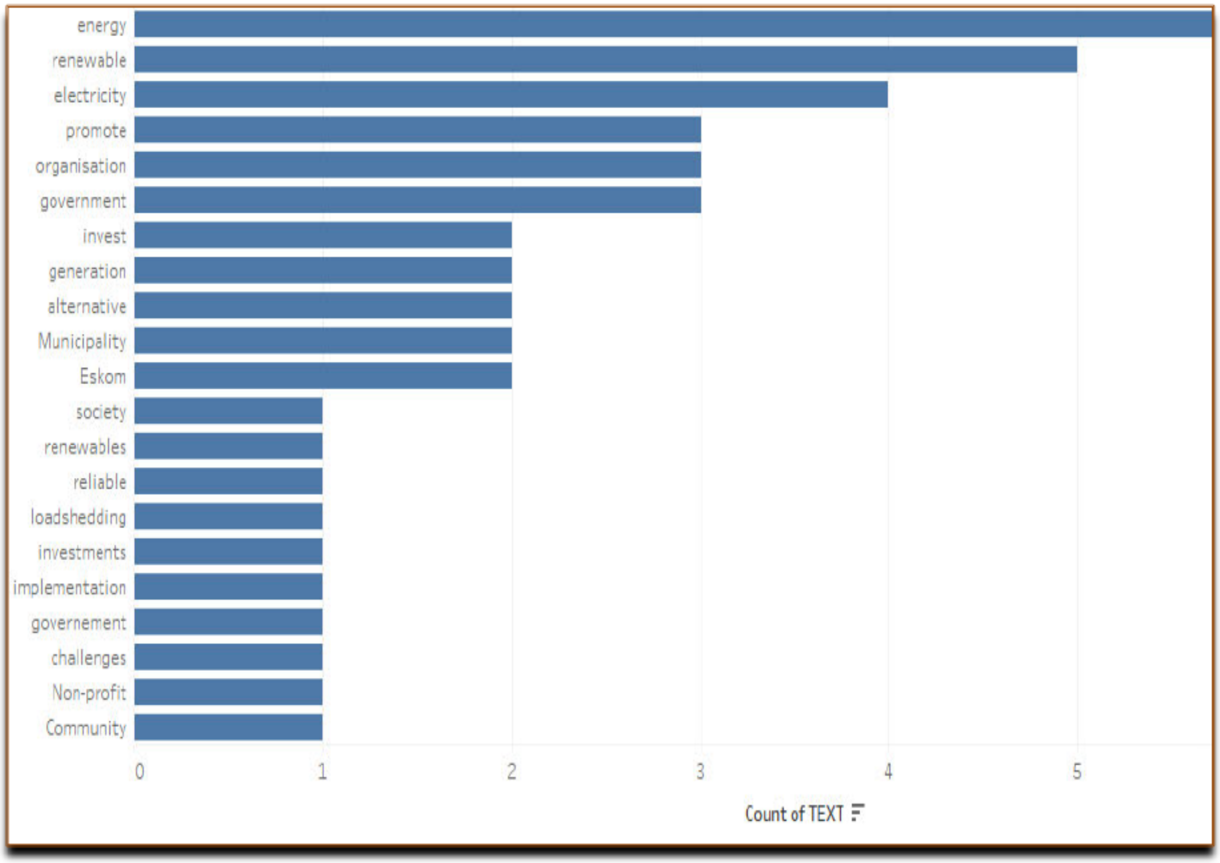


Figure 5.44: Word count from industry experts' comments

Implications for the above comments and analysis will be further elaborated in the next chapter.

5.6 SUMMARY

In this chapter both quantitative and qualitative analysis have been performed to address the study`s objectives. In line with the research question, this study aimed to provide the association between available renewable energy and the various economic benefits that will eventually lead towards poverty reduction in South African township. The data were recorded from questionnaires and interviews and analysed with the help of the Smart PLS 4.0 and the Tableau.4.0 statistical as well as data visualisation software respectively. The former helped with quantitative analysis while the later dealt with a thematic grouping of words into key words analysis. These findings were confirmed with either method to cater for the shortfalls of each methodology. Both the quantitative and qualitative analyses have provided findings which form groundwork for the development of a framework which will be fully explored further.

The next chapter presents detail discussion of the study findings.

CHAPTER SIX

DISCUSSION OF FINDINGS

6.1 INTRODUCTION

This chapter discussed the main results of the study. The main aim of the chapter was to interpret and describe the significance of results based on what was already known about the research problem under investigation. The chapter further described the social situation of respondents in terms of the wider South African context. In addition, this chapter is set to clarify any new understanding or fresh comprehensions about the problem after the researcher has taken the results into consideration. According to Nenty (2009), the researcher must always ensure that the discussions is constantly linked to the research questions or hypotheses in which the researcher poses and the reviewed literature. The discussion of findings section in a study is habitually regarded as the critical aspect of a research paper because of it chiefly efficiently validates one's ability to reason critically regarding the data.

The discussion of the empirical results and findings collates existing literature and critique where possible. The analysed data were collected using the instruments of a questionnaire collected from 252 participants who are residents of Soweto and an interview method with 10 families from Soweto and 5 energy industry expects targeted for in-depth interviews. The study questionnaire was constructed and structured into five sections, namely: (I) Socio-Economic status; (II) Poverty reduction; (III) Economic growth; (IV) Environmental conduction / Climate change; and (V) Trade opportunities. These five sections of questionnaire were designed to address the study five null hypotheses. The results were analysed per each of the research questions and presented in the table and figure forms, as separate from the quantitative analysis section and the qualitative analysis section. The primary quantitative data were analysed using SPSS version 29 for Windows, descriptive and inferential statistics and principal components analysis generated to help answer the study`s research questions and achieve the objectives. This chapter presents the discussion of the findings for each section of the questionnaire by merging the outcome of the quantitative data collected, qualitative data collected and the literature review.

6.2 SOCIO-ECONOMIC STATUS

Section one of the chapter presented the discussion of results in as far as socio-economic charecteristics of the respondents is concerned. Respondents were asked to indicate their personal details, namely: gender, age, living condictions, house hold structure, family size and financial income. This information was critical in determing social status and whether the respondents' demographic profile had or did not have any influence on their perception about renewable energy. For instance, when it comes to gender, the study found that the majority of respondents (128; 51%) were males, while 124 (49%) were females. However, these results are in contradiction to the current South African statistics which shows that there are more females than males in South Africa. According to Stats SA (2019), in 2019 the South Africa's female population amounted to approximately 29.7 million (50.72%), while the male population amounted to approximately 28.86 (49.28%) million inhabitants. According to Stats SA (2017), "males make up 49,6% of the population in SOWETO, while females make up 50.4% of the population. Figure 6.1 below depicts the graph of South African total population by gender from year 2011 to year 2021.

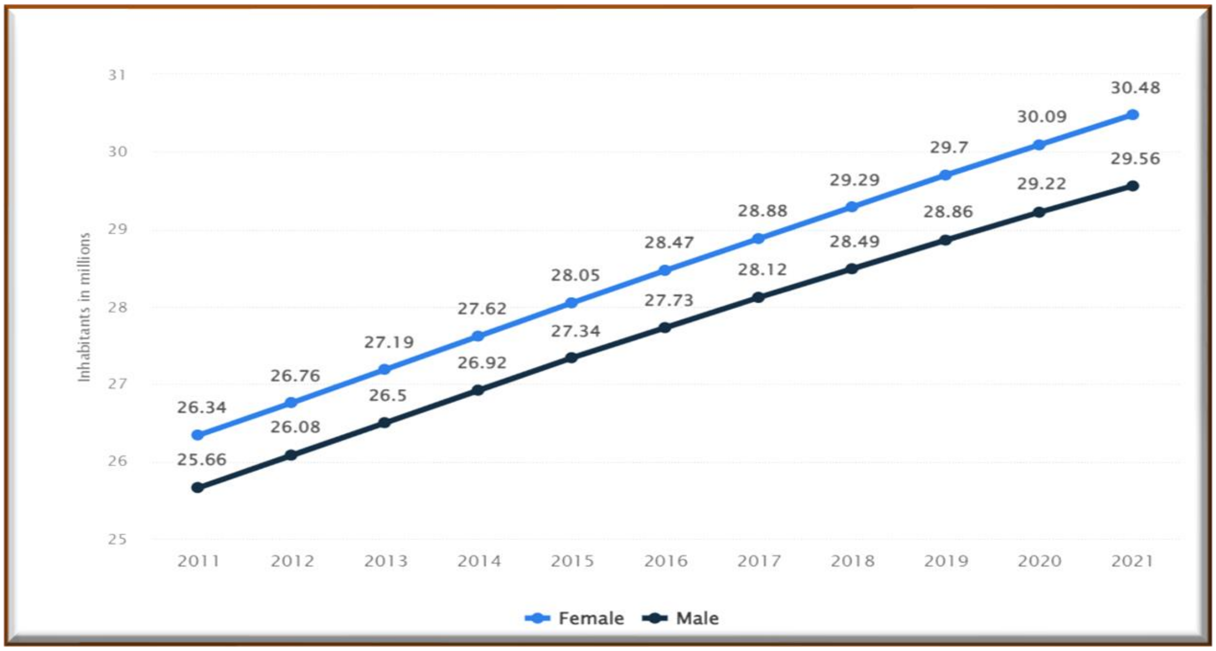


Figure 6.1: South Africa total population by gender from 2011 to 2021 (in millions)
Source: Statista (2022)

The statistic above shows the total population of South Africa from 2011 to 2021 by gender. In 2021, South Africa's female population amounted to approximately 30.48 million, while the male population amounted to approximately 29.56 million inhabitants (Statista, 2022). It is noted from the graph above that from 2011 to 2021, female population in South Africa has always been above that of male population. The population growth in this regard has always been proportional to the gender, whereby, female gender is always above male gender. It is worth pointing out that gender of the respondents in this context, does not necessarily imply anything because renewable energy adoption has nothing to do with one's gender. This is just a merely indication that males were majority participants over females in the study conducted at the Soweto neighbourhood. The table below shows the racial breakdown of SOWETO.

Group	Percentage
Black African	98,5%
Coloured	1,0%
Indian/Asian	0,1%
White	0,1%
Other	0,2 %

Table 6.1: Soweto racial breakdown

Source: StatsSA (2017)

The table above shows the population groups as a percentage of the total population in Soweto. The racial breakdown of Soweto is dominated by Black African population, as during the apartheid years, black Africans were forced to live on the outer edges of cities. Thus, black African's dominates the population profile of Soweto. Black Africans make up 98.5% of the population of Soweto, with Coloureds making up 1%, Indian/Asian, Whites and other race groups making up a mere 0.4% of the total population of Soweto.

6.2.1 Participants age group

When the respondents were asked to indicate their age group, most of the respondents (34%) were between 40-49 years old, followed by those who were between 50-59 (26%). In addition, the figure 5.2 depicts that 18% of the respondents were between 30-39 years old, while 13% were 60 and above. Few participants (9%) in the study belongs to age group 18-29. The study notes that 73% of the participants were above youth level (40 years and above) which is a clear indication of maturity level of the participants. Definitions of youth vary considerably amongst countries. The United Nations defines youth as those aged between 15 and 24 years. The United Nations, however, recognises that each region may have its own specific definition of youth. In South Africa, youth consist of those aged 15 to 34 years (Stats SA, 2021). Contrary to the results above, according to Stats SA (2019), it is important to note that in 2015, the median age of the South African population was 26.4 years. The graph below, figure 6.2 depicts the total population of South Africa in 2022, by age group.

According to Galal (2022), South Africa's population increased in 2022, counting approximately 60.6 million inhabitants. Of these, roughly 22.12 million were aged 0-19, while 609,000 people were 80 years or older (Statista, 2022). Although South Africa’s yearly population growth has been dropping since 2013, the growth rate still stood above the world average in 2021. In 2021, the global population increase reached 0.94 percent, while for South Africa, the rise was 1.23 percent. For the period 2016 to 2021, Gauteng and Western Cape are estimated to experience the largest inflow of migrants of approximately, 1 564 861 and 470 657 respectively. Gauteng still comprises the largest share of the South African population, with approximately 15,81 million people (26,3%) living in this province. The majority of the people lived in the borders of Gauteng, the smallest of the nine provinces in land area (Galal, 2022). Although Western Cape was the third-largest province, one of it cities, Cape Town, had the highest number of inhabitants in the country, at 3.4 million.

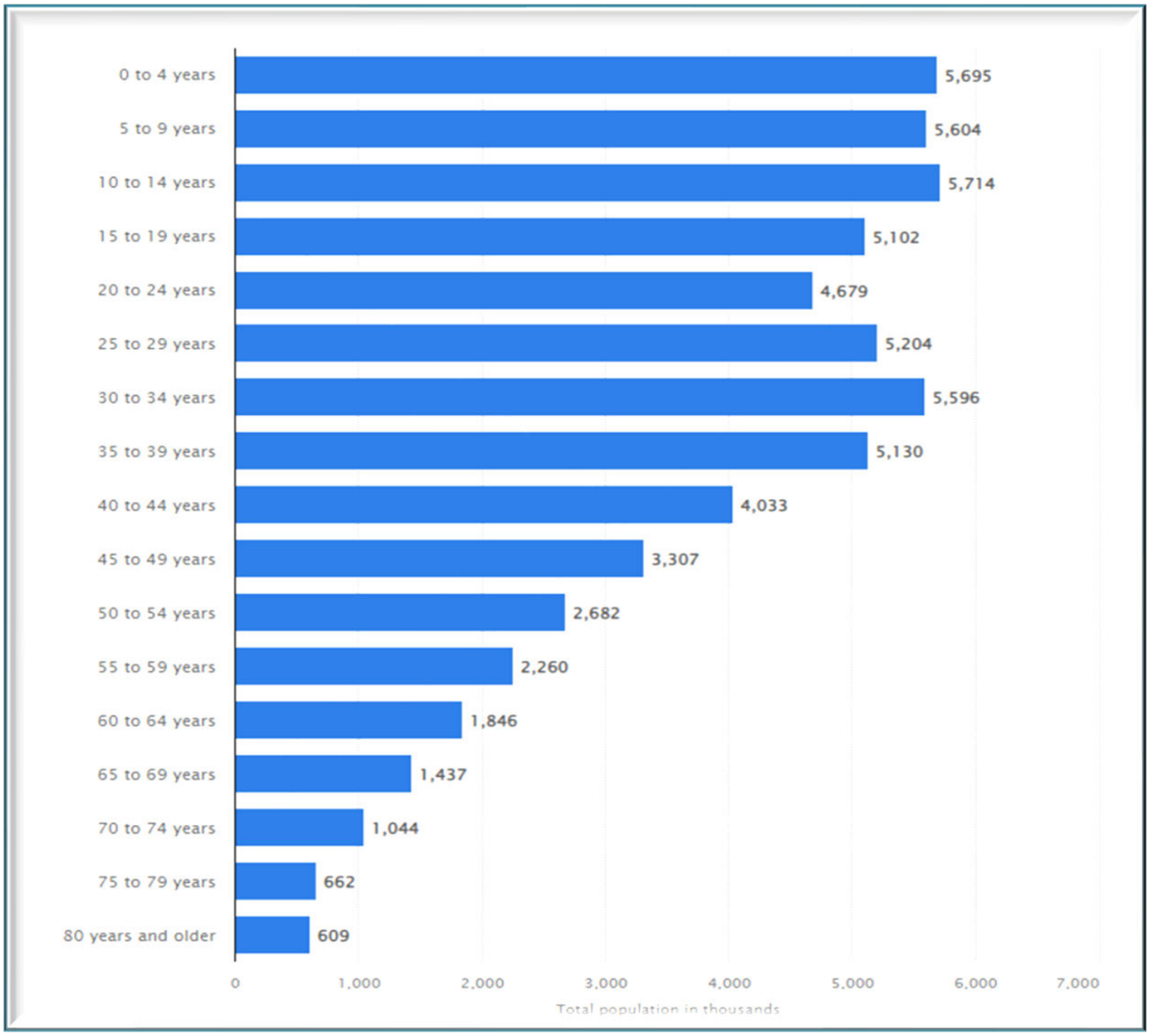


Figure 6.2: Total population of South Africa by age group

Source: Statista (2022)

Figure 6.2 above shows that majority of the population in South Africa (42,724; 70.50%) belongs to youth level to mid adults (0 to 39 years). While those that are 40 years and above, constitute 29.5% (17,880). According to the report from SA Gov. (2022), about 28,3% of the population is aged younger than 15 years (17,04 million) and approximately 9,2% (5,51 million) is 60 years or older. Of those younger than 15 years of age, the majority reside in Gauteng (21,8%) and KwaZulu-Natal (21,2%). The proportion of elderly persons aged 60 years and older in South Africa is increasing over time and as such policies and programs to care for the needs of this growing population should be prioritised. South Africa has a large population under 14, who will be looking for job opportunities in the future. However, the country's labour market has had difficulty integrating these young people. Specifically, as of the third quarter of 2022, the unemployment rate reached close to 60 percent and 42.9 percent among people aged 15-24 and 25-34 years, respectively (Galal, 2022). In the same period according to Statista (2022), some 25 percent of the individuals between 15 and 24 years were economically active, while the labour force participation rate was higher among people aged 25 to 34, at 71.2 percent.

6.2.2 Soweto living conditions and household structure.

Individuals rely on their families and households for their physical, social, economic well-being and survival. Most people consider families and households as their most important social institutions and social reference groups. Although traditional family structures are changing, they remain very important in countries such as South Africa where large proportions of the population are subject to debilitating poverty and unemployment and institutional support is inadequate. StatsSA (2018) defines households as all individuals who live together under the same roof or in the same yard, and who share resources such as food or money to keep the household functioning. The definition is much more restrictive than the concept of a family which usually refer to individuals who are related by blood and who may live very far apart. Although household members are usually related, blood relations are not prerequisite for the formation of a household.

According to WHO (2018), healthy housing is an essential support of decent health in terms of its World Health Organization (WHO) definition as a state of complete physical, mental and social wellbeing, and not just the absence of disease. The study conducted by Teare, Naicker, Swanepoel, Street and Mathee (2021) revealed that, healthy housing is associated with 'a feeling of home' and also refers to the quality and role of the physical structure in enabling health, including aspects related to shelter from the elements, access to safe sources of energy and healthy indoor and ambient air, access to sufficient quantities of safe water, thermal comfort, absence of dampness and mould, and protection from pollutants, injury hazards and pests. Healthy housing also relates to local availability of education and health services, green space, active public transport options and protection from waste and pollution (Bonnefoy, 2017).

The majority of the townships in South Africa are designed such that they are closer to industrial areas so that residents of the township can easily reach their workplace. Teare, et al., (2021) argue that the location of housing in nearby proximity to places of industrial contamination may cause unnecessary public exposure to contaminants in air, soil and water, with concurrently high burdens of ill health, as indicated by several studies conducted in numerous parts of the world and in fluctuating population groups. A study undertaken by Al-Wahaibi and Zeka (2015) disclosed that residing close to an industrial park was associated with high levels of critical respiratory disease, asthma, conjunctivitis, and dermatitis. The risks of ill-health were highest in older people and those of lower socio-economic status.

The characteristics of the dwellings in which households live and their access to various services and facilities provide an important indication of the well-being of household members. It is widely recognised that shelter satisfies a basic human need for physical security and comfort (StatsSA, 2018). When participants were asked to indicate their living conditions, most of the respondents (48%) were living in their own houses The study revealed that majority of participants were 40 years and above which is the indication of responsible and accountable participants, hence majority of them own houses. These were followed by those who were renting a house or a room (33%). This percentage of participants renting is an indication of tough township living conditions whereby a quarter of people living in Soweto are renting. A few participants (13%) were living in partner / spouse house, these participants are cohabiting and staying in their partners house which they do not own or rent. They might be helping their partners with household bills, depending on the cohabitation arrangement. Only 6% of participants were living in their parents' houses. These are normally young people in the township that just started working or still looking for employment, who cannot afford to buy a house or rent a place to stay. The next table below, take a look at the tenure status of households in Soweto.

Tenure Status	Percentage
Rented	28,6%
Owned but not yet paid off	7,1%
Occupied rent free	14,3%
Owned and fully paid off	21,4%
Other	0%
Owned and fully paid off/paying off	28,6%

Table 6.2: Soweto household tenure status
Source: StatsSA (2017)

A large portion of households rent the dwellings they stay in (28.6%), and of that a large part is backyard shacks being rented by household owners. Another proportion of household reported they own and have fully paid off their dwelling (21.4%). A large part of these dwellings would be informal shacks or government provided housing for which limited payment was required or housing was supplied free of charge. The table 6.2 above, reflects that 57.1% of the household are owned but either paid off or not paid off and followed by household that are rented. The results of the study are synonymous with table 6.2 above where the study confirms that majority of the participants are owning their houses followed by those that are renting. The study results collected are accurate replication of the Soweto household tenure status.

According to Marmot and Bell (2016), poor-quality housing, polluted living environments, and poor economic and social conditions (such as unemployment, uncertain employment, and limited education) may independently exert detrimental health effects on affected communities. In South Africa (SA), economic pressures underpinned by poor economic growth, high levels of unemployment, increasing consumer prices for energy and food, and household dependence on credit are some of the factors driving high levels of poverty. In 2015, more than 55% of South

Africans were living in poverty, most of whom were black Africans, females, children, those with little or no education (Teare, et al., 2021).

With regard to household structure, the majority of respondents (56%) were living in a 1-2 room, followed by those who were living in a 3-4 room house (28%). Additionally, the study shows that 10% of the participants are living in a 7-8 room house, while there were only 6% participants who were living in a 5-6 room house. It is important to note that for the fact that the majority of respondents were living in 1-2 room houses, they are most likely to be paying more money on electricity. In as far as family size is concerned, most of the respondents (35%) were a family of 1-2 members, followed by those who were 5-6 family members (25%), 7-8 family members were also 25%. The study revealed that 15% of the participants were 3-4 family members. Although a number of people residing in a household does not necessarily suggests the amount of money to be spent on electricity, it is always assumed that the greater number of people reside in a house, the more money they will spend on electricity and food. For instance, a geyser tends to work more where there are many people in a household, and they tend to cook more food to feed the entire family as compared to a small family. Their spending on electricity bills is higher than that of a small family. Therefore, one is tempted to assume that since most of the respondents were living in their own houses, they are most likely to easily take a decision whether to implement renewable energy or not in their households in order to reduce on high electricity spending.

6.2.3 Soweto household source and monthly income

In the third quarter of 2022 according to Galal (2022), the unemployment rate among Black South Africans reached 36.8 percent, marking a year-on-year change of 1.9 percent compared to the first quarter of 2021. The unemployment rate among white South Africans reached 10 percent in the first quarter of 2022, with a 1.8 percent year-on-year change (Statista, 2022). According to the *Quarterly Labour Force Survey (QLFS*) of the 1st quarter of 2021, young people are still struggling in the South African labour market. The official unemployment rate was 32,6%. This rate was 46,3% among young people aged 15 – 34 years, implying that almost one in every two young people in the labour force did not have a job in the first quarter of 2021 (QLFS, 2021).

About a quarter (24,4%) of the youth have jobs and 45,3% of them participate in the labour market. The QLFS (2021) report that within the youth, those aged 15–24 years are more vulnerable in the labour market with an unemployment rate of over 63%, an absorption rate of about 7,6% and a labour force participation rate of 20,6%.

With regard to source of income, the study found that majority of the respondents (70%) were employed, getting a salary, followed by those who were self-employed (17%). Only 13% of respondents were getting income from social grant. These results could mean that respondents stand a good chance to adopt renewable energy as the majority of them were employed. In addition, majority of respondents 76% indicated that 1-2 people were working in the household, followed by those who said 3-4 people were working in the households (24%). These results did not come as a surprise that the majority of respondents were from households that have only 1-2 people in employment because it is a sad reality that there is high unemployment rate in South Africa.

The burden of unemployment in South Africa is concentrated amongst the youth as they account for 59,5% of the total number of unemployed persons. The unemployment rate among the youth is high irrespective of education level. The graduate unemployment rate was 40,3% for those aged 15 - 24 and 15,5% among those aged 25 - 34 years, while the rate among adults (aged 35 - 64 years) was 5,4% (Stats SA, 2017). Stats SA (2021) report revealed that of the 10,2 million persons aged 15 - 24 years, 32,4% (approximately 3,3 million) were not in employment, education or training, implying that close to one in three young South Africans between the ages of 15 and 24 years were disengaged with the labour market in the first quarter of 2021. According to the report from Statista (2022), some of these young people have become discouraged from participating in the labour market and they are also not building on their skills base through education and training, they are not in employment, education or training (NEET). The NEET rate, seen in conjunction with unemployment rates over 60%, suggests that the youth face extreme difficulties engaging with the labour market in South Africa.

Education and prior work experience play an important role in the labour market. According to Statista (2022), employers often prefer to employ those with previous work experience and a higher level of education. Unfortunately for the youth, lack of work experience is a stumbling block that results in them finding it hard to secure employment. In most cases, young people that are in employments have contracts that have unspecified duration, or the contracts are of a limited duration, and consequently do not have access to employee benefits such as medical aid, pension fund, paid sick leave and permanent employment (Stat SA, 2021). Figure 6.3 below depicts a graph of South African unemployment rate by population group, from 2019 (Q1) to 2022 (Q3).

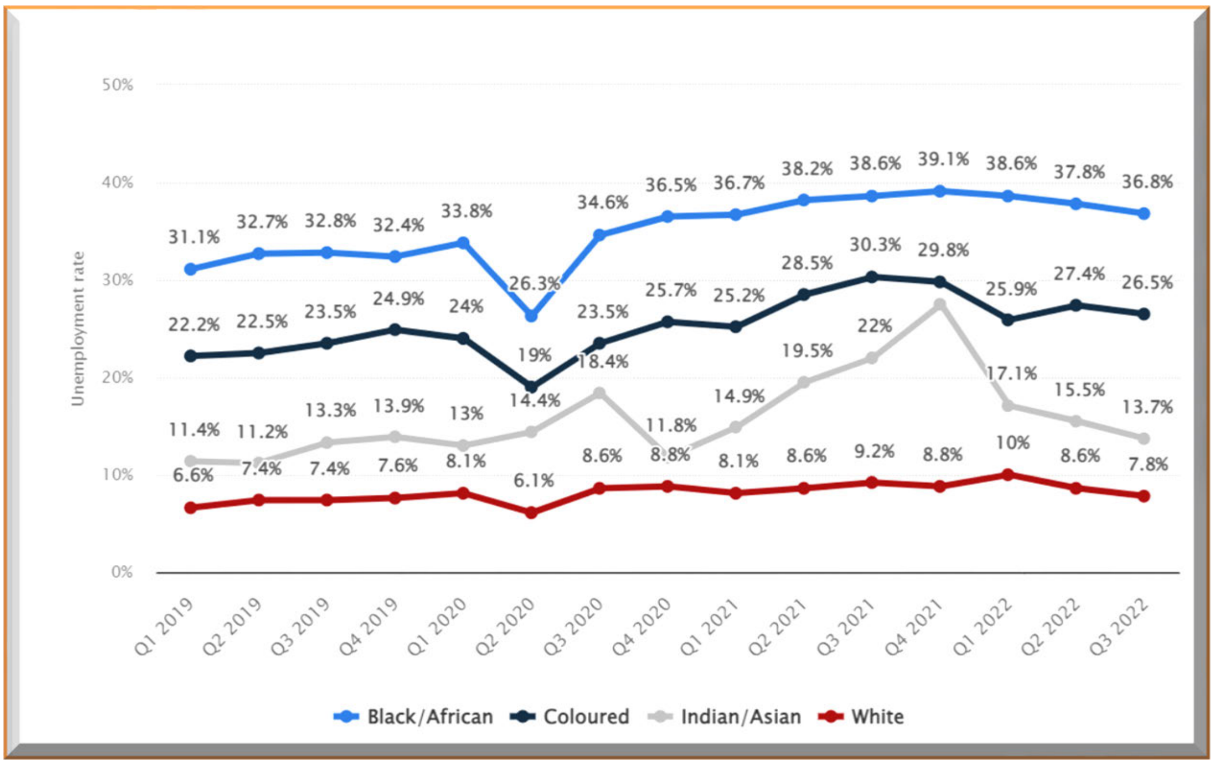


Figure 6.3: Unemployment rate in South Africa from Q1 2019 to Q3 2022, by population group

Source: Statista (2022)

The unemployment rate is the share of the labour force population that is unemployed, with the labour force being all employed or unemployed individuals looking for work. South Africa is struggling to absorb its youth into the job market. For instance, according to Statista (2022), the unemployment rate among young South Africans aged 15 - 24 years reached almost a staggering 60 percent in the third quarter of 2022. In 2021, the unemployment rate in South Africa was nearly

33.6 percent following an increasing trend since 2008 (Statista, 2022). The rate was highest among Black South Africans reaching as high as 36.8 percent in the third quarter of 2022. Furthermore, Teare et al., (2021) argued that women had higher unemployment rates than men. Since the start of 2016, the unemployment rate of women has been steadily over that of men, reaching close to 35 percent compared to 31 percent, respectively. Figure 6.3 above shows clear that majority of the population in South Africa which are Black / African are suffering a high unemployment rate.

In South Africa, a new minimum hourly wage went into effect on March 1, 2022. According to Diawara, Shrestha, Carselia, and Farmer (2018), the minimum salary reached 23.19 South African rand per hour (1.44 U.S. dollars per hour), up from 21.69 South African rand per hour (1.35 U.S. dollars per hour) in 2021. In addition, the preponderance of employed South Africans worked between 40 and 45 hours weekly in 2021. When it comes to total monthly household income, the majority of respondents (51%) indicated that the monthly income in the household was between R12,001 and above, followed by those who said it was between R9,001 –R12,000 (25%). The study revealed that 10% of participants who respondent were earning between R6001 – R9000. Those that are earning between R0 -R3000 and R3001 to R6000 were 6% and 7% respectively.

The high percentage (51%) of participants in Soweto that are earning R12001 and above is an indication that employed people in Soweto might be working in jobs that they are qualified for and have better work experience in order for them to earn this much higher salary. These results implies that most of the households stand a good chance of affording renewable energy. It is a well-known fact that renewable energy demands a lot of money at the implementation phase, thereafter it is highly unaffordable to a normal family that only depends on salary to pay bills and put food on the table. In contrary with the results above, Frey and Linke (2002) argue that solar energy is considered to be the newest type of renewable energy source, as well as one of the least expensive types of managing electricity bill. Figure 6.4 below, depicts the graphs of South Africa average monthly earnings.

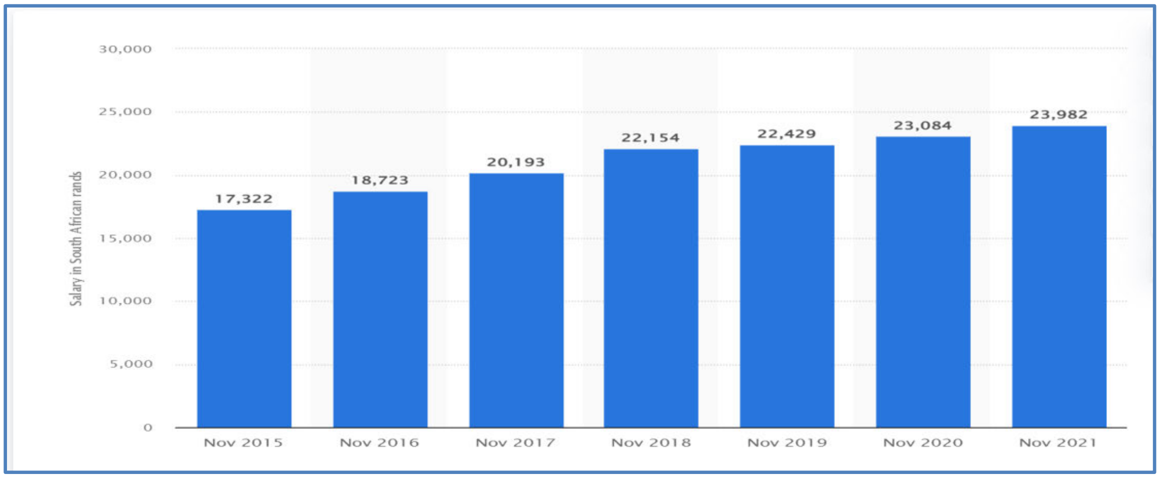


Figure 6.4: Average monthly earnings in South Africa from November 2015 to November 2021*(in South African rands)*

Source: Statista (2022)

The average monthly salary for South Africans who were employed in the formal non-agricultural sector was close to 24 thousand South African rands (comparable to roughly 1.64 thousand U.S. dollars) in November 2021, which represented a yearly increase of 3.9 percent. During the period under review, the overall growth trend was positive, with the earnings increasing by 38.4 percent from 17.3 thousand South African rands (1.18 thousand U.S. dollars) in November 2015 (Statista, 2022).

When participants were asked to indicate whether they were aware of alternative energy, the majority of respondents (94; 75%) revealed that they were actually aware, while 32 (25%) said they not aware of alternative energy. This is energy that is not generated or sourced from the grid. It is worth noting that for the fact that the majority of respondents were aware of the alternative energy, one is tempted to assume that the respondents stand a good chance to implement it if they so wish. Moreover, respondents were asked to indicate the type of alternative or other energy source that they are using in their households either for cooking, lighting or heating the house, the study found majority 126 (50%) of participants in the study are not using alternative energy in their households, followed by those who are using gas 96 (38%). In addition, the results show that 30 (11%) are using coal, while none of them are using paraffin and wood.

The findings of the study evident that at least half of the Soweto households who are electrified relies on grid energy source for cooking, lighting, or heating their households. Hence, they are not using other sources of energy. The 38% and 11% of household that are using gas and coal respectively, they most likely using these sources of energy for cooking, in order to save grid electricity usage. Cooking represents one of the most energy-intensive applications. DoE (2012) report shows that slightly more than three-quarters (76%) of households use electricity as the main energy source for cooking. DoE (2012) report revealed that only around a tenth (8%) of electrified households continue to depend on firewood as a main cooking source, with marginal shares reporting gas, solar electricity, paraffin and coal. For non-electrified households, firewood and paraffin predominate as the main energy source for cooking purposes (40% and 50% respectively). According to Pillay (2011), gas, coal, solar electricity and electricity from generators are used in a small percentage of household as the primary source to meet their cooking needs. Apart from cooking, another energy-intensive thermal application is domestic space heating (DoE, 2012). Hills (2012) argues that on aggregate, two thirds of South African households (65%) use an energy source to heat spaces and keep warm, with the remaining third not using energy sources but opting mainly to wear warm clothing and to use blankets". In terms of lighting, The DoE (2012) report revealed that household that have been electrified almost exclusively use electricity for lighting purposes (97%), with a marginal contingent specifying that they continue to rely on candles (1%).

Winkler (2012) indicate that considerable patterns of difference exist between electrified and non-electrified households in the range of energy sources that residents employ to meet their basic needs. Those with electricity all reported that they used this source either for lighting, cooking or heating, though it is apparent that other sources such as candles, paraffin, firewood and gas continue to be relied upon in at least a fifth of cases (Pillay, 2011). Conversely, in the absence of a domestic connection, non-electrified households rely primarily on candles, paraffin and firewood, with more nominal shares reporting the use of coal and gas (Hills, 2012). The use of dry cell and car batteries, a solar system, or generator hardly features for electrified and non-electrified households alike, being reported in fewer than 5% of cases (DoE, 2012). Malkina-Pykh and Pykh (2002) on sustainable energy resources established that the United States during 2002 was heavily relying on coal, oil, and natural gas for its energy. Likewise, in his study entitled Indoor air pollution and health in developing countries, Ezzati (2005) argues that biomass fuels and coal are vital to health and welfare in developing nations. Similarly, Ezzati et al., (2004) is of the view that worldwide, almost 3 billion people use biomass such as wood, charcoal, crop residues, and animal dung, and coal as their main source of energy for cooking, heating, and other household needs such as food preservation.

Karytsas, Mendrinos and Karytsas (2020) classify social impacts of renewable energy technology into four categories, namely a) public perceptions (e.g. esthetics, impact of lifestyle, social benefits, impact on property values), b) employment (e.g. job creation, addition to employment diversity, poverty alleviation), c) health & safety (e.g. public safety, work safety) and d) local infrastructure development (e.g. development of infrastructure, local empowerment). Positive impacts of renewable energy may include security and diversification of energy supply, increased self-reliance; creation of job positions, new income source, opportunities and benefits for rural areas and remote communities; improvement of local population's skills and education, and improved health (IRENA and CEM, 2014). The study conducted by Shoaiba and Ariaratnam (2016) argue that the renewable energy technology impact on improving standard of living, human development and social cohesion is significant. The paper concluded that, although renewable energy had positive socio-economic impacts on the communities, it cannot be the only solution to sustainability and has to be treated as a part of the solution rather than the whole.

6.3 POVERTY REDUCTION

Having adequate and affordable access to energy sources is vital to address household poverty. In order to assess household access to energy, according to Rodrigues (2015), the general household survey (GHS) measures the diversity, and main sources of energy used by households to satisfy basic human needs (cooking, lighting, heating water, space heating). In addition to measuring access to electricity, the GHS is also concerned with measuring the extent to which households are connected to and use grid or mains electricity as this could provide a useful measure to guide future electrification programmes (StatsSA, 2018). According to Pillay (2012), a household that spends more than 10% of their net income on energy is regarded as energy poor or in energy poverty. Rodrigues (2015) argues that a household is considered energy poor if it is characterised by one or more of the following attributes: (i) the amount of energy the household uses is reported as being less than adequate for its needs; (ii) the amount of energy the household uses for lighting is reported as being less than adequate for its needs; (iii) the amount of energy the household uses for cooking is reported as being less than adequate for its needs; (iv) the amount of energy the household uses for heating rooms and keeping warm is reported as being less than adequate for its needs.

Another measure of energy poverty according to Heese and Allan (2014), relies on assessments of the condition of one's place of residence, focusing particularly on thermal comfort levels relative to social needs. In essence, this involves rating the thermal efficiency of dwelling units, since this influences the amount of energy required to heat the home to an acceptable standard and typically represents a notable determinant of domestic energy costs. DoE (2012) report mentions that a household is considered energy poor if it has less than 60% of South Africa's median per capita monthly income, and meets one or more of the following conditions: (i) the household reports that it is dissatisfied or very dissatisfied with its accommodation; (ii) the state of repair of the household is described as poor; (iii) one or more of the following problems are reported with the accommodation: lack of adequate heating, a leaky roof, damp walls, floor or foundations, or damaged or broken windows or doors; (iv) the health of a household member has deteriorated due to the housing conditions.

In this study, respondents were asked to indicate the method they were using to access electricity. The study established that the majority of respondents (194; 77%) were accessing the electricity through an in-house post-paid meter, while 58 (23%) were using an in-house pre-paid meter system. The study revealed that all participants are coming from electrified households. The electricity connections are either post-paid meter or pre-paid meter. Pre-paid electricity meter is preferred by utilities and municipalities, since it assures utility and municipalities with money collection upfront and compare to post-paid meter where consumers of electricity will access electricity for a month without pay and at the end of the month, the consumer will receive a bill on electricity consumption. This usually causes a major challenge with households that are energy poor and leaving under poverty. Also, utility and Municipalities are unable to collect all money consumed in electricity by residents (BusinessTech, 2023). Furthermore, none of the participants are connected to another source which they pay for; connected to another source which they do not pay for; no access to electricity. What is immediately clear in these results is that none of the respondents were using renewable energy. This could be a serious course for concern for the government and environmental experts and could simply imply that more awareness about the benefits of renewable energy needs to be communicated to the citizens.

When participants were asked to indicate their electricity supplier, the majority of respondents (152; 60%) were receiving the electricity from Eskom, while 100 (40%) were receiving electricity from the municipality. In addition, the study found that none of the respondents were receiving the electricity from private energy suppliers and off the grid. Similar question was asked to respondents who participated in the interview survey. Few of the participants respondent as follows:

> *Our service provider for electricity is City Power Municipality and we are connected to the grid via electricity prepaid meter.*
> *We are connected with Eskom prepaid meter.*
> *Our pre-paid meter if from Eskom.*
> *Eskom pre-paid meter*

These results suggest that there is a strong monopoly when it comes to power production in South Africa. The result of the study confirms that the majority of Soweto residents are receiving their electricity supply from Eskom. In Soweto, there is a culture of resistance in paying for electricity debt. According to BusinessTech (2019), Eskom has identified the worst offenders when it comes to non-payment of electricity, referring to Soweto as the worst of them all. The township boasts a population of 1.3 million, in a city with an overall population of around 5.6 million (Stats SA, 2019). As of 30 June 2019, Soweto owes Eskom R18.9 billion in unpaid bills, accounting for more than half of total arrear debt plus interest (BusinessTech, 2019). These results also shed some light on why South Africa is constantly experiencing power shortages. It is believed that the introduction of renewable energy in particular solar panels will address the power outages in the country as more role players will be allowed to generate electricity. The literature shows that renewable energy generated from solar panels has been long adopted in other countries and it continues to play a significant role in energy production (Kannan and Vakeesan (2016); Sukhatme and Nayak (2017); Kalogirou (2013); Chen, 2011). Kannan and Vakeesan (2016) share similar sentiments by stating that solar industry is developing steadily all over the world because of the high demand for energy while major energy source, fossil fuel, is limited and other sources are expensive. The latter authors further state that solar energy has become a tool to develop economic status of developing countries and to sustain the lives of many underprivileged people as it is now cost effective after long aggressive research done to expedite its development. Similar sentiments are shared by Jacobs (2021) who observes that it has become a well-known fact that solar panels are becoming more popular, more apparently among homeowners. Jacobs (2021) further notes that solar panels are transforming the way people live. One of the most glaring benefits of using solar panels is the fact that they have become so effective in making the world environmentally friendly.

Furthermore, Jacobs (2021) argues that solar panels are becoming more proficient and inexpensive as the technology behind them gets perfected. In with the results above, Kumar et al., (2019) is of the opinion that this source of energy is a cleaner, and an often cheaper, variant of power that once deployed, provides South African institutions with an excellent opportunity to thrive. Similar sentiments are shared by Zawilska and Brooks (2011) who observe that within South Africa, homeowners are also choosing to move to solar panels compared to other energy sources. Zawilska and Brooks (2011) add that this is mainly due to the increasing affordability and the wide range of benefits they offer. In line with these views, Fluri (2009) argues that the only cost associated with the use of solar energy is the manufacture and installation of the components, which means that despite the large initial investment, there are no additional costs associated with their use. Fluri (2009) further notes that renewable, non-polluting and available planet-wide, solar power contributes to sustainable development and job creation where it is installed.

When respondents were asked to indicate the amount of money they were spending on electricity on a monthly basis, the majority of respondents (120; 48%) were spending R1001 – R2000 to buy electricity on a monthly basis, followed by those who spent R2001 – R3000 (64, 25%). The results indicated that those who spent R100 – R500 and R501 – R1000 were 13% and 14% respectively. Also, the study established that the majority of respondents (172; 68%) felt that they were spending too much money on electricity on a monthly basis, followed by those who said it was far too high (64; 25%). Only 6% (16) of the participants felt that the money they are spending on electricity is about right. Similar question was asked to respondents who participated in the interview survey in Soweto. Participant responses included:

> *Eskom is planning to further increase electricity price even though we are already paying high price of electricity.*
> *Electricity price paid in Soweto is not fair.*
> *Price paid for electricity is too much.*
> *Electricity price paid is very high.*

The residential sector in South Africa was comprised of approximately 16.9 million households in 2016, of which about 86% were electrified (Stats SA 2016: 96; DOE 2018: 24). Electrified households consume roughly 17% of the country's total grid electrical energy to provide energy services (DOE 2018: 47), the most significant of which is resistive water heating. During peak periods, the residential sector can account for up to 35% of national electricity demand and energy efficiency in the residential sector can therefore contribute to reducing peak demand (McNeil, Covary & Vermeulen, 2015: 2). Households in South Africa are heterogeneous, and electricity use by households is not well characterised by averages. Appliance ownership, age, utilisation patterns and monthly spend on electricity all vary with household income which is very diverse. Poverty remains high and limits household electricity and appliance purchases (Hughes and Larmour, 2021). For example, a Stats SA study (2017a: 14) found that in 2015 55.5% of the population were living below the Upper-Bound Poverty Line (UBPL). Energy poverty is equally prevalent in South Africa, particularly in lower income households where electricity is often used in combination with solid fuels. Studies have shown that up to half of South Africa's households may be in energy poverty (DOE (2013); Koch, 2020: 24). Hughes and Larmour (2021) state that the cost of purchasing electricity can contribute significantly to energy poverty and therefore energy efficiency interventions can also realise important social benefits in South Africa's lower income households.

The pricing of electricity has become a critical topic in national dialogue, following the introduction of significant price increases in an effort to circumvent the occurrence of rationing, which is commonly known as load-shedding (DoE, 2012). In 2008, the Department of Minerals and Energy announced that South Africa was faced by serious electricity difficulties, which related to capacity, supply, and maintaining an appropriate reserve margin. The state electricity company, Eskom, thus needed increased financial resources to resolve these problems. While these were related, they had different prime causes and required different responses (Altman et al, 2008: 11). Eskom's solutions included increasing the price of electricity, the implementation of load-shedding, and acquiring a loan from the World Bank to improve old infrastructures and build new power plants, viz Medupi and Kusile (DoE, 2012). In a report entitled, National Response to South Africa's Electricity Shortage (2008:1), the government argued that these measures were necessary to prevent a collapse of the national electricity supply system, as the country was faced with an emergency situation.

In 2010 National Energy Regulator South Africa (NERSA) subsequently approved an average tariff increase of 25.5% over the next three years, using a Multi-Year Price Determination (MYPD 2) system. However, residential tariffs are subsidised and therefore homeowners pay an increase of only 14.3% and 16% for 2010/11 and 2012/13 respectively (DoE, 2012). Furthermore, in terms of the 2008 Electricity Pricing Policy which introduces an inclining block rate structure for billed customers, consumers who use more are charged a higher average price. These are effectively punitive charges which protect lower usage customers and ultimately deter electricity wastage. In 2023, NERSA granted Eskom a 18.65% price hike in January, the national energy regulator also approved a 18.49% hike for municipalities (BusinessTech, 2023). The increase for Eskom's standard tariff customers will be effective from 1 April 2023 and for municipalities from 1 July 2023. Nersa's proposed increase faced major public backlash from already cash-strapped South

Africans who have experienced restricted access to electricity. Load shedding has been implemented every day in 2023. South Africa has been in a near-permanent state of load shedding since September 2022 (BusinessTech, 2023). With these ever-increasing electricity tariffs, South Africans continues to remain in poverty.

When respondents were asked to rate their level of satisfaction with regard to the electricity provision in their households, the majority of respondents (52%; 132) were neither satisfied nor dissatisfied with the provision of electricity in their households, while those who were dissatisfied and very dissatisfied were 29% and 19% respectively. The results revealed that there were no participants who were satisfied or very satisfied with the provision of electricity in their neighbourhood. This is the clear indication that respondents who participated in the study were not happy with quality of electricity provided to them. A question about quality of electricity supply was also asked to respondents who participated in the interview survey and the following responses were captured:

> *Electricity quality is very poor and bad for our community.*
> *Quality of electricity continue to deteriorate.*
> *Electricity supply in our neighbourhood is poor.*
> *Quality of electricity supply in our township is bad.*

Furthermore, respondents were asked to indicate their reaction to the electricity hike that occurs time and again in South Africa. The study established that a significant number of respondents (96; 38%) said they use other energy sources such as paraffin, gas, coal, wood and candles, followed (88; 35%) by those who said they continued to use the same level of electricity and paid extra amount of money. Only 27% of participants who said they reduced the amount of electricity used in their households. Respondents were further asked to indicate whether in the last 12 months their household had cut back on spending on energy for lighting, cooking or heating in order to make ends meet. The results show that the majority of respondents (138; 55%) in the last 12 months in their households they had occasionally cut back on spending on energy for lighting, cooking or heating in order to make ends meet, while those who rarely and never cut back on spending on electricity were 26% and 13% respectively. Similar question was asked to respondents who participated in the interview survey in Soweto. Participants responses included:

We replaced our lights with energy saving lights and also change some of the appliances to energy saving appliances.

We didn't do anything, but we reduced on buying food and entertainment spend.

We are using solar geyser and replace the stove with gas stove.

We did not do anything; we suffer the increase of electricity.

Finally, when asked to indicate whether they experienced electricity cut-off as result of load-shedding, power cut or equipment failure in their area of residence, the majority of respondents (194; 77%) said they very often experienced load-shedding, power cut or equipment failure in their area of residence. In addition, 58(23%) said they often experienced load-shedding, power cut or equipment failure in their area of residence, while none of the respondents said they never experienced load-shedding, power cut or equipment failure in their areas. Similar question was asked to respondents who participated in the interview survey in Soweto. The following responses were captured:

The lack of Eskom plant maintenance has led to the entire country experiencing black out.

Loadshedding is happening very often due to lack of maintenance.

Loadshedding is affecting the entire community of South Africa and is happening every week.

We were once without power in our neighbourhood for 3 weeks due substation failure.

Loadshedding in our area is happening many times in a day.

A further question was asked to interview participants about how has power cuts / loadshedding impacted or affected their normal life? The following feedback from respondents was recorder:

Electricity crises has led to many of our home appliances damaged and we have to buy new appliances with money that is supposed to be used to buy food.

> *We do not have water due to loadshedding. Municipality reported that water pumps have been damaged due to loadshedding which affected water supply.*
> *We had to throw away lot of food which was spoilt due to loadshedding. More especial meats. Now we buy meat that will be cooked same day.*
> *Power cable was stolen during loadshedding and when power returned, our entire streetlights were off, and we did not have power in our homes for almost 2 weeks.*

The TimesLIVE (2023) newspaper reported that criminals were capitalising on the rolling blackouts. There has been a lot of criminal activities during load-shedding and power failures. Most of these criminal activities are related theft crime, theft out of properties, break-ins at houses and copper theft were top of the list (TimesLIVE, 2023). Load shedding has knock-on effects on home security, and the increased frequency and duration of rolling blackouts in the country are causing damage to these systems. According to BusinessTech (2023), regular power cuts are impacting a range of technologies and communications systems, including alarm systems that starts to malfunction without adequate battery backup. Homeowners are to ensure their battery backups and security support systems are maintained during load shedding (TimesLIVE, 2023).

These findings from the questions asked, speak volumes in terms of the significance of expanding the number and range of role players in the power generation in South Africa. As a matter of fact, these results actually point to a crisis in the energy sector in the country that more role players are required in South Africa to increase power generation. It must be reiterated that the inadequate supply of electricity to the population has had the worst effects on the poor who cannot afford the cost of electricity. South Africa citizens have expressed their desperation to access electricity through copious service delivery protests (BusinessTimes, 2021). Irate citizens endeavour to realise Socio-Economic justice by holding the government responsible for the hardships they endure, when their electricity is disconnected due to their inability to pay for electricity usage (DoE, 2012). The illegal reconnecting of electricity supplies has become a nationwide survivalist tactic for the poor, after it gained popularity through the mobilising of the Soweto Electricity Crisis Committee (SECC), according to Egan and Wafer (2004). It should be accepted that balancing supply and demand for a resource as crucial to human life as electricity is an intricate and continual process (BusinessTimes, 2021). In 1994, as the new South Africa embarked on the twin goals of democracy and development, navigating its way through historical inequalities and underdevelopment, as well as through sometimes adverse global imperatives, it could only have been expected that challenges will be faced along the way (DoE, 2012). These challenges require innovative responses from both the government and its citizens who jointly have to pave the way towards universal access to energy, and the Socio-Economic benefits thereof.

In line with the results above, Zawilska and Brooks (2011) observe that within South Africa, homeowners are also choosing to move to solar panels compared to other energy sources. It is worth noting that South Africa is a leader of solar power, especially because Africa, as a continent, has a long duration of sunshine. According to Amankwah-Amoah (2015), Africa receives many more hours of bright sunshine during the course of the year than any other continent of the earth, with many of the planet's sunniest places being situated here. It is therefore important to note that solar energy is one of the most readily accessible resources in South Africa, as the country's solar-equipment industry is developing. The need to invest in new power-generating capacity has been regarded as an opportunity for transition to the use of more sustainable energy sources, moving away from traditionally coal-fired plants (Winkler, 2007). Options for producing sustainable electricity include locally available sources such as renewable energy technologies and nuclear power, as well as hydroelectricity and combined-cycle gas turbines which are importable from other countries on the continent (DoE, 2012).

6.4 ECONOMIC GROWTH

The Worldbank (2023) reported that South Africa has taken considerable strides to improve the well-being of its citizens since its transition to democracy in the mid-1990s, but progress has stagnated in the last decade. The percentage of the population living below the upper-middle-income country poverty line fell from 68% to 56% between 2005 and 2010 but has since trended slightly upwards, to 57% in 2015, and is projected to have reached 60% in 2020 (Worldbank, 2023). Structural challenges and weak growth have undermined progress in reducing poverty, heightened by coronavirus (COVID-19) pandemic. Arndt, Davies, Gabriel, Harris, Makrelov, Modise, Robinson, Simbanegavi, Van Seventer and Anderson (2020) state that South Africa finds itself at war, and the enemy is the novel coronavirus, which gives rise to the Covid-19 disease. The only tool found to be available to mitigate the demographic effects of Covid-19 is some form of lockdown to reduce contagion by breaking existing social and economic forms of contact (Arndt et al., 2020). Such measures imposed a severe negative shock on the economy, with immediate loss of economic activity followed by medium-term and long-term economic effects. The lockdown measures that South Africa has put into place have profound economic implications (Worldbank, 2023). The implications of the pandemic in the rest of the world, and hence on demand for South Africa's export, are not as large as the effects of the domestic lockdown but are still very large by any normal measure.

The achievement of progress in household welfare is severely constrained by rising unemployment, which reached an unprecedented 35.3% in the fourth quarter of 2021. The unemployment rate is highest among youths aged between 15 and 24, at around 66.5%. According to Worldbank (2023) report, electricity supply shortages have constrained South Africa's growth for several years. Rolling scheduled power cuts (load-shedding) started in 2007 and have intensified exponentially, reaching close to 9 hours daily in 2022 (BusinessTech, 2023). This severe electricity shortfall has disrupted economic activity and increased operating costs for businesses, many of which rely on costly diesel generators (TimesLIVE, 2023). It has also affected other infrastructure such as water, IT, and service delivery (health and education). Arndt et al., (2020) argue that weak structural growth and the COVID-19 pandemic have exacerbated socio-economic challenges. South Africa has recovered its pre-pandemic GDP but not its employment level. At the end of 2022, there were still close to half a million fewer jobs than at the end of 2019, with women and youth persistently more impacted. Inequality remains among the highest in the world, and poverty was an estimated 63% in 2022 based on the upper-middle-income country poverty line, only slightly below its pandemic peak (StatsSA, 2022). These trends have prompted growing social demands for government support, which could put the sustainability of public finances at risk if they are to be met.

In the study, respondents were asked to indicate if they had knowledge or aware of renewable energy and majority of the respondents (188; 75%) said they knew about renewable energy, while only 25% said they were not aware about renewable energy. From these results, a quarter of participants who reside in Soweto did not know or have knowledge of what renewable energy is all about. Clearly these results suggest that more awareness on renewable energy is necessary among the respondents. Government should see to it that all citizens have knowledge of what renewable energy is all about. Also, when asked to indicate their perceptions on whether renewable energy can play a significant role in reducing the electricity bill in households, majority of the respondents (160; 63%) strongly agreed that renewable energy can reduce the electricity bill in their households. There is further 14% of respondents who agreed to renewable energy having potential to reduce their household's electricity bill, while 22% of the participants were not sure about this. This small group who is not sure is possible forms part of the respondents (25%) who did not know what renewable energy is about. A similar question about the possibility of renewable energy reducing electricity bill was asked to interview participants. The following responses were received from participants:

> *Yes, it will reduce electricity bill if government subsidise the supply and installation of solar panels.*
> *Solar panels are very expensive to install and will require subsidy from government in order for household to realise a reduction in electricity bill.*
> *Electricity bill can be reduced with installation of Solar panel in our roofs.*

The findings revealed that majority of the participants in the qualitative and quantitative study, do acknowledge that renewable energy in a form of solar rooftop panels can help in reducing their electricity bill, provided this form of energy generation is subsidised by either government or private institutions. In support of the results above, numerous researchers and green energy enthusiasts have written extensively on solar energy looking at its benefits and different kinds. Some of these authors include Kannan and Vakeesan (2016); Sukhatme and Nayak (2017); Kalogirou (2013); Chen (2011); Foster, Ghassemi, and Cota (2009), to name but a few. In support of the results above, Kannan and Vakeesan (2016) in their study established that world energy demand is growing fast because of population explosion and technological advancements. Hence, they suggest that it is important to go for reliable, cost effective and everlasting renewable energy source for energy demand arising in future.

Similarly, Sukhatme and Nayak (2017) observe that solar energy, among other renewable sources of energy, is a promising and freely available energy source for managing long term issues in energy crisis. On the other hand, Kannan and Vakeesan (2016) share similar sentiments by stating that South Africa has one of the highest solar irradiation levels in the word. This makes solar power an attractive alternative source of energy. According to Smit (2015), solar energy is generated when the sun shines on special photovoltaic cells that use the sun’s radiation energy to generate an electric current. Smit (2015) state that the main benefits of solar power are that it can supply remote areas with reasonably inexpensive power and it is a clean source of energy with no direct emissions. Similar views are shared by Tietenberg and Lewis (2018) who argue that there are numerous benefits of using renewable resources. One of these benefits is that they can be distributed over a wide geographical area, ensuring that developing regions have access to electricity generation at a stable cost for the long-term future (Tietenberg & Lewis, 2018). The latter authors further observe that the sun's heat also drives the winds, whose energy, is captured with wind turbines. Consequently, the winds and the sun's heat cause water to evaporate.

Moreover, respondents were asked to indicate if they were already using the renewable energy in the households. The study found that the majority of respondents (218; 87%) said they were not using renewable energy, while only 34 (13%) said they were already using renewable energy in their households. With regard to the period in which they have been using renewable energy, the majority of respondents (218; 87%) indicated that the statement was not applicable to them. This means that they were not using any renewable energy technologies. The few (13%) that were using or installed renewable energy in their households were installed for the period of: 3 – 6 months (6%); 6 – 9 months (4%) and 9 – 12 months (3%). Likewise, respondents were asked to indicate their level of satisfaction when it comes to the use of renewable energy. The study found that the majority of respondents (218; 87%) were not sure of their satisfaction level with the renewable energy. This is the group of participants that did not have renewable energy in their households. Those that were very satisfied and rather satisfied were 6% and 7% respectively.

When participants were asked to indicate their reasons for not using renewable energy, a significant number of the respondents (132; 52%) indicated that the reason they not using renewable energy it is because renewable energy equipment is very expensive, followed by those who were not sure about its benefits (35%) and those who did not know where they can purchase this technology called renewable energy (13%). As mentioned earlier in this chapter, this supports the call for government to create awareness and educate South Africans citizens about benefits of using renewable energy. In support of these results, promoting the use of renewables in energy portfolios requires assistance from public and private role players, however, investors are more likely to finance mature technologies (Masini and Menichetti, 2013). Many renewable energy technologies are still considered emerging technologies in developing countries and therefore perceived to have a certain degree of uncertainty associated with it. Government support in renewables (including political frameworks, subsidies, and reduced taxes) is essential for successful implementation (Barry et al., 2011; Cherni and Hill, 2009; Jaber et al., 2015; Gabriel, 2016). Both system-level and actor-level (behavioral characteristics of adopters) challenges affect the diffusion of renewable energy technologies, and the challenges experienced are largely influenced by current institutional frameworks (Mignon and Bergek, 2016). Government support also becomes significant when considering the additional costs associated with renewable energy implementation (Blazejczak et al., 2014; Iddrisu and Bhattacharyya, 2015). Cheung et al., (2016). If citizens cannot afford to set up the renewable energy due it being expensive, this will prevent and dent its implementation. The issue of renewable energy being expensive has been topical throughout the world and South Africa is no exception. Many people have actually indicated that one of the main reasons they are not adopting renewable energy in their households it is mainly due to the fact that it is expensive.

When asked to indicate if they believe that affordable renewable energy technologies will promote better economic growth in their household, the majority of respondents (176; 70%) strongly agreed that they believe that affordable renewable energy technologies will promote better economic growth in their household. Also, 6% of the participants agreed to the promotion of economic growth by rolling renewable energy. In addition, those who did not know and disagreed, were 17% and 6% respectively. A similar question was asked in the interviews to participants about the use of clean and cheap renewable energy sources to help improve household social and economic status. The following answers were captured:

> *If subsidy is made available by government, renewable energy sources will help improve family social status and economic status.*
> *Social and economic status of household will be improved if renewable energy can be rolled out.*
> *If not subsidise by government, renewable energy will not bring economic freedom in a household but will definitely improve social status.*
> *Renewable energy will improve household social status, maybe not so much economic status if not subsidise.*

The results reflect a good illustration because the respondents seem to understand the benefit of implementing renewable energy in their household. Participants also understand that renewable energy will not benefit them economically if government is not helping with subsidising this type of technology. Therefore, one can conclude that South African citizens are willing to implement renewable technologies if support and subsidy is provided. According to Nnaji et al., (2010), the use of renewable natural resources combined with efficient supply and use of fossil fuels with cleaner technologies, can help South Africa and other developing countries grow their economies while also replacing existing, inefficient polluting fossil fuel technologies that pollute the environment. Much as this may seem enticing, the issue of affordability particularly in respect of the poor, cannot be taken for granted. As a complementary measure, careful management of energy resources is important to promote economic growth, protect ecosystems and provide sustainable natural resources (Nnaji et al., 2010).

Researchers confirmed that renewable energy lifts economic development besides economic growth and reduces carbon emissions (Abbasi et al., 2020; Tu et al., 2022; Zhao et al., 2022a). In consonance with the International Renewable Energy Agency, renewable energy consumption will increase the global Gross domestic product to 1.1%, enhance human welfare internationally by almost 3.7%, and a progression in employment opportunities by 2030 (IRENA, 2016). There is an extended debate in the current literature about renewable energy and its impact on economic growth. Studies conducted by Bouyghrissi et al., (2021); Kasperowicz et al. (2020); Mohsin et al. (2021) demonstrated a positive and significant relationship between renewable energy, poverty reduction and economic growth and established the energy led economic growth hypothesis. Renewable energy consumption has a direct influence on the growth of the economy according to the growth hypothesis in 57% of the top 38 states of renewable energy consumption (Bhattacharya, Paramati, Ozturk and Bhattacharya, 2016). Bulut and Inglesi-Lotz (2019) reveals the statistically significant and positive influence of renewable energy consumption on economic development in 34 OECD countries.

6.5 ENVIRONMENTAL CONDITIONS / CLIMATE CHANGE

Globally, around three billion people rely on solid fuel mostly fossil fuel, causing health concerns and diseases like pneumonia, chronic respiratory diseases, and lung cancer. The rapid climate change we are now seeing is caused by humans using oil, gas and coal for their homes, factories and transport (BBC, 2023). When these fossil fuels burn, they release greenhouse gases, mostly carbon dioxide (CO_2). These gases trap the sun's heat and cause the planet's temperature to rise (BBC, 2023). It is found that with the 1% increment of growth there will be an increment in CO_2 emission up to 0.84% (Kumar, 2019). According to Worldbank (2023), climate change affects the social and environmental determinants of health, clean air, safe drinking water, sufficient food and secure shelter. Kumar (2019) mentions that reducing emissions of greenhouse gases through better transport, food and energy use choices can result in improved health, particularly through reduced air pollution. WHO (2021) reported that the health impacts of climate change will be determined mainly by the vulnerability of populations, their resilience to the current rate of climate change and the extent and pace of adaptation. In the longer-term, the effects will increasingly depend on the extent to which transformational action is taken now to reduce emissions and avoid the breaching of dangerous temperature thresholds and potential irreversible tipping points.

In the study, the respondents were asked to indicate if they had knowledge of climate change, meaning whether they knew what it is all about. The study found that majority of the respondents (236; 94%) said they had knowledge of climate change, meaning that they knew what it is all about. In addition, responses shows that only 16% of the respondents said they had no knowledge of climate change. Climate change is a topic world over and South Africa is no exception. Therefore, it was good to know that the respondents were aware of climate change. Governments of all nations are hard at work trying to sensitise and educate their citizens about the impact of climate change and its mitigation and adaptation. In support of the results above, Bahadori and Nwaoha (2013) observe that climate change due to greenhouse gases emission from fossil fuels has prompted several governments to channel resources in the commercial utilisation of renewable energy sources. Based on the government's energy policy and the South African Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), the aim has been to diversify away from coal and imported crude oil, helping to reduce climate change and save money and climate (Kumar et al., 2019; Zawilska & Brooks, 2011; Fluri, 2009).

When the respondents were asked to indicate how important is the issue of global warming to them, the study found that the majority of respondents (174; 69%) said the issue of global warming was somewhat more important to them, followed by those who felt that global warming is much more important than other issues (25%). There were only 6% of the participants who did not know the importance of global warming. In addition, respondents were asked to indicate if climate change will have direct negative effect on quality of life. Majority of the respondents (158; 63%) agreed that climate change will have direct negative effect on quality of life, followed by those who strongly agreed (78; 31%). Only 6% of the participants did not know the negative effect of climate change on quality of life.

Generating electricity and heat by burning fossil fuels causes a large chunk of global emissions. Most electricity is still generated by burning coal, oil, or gas, which produces carbon dioxide and nitrous oxide, powerful greenhouse gases that blanket the earth and trap the sun's heat (BBC, 2023). Globally according to Kumar (2019), a bit more than a quarter of electricity comes from wind, solar and other renewable sources which, as opposed to fossil fuels, emit little to no greenhouse gases or pollutants into the air. Climate change increases the factors that put and keep people in poverty. UN (2022) mentions the following effects of global warming: floods may sweep away urban slums, destroying homes and livelihoods, heat can make it difficult to work in outdoor jobs, water scarcity may affect crops. Over the past decade (2010–2019), weather-related events displaced an estimated 23.1 million people on average each year, leaving many more vulnerable to poverty (UN, 2022). Changes in the climate and increases in extreme weather events are among the reasons behind a global rise in hunger and poor nutrition. Heat stress can diminish water and grasslands for grazing, causing declining crop yields and affecting livestock. As greenhouse gas concentrations rise, so does the global surface temperature. According to UN (2022), the last decade, 2011-2020, is the warmest on record. Destructive storms have become more intense and more frequent in many regions. As temperatures rise, more moisture evaporates, which exacerbates extreme rainfall and flooding, causing more destructive storms (WHO, 2021).

Moreover, respondents were asked to indicate their view with regard to every individual doing something to adapt to environmental change. The study found that the majority of respondents (156; 62%) agreed that every individual has to do something to adapt to environmental change. In addition, the results reflected that 32% of the respondents strongly agreed, while only 6% did not know. Notably, the results show that none of the respondents disagreed and strongly disagreed. These results revealed that every individual who participated in the study know or understand that they can contribute towards protecting the environment. Brodie and Watson (2023) showed how human responses to climate change will adversely impact biodiversity. Focusing only on climate change, Kemp et al. (2022) explored various possible climate change scenarios, and concluded that there are ‘ample reasons to suspect that climate change could result in a global catastrophe’. When asked to indicate their perception on whether the grid energy supply has a direct negative effect on climate change, the majority of respondents (130; 52%) agreed and 32% strongly agreed that the grid energy supply has a direct negative effect on climate change. There was only 17% who respondent as do not know if grid energy supply has a negative effect on climate change. It is true that the electricity that is being generated by Eskom is not clean energy. Hence there have been calls for the Eskom to transform by adopting more renewable energy. Consequently, the government has made some great strides in this matter by commissioning a numerous independent power producers to produce clean energy.

When asked to indicate whether the South African government should spend money on campaigns to encourage people to save the environment, the majority of respondents (174; 69%) strongly agreed and 25% agreed that the South African government should spend money on campaigns to encourage people to save the environment. Only 6% who did not know if the South African government should spend money on campaigns to encourage people to save the environment. The importance of saving the environment cannot be over emphasised. Governments all over the world are working very hard to ensure that the environment is protected all the time. More policies have been introduced to protect the environment. Moreover, the respondents were asked to indicate whether clean and affordable renewable energy supply can help to save the environment. The study found that the majority of respondents (188; 75%) strongly agreed that clean and affordable renewable energy supply can help to save the environment while only 25% indicated as do not know if clean and affordable renewable energy supply can help to save the environment.

Smit (2015) mentions that coal is not only a non-renewable resource, but also plays a major role in climate change. Due to the huge amounts of CO_2 and other gases that are emitted during combustion, the generation of electricity through coal has a large carbon footprint and impacts negatively on the country’s water resources, air quality and biodiversity (Kumar, 2019). South Africa is the world's 13th biggest carbon emitter, pumping out 452 million tons of CO_2 in 2020, according to the latest data from the non-profit Global Carbon Atlas that put it four places in front of Britain, an economy eight times as big, and ahead of Mexico and Australia, but it is also blessed with some of the world's best sun and wind resources, and vast stretches of land on which to harvest them (IOL, 2016). In support of the above, as a result of the negative impact of coal-based power generation, alternative (renewable) sources of energy, such as the sun, wind and water, need to be considered. Such alternatives are also more sustainable and have come to be regarded as green energy sources. However, they do not come without a cost to the environment. Kumar (2019) argues that renewable energy projects contribute to improving environmental impacts such as reduction of carbon dioxide gas, awakening community about the climate change. Energy also has strong and important links to the environment.

According to Moriarty and Honnery (2023), the majority of researchers still believe that technical solutions can respond adequately to the problems of climate change, for instance, that a global switch to renewable energy can break the link between CO2 release and gross domestic product (GDP). The proposed technical solutions include greatly improving energy efficiency (Lovins, 2018); replacing fossil fuels by renewable energy and/or nuclear power; carbon dioxide removal (CDR), either by biological or mechanical means; and most ambitious of all, solar geoengineering (Moriarty and Honnery, 2022). The last two approaches would enable continued use of fossil fuels at least until the economic and environmental costs of continued fossil fuel use become too high. Moriarty and Honnery (2023) mention that in a long term, renewable energy may be able to eliminate much of the climate change forcing from energy use. The latter authors further state that this is of little use in the short time we have left to effectively mitigate climate change, as renewable energy is still a minor energy source. Thus, calls for the South African government to educate and create awareness to the larger society about the importance of climate change protection and for South African citizens to do something to protect the environment.

6.6 RENEWABLE ENERGY TRADE OPPORTUNITIES

South Africa’s steady economic growth as it increasingly focuses on industrialisation, together with its mass electrification programme to take power into deep rural areas, has seen a steep increase in the demand for electricity (BusinessTech, 2023). In fact, South Africa’s energy demand is expected to be twice the current levels by 2030. South Africa, which has always been heavily dependent on coal, is looking at ways to diversify its power-generating capacity (DoE, 2022). The Development Bank, the Treasury and Eskom are working on a renewable energy programme that involves independent power producers. The government is also looking to support sustainable green energy initiatives on a national scale through a diverse range of clean-energy options as envisaged in the Integrated Resource Plan 2010 (IOL, 2023). In terms of this plan, which is a 20-year projection on electricity demand and production, about 42% of electricity generated must come from renewable resources (DoE, 2022). Independent power producers have been introduced. Including projects that cover solar photovoltaic technology, wind, small hydro, and concentrated solar thermal generators, these privately held entities and facilities sell power to the government, contributing to the country's energy mix (IOL, 2023).

In the study, participants were asked to indicate what they thought of the cost effectiveness of the present sources of renewable energy. The majority of respondents (160; 63%) said that they do not know anything about the cost effectiveness of the present sources of renewable energy. They were followed by 17% who said the cost from renewable supply is very high, while 13% of the participants said Cost from renewable supply is very high. There was only 6% who mentioned that the cost is low. Moving South Africa's economy into greener energy will require vast funds in the longer term, with some analysts estimating at least $250 billion over the next three decades (IOL, 2016). In South Africa, the demand for installing renewable energy in household is very high in order to mitigate the non-stop load shedding experience by South African citizens. Banking group Capitec estimates that the start-up costs to get solar installed and going off-grid can range from R150,000 to R350,000 (BusinessTech, 2023).

Furthermore, the respondents were asked to indicate types of renewable energy supply they prefer as their source of energy. The study found that all respondents (252; 100%) said they preferred solar as their source of renewable energy. The respondents' preference of solar energy is most likely to be attributed to the fact that solar energy is cleaner and reliable than electricity from the grid. According to BusinessTech (2023), rooftop solar energy is expected to play a major role in dealing with Eskom's failings in South Africa. On the 23 January 2023, South African President, Mr Cyril Ramaphosa said that rooftop solar panels are a significant source of new generation capacity in South Africa, adding that the government is currently working on a pricing structure to allow customers to sell surplus electricity back to the national grid (BusinessTech, 2023).

Moreover, the respondents were asked to indicate what should be done to make renewable energy supply more affordable. The study established that the majority of respondents (176; 70%) indicated that government should provide subsidy to the citizens so that those who cannot afford to install solar panels in their household, will be able to. This was followed by 13% who mentioned that they prefer an option of rent to own renewable equipment's. In addition, 11% of responded that they would like banks to provide low interest loans for renewable equipment. A small group (6%) of participants responded that there is a need to invest in technology, which results in decrease in electricity price. One of the key responsibilities of governments is to make sure that the citizens have access to essential services such as water and electricity. The infrastructure such as water and electricity are key to any community development. Therefore, it is crucial for the government to make sure that all citizens have complete access to these essential services.

When asked to indicate whether the South African government should subsidise clean and cheap renewable energy supply, the majority of the respondents (176; 70%) strongly agreed and 30% agreed that the South African government should subsidise clean and cheap renewable energy supply. A similar question about SA government spending money to promote the use of alternative energy sources such as renewables was asked to participants in the interview survey. The following responses were captured from interview participants:

> *South Africa right now is experiencing many issues with electricity supply, maybe government should promote the use of renewable energy.*
> *The priority for government is to make sure we get renewable energy as the additional source of electricity.*
> *I support the promotion of renewable energy in South Africa.*
> *I agree with promotion of renewable energy supply in South Africa.*

The feedback from participants in the study indicate that all respondents agreed to government promotion and support of renewable energy source. As reflected in the data collected, all participants preferred solar rooftop as an alternative or replacement to grid energy supply. Despite no straightforward procedure for integrating a new rooftop solar initiative in the country, indications from the government point to a possible incentivization for homeowners to get solar panels on their property (BusinessTech, 2023). To incentivise greater uptake of rooftop solar, government and Eskom need to develop rules and a pricing structure such as a feed-in tariff for all commercial and residential installations on Eskom network.

In addition, the respondents were asked to indicate if the South African government should spend money to replace grid energy with clean and cheap renewable energy supply. The study found that the majority of respondents (132; 52%) strongly agreed and 40% agreed that the South African government should spend money to replace grid energy with clean and cheap renewable energy supply. There were only 8% respondents who said they are not sure if South African government should spend money to replace grid energy with clean and cheap renewable energy supply. Renewable energy is the way to go if countries are to curb the ever-changing climate. For instance, in South Africa most of the electricity that is produced by Eskom is generated through coal which is polluting the earth. There have been numerous calls for all countries to adopt renewable energy, and South Africa is currently trying to move to that direction. The White Paper on Renewable Energy of 2003 is one of the policy documents that laid the foundation for the promotion of renewable energy technologies such as solar, hydro, biomass, and wind (DoE, 2022). Through this policy document, a ten-year target of how renewable energy technologies could diversify the country's energy mix and secure cleaner energy was set. South Africa is also seeking to become a hub for so-called green hydrogen and electric vehicle manufacturing, both of which could attract significant private sector investment (IOL, 2023).

In the study, the respondents were asked to indicate if they would be willing to shift to off grid renewable energy supply if a local bank were to provide loans with attractive interest rate in addition to the government subsidy. The study found that majority of the respondents (148; 59%) strongly agreed and 35% agreed that they would be willing to shift to off grid renewable energy supply if local bank were to provide loans with attractive interest rate in addition to the government subsidy. There was only 6% of participants who were not sure if they will be willing to shift to off grid renewable energy supply if local bank were to provide loans with attractive interest rate in addition to the government subsidy. A similar question was asked to interview participants and their responses were as follows:

If solar rooftop panels can be subsidised and made affordable, we are going to install it in our house.

If solar roof panels can bring peace of electricity supply, our home will be the first sign to install solar.

I will support installation of roof solar panels if made affordable.

We support installation of roof solar in our house.

These results suggest that the respondents are aware of the value of adopting renewable energy and they seem to be willing to adopt it. South African citizens have taken energy security into their own hands. Solar energy installation is becoming a regular feature for business of all shapes and sizes, residential users are investing in solar panel installations, and this growth is being accelerated due to prolonged load shedding (BusinessTech, 2023). Pressure to shift away from Eskom has also mounted with by an electricity price increase authorised by National Energy Regulator of South Africa, which granted the utility to increase tariff price by 18.65% on the 01 April 2023 (IOL, 2023).

When asked to indicate if the South Africa government should give priority to clean and cheap renewable energy in order to meet its future energy needs and demands, majority of the respondents (192; 76%) strongly agreed and 14% agreed that the South Africa government should give priority to clean and cheap renewable energy in order to meet its future energy needs and demands. There were only 10% respondents who were not sure. In concurrence with these results, Kumar, et al. (2019) observes that solar energy plays a significant role in areas where electricity is not available. On the other hand, Zawilska and Brooks (2011) note that one of the most glaring benefits of using solar power is that it is renewable, clean and has no direct emissions, compared to other traditional methods of power production. Similarly, Fluri (2009) argues that solar panels can be used almost anywhere in South Africa and are suitable for low energy use such as lights and television. South Africa has taken off on a new trajectory of sustainable growth and development Since 2011 the country has introduced a world class competitive bidding process, which to date has delivered 92 Independent Power Producers who will contribute in excess of 6,327 MW (DoE, 2015). This world-renowned programme is set to inform the design of other related programmes on the continent and across the globe. The REIPPPP programme has successfully created an enabling framework for attracting substantial private sector expertise and investment for utility scale renewable energy (DoE, 2022). It has delivered cost effective, clean energy infrastructure to the country and contributed to the security of electricity supply that is expected to bring about a virtuous circle of investment and economic growth.

The successful introduction of renewable energy into the country's electricity generation mix is founded in the Constitution and given effect in three key policy development steps (DoE, 2015): White Paper on Energy Policy (1998), Renewable Energy White Paper (2003) and National Climate Change Response Policy White Paper (2011). The objectives of the White Paper on Renewable Energy of 2003 were to (DoE, 2022):

- Ensure that an equitable level of national resources was invested in renewable technologies.
- Direct public resources to implementation of renewable energy technologies.
- Introduce suitable fiscal incentives for renewable energy.
- Create an investment climate for the development of the renewable energy sector.

In line with the national commitment to transition to a low carbon economy, the Integrated Resource Plan (IRP 2010) which was promulgated in May 2011 set a more ambitious target of 17 800 MW of renewable energy to be achieved by 2030 in respect of the electricity generation mix (DoE, 2015). Within this 20-year planning horizon, about 5000 MW were planned to be operational by 2019, with a further 2000 MW expected to come online by 2020. The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) was established by the Department of Energy (DoE) in conjunction with the National Treasury and the Development Bank of Southern Africa (DBSA) at the end of 2010 (DoE, 2015)". The REIPPPP is one of South African government's urgent interventions to enhance the country's power generation capacity. Its main objective is to secure private sector investment for the development of new electricity generation capacity, thereby giving effect to the policy decision to diversify South Africa's energy mix which was articulated in the 1998 White Paper on Energy Policy of South Africa (DoE, 2022). The REIPPPP has also been designed to contribute to broader national developmental objectives such as job creation, social upliftment, and economic transformation primarily through broadening of economic ownership (IOL, 2023). If the REIPPPP is implemented correctly, there will be business opportunities for Small and Medium Enterprises (SME) in the form of solar rooftop panel installations and this will also present an opportunity to address the job scarcity that South Africa is facing. To address job scarcity, government require to promote and support local manufacturing of solar rooftop panels and steel frames that support solar panels.

6.7 SUMMARY

This chapter discussed the main results of the study. In addition, this chapter interpreted and described the significance of results based on what was already known with regard to the research problem under investigation. Furthermore, this chapter has clarified new understanding or fresh comprehensions about the problem as the researcher has taken the results into consideration.

The next chapter will present the summary, conclusions and recommendations based on the results of the study.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATION

7.1 INTRODUCTION

The previous chapter provided a discussion of the study's results based on the objectives and themes developed in the presentations of the study. This was to answer the main aim of the study, which was to develop a renewable energy framework towards poverty reduction in South African townships focusing on the Soweto township as a case study, through a survey in which the interview and questionnaire were used to gather data to enhance economic growth and better Socio-economic status of the people living in the South African townships. The results discussions were contrasted with empirical literature and findings of other scholars to validate the study's findings. This chapter provides concluding remarks and recommends based on the results of the study. This chapter also present a proposed framework developed to reduce poverty in the South African township using renewable energy technology. In addition, this chapter presents recommendations for further research. Furthermore, the chapter concludes by presenting a summary of the study.

7.2 STUDY CONCLUSIONS

The research conclusion summarises the discussion of the results chapter in relation to the null hypotheses of the study, discusses components of the proposed framework and concludes by either accepting or rejecting the null hypothesis.

H_1: There is no relationship between access to affordable renewable energy and socio-economic conditions in urban areas.

The study sought to examine the role of the renewable energy as a tool for poverty reduction strategy in Soweto Township. Based on the results of the study it can be concluded that although the majority of respondents were not using renewable energy, however, they are of the view that renewable energy can play a significant role in poverty reduction in Soweto Township. This did not come as a surprise because the majority of respondents indicated that they were aware of renewable energy. It is worth pointing out that their knowledge of renewables could easily imply that it would be easier for them to adopt it when the time is right to do so. Although "the majority of respondents said they have never used renewable energy before this should not be seen as a serious challenge given the fact that overall, very few South Africans are using renewable energy as a source of power in their households. Even the SA government has only recently approved bringing on board independent power producers to add energy to the grid. This is attributed to the power outages that the country is currently grappling with. The constant power outages have seen the rise in unemployment rate as more companies had to shut down their operations due to power outages. Without power supply it is impossible for some of the companies to operate.

Renewable energy supply plays an important role in enhancing energy diversity, long-term energy security and environmental protection. Renewable energy offers attractive and diverse options for rural areas and urban areas in achieving sustainable energy services. Although the implementation of renewable energy is perceived as expensive, as the technology matures and the markets expand, it is likely that the initial and implementation costs will decrease through achieving economies of scale. The implementation of renewable energy technology can offer a variety of socioeconomic impacts both on a national level, as well as on a local level. These benefits can result in increased social cohesion and stability coming from the introduction of an activity that generates employment and income, as well as an overall increased standard of living in terms of environment, health, and education.

In this study, the participants expressed satisfaction with renewable energy. In general, the participants perceived renewable energy as a positive development in their neighbourhood. They felt that renewable energy technology can lead to modest improvements in their social condition and economic condition. Considering the empirical outcome of this study and the literature cited in the study, this study therefore, concludes that there is a relationship between access to affordable renewable energy and socio-economic conditions in urban areas of South Africa. Thus, the null hypothesis is rejected.

H_2: There is no relationship between access to affordable renewable energy and poverty reduction in urban areas.

When it comes to the method of accessing electricity in the household, majority of the respondents were accessing the electricity through an in-house post-paid meter. This situation reflects the strong monopoly held by Eskom that has been in existence for many years. Due to the power cuts that are currently being experienced in the country, there has been a serious and constant outcry among many South Africans for the government to approve the inclusion of independent power producers to generate more electricity for the country.

In addition, the study found that the majority of respondents are spending R1001 – R2,000 to buy electricity on a monthly basis, followed by those who spent R2001 – R3000. It is worth pointing out that this is a significant proportion of family income to be spent on electricity on a monthly basis because most of the respondents indicated that they were earning not more than R12,000 in their households. Interestingly, the majority of respondents were neither satisfied nor dissatisfied with the provision of electricity in their households. This came as a shock given the fact that South Africa is currently and constantly faced with power outages that continue to ravage the economy. Sadly, in some areas of the country, there has been a rise in crime due to load-shedding as the streets turn dark time and again. Criminals are well-known for enjoying performing their criminal acts in the dark. In as far as reaction to electricity hike is concerned, the study found that a significant number of respondents said they use other energy sources such as paraffin, gas, coal, wood and candles. The other energy sources have been used in many households not only because of electricity hikes, but as the main source of energy. This is because in some areas there is no electricity, and therefore, as a result, community members are forced to use energy sources such as paraffin, gas, coal, wood, and candles.

Moreover, the study found that for the majority of respondents in the last 12 months during the time period of the data collection, cutbacks on their spending on energy for lighting, cooking or heating had been essential in order to make ends meet. Furthermore, the study also found that the majority of respondents said they very often experienced load-shedding in their area of residence. This did not come as a surprise at all given the fact that load-shedding is currently a hot topic in South Africa. The country is facing unending power-cuts that have proved to be stubborn to dismiss. These power cuts suggest that alternative power sources are extremely necessary to alleviate the load-shedding in the country. Recently, government has been hard at work trying to bring more renewable energy supplies to address the issue of power cuts in the country.

Renewable energy technology and poverty reduction issues are related in numerous ways. Lack of access to adequate and clean energy sources is detrimental to the living conditions of people, on their health as well as on their capacity to engage in productive activities. This can result in situations where people are stuck in poverty. Urban poverty has a bearing on the types of energy consumed, which in turn affects health, education and income earning opportunities. Therefore, giving people access to affordable and clean energy sources as an important lever of poverty reduction policies, shows that a significant proportion of the population in South Africa lack access even to the most basic energy supplies and services. The implementation of renewable energy systems in South Africa will help alleviate poverty. It is of utmost importance that the government and renewable energy policy makers should support the usage and implementation of renewable energy technologies in South Africa in order to reduce poverty that South Africans are subjected to. Considering the empirical outcome of this study and the literature cited in the study, this study therefore, conclude that There is a relationship between access to affordable renewable energy and poverty reduction in urban areas of South Africa. Thus, the null hypothesis is rejected.

H_3: There is no relationship between access to affordable renewable energy and economic growth in urban areas.

When asked to indicate their perceptions on whether renewable energy can play a significant role in reducing the electricity bill in households, the study found that majority of the respondents strongly agreed that renewable energy does reduce the electricity bill in their households. It is true that in many households there are always one or two forms of renewable energy. These include gas, paraffin, coal, wood, etc. Although many households in South Africa mainly rely on electricity for cooking, lighting etc., however, equally so, numerous households still rely on gas, wood, paraffin for similar activities. The study was also interested in the respondents' reasons for not using renewable energy.

The study found that a significant number of the respondents indicated that the reason they do not use renewable energy is because renewable equipment is very expensive. It has been observed that the start equipment is expensive for many people. However, it is worth noting that renewable energy such as solar panels is more expensive at the implementation phase because that is where the necessary equipment is required and that is where money is required. Thereafter, no money is required as the power is generated from the sunlight and the only money that is required is for the maintenance. In addition, respondents believe that affordable renewable energy technologies will promote better economic growth in their households. This could be true given the fact that one pays for renewable energy equipment such as solar panels and other essential equipment such as batteries only once and thereafter the sunlight takes its course.

Several studies suggested that the consumption of renewable energy has a positive correlation with economic growth. The increase in renewable energy usage enhances the overall welfare of the people beyond the gross domestic product of the country. It creates new jobs and business opportunities for the general public and entrepreneurs. The growth hypothesis positions that energy has a positive indispensable role in the expansion of an economy. Furthermore, energy and its consumption has a significant impact on the development of a sustainable economy. Therefore, renewable energy is the driver of economic growth. The growth hypothesis states energy plays a positive essential role in the development of an economy and supports the uni-directional causality between renewable energy consumption and economic growth in the long run. In summary, political, financial, and economic country risks directly or indirectly affect renewable energy and economic development, and therefore play an important role in the relationship between renewable energy consumption and economic growth. Considering the empirical outcome of this study whereby majority of respondents strongly agreed (70%) renewable energy will create improvements on household economic status and the literature cited in the study, this study therefore, conclude that There is a relationship between access to affordable renewable energy and economic growth in urban areas of South Africa. Thus, the null hypothesis is rejected.

H_4: There is no relationship between access to affordable renewable energy and environmental conditions in urban areas.

Moreover, the majority of respondents said they had knowledge of climate change, meaning that they knew what it is all about. Climate change is a serious topic throughout the world and everyone is required to rise to the occasion and do their part. The current method used by Eskom to generate electricity is not recommended by environmentalists and those advocating for clean and green energy. Therefore, it is instructive to know that respondents were aware of climate change. In addition, the majority of the respondents are of the view that climate change will have direct negative effect on quality of life.

The majority of the respondents strongly agreed that the South African government should spend money on campaigns to encourage people to save the environment. This could play a significant role in educating community members to equip themselves on what climate change is about. Once they are fully aware of what climate change is all about, they stand a good chance to mitigate the dangers posed by the ever-changing climate. The majority of the respondents strongly agreed that clean and cheap renewable energy supply can help to save the environment. Therefore, one may only hope that government and those responsible for framing policies about the adoption of renewable energy will continue to advocate for the adoption of renewable energy in many communities in South Africa.

Climate change is caused by the emission of greenhouse gas (GHG) which happen as a result of human activities and impact on the environmental conditions. The more greenhouse gas emitted, the more climate heats up and the worse the direct and indirect impacts on human and environmental conditions. South Africa’s dependence on coal as a primary fuel source for electricity generation makes it one of the world's top 15 greenhouse gas (GHG) emitters. To effectively deal with climate change and its direct and indirect impacts on human and the environment, we need to lessen the emission of greenhouse gas. The most effective energy generation sources that are essentially without emissions are typically climate dependent, which is especially the case for renewable energy resources such as wind and solar. Renewable energy sources generate energy without the use of fossil fuels and therefore reduces some types of air pollution which assist with reducing the effects of global warming and yet better the environment. Renewable energy sources such as solar and wind do not emit carbon dioxide and other greenhouse gases that contribute to global warming. Renewables make urban energy infrastructures more autonomous from remote sources and grids. Many businesses and industries in South Africa are committed in saving the environment and therefore, invest in renewable energy projects in order to avoid disruptions, including resilience to weather-related impacts of climate change.

Additionally, renewable energy technologies offer the opportunity to contribute to social and economic development, energy access, secure energy supply, climate change mitigation, and the reduction of negative environmental and health impacts. Economic development has been strongly correlated with increasing energy use and growth of greenhouse gas emissions, and renewable energy can assist the dissociate of that correlation, contributing to sustainable development. Renewable energy technologies can provide other important environmental benefits. Renewable energy technologies, in particular non-combustion-based options such as solar and wind, can offer benefits with respect to reducing air pollution and related health concerns. The empirical outcome of this study whereby majority of respondents agreed (63%) that environmental change or climate change will have a direct negative effect on the quality of life. This is also supported by literature cited in the study. Therefore, this study concludes that there is a relationship between access to affordable renewable energy and environmental conditions in urban areas of South Africa. Thus, the null hypothesis is rejected.

H_5: There is no relationship between access to affordable renewable energy and trade opportunities in urban areas.

Furthermore, the study found that all the respondents would prefer solar as their source of renewable energy. Solar energy is regarded as one of the cheapest and clean renewable energy as it relies on the sunlight to generate electricity. Solar panels are even easy to install as one place them on top of the house roof. Hence, the majority of the respondents were of the view that government should provide subsidy to community members who deserve it to make renewable energy supply more affordable. Some of the respondents believe that one needs to invest in technology which results in decrease on the electricity price. There are respondents who think that banks should provide low interest loans to community members to implement solar energy. Another critical point worth noting is that when it comes to the issue of government on replacing grid energy with renewable energy, the majority of respondents strongly agreed that the South African government should spend money to replace grid energy with clean and cheap renewable energy supply.

South Africa’s enormous potential for a green economy and renewable energy, particularly solar, wind and hydro energy can help secure the country’s energy supply, boost foreign direct investment (FDI) and improve South Africa energy security. Promoting a green economy also means creating employment opportunities and helping the country meet its future climate commitments. South Africa has enormous potential to diversify into renewable energy production when compared with other regions. The country claims some of the greatest sustained sunlight in the world. The promotion of the country’s energy mix to supply constant and reliable power will provide business prospects for the public and private sector, while creating new job opportunities, even if the renewable energy supply is mainly deployed using Eskom’s existing infrastructure and municipal power grid, new job options will be created by the utility and Municipality. If Eskom were to procure, and subsequently, supply a constant, affordable and reliable renewable energy via Independent Power Producers (IPPs) as part of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), this would create more investment and business opportunities within the private sector.

Furthermore, renewable energy deployment has a potential to enhance the economy and attract further foreign investment. The implementation of the new renewable energy projects across the country will include industries outside of the energy sector, in terms of the construction of infrastructure, steal manufacturing sector, service sector, innovation and technology sector. The involvement of other business sectors in the deployment of renewable energy projects will assist South Africa to address the challenge of job creation and create business to small and medium enterprises (SME). Considering the empirical outcome of this study whereby majority of respondents strongly agreed (59%) that there are willing to shift to off grid renewable energy supply if local bank provides loans with attractive interest rates in addition to the government subsidy. This is also supported by literature cited in the study. Therefore, this study concludes that there is a relationship between access to affordable renewable energy and trade or business opportunities in urban areas of South Africa. Thus, the null hypothesis is rejected.

7.3 STUDY RECOMMENDATIONS

The primary objective of the study was to investigate the role of clean and affordable renewable energy as the alternate source of energy in reducing urban poverty and contribute to poverty reduction in Soweto neighborhood. In support of the above primary objectives, the study sought to establish renewable energy practices towards poverty reduction in Soweto, establish if an increase of renewable energy improves energy access, therefore reducing urban poverty architecture, improves socio-economic status and increase economy, identify trade opportunities in green energy power and the renewable energy sector for community sectors, and to develop a renewable energy framework that would reduce poverty, thereby improving economic growth and better socio-economic status of the people living in the South African townships.

The study therefore proposes a conceptual framework below for clean and affordable renewable energy as a poverty reduction strategy, developed based on the above-mentioned study objectives. As proposed in chapter 2 (figure 2.5) and empirically tested in chapter 5 (figure 5.40), the following detail framework is developed for renewable energy technology as a poverty reduction tool.

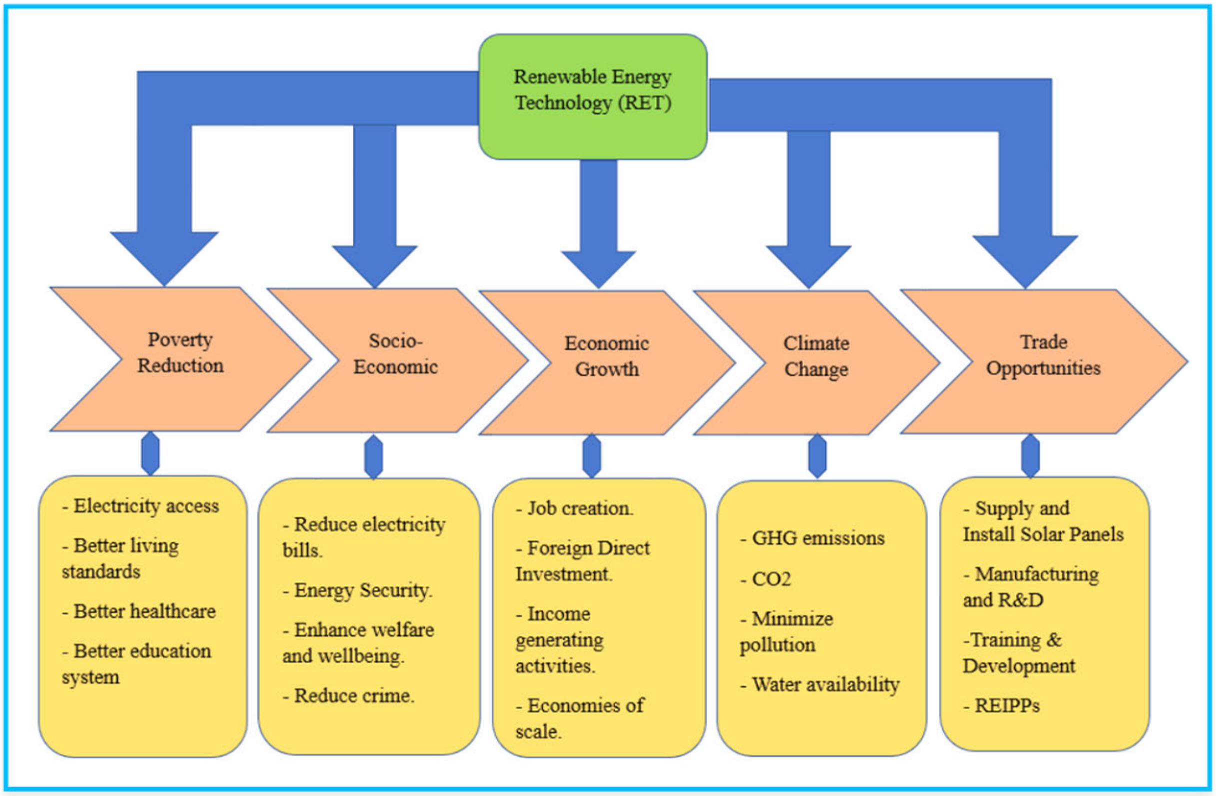


Figure 7.1: Proposed detail framework for renewable energy as a poverty reduction tool.
Source: Author's own (2023)

The impact of load shedding (rolling electricity blackouts) has affected South Africa's power sector since 2008; however, as of 2020 the impact across multiple sectors has become amplified. Between November 2022 and March 2023, South African businesses and households have experienced some form of load shedding or power failure every working day, and as a result, on February 09, 2023, the South African President, Cyril Ramaphosa declared a national state of disaster to respond to the electricity crisis in his State of Nation Address.

This declaration emphasises the degree of the challenge facing South Africa and its different stakeholders. As a result of the rolling electricity blackouts, there is a need for South Africa to urgently implement different technology of generating electricity in a form of renewable energy technology. In addition, clean energy plays a crucial role in achieving the Millennium Development Goals (MDG) such as reducing poverty, improving Socio-Economic status, growing economy and saving the environment. In order for renewable energy to be accepted in a society as an alternative power source that addresses the challenges currently faced by South Africans, it need to meet the two essential criteria: low prices that are affordable to low-income people and basic functioning that address people's social needs.

Renewable energy development brings advantages on the society in South Africa. These advantages were discussed in detail in Chapter 3 of the study. According to the interview results respondent believe that South African government should spend money in investing to renewable energy technology, in particular solar panels. The installation of solar panel will provide lighting for health centers which assist in products storage such as vaccines and medications for the best functionality of the hospitals. In addition, some of the respondents in the interviews mentioned that solar panel installation will help with reducing their electricity bill. Renewable energy will also help with food storage in some houses and the progress of work at offices during a power outage. Another benefit of renewable energy includes the reduction of the use of firewood for lighting and cooking for rural communities, which lowers the number of people affected by respiratory diseases due to inhaling smoke produced using burning wood for cooking. There has also been an improvement in water availability and access to potable water due to solar pumping for the communities. The data collection findings from the interviews showed that the impact of load shedding in South Africa has affected students when studying for exams. One of the participants mentions …*Our daughter is doing Grade 12 and requires studying and prepare for Grade 12 exams and trials, but fluctuating Loa shedding has affected her studying routine which led to her poor performance in Grade 12.…* The use of renewable energy will help students in their studies have a better opportunity to study so that they can achieve better results. Overall, the use of renewable energy will also help public facilities to have light and will add substantial social benefits in increasing small business activities thereby reducing the level of unemployment and contributing to better overall health.

In rural areas, the majority of households continue to rely on the use of firewood for cooking causing women to inhale a lot of smoke while taking home care. This continues to cause respiratory issues amongst other health issues. Based on the study findings, majority of participants in the interviews believed that there is a need for South African governments to subsidise and roll out renewable energy technologies that will be appropriate based on the local concept and communities, and affordable. Currently, an important barrier is the high cost of solar equipment which discourage its wide adoption. It is essential that instead of importing renewable energy technologies, a critical evaluation and research is done in the country to identify the best technology that will be most appropriate to South Africa and build appropriate knowledge to help manufacture these technologies in country at reduced prices. Besides, if strong policy regulations are put in places such as the introduction of laws that protect air quality, water, and the environment this will encourage people to switch to best practices for better results.

The sections below, present further recommendations of the study

7.3.1 Awareness of renewable energy

Although the majority of respondents said they were aware of renewable energy, a significant number of them said they were not aware at all of what renewable energy is all about. More needs to be done to promote communication and awareness of renewable energy and renewable energy technologies. Therefore, the study recommends that government should create awareness around renewable energy in communities around the country. This awareness can be managed through municipalities if they work closely with community members.

7.3.2 The use of renewable energy

The study found that the majority of respondents are not using renewable energy because they believe that renewable equipment cost is very expensive, and some respondents said they are not sure about its benefits. The study therefore recommends that major banks should create renewable energy financing products in their list of product offer. Also, government should provide the citizens with affordable renewable energy equipment, such as solar panels to those that are regarded as poor and also provide incentives to those that implement solar panels in their household. In addition, government should motivate and educate South Africans about different types of renewable energy and the benefits that renewable energy brings to the community and the environment, which citizens can use as a source of clean and green energy. A reduction in the initial cost (or form of subsidy) of renewable energy technology is critical in order to make them more competitive with conventional technologies.

7.3.3 Methods of accessing electricity in the household

When it comes to the method of accessing electricity in the household, the majority of respondents said they are accessing electricity through an in-house post-paid meter. Although this did not come as a surprise, the study recommends that the utility and Municipalities should replace all post-paid meters with pre-paid meters, as this will assist the utility and Municipalities to ensure revenue is collected from household electricity consumption. In addition, government should educate and provide alternative power generation for the citizens to choose from and these alternatives should be cheaper, more reliable and cleaner energy sources. This alternative power source should be in a form of renewable energy, in particular solar panels for household. It is further recommended that renewable energy technology projects should have a pro-poor focus.

7.3.4 Types of energy supply

The study found that the majority of respondents in Soweto receive electricity from Eskom. Therefore, the study recommends that more clean and cheap energy suppliers are provided to the citizens via the utility, Municipalities and private energy power producers. It is believed that the more the country has more role players in the power production, especially renewable energy, the country will be able to eradicate load-shedding, while creating job opportunities for Independent Power Producers. Legal and regulatory frameworks should be put in place to give equal access to independent power producers operating with renewable energy technologies.

7.3.5 Load-shedding

The study found that most respondents said they very often experienced load-shedding in their area of residence. Therefore, the study recommends that the government should ensure that there are more role players in the energy production industry to provide cheaper and clean energy to the South Africans. In order to assist with addressing load-shedding challenges, private and public sectors need to work together to invest in research and development (R&D) of the renewable energy technologies that will be safe, reliable, affordable and clean energy sources. R&D in the renewable energy technology should be promoted in order to develop the local industrial market.

7.3.6 Climate change

Although the study established that the majority of respondents (94%) were aware of climate change, and a small number (6%) were not. Therefore, the study recommends that government should educate the citizens about what climate change is about and what everyone can do to mitigate it and protect the environment. It is important to note that one of the methods of mitigation climate change is the adoption of renewable energy such as solar panel energy supply. Training and skills development in renewable energy technology in relation to climate change for nationals should be promoted as a private and public initiative.

7.4 CONTRIBUTIONS OF THE STUDY

7.4.1 Contribution of the study to the Body of Knowledge

The study adds to the body of knowledge, the element of the South African energy industry in the context of renewable energy as the strategy for poverty reduction in South African communities. The study contributes to the growing body of literature aimed at providing greater insight into the South African energy supply. It draws a link between renewable energy practices in chapter 3, poverty reduction and the empirical results within the South African township, which, as per the knowledge of the researcher, there is not many studies conducted within this scope. The study developed a business framework that can be consulted by aspiring entrepreneurs who intend embarking on trading or starting a business in the field of renewable energy. Moreover, the research provides an opportunity for future researchers to further perform validity testing of the framework in a different industry or expand on the scope of research.

7.4.2 Contribution of the study to community

The literature in chapter 3 of the study revealed that renewable energy saves lives. Not just the life of the planet but the entire ecosystem, including the lives of many people in the communities. This section discusses the cost and benefit of adopting green energy in Soweto. The cost benefit of green energy is illustrated in four categories, namely: economic, social, environmental and government. The study further discovered that the participation and ownership by citizens or members of Soweto in a green energy project will creates local socio-economic value, creates local jobs, boost the township economy, and helps encourage positive opinions or views towards green energy technology. This, in turn, increases citizen and community participation for the green energy transition towards renewables, which further contributes towards achieving the government targeted goals of energy mix to aid South African communities from the effect of loadshedding.

In addition, the study revealed that the impact of loadshedding and power failures in the community has resulted in most local township businesses closing and some reducing operating hours. The contribution of the study to the community is that, the increase access to energy in the community emanate from the availability of renewable energy technology will simply means extended hours to conduct night-time economic activities, which leads to more productivity that generates further income and helps with local job creation by employing local staff in the communities to install, monitor and maintain solar photovoltaics (PV) mini-grids and ensure that households and businesses are paying for the energy services on time.

Training and development of community members and staff involved in the renewable energy projects should be initiated to empower those that are involved in this project. The study also concluded that deploying solar panels to the households will help communities to save money in a long run and receive reliable electricity in their households. By deploying solar panels, not only communities should they save money in the long-term, but they should offer reliable, renewable energy sources for powering all types of activities, from working from home and online schooling to family entertainment. Furthermore, the study, in its review of energy sources in chapter 3 that solar solutions help reduce emissions and combat climate change in communities, while also helping to protect against energy shortages. With so many advantages, there is no doubt that solar solutions can provide an invaluable asset to any household.

7.4.3 Contribution of the Study to energy utility

In South Africa, the electricity supply is mainly coal-based and generated by Eskom. South Africa is currently facing the growth in demand for energy which resulted to the larger community experiencing non-stop loadshedding. The growth in demand and lack of the utility to meet the country energy demands, is not the only reason for renewable energy supply options. The most important reason for the utility to prioritise the transition to renewable energy is because coal and other fossil fuels produce carbon dioxide when burned to produce energy. The carbon dioxide produced by Eskom represents a serious environmental threat to South Africa and the world at large. The study concluded that climate crisis is strongly related to energy supply options, with coal being main contributor to electricity generation, will result to urban and rural air pollution. If renewable energy is adopted by the utility, the utility will provide reliable and sustainable energy supply to the country, which in turn improves energy security, reduces and ultimate remove loadshedding. Using renewable energy, the maintenance requirements are lower than with traditional energy technology. In South Africa, there is an unlimited supply of sunlight which will assist the utility with generating and producing reliable and stable energy.

7.4.4 Contribution of the Study to business

Solar panel energy generation is becoming more popular in South Africa due to repeated load-shedding and the increasing electricity costs that businesses and energy consumers are subjected to undergo. The state-owned power utility in South Africa, has been plagued by issues of mismanagement and aging infrastructure, resulting in repeated power outages. As a result, individuals and businesses are seeking alternative sources of electricity such as solar power to ensure that they have power even during load shedding. The requirements for solar systems and solar installation services have increased as both individuals and businesses seek to switch to more reliable and sustainable energy sources. Solar panel solutions offer various advantages to businesses, providing improvements in operational efficiency, environmental impact and energy restrictions. On the operational side, solar panel solutions offer improved energy autonomy and cost efficiency. Solar energy is more reliable than grid electricity, reducing the risk of power outages. Additionally, solar solutions also reduce dependence on rising energy costs and produce clean energy at a lower cost. All these factors mentioned have created an attractive business prospect for entrepreneurs to venture into the solar panel supply, installation and maintenance business in South Africa. This section outlines the contribution of the study to business by presenting a generic solar panel business plan in South Africa.

The business plan structures are considered for creating a business in solar panels installations and services. The study revealed that majority of the participants agreed that they can invest in implementation of solar panels in their households if South African government provide subsidy to the roll out of solar panels. In Chapter 2, a business model canvas for start-up renewable energy business was presented. Furthermore, building from the theoretical frameworks in chapter 2: SWOT, PESTEL and business model canvas and informed by the study findings, a detail business plan framework follows created and ready to be used for a startup enterprise and aspired entrepreneurs within South Africa. This business plan framework is informed by the outcomes and empirical findings of this study. This business plan framework can serve as a template that other people or solar power entrepreneurs could use as a model and construct their business plan accordingly. For the purpose of this study, the enterprise name is called Gina Solar Energy (GSE) Pty Ltd.

i. Industry Overview

The increase in the load shedding and power failures in the context of South Africa is a major problem at present. There is uncertainty as to how to solve this problem as long as we depend on the existing source i.e., coal. So, the time has come to go for alternative energy source like solar power supply. Most of the activities in the government as well as private business, banks, hospitals, hotels, schools, manufacturing etc., are significantly detrimentally affected by increasing load shedding. At the household level, people are bound to stay in the darkness, apart from news, television, radio, water pumping problem in the communities. Acknowledging all these challenges, the establishment of solar panel installation business is essential in South Africa. Solar panel installation is rapidly gaining huge market acceptance all over the globe and in South Africa, simply because of how efficient and beneficial it has become to most people. Solar panel is a device that helps convert sunlight into electrical energy and stores it for use.

ii. Business model

Gina Solar Energy (Pty) Ltd presents the market with reliable, affordable and convenient solar panel solutions for the people and businesses suffering from load shedding and power failure related challenges. We are a solar panel sales, installation, maintenance and service company that is set to compete in the highly competitive solar panel installation, maintenance and repair services industry not only in South Africa, but also throughout the South African Development Community (SADC) market. GSE will offer services such as solar panel sales, installation, repair, servicing and maintenance. Its mission will focus on areas of chronic urban poverty in order to play a commercial part in poverty alleviation.

iii. Products and Services

GSE was established with the aim of maximizing profits in the solar panel sales, installation, maintenance and repair services industry. GSE products and services are listed below:

- Sale and distribution of solar panel and accessories
- Servicing, maintenance and repair of solar panels
- Roof mounted panel installation
- Solar tracking panel installation
- Ground mounted panel installation
- Fixed rack panel installation
- Monitoring services
- Other related solar panel installation, maintenance and repair services

iv. Business Structure

At GSE, we will ensure that we employ people that are qualified, hardworking, creative, customer centric and are ready to work to assist us build a successful business that will benefit all the stake holders (the owners, workforce, and customers). In view of the above mentioned, GSE will hire qualified and competent staff to occupy the following positions:

- Chief Executive Officer
- Sales and Marketing Executive
- Operational and Technical Executive
- Financial Manager
- Administration Manager
- Solar Panel Installation, Repair and Maintenance Technicians
- Client Service Support and Consultants

v. Market analysis

The demand for solar panel installation services in South Africa has been increasing due to a variety of factors. The unreliability of Eskom’s power supply and regular load shedding have led to individuals, households and businesses to seek alternative power sources, such as solar energy. The escalating cost of electricity has made solar energy an attractive choice for those looking to save money on their energy bills.

vi. Market Trends

The market trend in the solar panel installation, maintenance and repair industry is that companies in this industry install solar panels as part of general residential and commercial contracting services. The government’s push for renewable energy and various incentives for solar adoption will contribute to the growing demand for solar panel installation and services. In the coming years, requirements for solar panel installation and service are projected to continue growing.

vii. SWOT Analysis

As part of the market analysis and the research conducted in the study to determine the market in Soweto neighbourhood, the business has conducted a comprehensive SWOT analysis for GSE. SWOT analysis has been conducted to assist GSE in building a well-structured solar panel installation, maintenance and service business that can constructively compete in the highly competitive solar panel installation, maintenance and repair service industry in South Africa and SADC. For summary of SWOT analysis, please refer to figure 2.2 in chapter 2.

viii. Target Market

The empirical study conducted in this research revealed that majority of respondents agreed that they will install solar panels in their households if government subsidies and banks can fund these projects. In view of that, the target market for GSE includes homeowners, real estate Owners, hotels, schools, small and medium-sized businesses, and large corporations looking to invest in solar panels. The business will focus on specific areas or industries to shape out a niche market, such as residential estates.

ix. Sales and marketing strategy

As a business, we are mindful of the fact that there is tougher competition in the solar panel installation, maintenance and repair services industry; hence we will be able to hire some of the best marketing experts to handle our sales and marketing. GSE is set to make use of the following marketing and sales strategies to attract clients:

- Introduce our solar panel installation, maintenance and repair service company by sending introductory letters alongside our brochure to individuals, households, corporate organisations and key stake holders.
- Promptness in bidding for solar panel supply, installation, repair, and maintenance contract from the government and other corporate organisations.
- Advertise our business in relevant business magazines, newspapers, TV stations, and radio station.
- List our business on local directories.
- Attend relevant international and local expos, seminars, and business fairs.
- Leverage on the internet to promote our business.

x. Pricing Strategy

At GSE, we are targeting low-income customers to make the poverty reduction link. Therefore, we will keep the prices of our supply and services below the average market rate for all of our customers by keeping our overheads low and by collecting payment in advance from corporate organisations who would hire our services. Pricing of the solar panels and services will be mentioned in Rands (RZar) in our webpage.

xi. Sources of Income

At GSE, we will generate income by offering the following solar panel installation, maintenance and repair related services:

- Sale and distribution of solar panel and accessories
- Servicing, maintenance and repair of solar panels
- Roof mounted panel installation
- Solar tracking panel installation
- Monitoring services

xii. Payment Options

At GSE, our payment policy will be all inclusive because we are absolutely informed that different people prefer different payment options as it suits them. Here are the payment options that we will make available to our clients:

- Payment by via bank transfer
- Payment via online bank transfer
- Payment with cash

xiii. Sustainability and Expansion Strategy

Our main goal of starting GSE is to build an enterprise that will survive off its own cash flow without the requirement for sourcing finance from external sources once the business is officially running.

At GSE, we know that one of the ways of achieving approval and winning customers over competitors is to offer our solar panel installation, maintenance and repair services at slight cheaper than what is attainable in the market, and we are well prepared to survive on lower profit margin, while benefiting from economies of scales.

xiv. Corporate social responsibility (CSR)

At GSE we embrace two categories of CSR, namely: environmental responsibility and economic responsibility.

On environmental, we seek to reducing harmful practices, such as decreasing pollution, and greenhouse gas emissions. While on economic, our goal is to create local jobs in communities where we are doing business in order to address social injustices and help communities to reduce poverty by providing employment.

7.5 SCOPE FOR FURTHER RESEARCH

This section of the chapter discusses recommendation for future studies. This future research section builds on key results of this study. In addition, these recommendations seek to address some obvious gaps in this study. The study sought to examine the role of the renewable energy as a tool for poverty reduction strategy in Soweto Township. However, it is important to note that such an inventory is not enough to expose the complete degree to which renewable energy can be used to eradicate poverty in South Africa. Four key areas that are recommended for further research are discussed below.

7.5.1 Standards

It has been observed that there are no clear standards and strategies that are provided with regard to the kind of renewable energy that can be adopted to address poverty issues in South Africa. Therefore, research South African government department of energy in this area would be invaluable.

7.5.2 Satisfaction levels of citizens

The target population in this study were only residents in a selected neighbourhood of Soweto Township in Gauteng. It would be interesting to understand the opinions of other citizens from other part of Soweto and further other township experiences outside Soweto and Gauteng, as their profile is different. This could have contextualised the use of renewable energy in Soweto. As a result, the study only relied on the views of few citizens. Therefore, future studies should focus on the insights, experiences and opinions of other residents from other township in South Africa to establish a clearer picture of the role of renewable energy as a tool for poverty reduction.

7.5.3 Area of study

Due to the diversity of townships in South Africa, this study constricted its scope to a selected section of Soweto Township. In addition, financial and time confines also made it impossible to target all the sections in Soweto and outside Soweto. Therefore, future studies should focus on these logistically excluded areas or ensure that they are part of any future and major studies.

7.5.4 Renewable energy policy

A study is essential to examine the state of national renewable energy policies that would direct and influence the officialisation of household renewables installation. In addition, the policy needs to be formulated around taking households off the grid or switching between grid and off grid. Furthermore, the policy will also address tariffs charges to the municipality or offset what citizens owe the municipality for their energy supplied by the latter.

7.6 DE-LIMITATIONS OF THE STUDY

The research was limited to Dobsonville neighbourhood in Soweto, Gauteng. This may not be adequate to give a generalised perspective for other townships in the country, along with their experiences in the energy supply and renewable energy as an alternative energy source to address poverty reduction in the South African township. In this case, future research is important to include other neighbourhood from Soweto, along with implementing the research in other township at a country level. It is worth noting that only respondents from the urban location in Dobsonville neighbourhood were included in the study to get reliable results. The respondents from the informal settlement were exclude from the study. The reason for not including participants from the informal settlement is that it was not easy to access them as they were scattered all over and sometimes in risky areas. Furthermore, some respondents did not comprehensively understand English (which was used in the semi-structured questionnaires), but difficult questions were clarified to them in their vernacular languages. Hence, future studies can also make use of local languages to improve on the simplicity and explanation of questions. Another consideration is a study conducted over an extended period as this may be significant for improving the validity and reliability of the results.

7.7 STUDY SUMMARY

The study is divided over seven chapters. Chapter one begun by citing the background and aim of the study and placing the energy industry as the context of the study. The chosen location of the study was unpacked in detail. The study hypotheses and objectives were introduced in this chapter. Following was chapter two, which discussed the diffusion of innovations theory as the theoretical framework chosen for the study. Furthermore, chapter two examines the following theories: SWOT analysis, PESTEL analysis and Business Canvass model, which guide the study to achieve the aim of developing a business plan that is competitive for renewable energy business. Chapter two conclude by developing a business conceptual framework relevant to the study. In chapter three, the energy industry in South Africa, which forms the context of the study was reviewed in detail. Different types of renewable energy were identified and discussed in chapter two together with renewable energy best practice strategies. Chapter three closed by outlining the concept of sustainable development and empirical literature of the dependent variables were discussed.

Chapter four discussed the research design, philosophy and the methodology adopted to conduct quantitative and qualitative research methodology. Furthermore, chapter four discusses in detail the impact of COVID-19 on the research process. Chapter five presented and analysed the empirical results of the study, collected via closed ended (quantitative) and open ended (qualitative) questionnaire. Chapter six discussed the empirical results of the study, directing to either agreements or disagreement of the empirical results to the established literature. Lastly, chapter seven provided research proposed framework and the conclusion of the study in relation to hypotheses which were set in chapter one. The delimitations of the study were presented in this chapter. Finally, contributions, recommendations, and suggestions for future research were made.

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APPENDIX A: ETHICAL APPROVAL LETTER

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

24 July 2023

Mondli Gina (219090350)
Grad School Of Bus & Leadership
Westville Campus

Dear M Gina,

Protocol reference number: HSSREC/00005849/2023
Project title: Developing a renewable energy framework towards poverty reduction in South African townships: A case of Soweto township
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 12 July 2023 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 24 July 2024.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics

APPENDIX A1: AMENDED ETHICAL APPROVAL LETTER

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

06 February 2024

Mondli Gina (219090350)
Graduate School of Business & Leadership
Westville Campus

Dear M Gina,

Protocol reference number: HSSREC/00005849/2023
Project title: Developing a renewable energy framework towards poverty reduction in South African townships: A case of Soweto township
Amended title: Towards a renewable energy framework for poverty reduction in South African townships: A Case of South-West Townships (Soweto)

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 02 February 2024 has now been approved as follows:

- Change in title

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

Best wishes for the successful completion of your research protocol.

Yours faithfully

[redacted]

Professor Dipane Hlalele (Chair)

/ss

Humanities & Social Sciences Research Ethics Committee
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Tel: +27 31 260 8350 / 4557 / 3587
Website: http://research.ukzn.ac.za/Research-Ethics/

Founding Campuses: Edgewood | Howard College | Medical School | Pietermaritzburg | Westville

INSPIRING GREATNESS

APPENDIX B: INFORMED CONSENT LETTER

Dear Participant,

My name is **Mondli Gina** (219090350). I am a PhD candidate studying at the University of KwaZulu-Natal, Westville Campus. The title of my research is: **Developing a renewable energy framework towards poverty reduction in South African townships: A case of Soweto township**. The aim of the study is to develop a renewable energy framework towards poverty reduction in South African townships focusing on the Soweto township as a case study, through a survey in which the interview and questionnaire are used to gather data to enhance economic growth and better Socio-economic status of the people living in the South African townships. I am interested in interviewing you so as to share your experiences and observations on the subject matter.

Please note that:

- The information that you provide will be used for scholarly research only.
- Your participation is entirely voluntary. You have a choice to participate, not to participate or stop participating in the research. You will not be penalized for taking such an action.
- Your views in this interview will be presented anonymously. Neither your name nor identity will be disclosed in any form in the study.
- The interview will take about 15 minutes.
- The record as well as other items associated with the interview will be held in a password-protected file accessible only to myself and my supervisors. After a period of 5 years, in line with the rules of the university, it will be disposed by shredding and burning.
- If you agree to participate, please sign the declaration attached to this statement (a separate sheet will be provided for signatures)

I can be contacted at: Graduate School of Business and Leadership, University of KwaZulu-Natal, Westville Campus, Durban. Email: 219090350@stu.ukzn.ac.za, Cell: +27 82 6617 767.

My supervisor is Prof. Emmanuel Mutambara who is located at the Graduate School of Business and Leadership, Westville Campus, Durban of the University of KwaZulu-Natal. Contact details: email mutambarae@ukzn.ac.za, Phone number: +27 74 5615 083.

The Humanities and Social Sciences Research Ethics Committee contact details are as follows: HSSREC Research Office, University of KwaZulu-Natal, Email: hssrec@ukzn.ac.za, Phone number +27 31 260 8350/4557/3587.

Thank you for your contribution to this research.

DECLARATION

I………………………………………………………………………………… (*full names of participant*) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire. I understand the intention of the research. I hereby agree to participate.

I consent / do not consent to have this interview recorded (if applicable)

SIGNATURE OF PARTICIPANT DATE

……

APPENDIX C: INTERVIEW SCHEDULE

INTERVIEW SCHEDULE		
Item	**Interview Questions**	**Interview Responses**
1	Who is the electricity provider in the neighbourhood and how are you connected?	
2	In your opinion, do you believe the quality of electricity supply in the neighbourhood is good?	
3	Do you believe that the price paid for electricity in your neighbourhood is fair?	
4	What did your household do as a result of the increase in electricity prices in the last 12 months?	
5	In your area, how often have you experience electricity cut-off because of either load shedding, power cut or equipment failure?	
6	How has power cuts / loadshedding impacted or affected your normal life?	
7	Do you think that the use of renewable energy supply can help to reduce your electricity bill?	
8	Do you believe that SA government should spend money to promote the use of alternative energy sources such as renewables?	
9	Do you believe that using clean and cheap renewable energy sources will help to improve your household social and economic status?	
10	If renewable energy (i.e. Roof top solar panels) is made cheap and subsidise, would you shift to installation of renewable energy in your house?	

APPENDIX D: QUESTIONNAIRE

Section I: Socio-Economic Status (SES) Questions (To be administered to all participants)
Section II: Poverty reduction (To be administered to all participants)
Section III: Economic growth (To be administered to all participants)
Section IV: Environmental conditions / Climate change (To be administered to all participants)
Section V: Renewable energy trade opportunities (To be administered to all participants)
Section VI: Only for NGO's, Utility, Municipality and Civil Society Organisations

NB: *Please select ☒ one box on each question*

SECTION I: Socio-Economic Status (SES)

No.	Questions	Options
1	Gender	1. Male ☐ 2. Female ☐ 3. Prefer not to say ☐
2	Age	1. 18 – 29 ☐ 2. 30 – 39 ☐ 3. 40 – 49 ☐ 4. 50 – 59 ☐ 5. 60 and above ☐
3	Living conditions	1. Own house ☐ 2. Rental house / room ☐ 3. Parent house ☐ 4. Partner / spouse house ☐ 5. Other……………… ☐
4	Household Structure / Size (Including bedroom, kitchen and living room)	1. 1 - 2 rooms ☐ 2. 3 - 4 rooms ☐ 3. 5 - 6 rooms ☐ 4. 7 - 8 rooms ☐ 5. 9 and above ☐
5	Family Size (including children)	1. 1 - 2 people ☐ 2. 3 - 4 people ☐ 3. 5 - 6 people ☐ 4. 7 - 8 people ☐ 5. 9 and above ☐

6	Source of Income	1. Salary / Wage ☐ 2. Self-Employment ☐ 3. Property / Rental Income ☐ 4. Social grant ☐ 5. Other…………………. ☐
7	People working in household	1. 1 - 2 people ☐ 2. 3 - 4 people ☐ 3. 5 - 6 people ☐ 4. 7 - 8 people ☐ 5. 9 and above ☐
8	Household income per month (Include all money received from all sources)	1. R0 - R3000 ☐ 2. R3001 - R6000 ☐ 3. R6001 - R9000 ☐ 4. R9001 - R12000 ☐ 5. R12001 and above ☐
9	Do you know what alternative energy is all about?	1. Yes ☐ 2. No ☐
10	Are you using any alternative energy at home for lighting, cooking or heating?	1. Wood ☐ 2. Coal ☐ 3. Paraffin ☐ 4. Gas ☐ 5. None ☐

Section II: Poverty Reduction

11	Access to electricity in household	1. In-house post-paid meter ☐ 2. In-house pre-paid meter ☐ 3. Connected to another source which I pay for ☐ 4. Connected to another source which I do not pay for ☐ 5. No access to electricity ☐
12	Type of energy supply	1. Utility supply i.e. Eskom ☐ 2. Municipality grid supply ☐ 3. Off-grid supply ☐ 4. Private energy supply ☐ 5. Other………. ☐

13	Average Monthly electricity spend / bill	1. R100 - R500 ☐ 2. R501 - R1000 ☐ 3. R1001 - R2000 ☐ 4. R2001 - R3000 ☐ 5. R3001 and above ☐
14	In your opinion, how do you rate the price you pay for electricity each month?	1. Far too high ☐ 2. Too high ☐ 3. Do not know ☐ 4. About right ☐ 5. Too low ☐
15	How satisfied or dissatisfied are you with the way electricity is being provided in your neighbourhood?	1. Very satisfied ☐ 2. Satisfied ☐ 3. Neither satisfied nor dissatisfied ☐ 4. Dissatisfied ☐ 5. Very dissatisfied ☐
16	What did your household do as a result of the increase in electricity prices in the last 12 months?	1. Continued to use the same level of electricity ☐ 2. Reduced the amount of electricity used ☐ 3. Used energy-efficient appliances ☐ 4. Used other sources, i.e. paraffin, candles etc. ☐ 5. Other:…………………….. ☐
17	In the last 12 months, has your household cut back on spending on energy for lighting, cooking or heating in order to make ends meet?	1. Very often ☐ 2. Often ☐ 3. Occasionally ☐ 4. Rarely ☐ 5. Never ☐
18	In your area, how often have you experience electricity cut-off because of either load shedding, power cut or equipment failure?	1. Very often ☐ 2. Often ☐ 3. Occasionally ☐ 4. Rarely ☐ 5. Never ☐

Section III: Economic Growth

19	Do you know what is renewable energy supply is all about?	1. Yes ☐ 2. No ☐
20	Do you think that the use of renewable energy supply can help to reduce your electricity bill?	3. Strongly agree ☐ 4. Agree ☐ 5. Not sure ☐ 6. Disagree ☐ 7. Strongly disagree ☐
21	Have you started using renewable energy supply?	1. Yes ☐ 2. No ☐ 3. Not applicable ☐
22	If 'yes', how long have you been using renewable energy supply?	1. Less than 3 months ☐ 2. 3 - 6 months ☐ 3. 6 - 9 months ☐ 4. 9 - 12 months ☐ 5. Not Applicable ☐
23	If 'yes', what is your level of satisfaction with your renewable energy supply?	1. Very satisfied ☐ 2. Rather satisfied ☐ 3. Not sure ☐ 4. Rather dissatisfied ☐ 5. Very dissatisfied ☐
24	If 'no', then what are your reasons for not using renewable energy supply?	1. Renewable equipment cost is very expensive ☐ 2. Product quality is not very good/reliable ☐ 3. Not aware from where I can purchase it ☐ 4. Not sure about its benefits ☐ 5. Other:……………………. ☐
25	Do you believe that affordable renewable energy technologies will improve your household economic status?	1. Strongly agree ☐ 2. Agree ☐ 3. Don't know ☐ 4. Disagree ☐ 5. Strongly disagree ☐

Section IV: Environnemental conditions / Climate change

26	Have you heard of global warming, sometimes called climate change or environmental change?	1. Yes ☐ 2. No ☐
27	How important is the issue of global warming to you?	1. Much less important than other issues ☐ 2. Somewhat less important ☐ 3. Don't Know ☐ 4. Somewhat more important ☐ 5. Much more important than other issues ☐
28	Environmental change / climate change will have a direct negative effect on the quality of life.	1. Strongly agree ☐ 2. Agree ☐ 3. Don't know ☐ 4. Disagree ☐ 5. Strongly disagree ☐
29	Every individual can do something to adapt to environmental change.	1. Strongly agree ☐ 2. Agree ☐ 3. Don't know ☐ 4. Disagree ☐ 5. Strongly disagree ☐
30	Grid energy supply has a direct negative effect on climate change.	1. Strongly agree ☐ 2. Agree ☐ 3. Don't know ☐ 4. Disagree ☐ 5. Strongly disagree ☐
31	The South African government should spend money on campaigns to encourage people to save the environment.	1. Strongly agree ☐ 2. Agree ☐ 3. Don't know ☐ 4. Disagree ☐ 5. Strongly disagree ☐
32	Clean and cheap renewable energy supply can help to save the environment.	1. Strongly agree ☐ 2. Agree ☐ 3. Don't know ☐ 4. Disagree ☐ 5. Strongly disagree ☐

Section V: Renewable energy trade opportunities

33	What do you think about the cost effectiveness of the present supply of renewable energy?	1. Cost from renewable supply is very high ☐ 2. Cost is just comparable with other supply ☐ 3. Don't Know ☐ 4. Cost is low ☐ 5. Cost is high ☐
34	What form of renewable energy supply do you prefer to get access to power from, if affordable?	1. Solar ☐ 2. Wind ☐ 3. Biomass ☐ 4. Biogas ☐ 5. Other:………………………… ☐
35	What should be done to make renewable energy supply more affordable?	1. Government should provide subsidy ☐ 2. Invest in technology, which results in decrease in electricity price ☐ 3. Not sure ☐ 4. Banks to provide low interest loans ☐ 5. Rent to own renewable equipment's ☐
36	The South African government should subsidise clean and cheap renewable energy supply energy supply.	1. Strongly agree ☐ 2. Agree ☐ 3. Not sure ☐ 4. Disagree ☐ 5. Strongly disagree ☐
37	The South African government should spend money to replace grid energy with clean and cheap renewable energy supply?	1. Strongly agree ☐ 2. Agree ☐ 3. Not sure ☐ 4. Disagree ☐ 5. Strongly disagree ☐
38	Would you be willing to shift to off grid renewable energy supply if local bank provides loans with attractive interest rates in addition to the government subsidy?	1. Strongly agree ☐ 2. Agree ☐ 3. Not sure ☐ 4. Disagree ☐ 5. Strongly disagree ☐

39	The South Africa government should give priority to clean and cheap renewable energy in order to meet its future energy needs and demands?	1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly disagree	☐ ☐ ☐ ☐ ☐

Section VI: Only for NGO's, Utility, Municipality and Civil Society Organisations

40	Type of Organisation	1. NGO / NPO 2. Utility 3. Municipality 4. Community based organisation (CBO) 5. Other:……………………….	☐ ☐ ☐ ☐ ☐
41	Has your organisation worked on energy related issues?	1. Yes 2. No	☐ ☐
42	My organisation is satisfied with the way that electricity is being provided in the neighbourhood.	1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly disagree	☐ ☐ ☐ ☐ ☐
43	My organisational believes the price the neighbourhood pays each month for electricity too high.	1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly disagree	☐ ☐ ☐ ☐ ☐
44	What is the quality of electricity supply in the area where your organisation operate?	1. Very good quality 2. Good quality 3. Acceptable quality 4. Poor quality 5. Very poor quality	☐ ☐ ☐ ☐ ☐
45	What did your organisation do as a result of the increase in electricity prices in the past 12 months?	1. Advise to reduce the amount of energy usage 2. Advise community to use energy-efficient appliances and equipment's 3. Advise community to use renewable energy 4. Advise community to change from post-paid to pre-paid meter 5. Other:……………………………..	☐ ☐ ☐ ☐ ☐

46	What do you think should be the one priority for the Department of Energy in providing electricity?	1. Keep electricity prices low ☐ 2. Get non-electrified households electrified ☐ 3. Give information on how to save electricity ☐ 4. Subsidise renewable energy ☐ 5. Other:…………………………… ☐
47	To which of the following should South Africa give priority in order to meet its future energy needs?	1. Natural gas ☐ 2. Nuclear power ☐ 3. Renewable energy i.e. solar, wind, etc ☐ 4. Hydropower ☐ 5. Other:…………………………… ☐
48	The South African government should spend money on campaigns to encourage people to use less energy.	1. Strongly agree ☐ 2. Agree ☐ 3. Not sure ☐ 4. Disagree ☐ 5. Strongly disagree ☐
49	The South African government should spend money to promote the use of clean, cheap renewable energy in order to save the environment.	1. Strongly agree ☐ 2. Agree ☐ 3. Not sure ☐ 4. Disagree ☐ 5. Strongly disagree ☐
50	Using clean and cheap renewable energy sources helps to improve household social and economic status.	1. Strongly agree ☐ 2. Agree ☐ 3. Not sure ☐ 4. Disagree ☐ 5. Strongly disagree ☐

APPENDIX F: LANGUAGE EDITING CERTIFICATE

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It is hereby certified that this dissertation has been proofread and edited for spelling, grammar and punctuation by a professional English language editor from www.OneStopSolution.co.za

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Developing a renewable energy framework towards poverty reduction in South African townships: A case of Soweto township

A dissertation submitted in fulfillment of the requirements for the degree of
Doctor of Business Administration
at the Graduate School of Business and Leadership, University of KwaZulu-Natal, South Africa

Editor

Debby Dewes	[redacted]
Name	Signature

03 July 2023

Date

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