ENERGY POLICIES FOR SUSTAINABLE DEVELOPMENT OF INFORMAL SETTLEMENTS UPGRADING IN SOUTH AFRICA

by

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A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Sustainable Energy and Efficient Cities (SEEC)

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Johannesburg, September 2019

Declaration

I declare that this research report is my own unaided work. It is being submitted for the Degree of Master of Architecture in Sustainable and Energy Efficient Cities to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

Signature of Candidate 

16-09-2019

Abstract

South Africa is experiencing numerous challenges, such as low economic growth, social disparities, and poor governance (Du Plooy, 2017). The energy crisis in South Africa is not new, especially for the inhabitants of informal settlements. The poor energy supply to the residents of these settlements leads them to use other energy sources that meet some of their needs such as paraffin, coal, wood and solid waste, which lead to air pollution and serious health and environmental diseases (Winkler, et al., 2006). “For a transition of this magnitude to be successful, a holistic perspective of sustainability is required across several sectors” (Du Plooy, 2017, p. 4). This research will examine how South African policies are dealing with upgrading these settlements and how they are providing sustainable energy to the inhabitants of the informal settlements. Although research on the upgrading of informal settlements is extensive, the promotion of sustainable energy upgrading in informal settlements to alleviate the energy crisis still needs to be answered. The responsibility of governments and municipalities rely on developing clear and explicit planning to improve informal settlements and secure their basic needs while minimising the impact of settlements on the environment and work to sustainable energy transition (SET).

The study contributes to discussing the possibility of reducing energy poverty, while highlighting the need to have a balance across all the society populations to achieve the concept of sustainable development. The purpose of the research is to encourage and show the right of the inhabitants of these settlements to obtain the most basic rights, according to the rights of energy in South Africa, taking into account the preservation of a clean and sustainable environment by providing what citizens need without compromising the ability of the future generations to meet their needs. This research is based on a review of the literature which has been collected from books, journals, articles, reports, previous related researches, some information from the internet

(archival research) and energy polices. It depends on energy policies and laws of the state of South Africa, as well as nongovernmental organisations associated with the development of informal settlements and energy. It is expected from the research that all the responsible authorities of the inhabitants of these settlements, whether municipalities or other government sectors, consider serious and tangible upgrading of these settlements to relieve the informal settlements inhabitants from the suffering of poverty and from lack of the basics of living. Also, these authorities should reconsider their responsibilities to preserve their environment where the energy policy of South Africa aims to achieve a clean and sustainable environment by 2025 (Winkler, et al., 2006). The research attempts to understand the imbalance of not covering and extending energy for all residents and how to access sustainable energy that covers the inhabitants of informal settlements and limits extreme poverty of energy.

Key words: Energy policies, sustainable development, sustainable energy transition, informal settlements, Renewable energy

Acknowledgments

More than anything else, I need to thank the Almighty without whom anything is possible. Thank you, Allah, for all the guidance, opportunities and challenges you have placed before me.

To my supervisor, Prof Aly Karam, thank you for your supervision, your wealth of knowledge and experience, support and precious time rendered to me.

I express my gratitude to my dear husband Emad Al Masri, the love of my life, who stood by my side and supported me all the time, sharing my wish to reach the goal of completing this task. Your faith and words of wisdom have helped me to reach this point. From the bottom of my heart I love you so much.

To my father Mohammed Alkhouli and my mother Rana Al-Issawi, who stood by my side from the beginning of the journey, I love you both for everything. You have made me a strong woman who I am now, and I will forever be grateful. I am proud to be your daughter.

To my sisters and brothers, your encouragement encouraged me to go further in life.

Finally, I am very indebted to all other friends for their thoughts, assistance and encouragement during this degree programme.

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List of Acronyms

ANC	African National Congress
BNG	Breaking New Ground
CSP	Concentrated Solar Power
DME	Department of Minerals and Energy
DoE	Department of Energy
DPE	Department of Public Enterprises
DRC	Democratic Republic of Congo
EFA	Electricity For All
EIA	Environmental Impact Assessment
FBE	Free Basic Electricity
GHG	Greenhouse gases
GDP	Gross Domestic Product
GW	Gigawatt
HDI	Human Development Index
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRP	Integrated Resources Plan
kWh	kilowatt hour
LNG	Liquefied natural gas
MoE	Ministry of Energy
MW	Megawatt
NDP	National Development Plan
NEP	National Electrification Program
NERSA	National Energy Regulator in South Africa
NUSP	National Upgrading Support Programme
OECD	Organisation for Economic Co-operation and Development

PV	Photovoltaic
RDP	Reconstruction and Development Programme
RE	Renewable Energy
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SABIA	Southern African Biogas Industry Association
SAWEA	South African Wind Energy Association
SD	Sustainable development
SEA	Sustainable Energy Africa
SET	Sustainable Energy Transition
SHS	Sustainable Human Settlements
SPLUMA	Spatial Planning and Land Use Management Act
UISP	Upgrading of Informal Settlement Programme
WWF	World Wide Fund for Nature

CHAPTER 1: OVERVIEW AND FORMULATION OF PROBLEM

1.1 Introduction

Informal settlements are a widespread global phenomenon. About eight million people live in informal settlements in South Africa (Housing Development Agency (HDA), 2013). Informal settlements are spreading around the outskirts of the cities, close to landfills, railways, valleys and land far from the eyes of the government. Being in such places makes it difficult for these people to access basic services. South Africa continues to suffer from a lack of energy supplies, particularly in informal settlements (Stiftung, 2014). While the spread of informal settlements is increasing, the need for electricity is also increasing. South Africa's energy policies need to focus more on sustainable energy production to address energy shortages, reduce harmful emissions and promote sustainable development (Winkler, et al., 2006). Previous studies such as Winkler, et al. (2006) and Du Plooy (2017) have suggested that sustainable energy transformation involves a radical change in energy policy as well as changes in behavioural and social lifestyles and improved energy efficiency in buildings and technologies. The arguments and criticisms are built by dealing with the literature review on energy policies for SET by the year 2025.

The next section of the report provides a brief background on energy policies in South Africa. The basis of the research problem, rationale and study objective are in the following sections of this chapter.

1.2 Background

Previous studies indicate that energy policy is based on three different periods. The first is the apartheid era which lasted until 1994 (Du Plooy, 2017). During the apartheid period, policies focused on energy security because of political isolation (ibid). This was followed by the second period,

which is the period of democratic elections that took place in 1994 (ibid). This period focused on the equality of blacks and whites and addressed the injustices of the past for the large group of people who were deprived of basic services. The third period is from 2000 onwards, which is the period that came after the ecstasy of independence and aims to provide the necessary energy for the country (ibid).

South Africa's energy policy and renewable energy policy recognises global agenda issues such as the need for development paths to move forward in a sustainable way (Du Plooy, 2017). This requires the government to be able to balance the task of providing services to the poor and bearing the costs, in addition to the implementation and compliance with domestic and international laws that protect the environment (Winkler, et al., 2006). The implementation of the Spatial Planning Law under apartheid early in 1948 led to the fragmentation and separation of settlements in most of South Africa's cities, including Johannesburg (Beavon, 2001). The administration was deliberately oppressive and did not allow for social integration among different groups. The whites occupied lucrative basic economic centres, while blacks settled on the outskirts of cities in townships (Keller, 2012). The spatial planning had a direct impact on the deprivation of energy supply to the residents of informal settlements. The Law on Spatial Planning and Land Use Management Act No. 16 of 2013 (SPLUMA) clarifies the importance of working to reform the apartheid legacy of spatial injustice (Department of Rural Development and Land Reform, 2013). SPLUMA states that there are four development principles: spatial justice which must be achieved among the various groups of society, spatial sustainability, spatial flexibility, and good land use management (ibid).

The energy crisis in South Africa is not new, especially for the inhabitants of informal settlements. Prior to 1994, providing energy supply was on the basis of racial discrimination (Winkler, et al., 2006). However, in 2000, a decision

was made by the South African national government to provide free basic electricity (FBE) for the families whose income is less than R3 500 (Department of Minerals and Energy (DME), 2003a). However, despite the provision of free basic energy, this does not meet the needs of all residents of the settlements (Stiftung, 2014). The studies show that the poor energy supply to the residents of these settlements leads them to use other energy sources that meet some of their needs such as paraffin, coal, wood and solid waste, which lead to air pollution and cause serious health and environmental diseases (Winkler, et al., 2006).

The promotion of informal settlements through demolition and reconstruction in the middle of the 20th century was followed by the architect John Turner in the late 1960s who proposed a theory of upgrading the same location for these settlements and developing plans that would show the government's role in addressing basic services and creating jobs (Abbott, 2002). It is the responsibility of South African government to provide clear and explicit planning policies which help improve access to electricity in informal settlements which do not jeopardize the basic needs of the low-income people but also have a less harmful impact on the environment (Keller, 2012).

In 1987, the Brundtland Commission, which was run by the UN General Assembly, presented the concept of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Harrison, et al., 2014, p. 15). Sustainable development aims to balance environmental, economic and social development (ibid). The insufficient energy in informal settlements affects the evolution of sustainable development (Ramshamole, 2011). Due to the limited supply of electricity, people living in informal settlements have had to resort to alternative energy sources which require paraffin, candles and coal, which can lead to the burning of the entire settlement because of the proximity of houses to each other and also because the houses are made

of flammable materials, leading to environmental pollution and health issues (Raphela, 2011).

The failure of government to provide equal access to electricity has a devastating impact on the educational needs of young people living in informal settlements as they cannot study at night or go on the Internet (Raphela, 2011). This results in low education levels and the possible exclusion of the residents from the formal economy. If they have less electricity the youth will have less productive means and will face the risk of resorting to crime (ibid). To achieve the goal of establishing an adequate and environmentally friendly energy system for all, the energy policy of South Africa has decided to move towards sustainable energy and to achieve sufficient and clean energy for all by 2025. So we need to go back to literature and policies to explore the evolution for a sustainable energy transition.

1.3 Problem statement

One of the important goals of energy policy in South Africa is the access to safe and environmentally friendly energy for all South Africans by 2025, including the informal settlements (Department of Minerals and Energy (DME), 1998). The residents of informal settlements are still using alternative energy sources such as coal, wood, paraffin, liquefied petroleum gas and wood for cooking, heating and lighting (ibid). This behaviour has compounded the problem and made the adoption of upgrading informal settlements programme much more complex as the successful execution of the program will require building homogeneous relations between energy policy, housing policy, land rights and non-Governmental organization and policymakers.

The research will show whether South Africa's scale of change in the transformation of the energy sector into sustainable energy sources of

generation are adequate and therefore whether current efforts will succeed in setting SET within the specified time frame.

1.4 Rationale of the study

Although research on the development of informal settlements is extensive, there is still a need to respond to the promotion of sustainable energy development in informal settlements to mitigate the energy crisis. The study contributes to the discourse surrounding the possibility of reducing energy poverty among the population of informal settlements, highlighting the need to strike a balance among all the population to achieve the concept of sustainable development while addressing the challenges of climate change and resource constraints. The study will discuss how local governments and policies can provide electricity to the inhabitants of these settlements in a sustainable and secure manner. The study explores the energy used to cover the population of informal settlements in South Africa to reduce energy poverty as well as the current trends in promoting sustainable energy transition.

1.5 Objective of the study

The study objective is to contribute to the knowledge base to encourage governments, policymakers and officials in the development of the electrical power sector in South Africa. In other words, it explores the effectiveness of different policy interventions aimed at improving the sustainability of the electricity sector in South Africa. These research discussions help to create awareness among stakeholders (who sometimes have diverse and competing sustainability objectives) to achieve a sustainable electricity sector in the future with strategic cooperation that makes the necessary concessions to reach the common goal. They also encourage and show the right of the inhabitants of these settlements to obtain their most basic energy need according to the rights of energy in South Africa while taking into account the

preservation of a clean and sustainable environment by providing what citizens need without compromising the ability of new generations to meet their needs.

1.6 Research question

Renewable energy generation has become an important tool in sustainable development and bridging the current and future needs of the community. The problem statement discussed above shows that there are many energy development challenges in South Africa.

How adequate is South Africa's rate of change in transforming the electricity sector into sustainable sources of generation, and therefore will current efforts foster/succeed in achieving a sustainable energy transition within the specified timeframe?

1.7 Sub-questions

- What are the barriers to achieving sustainable energy in South Africa?
- Do investment in renewable energy and lack of infrastructure affect the sustainable energy transition in South Africa?

1.8 Summary of the research method

The research adapts the archival research method. It is based on the analysis of policies and literature collected from books, journal articles, reports, previous related researches and some information from the internet. It depends on energy policies, renewable energy policies and laws of South Africa, as well as the organisations and non-government organisations associated with the development of informal settlements and sustainable energy. The research sets out to define policies from the past and the present. Archival research involves studying historical and political documents to provide access to different information. It is also possible to use extension research in non-historical documents (Ventresca & Mohr, 2001).

1.9 Ethical considerations

The University of the Witwatersrand code of ethics and protocols have been strictly followed and fulfilled for the entire research and from all aspects. This is archival material and is available on the internet and in libraries, so there is no requirement for protecting the data as it is available in the public domain. During the research, I include various arguments and ideas related to the research topic and I also maintain the proprietary rights of the used information in addition to providing the source of the information.

1.10 Chapters organization

Chapter 1 of this research report presents a brief background on energy shortages in South Africa and discusses some of their historical and current issues with respect to the provision of energy to the informal settlement population. This chapter also includes the rationale behind the study, the study objective, the problem statement, the research question and the summary of the research method. Chapter 2 presents the literature review section, which will include discussions on the White Paper on Energy Policy and the White Paper on Renewable Energy policy, discussions on the sustainable energy transition and discussions on upgrading of informal settlements. Chapter 3 provides an analysis of whether South Africa will reach its target or not. This chapter also aims to prepare answers to research questions as well as talk about ethics and research limitations. The final chapter provides a summary and recommendations based on the analysis and compilation of the collected data.

CHAPTER 2: POLICIES AND PRACTICES – FINDING A PATH TO SUSTAINABLE ENERGY FOR ALL

2.1 Introduction

This chapter engages with the discourse surrounding energy policies through a vigorous review of literature on energy policies. The policies focus on promoting the sustainable development for informal settlements in South Africa. This chapter will discuss concepts, arguments and debates presented by various authors in this field of research. Finally, the chapter will provide a conceptual framework, which will clarify and expand on the relevant concepts behind the successful distribution of sustainable energy as discussed in the literature reviews.

2.2 Definitions

This section provides the definitions of the main concepts used in this research. The purpose is to familiarise the readers with these definitions and provide them with the background of each of the definitions.

2.2.1 Informal settlements

The Organisation for Economic Co-operation and Development (OECD) in South Africa defines the informal settlements as “areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally unplanned settlements and areas where housing is not in compliance with current planning and built regulations” (OECD, 2001, p. 1). UN-Habitat (2015) has defined informal settlements as areas or dwellings in which people live either illegally by occupying the land, or the cases where the poor lease land from the landowner. Informal settlements are often located in the dangerous parts of urban areas, geographically and environmentally, where they lack infrastructure and basic

services. Informal settlements are characterised by poverty, insecurity, lack of tenure and services, public space and green areas, and they are constantly subject to evacuation, disease and violence (UN-Habitat, 2015, p. 1). The Nelson Mandela Bay Metropolitan Municipality defines informal settlements as “one or more shacks constructed on land with or without the consent of the owner of the land or the person in charge of the land. In some settlements, no formal layouts have been approved whilst in others there are formal sites. Services are communal in nature” (Housing Development Agency (HDA), 2013, p. 7). According to the Ekurhuleni Metropolitan Municipality, “as a basic characteristic, the occupation of the land is unauthorised. In addition, the use of the land may be unauthorised, and in most cases the construction standards do not comply with building regulations” (ibid, p. 7).

2.2.2 Energy poverty

Lack of electricity is a clear indicator of energy poverty (Du Plooy, 2017). This indicates the large numbers of people in developing countries who are lacking electricity compared to developed countries (ibid). As a result, this contributes to the increased use of environmental polluting fuels to meet people’s basic energy needs. Access to energy is essential to improve the quality of life and is also essential for economic development (Runsten, 2015). The International Energy Agency suggests the following definition: “Energy poverty refers to a situation where a household has technically access to energy but cannot afford adequate energy services to meet basic needs” (Kulinska, 2017, p. 672).

2.2.3 Sustainable energy transition definition (SET)

SET is the process of shifting from the use of fossil fuels as the primary energy source of our economy to a renewable energy economy while maintaining an adequate level of energy for each individual (Runsten, 2015). SET aims at equality and material availability, transitional dynamics from an

energy perspective, and economic accounting aimed at addressing all three pillars of sustainability (ibid).

2.2.4 Apartheid

Apartheid was the political policy governing relations between the white minority and the non-white majority in South Africa in the 20th century from 1948 until the early 1990s. It encompassed oppression based on race in all matters such as places of living, housing, work, the type of education individuals could receive, and even the provision of the basic services. Apartheid left a social and economic impact and a negative environment until today (Mayne, 1999).

2.2.5 Informal settlements upgrading

> "Upgrading is a staged process of improvement of quality of life in informal settlements, based on incremental provision of services and tenure. It should seek to maximise in-situ development in appropriate areas and minimise relocation. An effective improvement process is built on close community participation and cooperation, aiming to strengthen livelihoods strategies of the poor. Housing is provided by a variety of methods, including self-build, People's Housing Process, social housing or affordable rental, individual subsidy or consolidation subsidy". (National Upgrading Support Programme (NUSP), 2017)

2.2.6 Sustainable development (SD)

In 1987, the Brundtland Commission presented the concept of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Harrison, et al., 2014, p. 15). This is applicable to several things, including energy, while the United Nations (2015) in its Seventh Goal of the Sustainable Development Agenda confirmed that by 2030 UN will "expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed

countries, with their respective programmes of support" (United Nations, 2015, p. 19).

2.2.7 Renewable energy (RE)

Renewable energy is the energy that is inexhaustible because it is derived from renewable resources such as wind, sunlight, waves, tides, geothermal, biomass and nuclear power (Department of Minerals and Energy (DME), 2003a). Renewable energies are clean and have competitive sources, compared to fossil fuels. Renewable energies differ from fossil fuels with their diversity, availability and applicability everywhere in the world. Renewable energy sources are therefore an essential element of a sustainable energy system that allows sustainable development today without risking the future generations.

2.3 History of energy policy

ESKOM is an electricity company utility in South Africa, founded in 1923 and one of the top companies in the world for power generation capacity (Conradie & Messerschmidt, 2000). It was known as the Electrical Supply Authority and in 1986 changed its name from ESCOM to ESKOM (ibid). In the early 1990s, ESKOM controlled the production and export of energy by generating 95% of the electricity used in South Africa and having 90% of the coal-fired power plants (ibid). The process of supplying electricity consists of three stages: generation, transmission and distribution. Electricity generation is the process by which electricity is produced. Transmission is the transfer of the electricity generated in power plants via high voltage power lines long distances to local distribution networks. Distribution is the actual delivery of electricity to end consumers (Oosthuizen, 2016).

ESKOM is responsible for more than 95% of electricity generation and distribution in South Africa as it is the dominant power producer. Municipalities are responsible for part of the distribution of electricity, but not

all homes and companies are supplied by municipalities only, where ESKOM provides electricity directly to the customer (Oosthuizen, 2016). In some cases, municipalities generate electricity but on a very limited scale (ibid). Oosthuizen (2016) has noted that historically, in the late 20th century, municipalities were responsible for the distribution of electricity in towns and cities, but black-populated areas were excluded from the distribution by municipalities while ESKOM assumed responsibility for supplying electricity to areas where blacks lived. In the 1980s, ESKOM invested heavily in infrastructure for power generation. Six coal-fired power plants were operating by 1983, with more than 22 000 megawatts of power. Despite ESKOM'S efforts to produce the largest amount of energy, it is clear that the energy supply crisis was increasing (Oosthuizen, 2016)

Prior to 1994, providing energy supply was on the basis of racial discrimination, with the energy services provided to the white population, who formed of the population 11% at that time, as well as to institutions, governments and the private sector, while the majority of the population did not have any energy supply (Department of Minerals and Energy (DME), 1998). After the 1994 democratic elections, which focused on the equality of blacks and whites and tackling the grievances of the past for the large group of people deprived of basic services, a new energy policy, the White Paper, was introduced in 1998. "The White Paper consisted of four parts: context and objectives for energy policy, demand sectors, supply sectors, and cross-cutting issues" (Davidson, 2004, p. 6). In 2000, the Department of Energy (DoE) in South Africa set goals to eliminate energy transfer for certain categories and to create ways to produce energy in a sustainable way (ibid).

> "Subsequently, the 1998 White Paper on Energy Policy (Department of Minerals and Energy (DME), 1998) sets out a gradual liberalization of the power sector in line with the standard model which would see the corporatization and outsourcing of various functions of Eskom. Notably, the White Paper anticipated the creation of a separate transmission utility and system operator which would be owned by the

> state in the first instance but with a view to a possible future sale. The 1998 White Paper was followed by a cabinet memo in 2001 announcing that 30% of electricity generation, including renewable energy, would come from Independent Power Producer in solving South Africa energy crisis (IPPs) which was followed by the decision made by the Council of Ministers that Eskom will no longer be allowed to build new electricity generation". (Baker, 2016, p. 6)

2.4 Energy deprivation due to apartheid

The conflict between the national government and oppressed peoples continued from the early 20th century until the democratic election in 1994. This was aimed at bringing down and erasing what apartheid had caused as a result of depriving them of their rights (Bekker, et al., 2008). In the early 1990s in the pre-election period (1994), the Electricity for All (EFA) programme was established with the aim of providing electricity to the largest population, without distinction (ibid). The long-standing apartheid in South Africa has led to discrimination in the provision of services between blacks and whites (Keller, 2012). The 1996 census showed that only 58% of the population had access to electricity (ibid). The difference was evident in the provision of basic services and infrastructure between white and black residents (Keller, 2012). ESKOM took it upon itself to deliver electricity to the families that could not afford to pay, through the free basic electricity (FBE) programme (Bekker, et al., 2008). However, 65% of the informal population and the rural population of South Africa still lacked electricity (Department of Minerals and Energy, 2001). Therefore, a large proportion of the population of informal settlements still use alternative sources of energy (i.e. coal, paraffin, wood, candles), in addition to the fact that a large proportion of these settlements do not have access to free electricity or other national electricity sources (Keller, 2012). Despite the success of the National Electrification Programme (NEP), which succeeded in developing the electricity programme for households, the National Energy Regulator in South Africa (NERSA) has not achieved its social and economic goals in the development and delivery

of electrical services and infrastructure development (Visagie, 2008). NEP helped to facilitate access to electricity and FBE helped to make the electricity service affordable. However, there is still a clear use of the unsustainable energy resources by the residents of the informal settlements (Keller, 2012). In 2010, South Africa's energy policy showed that the population of informal settlements exceeded 10% of the total population (Lemaire & Kerr, 2016). In 2010, pressures came from government to partially change the White Paper for energy and provide electricity to the poorest dwellers at the lowest prices and in some cases to be provided free (ibid).

Lemaire and Kerr (2016) have noted that in Cape Town, there are significantly more informal settlements where in some cases the owners of the land allow the establishment of settlements for profit, leading to the illegal exploitation of informal residents. Due to this exploitation and their socio-economic status, the residents of these informal settlements steal electricity connections from the distributed network (ibid). This increases the dangers of electrocutions and shack fires, which claim many lives unnecessarily. If we look internationally, it is noticeable that informal settlements are spread all over the world. Lemaire and Kerr (2016) have given the example of how in India in 2011, about 70% of the residents of the informal settlements in the city of Mumbai had been getting electricity illegally. It turns out that the cost of obtaining an official power line is one of the most negative high-cost factors affecting the population of informal settlements. One of the most important barriers to the supply of electricity services in India and South Africa is not giving the required importance to this category in the urban development of the country (Lemaire & Kerr, 2016).

2.5 Housing policy and informal settlements

The right to have a decent shelter has been recognised in many national constitutions, as well as in the Universal Declaration of Human Rights and in the International Covenant on Economic, Social and Cultural Rights, which

was unanimously adopted by the world community in 1948 (Thiele, 2002). Chapter Two of the Constitution of South Africa contains the Bill of Rights, a human rights charter that protects the civil, political and socio-economic rights of all people in South Africa (SA Constitution, 1996). Housing is one of the major problems facing people in South Africa because of the legacy of apartheid, which led to the spread of the informal settlements on a large scale (Sikota, 2015). Sikota (2015) stressed that other important issues related to the demand for housing were access to other basic services such as water, sanitation, electricity and so on.

The Housing White Paper was developed in 1994 for a new housing policy and strategy for South Africa. This aimed to help achieve social justice and provide rights of the poor with the participation of the government and the private sector (Keller, 2012). But two decades after the implementation of the White Paper on Housing, there is still a significant increase in the growth of informal settlements. The annual rate of increase in informal housing is 3.5% compared with the increase in official housing by only 2.5% (ibid). The existence of a small stock of official housing and the high cost has led to a significant increase in the number of families which have been forced to become a residents in informal settlements (Sikota, 2015).

2.5.1 Upgrading informal settlements approach

As part of the upgrading of informal settlements, there are two main approaches: the total redevelopment upgrading approach, and the in-situ upgrading approach (Runsten, 2015). The total redevelopment aims for the complete development of the informal settlement by moving it to other more suitable locations while providing basic services where the locations are usually chosen around the cities (ibid). The in-situ upgrade approach is the opposite of the total redevelopment approach and it aims at expanding the services, such as water, electricity and sanitation, and improving infrastructure at the same site (ibid). Runsten (2015) explained that there is

no justice in upgrading the settlements on the periphery of cities. Instead, they must be integrated within the city to ensure social justice and provide these settlements with amenities (Runsten, 2015).

2.5.2 Breaking New Ground (BNG) 2004

The National Department of Housing released its Comprehensive Housing Plan for the Development of Sustainable Human Settlements, titled “Breaking New Ground” (BNG) in 2004. BNG came to complement the principles of the White Paper for Housing and to try to fill the gaps that had occurred over the past 20 years (Royston, 2009). The concept of building houses has moved on from the unsustainable traditional building to how to develop sustainable human settlements (SHS) (ibid). Sustainable human settlement meets the basic needs that help access to social, economic and environmental development (Royston, 2009). BNG defined SHS as “well-managed entities in which economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence and result in sustainable development, wealth creation, poverty alleviation and equity” (Charlton, et al., 2014, p. 6). Therefore, BNG helps to create quality accommodation and good location requirements (Royston, 2009). BNG is an updated version of the Reconstruction and Development Programme (RDP) that has been established as a stronger plan with better management of the commitment to timely delivery of housing. BNG also shifts the strategic focus of only ensuring affordable housing to ensuring the delivery of housing in both permanent and residential settlements (ibid).

BNG “reinforced the notions of spatial transformation and integration” (Charlton, et al., 2014, p. 6). BNG helped to address the apartheid spatial fragmentation by “locating new housing projects on well-positioned land through the release of state-owned land or the expropriation (at market value) of private land” (Keller, 2012, p. 32). BNG paved the way for the Upgrading of Informal Settlement Programme (UISP), which helps to integrate the urban

fabric of informal settlements with its surroundings to eliminate its spatial and social exclusion (Keller, 2012). UISP provides the establishment of temporary services platforms as such establishment is considered the first step to providing permanent services (Tissington, 2011). UISP emphasises the importance of promoting people wherever they are and thus relocating and resettling people on a voluntary and cooperative basis. UISP notes the importance of the level of good infrastructure that supports the programme of upgrading informal settlements (ibid).

2.5.3 Upgrading of informal settlements and energy

Governments need to address the underlying causes of social and economic poverty aggressively affecting informal settlements (Marutlulle, 2017). The population of urban areas is increasing due to population growth and rapid urbanisation, which increases the growth of informal settlements (ibid). Most municipalities cannot afford to provide for the huge demand for basic services for these informal settlements, without support from the private sector (ibid). The upgrade of these settlements is either an in-situ upgrade or by relocation (Runsten, 2015). The establishment of informal settlements is not considered as a permanent solution to an increasingly national problem. The government must provide a more permanent solution to the basic energy requirements, which takes time given the slowness of implementing policies in South Africa (Misselhorn, 2010).

NUSP (National Upgrading Support Programme) has been designed to address the key challenges of UISP (National Upgrading Support Programme (NUSP), 2007). Nowadays, there are more than 2 600 informal settlements in South Africa compared to around 300 in 1994. “These settlements have between 1.1 million and 1.4 million households (according to Stats SA Community Survey 2007)” (ibid). The goal of NUSP was to strengthen the capacity of all institutions involved in upgrading informal settlements and to reach 400 000 families in 2014, which helps in the ease of supplying these

settlers with safe electricity and sanitation through implementing an effective infrastructure (ibid).

In 2010, due to electricity shortages in South Africa, a national electricity plan was developed, namely the Integrated Resources Plan (IRP) aimed at establishing new power plants at the lowest possible cost for 2010-2030, while ensuring sustainable development. The goal is to generate enough energy needed to generate 11.4 GW on renewable energy, 6.3 GW of coal, 9.6 GW of nuclear power and 11 GWs from other generation sources, achieving a reduction of carbon and carbon dioxide emissions in line with the South African development aim (Peters, 2011).

EThekwini is one of the municipalities involved in the upgrading of informal settlements. The municipality of eThekwini has provided about 9 000 new housing units to the residents of informal settlements every year since 2006 (EThekwini Municipality, 2014). However, the occurrence of settlements is still very high, which is caused by the annual high urbanisation trends of the city of Durban. The city of Durban is considered to have the third largest population after Johannesburg and Cape Town. The challenges faced by the municipality of eThekwini arise from the supply of clean infrastructure, which is costly because these settlements are located in environmentally sensitive areas (ibid). While the officials of eThekwini's municipality are struggling to plan for the urban realm due to the effects of apartheid spatial planning (ibid). We must take into consideration that "upgrading informal settlements needs to be understood as a solution for those who live there. It is not just as an intervention that minimises their problems" (EThekwini Municipality, 2014, p. 10).

The RDP is the original policy document of the African National Congress (ANC) aimed at promoting the principles of sustainability, integration and equality. RDP aimed to help transform the country into a democratic and non-racial society by redistributing resources (Ndeke, 2011). The RDP has

developed a policy framework to guide the country to implement strategies in urban development, reconstruction of poor services, elimination of inequality and elimination of poverty, and thus the creation of a democratic society. From 2010 to 2014, the national government sought to provide one million housing units subsidised over five years to families with monthly incomes of less than R3 500 (ibid). During that period, the economy grew by 6%. This growth was based on investment in infrastructure, power generation and energy distribution (Ndeke, 2011).

2.6 Policies to address energy poverty

The Department of Energy (DoE) recognises that access to electricity is a constitutional right for every citizen of South Africa, regardless of location (Runsten, 2015). Runsten (2015) argued that current policies may not be enough to address all electricity objectives. Winkler (2006) highlighted the importance of South Africa embracing sustainable alternative energy as the most successful way of saving energy for all, as well as solving the problem of high costs. The success of the national electrification programme was limited as it failed to provide electricity to the growing informal sector (Visagie, 2008).

2.6.1 Access to electricity

To understand the energy poverty that is being talked about in informal settlements, it is necessary to understand how to access electricity. Many residents of informal settlements suffer from an extreme lack of electricity, which leads them to illegal access to electricity through theft (Runsten, 2015), as shown in Figure 2.1 and 2.2. As Runsten (2015) highlighted, access to electricity varies among informal settlements households based on their location. For example, 80%-85% of informal settlements located on municipal land can access the electricity (ibid). In contrast 60% of the population of remote informal settlements or settlements located on private land can

access electricity (Runsten, 2015). Most of the population of informal settlements live on uninhabitable land, depriving them of basic services (Singh, 2014). Families that have access to electricity will continue to use other types of fuel because of the inability to afford high electricity costs (ibid). As shown in Figure 2.3. In addition, more than 10% of such families' income is spent on electricity compared to wealthier families which spend 2% to 3%. Access to energy for cooking and heating is one of the most common applications of paraffin and coal (ibid). Wolpe and Reddy (2010) argued that paraffin and coal were not safe for human health as well as having effects on the environment and are used in unsafe ways as well as they cause fires, as shown in Figure 2.4. This exposes millions of people to respiratory diseases because of harmful organics scattered from fossil fuel derivatives. Thus, the burden of the cost of high healthcare is borne by the state (ibid). The technical losses of the electricity grid due to illegal connections, theft of electricity, and low network stability were estimated at 2%-9% of municipal revenues in 2004, which increases the capacity of the load (Runsten, 2015). The unreliability of government energy services and unexpected and irregular cash flows leads to the use of multiple fuel patterns (Singh, 2014).

Figure 2.1 (Evans, 2015) and **Figure 2. 2** (Peters, 2015): Ways in which the inhabitants of informal settlements steal the electricity.

Figure 2.3: The inhabitants of informal settlements using alternative energy sources to produce electricity (Maregele, 2017).

Figure 2.4: Fires caused by alternative energy sources (like coal and paraffin) (Blackbeard, 2014).

2.6.2 Free basic electricity

The residents of informal settlements suffered from a lack of energy over the years, which led to a declaration in 2000 by the South African national government to provide free basic electricity to help provide basic energy

requirements (Department of Minerals and Energy (DME), 2003a). “The FBE allocation subsidy will only be affected when a qualifying consumer has been officially connected to the electricity supply system of a Service Provider” (ibid, p. 24). The Department of Minerals and Energy (DME) allocated 50 kWh per month to each of these households. This cost is R48 per household as a maximum, “so any difference between the future actual maintenance and operation costs, and the subsidy will be borne by the consumer” (Department of Minerals and Energy (DME), 2003a, p. 9). South Africa’s ESKOM is still providing FBE as the municipalities have signed an agreement with it to extend electricity to these informal settlements located in the supply areas of ESKOM (ibid).

Municipalities are responsible for identifying the locations and places to extend the electricity (Department of Minerals and Energy (DME), 2003a). There is a difference in the definition of municipalities for the approach of free basic electricity and the method of implementation, as well as poor management in the classification of poor families as ‘in need’ and ‘not in need’ of electricity (Stiftung, 2014). There are still about seven million households depending on unsafe energy forms (ibid). One of the challenges in implementing FBE is the difference approach between ESKOM and municipalities (Stiftung, 2014). FBE has been criticised by Keller (2012) because the supplied 50 kWh was not enough to do the main things at home, since cooking and heating water consume a lot of energy which exceeds more than 50 kWh.

FBE faces many structural and institutional challenges in the implementation process (Keller, 2012). Many rural areas suffer from a lack of infrastructure, therefore making it not possible to benefit from the FBE. Visagie (2008) pointed out that FBE does not reach families which are living in informal settlements located in unauthorised areas. FBE is provided every month to 30% of households that lack electricity. This is in stark contrast to the figures

provided by the DoE, which indicates 69% of poor households receive FBE (ibid). This large discrepancy in data sources makes it difficult to identify precisely the beneficiaries of the FBE (Stiftung, 2014). In several instances, municipalities deviate from the main purpose of FBE and from providing the service to the meant targeted poor families, which should receive the FBE benefit, by providing the service to some wealthy families that should not be privileged by this benefit (ibid). “It is important to note, however, that each municipality has the authority to spend unconditional grants as they deem necessary making it difficult to determine if funds have been spent on subsidising services to the poor” (Stiftung, 2014, p. 30). The cost of the subsidy for FBE is R5.7 billion every year, while these funds could be used for alternative energy (ibid).

2.7 Renewable energy

South Africa relies nearly 90% or more on coal as a primary source of energy, with coal generating 75% of the energy supply (Department of Minerals and Energy (DME), 2003b). South Africa's initial dependence on coal is the main contributor to greenhouse gas emissions and climate change. South Africa has among the highest per capita carbon dioxide emissions in the world (ibid). It is important to consider alternative sources to fossil fuel energy that have less impact on the environment such as renewable energy sources. The levels of solar radiation in South Africa are among the highest in the world, with a daily average of 4.5 to 7 kWh (ibid). South Africa has enough resources to produce renewable energy. To benefit from these resources, the government must provide financial support mechanisms, develop infrastructure and technologies, and promote awareness and capacity building (Sustainable Energy Africa (SEA), 2013). The government's vision, political principles and strategic objectives are to promote renewable energy in South Africa (ibid). The South African government has ratified the United Nations Framework Convention on Climate Change and the Kyoto Protocol

so “it is essential that the government establish a renewable industry through a phased and flexible strategy based on partnerships" (Sustainable Energy Africa (SEA), 2013, p. 3).

2.7.1 White Paper vision on renewable energy

The White Paper on Renewable Energy states that renewable energy “harnesses naturally occurring non-depletable sources of energy, such as solar, wind, biomass, hydro, tidal, wave, ocean current and geothermal, to produce electricity, gaseous and liquid fuels, heat or a combination of these energy types” (Department of Minerals and Energy (DME), 2003b, p. 1).

To satisfy the South African Constitution’s aims and directives for energy management and policy, the government’s vision must satisfy and build the bases required to make energy supply available and delivered to everyone at affordable prices, irrespective of geographic location. Renewable energy plays a key role in the energy economy of scale and helps in improving the citizens’ quality of living and satisfying their power needs.

“The production and distribution of energy should be sustainable and lead to an improvement in the standard of living of citizens” (Department of Minerals and Energy (DME), 2003b, p. 6). The White Paper on Renewable Energy aims to use more efficient technologies, so renewable power generation at the desired location reduces the cost of transportation and the cost of the infrastructure needed to deliver energy (ibid).

With the increasing demand for energy and the growing environmental concerns because of the reliance on fossil fuels, the development of renewable energy plan is of strategic importance to South Africa (Department of Minerals and Energy (DME), 2003b). The World Summit on Sustainable Development emphasised the importance of its application and the need to contribute to the conservation of environmental resources (ibid).

2.7.2 Non-retained electricity policy

South Africa cannot afford the high economic costs of providing grid electricity to all (Runsten, 2015). Therefore, it should rely on the production of electricity outside the electricity grid using homes' solar systems. The Ministry of Energy bears 80% of the capital cost of households with incomes of less than R3 500, but this solution is limited to houses that are two kilometres away from the network and must be included in municipal planning (ibid).

Runsten (2015) criticises the Ministry of Energy for allowing the sale of thermal fuels and liquefied petroleum gas to informal settlements not supported by solar system, in the belief that they help these families to meet their energy needs without considering the negative effects on sustainable development. Sustainable Energy Africa (SEA) (2014) highlighted the lack of coordination between government agencies and non-governmental organisations working in the informal sector, as they also work separately from each other. Singh (2014) highlighted the importance of interaction between different levels of government and the importance of beneficiary participation, which helps to find a more efficient approach to energy service delivery.

2.7.3 Renewable energy sources

South Africa's geographical location is supplied by many of the renewable energy resources. The coastline stretches about 3 000 kilometres around the edges of Africa, which can be used to generate wind and wave power although varying in strength from one region to another. South Africa is classified as semi-arid, which means that it is possible to take advantage of vast areas of electricity generation from solar energy. There are great opportunities for biomass, but hydropower opportunities are scarce because water is scarce. (Oosthuizen, 2016)

2.7.4 Electricity generation from wind power

Wind power is a renewable energy source that is highly competitive compared to traditional energy sources. Wind turbine power generation capacity increases “by the square of its blade length and increases by the cube of the wind speed” (Oosthuizen, 2016, p. 36). South Africa’s wind farm electricity prices fell by 43% between 2011 and 2014 (ibid). With continuous advances in technologies and efficiency improvements, the prices of electricity produced from wind farms are expected to decrease compared to the coal-fired power at ESKOM (Oosthuizen, 2016). According to the first display window of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), the average cost per kilowatt-hour is 1.14 South African rand (R) and is expected to fall to R0.74 under the third window (Eberhard, et al., 2014). In the framework of the REIPPP programme, 34 wind power projects have been approved during the four rounds, of which 3 343 megawatts are expected to be produced at a cost of more than R50 billion of investments (ibid).

South Africa has great potential in the energy field. Figure 2.5 shows the South African wind atlas, while the different colours show the wind speeds in each region. The capacity of national wind power is expected to reach 30 000 megawatts, according to the South African Wind Energy Association (SAWEA) (Oosthuizen, 2016). Wind power is environmentally friendly and produces energy without pressure on the water supply compared with traditional power plants that use a lot of water. Wind power is a clean and safe source of energy (ibid). Wind farms are usually placed in places where maximum power generation is possible, but wind farms cannot produce electricity continuously for varying wind speeds from day to day (Oosthuizen, 2016). It is therefore normal to have intermittent energy in wind energy and this indicates that it is necessary to use it with other renewable energy sources of power generation.

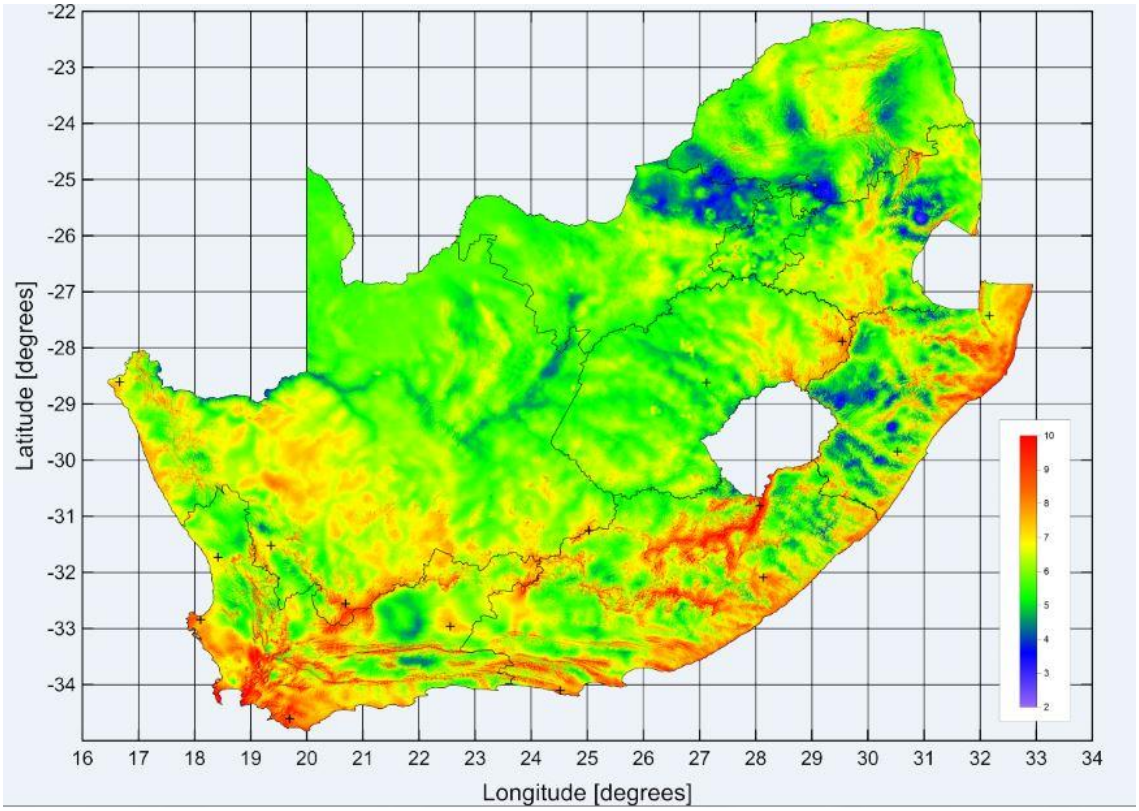

Figure 2.5: Wind atlas/wind resource map for South Africa.

Source: http://www.wasaproject.info/

2.7.5 Electricity generation from solar energy

Solar energy is a dominant renewable energy source in the present and foreseeable future. South Africa has about 300 days of sunshine a year and thus it is considered as one of the highest in the world to benefit from solar energy (Oosthuizen, 2016). Figure 2.6 shows the map of solar radiation energy in South Africa. South Africa, however, produces far less solar power than Germany, France and the United Kingdom (ibid). As noted by Eberhard et al. (2014), Both the Solar Photovoltaic (PV) and Concentrated Solar Power (CSP) are solar energy technologies which are used based on the level of solar radiation. The northern parts of South Africa prefer to use CSP because

they receive the highest level of annual solar radiation. CSP can solve the interruptions problem by using integrated heat storage systems (Eberhard, et al., 2014). There are seven CSP plants under construction in South Africa, all located in the Northern Cape District where the REIPPP programme is developing all of them (Oosthuizen, 2016). The seven CSP plants will produce 600 megawatts at an investment cost of over R40 billion (ibid). “The average cost per kWh for CSP projects under the first bid window of the REIPPP programme was R2.69, decreasing to R1.64 under the third bid window” (Oosthuizen, 2016, p. 40). Oosthuizen (2016) stressed the importance of taking advantage of as much solar energy as possible and said it is a great opportunity and a qualitative leap forward for economic, social and environmental development.

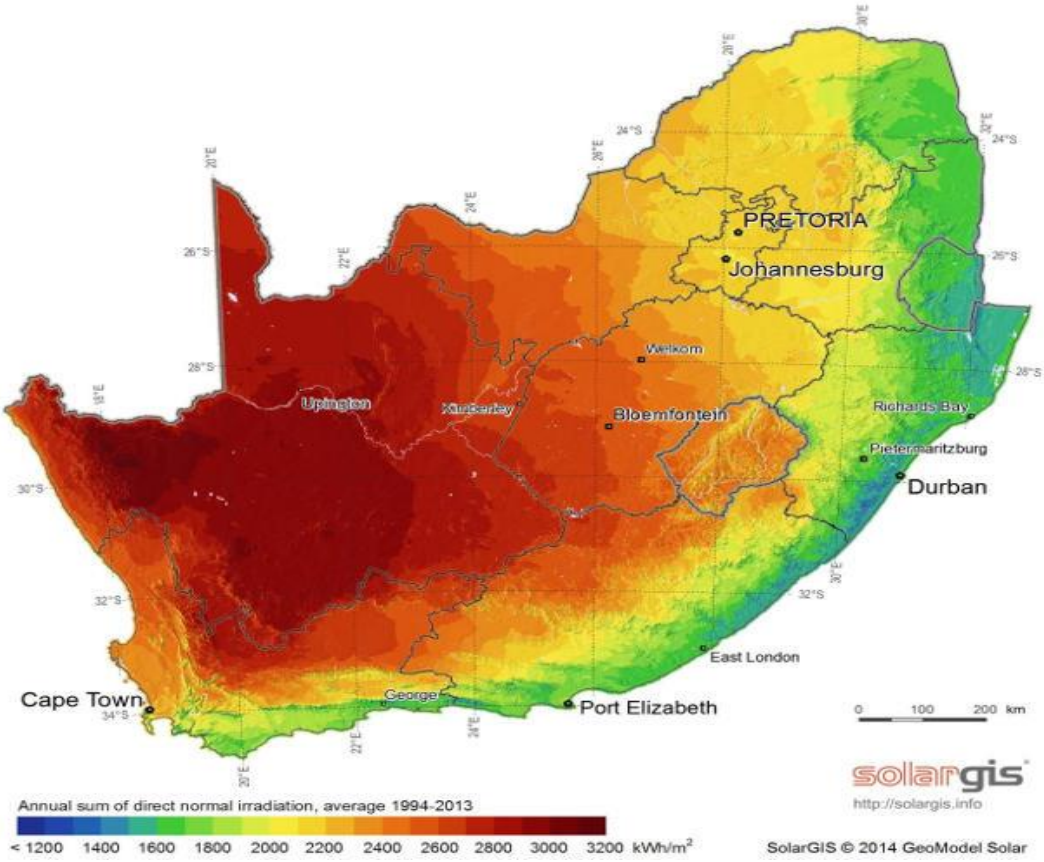

Figure 2.6: Map of solar radiation energy in South Africa

Source: https://www.energy.org.za/news/158-new-solar-resource-maps-for-south-africa.

Photovoltaic systems consist of cells that convert sunlight into electricity where each cell generates a certain amount of electricity based on the intensity of the solar radiation reaching it (Oosthuizen, 2016). The amount of sunlight is dependent on technology developments and existing investments. Over the past decade, the cost of photovoltaic systems has been very low and is expected to fall further by 2020 (ibid). The REIPPP programme found that the prices of solar photovoltaic projects declined by 68% between 2011 and 2014 (Eberhard, et al., 2014). The average cost of solar PV per kWh is R2.76 based on the first display window of the REIPPP programme, and under the third display window it fell to R0.99 per kWh (ibid). There are 45 photovoltaic solar projects under construction and a power generation of 2 297 MW is expected at a cost of R60 billion, with five of these projects in the Western Cape (Oosthuizen, 2016).

2.7.6 Electricity generation from natural gas

Oosthuizen (2016) has noted that all natural-gas power plants are located in the Western Cape Province. Natural gas is produced with open cycle gas turbine technology, which can produce electricity for the network in only 30 minutes. “This means that they are currently not intended to supply base-load power to the grid, but only supply power in times of high demand” (Oosthuizen, 2016, p. 42). Natural gas power plants burn cleaner fuels compared to coal or oil plants. Energy generated from natural gas is environmentally friendly as it releases less greenhouse gases and they also “operate at higher efficiency rates than coal and oil power stations” (Oosthuizen, 2016, p. 42). Natural gas power plants have high load-bearing capabilities and therefore these natural gas plants are considered as a solution for the intermittence issues of renewable energy (ibid). To generate electricity from natural gas requires a good infrastructure. South Africa lacks a dedicated liquefied natural gas (LNG) import infrastructure (ibid). The

government has stressed the importance of using natural gas to generate energy and that it will be the main catalyst in the expansion of infrastructure (Oosthuizen, 2016). That will dramatically change the image of energy in South Africa.

2.7.7 Electricity generation from nuclear energy

ESKOM owns two nuclear power plants located at the north of Cape Town, which produce up to 1 800 MW of power and produce about 4% of the national electricity supply (Oosthuizen, 2016). Nuclear power plants need a long time to develop them, from the start of the project to the time of operation at the plant (Eberhard, et al., 2014). Thus, the time required to have energy production is expected to take eight to ten years (ibid). Thus, nuclear power cannot solve the problem of power shortages in the short term but in the long term (Eberhard, et al., 2014). The production of electricity from nuclear energy is a concern because of the risk of high radioactivity, but at the same time it is cleaner than coal and more sustainable than fossil fuel technologies (Oosthuizen, 2016). Thus, the Department of Energy (2013) confirmed that nuclear power generation helps reduce greenhouse gas emissions in South Africa and helps address energy poverty. However, South Africa is still limited in the establishment of nuclear power projects (Oosthuizen, 2016).

2.7.8 Electricity generation from biogas

Biogas is generated from agricultural wastes and other organic waste and is a source of renewable energy and reduces carbon emissions (Van der Walt, 2015). It thus contributes to the sustainable management of waste and reducing traditional energy supplies. Local applications of biogas in South Africa are still limited. The Southern African Biogas Industry Association (SABIA) estimated that 2.5 gigawatts of energy could be produced from food, fertiliser and agricultural residues. (Van der Walt, 2015)

> “Biogas is the only RE technology included under the ministerial determinations for which no IPP bids have been received to date. The DoE and SABIA are working to address this and the Independent Power Producers (IPP) office has revised the tariff on request. …. In terms of national legislation, the owners of biogas operations not connected to the national gas pipeline grid do not have to be licensed, but they are required to register with NERSA” (Van der Walt, 2015, p. 86).

South Africa has not put in place its efforts to take advantage of natural gas as it has recorded less than 200 biogas processes since 2011 (Van der Walt, 2015). If compared to other countries, production is very low. For example, China recorded 17 million biogas processes, while India recorded 12 million (ibid). The Ministry of Energy has shown the importance of investing in the country's biogas by hosting two conferences in 2013 and 2015, respectively, in collaboration with SABIA (ibid). Although several sites in South Africa can be used to spread renewable energy. As shown in Figure 2.7.

Figure 2.7: This map explains how we can locate the renewable energy in all South Africa (Van der Walt, 2015, p. 54).

2.8 Sustainable energy transition (SET)

South Africa faces many challenges such as low economic growth, social disparities and mismanagement which have created other challenges in the electricity sector in achieving sustainable energy (Du Plooy, 2017). The idea behind the successful transition of sustainable energy is therefore a comprehensive perspective of sustainability across different sectors. “A Sustainable Energy Transition (SET) is vastly complex and requires a multi-disciplinary approach to address societies’ developmental and economic growth need” (Du Plooy, 2017, p. 3).

Developing countries face two challenges: the first is to deliver energy to all and the second is to meet the goals of renewable and clean energy (Du Plooy, 2017). This is in line with the seventh objective of sustainable development that is “to ensure access to modern, reliable and sustainable energy for all” (United Nations, 2017, p. 7). Achieving sustainable energy for all is the subject of international discussions to develop strategies and policies to achieve carbon reduction and address climate change (Center for Climate and Energy Solutions, 2015). South Africa's efforts to reduce carbon emissions began in 1998, a few years after the publication of the White Paper on Energy (Du Plooy, 2017). Since 2008, South Africa has sought to rely more on renewable energy resources such as solar PV, CSP, wind power and hydrogen (Department of Energy, 2015). Renewable energy technology has demonstrated its ability to attract attention during the past two decades and demonstrated its positive impact on the economy, society and the environment (ibid). “However, the intermittence of the renewable energy supply, grid stability and the ability of renewable energy to connect and transmit electricity remain challenges for the South African electricity sector (Du Plooy, 2017, p. 2). South Africa is a developing country, but it is the

largest producer of greenhouse gases on the African continent compared to its low economic growth and high poverty rate (Baker, et al., 2014). “South Africa has many challenges to overcome within the electricity sector, which include: infrastructure development, sustainable generation capacity additions, electricity price increases, social development and network planning” (Du Plooy, 2017, p. 3).

The DoE has shown that it has no intentions to abandon coal entirely but has stressed the importance of SET and achieving it based on renewable energy sources and being environmentally friendly (Department of Energy, 2015). But the DoE confirmed that “The coal generation will be reduced to 62 percent by 2025, as opposed to the 81 percent contribution in 2015” (Du Plooy, 2017, p. 35). The carbon dioxide emissions in South Africa are estimated by 2025 at 470 and 550 million tonnes per year (Walwyn & Brent, 2014). South Africa joined the 2009 international commitments to reduce emissions “by 34 percent from business-as-usual levels by 2020, and 42 percent by 2025” (Du Plooy, 2017, p. 39). The decline in renewable energy costs over the past decade has led to a loss of interest in coal as a source to produce energy due to its high cost compared to renewable energy (Walwyn & Brent, 2014). One of South Africa's key agreements to promote renewable energy and energy efficiency is its agreement with the Democratic Republic of Congo (DRC), which took place in September 2014. “The project has a generating potential of 40 000 MW of hydroelectricity, of which South Africa will have a 2 500 MW off take” (Du Plooy, 2017, p. 36).

Renewable energy has become a competitive source of energy, which is leading policymakers to develop a plan to introduce renewable energy as a key energy source in South Africa. This resulted in establishing the 2011 programme by the government called the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), affiliated to the Ministry of Energy, for the purpose of the installation of 17.8 GW renewable

power generation capacity during 2012-2030 (Walwyn & Brent, 2014). The main objective of REIPPPP is to meet the needs of the electricity sector for energy by financing sustainable energy projects, to reduce the high CO2 emissions and to strengthen the economy (ibid). Renewable energy is the new future hope for South Africa. According to the Department of Environmental Affairs, carbon dioxide will be reduced by 2050 to a maximum of 428 million tons per year (Department of Energy, 2013).

REIPPPP has successfully developed renewable energy projects at very competitive prices, supporting 64 independent power projects with a capacity of around 4 000 megawatts at a cost of $14 billion (Rennkamp, 2013). The 64 projects are solar photovoltaic, concentrated solar, wind, biogas, biomass and landfill technologies. REIPPPP has enhanced the success of renewable energy projects as it has been the dominant force for renewable energy growth since 2011 and the goal is to reach 17 gigawatts by 2030. Renewable energy sources contribute to South Africa's national aspirations for clean, safe and affordable energy. (ibid)

According to the IRP 2011 goals, by 2030 renewable energy will account for 9% of the total energy share, with the exception of hydropower (Du Plooy, 2017). The World Wide Fund for Nature (WWF) assumes that South Africa should increase its capacity to generate energy from renewable sources of energy by between 11% and 19% (Scholtz, et al., 2017). The South African government has managed to supply nearly half a million solar heaters to reduce energy requirements in 2015 (Department of Energy, 2015). REIPPPP has been characterised by its high-quality organisational structure. From its inception in 2011 to 2014, renewable energy contributed a net benefit to the South African economy of R0.8 billion (Du Plooy, 2017). REIPPPP contributes 1 500 megawatts of power generation to the South African network (ibid). Energy transfer is mainly dependent on the provision of adequate infrastructure and a stable network of the energy network

(Department of Energy, 2015). However, significant investments are needed in infrastructure, operation and maintenance costs and regulation for renewable energy sources (Smith & Stirling, 2008). Therefore, the financial cost is a frustrating factor for SET, especially in developing countries (Oosthuizen, 2016).

Network planning is necessary for the IRP to ensure that the energy produced is delivered to consumers in need. South Africa continues to be criticised for its heavy dependence on coal for electricity generation. The electricity system in South Africa is based on several important events: historical colonialism, apartheid, nationalism and state-led development (Power, et al., 2016). South Africa's energy crisis and climate change is due to its heavy dependence on coal, and alternative energy such as paraffin and others show a great need to find alternative electricity supplies (Du Plooy, 2017).

2.8.1 Understanding the need for sustainable development (SD)

The shift towards the sustainable energy transition is essential for sustainable development. This is because energy saving affects the triangle of sustainability and promotes the development of its economic, social and environmental conditions as shown in Figure 2.8.

Figure 2.8: Sustainability Triangle

Source: https://sisu.ut.ee/env-intro/book/export/html/9409

Sustainable development is the more efficient exploitation of natural resources to reduce its impact on the environment, but also to increase economic growth while improving the social impacts of future generations at the local and global levels to ensure a more just and more sustainable future (Ismail, 2017). Weakley (2013) emphasises the importance of social justice to improve the quality of life of the population and eliminate social injustice. The concept of sustainable development has been emphasised, as well as that governments around the world must strive to achieve it, which will help to enhance resilience and prolong life on the planet (Harrison, et al., 2014).

As a response, the sustainability agenda aims to reduce energy consumption, reduce private transportation use, improve land use, improve engineering of waste systems, reduce materials use, and create a clean and efficient

environment (UN-Habitat, 2009). The pursuit of sustainability through sustainable development approaches is a major challenge for governments, and requires a broad understanding of issues related to urban planning, poverty, the natural environment, and social and cultural aspects (ibid). Despite the theoretical understanding of sustainable development, its applications in South Africa were slow (Ismail, 2017). Weakley (2013) argues that the triangle of sustainability must be achieved in a balanced manner otherwise, if there is a greater focus on one of them rather than the other, ultimately the city becomes unsustainable.

2.8.2 Limitations of sustainable development

The government and the private sector in developing countries focus on making profits without any consideration for environmental and social impacts, creating constraints to sustainability (UN-Habitat, 2009). When looking at the definition of sustainability, we find it simple, but it is harder to achieve the goal because it is complex and requires extensive experience and different skills across multiple disciplines (Harrison, et al., 2014). Early recognition of the importance of sustainability requires having the sustainability as part of the education system in South Africa where education and knowledge help to achieve systematic development in the developing countries (ibid). Poor democratic control affects the progress of sustainable development (Pieterse, 2011). Politics has different interests, which creates competition between stakeholders and actors within and outside the government. Such competition leads to different perspectives, resulting in unsustainable and unfair decisions (ibid).

The apartheid policy in South Africa, in addition to the separation of spatial planning, inadequate infrastructure and inadequate services, put significant constraints on sustainable development (Ismail, 2017). Good infrastructure networks meet the needs of the smaller proportion of urban dwellers who are wealthier (Pieterse, 2011). However, the urban poor remain on the outskirts of

the city, which forces them to rely on the materials surrounding them without thinking about the negative impact on their health and the environment, which limits the cities of South Africa from developing towards sustainability (ibid). Lack of management and expertise in local authorities is also slowing down the delivery of sustainable human settlements, which force poor people to live in dangerous and unsafe areas and use harmful energy sources. “Current government subsidies rarely cover the cost of quality residential structures that ensure safety and privacy” (Smeddle-Thompson, 2012, p. 8).

2.8.3 The need for sustainable settlements

The massive urbanisation around the world drives the need for SD of settlements and cities. According to UN-Habitat (2009), the world’s urban population is expected to grow between 2005 and 2030. Asia and Africa are expected to host the largest proportion of urban growth. It is estimated that by 2030 more than 80% of the urban population will live in developing cities (ibid). UN-Habitat (2009) reported that 32% of the world’s urban dwellers live in slums with 90% of them in developing countries. The largest proportion of urban dwellers in South Africa, almost 71%, live in slums (Smeddle-Thompson, 2012). All of these factors are strong drivers to execute practices towards SD, particularly in Asia and Africa (ibid). According to Smeddle-Thompson (2012), settlements are sustainable when production and consumption systems are compatible with sustainable development objectives.

2.9 Conceptual framework

This conceptual diagram illustrates the basic concepts of energy policy research as well as renewable energy policy and housing policy. The starting point was the review of energy policies and applications since its inception to date, as well as literature review. The diagram also shows how the government is trying to improve the energy sector through post-apartheid policies to combat energy poverty and access to safe and environmentally friendly energy for all inhabitants in South Africa including informal settlements inhabitants. As shows in figure 2.9.

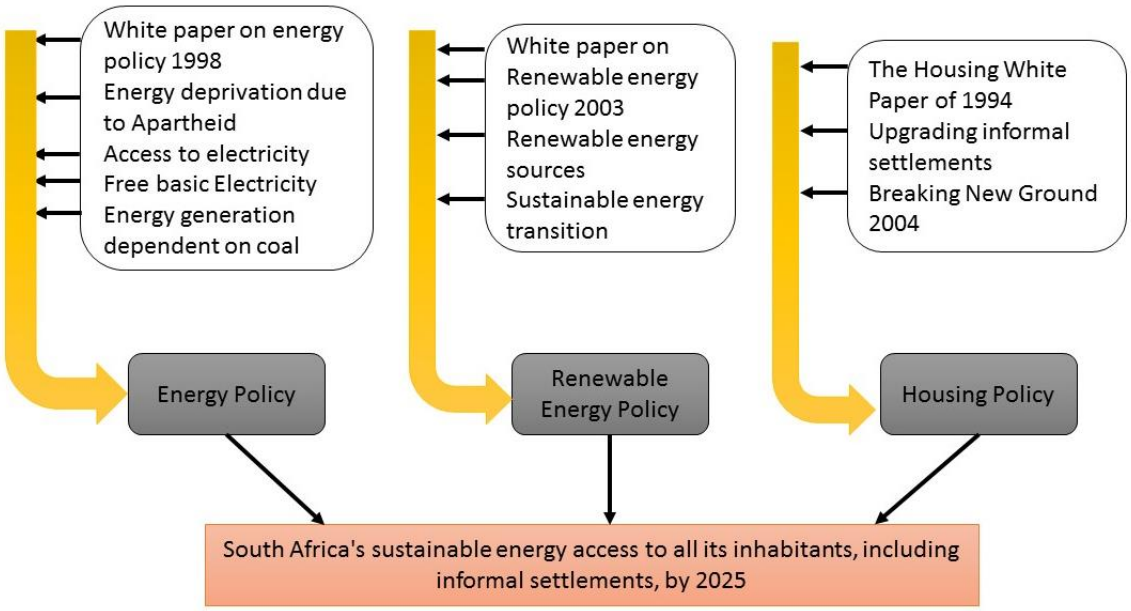

Figure 2.9: Conceptual framework

2.10 Conclusion

Having discussed at length the literature surrounding energy provision in informal settlements and the relevant policies that support it, this conclusion will summaries some of the key arguments which have arisen. This is to set up the discussion that will come in the analysis of the mentioned policies and their implication for the research problem statement and questions. South Africa has a distinctly unique history when it comes to service provision in that it has been through apartheid, which meant the separate development of races. The affluent whites lived in cities with adequate service provision including transport, water and electricity. Informal settlements began to spring up given the need to locate closer to the economic opportunities in central areas which were previously only for whites. However, ESKOM which is the main electricity provider, could not provide electricity to all homes due to its limited capacity.

The negative consequences of apartheid have made South Africa face challenges such as low economic growth, social inequalities and mismanagement, which have affected the capacity of the energy sector to provide sustainable and clean energy for informal settlements. South Africa is ranked as the 6th largest coal exporting country in the world due to the rich coal natural resources and mines in the country. This is one of the main reasons that motivate the country's heavy reliance on the coal to generate the required energy. Also, due to the excess availability of coal, the coal market price makes it cheaper for consumers compared to renewable energy sources. One of the arguments which stand out in this study is the over-reliance on coal, with South Africa using 90% of coal as the primary source of energy. This is on the high side given that it only produces 75% of the energy supply and that it is nonrenewable. The state has also argued that energy supply or access can lead to a reduction in poverty, but I have concluded that not everyone gets this access, so this is not the best option. It is up to

municipalities to provide energy to informal settlements through the free basic energy initiative, however, this too faces challenges. Municipalities are responsible for identifying the locations and places to extend the electricity supply, but mismanagement and the inability to classify poor families have made implementation difficult.

CHAPTER 3: RESEARCH METHODOLOGY

In this chapter, the author discusses the research method and how this research proceeded by collecting data from the policy documents and literature sources, and then analysing the results to answer the research question. This research is a qualitative study that includes a description of how the data is analysed and the potential limitations of the study. The purpose of this research is to investigate whether renewable and clean sources of energy could be accessible to all South Africans by 2025 in accordance with the objectives of the Energy Policy of South Africa. To maintain the reliability of the results, the information was gathered from different sources. The arguments and differences about the research problem were explained through various documents from these different sources. The study used data from books, journal articles, previous peer reviewed research reports, online resources, the Constitution, and energy policies.

3.1 Desktop research

Desktop research refers to data that can be collected from different documents This includes analysing documents without the need to question people through interviews or questionnaires or monitor their behaviour (Skills You Need, 2011). Desktop research is the main way historians gather data about their research topics. Documents are tangible materials in which facts and ideas are recorded in the form of newspaper articles, laws, maps or media formats - such as video or audio. Documents can be in the form of governmental and non-governmental policy records, newspaper articles and old published reports that can be reworded to produce a valuable picture (Patton, et al., 2013). The desktop researcher should review the results of previous research to gain a broad understanding of the field. “Documents can reveal a great deal about the people or organisation that produced them and the social context in which they emerged" (Skills You Need, 2011).

Desktop research is effective in policy analysis research. Policy research is a type of knowledge production that holds the key to understanding and analysing a complex problem and addresses the immediate needs of society (Patton, et al., 2013). This research report is based on a qualitative study that included a survey of literary sources, articles, research, and published government documents. Policy analysis is a breakdown of the energy policy problem then analysing its component parts, which requires the researcher to describe the state of the current infrastructure, including current intervention efforts - and then to understand and reach the causes of the problem to clarify and raise awareness among policymakers.

According to Patton et al (2013), policy analysis always happens after someone has discovered a problem or suggested a solution. The successful analysis of the policy has several advantages, including good problem formulation, comprehensive research on alternatives, knowledge of the limitations and causes of the problem, recognition of the importance of the environment and future generations, attention to equity among all groups of society, and verification of the relevance of the current policy. The desktop study works to assess policies to verify the extent to which policy objectives are applied. This requires considering of previous research to find the required results and determining whether the current policy is successful and should continue as it is to achieve its objectives, or whether it must be modified to move towards the goals and objectives. In desktop research, the analyst compares actual performance with targeted performance and seeks reasonable interpretations of differences. (Patton, et al., 2013)

Choosing the desktop research for an in-depth understanding of the subject matter and a logical and documented understanding of what people have done in the past is a quicker and cheaper method of accessing the desired research results and identifying the imbalance or weaknesses of the research topic. Thus, the research would be more credible because it would be based

on documented past information. However, it is not entirely easy to access the archived reports, as sometimes there is a flaw in how to search, and sometimes there is no clear defined place to access previous reports. (Travis, 2016)

Long-Sutehall et al. (2010), pointed out that the method of desktop research provides a new strength to the structure of basic social knowledge. Therefore, many researchers apply this method if they aim to study specific issues and problems that are distinct from those of the original analysis by creating a new conceptual focus on issues and problems which are studied “and describe the contemporary and historical behaviour of individuals, communities, groups or organizations or to provide case material for teaching and methodological development" (Long-Sutehall, et al., 2010, p. 336).

Bhat (2019) has indicated that the following are common methods of searching for documents using the desktop research method. The information required for research can be obtained in several ways, for example by downloading free documents from the Internet or by purchasing them from governmental and non-governmental organisations research. The benefit of obtaining such documents is that they are original and trustworthy. Documents can also be obtained from public libraries, which are considered an important repository of information, documents, reports, research, government publications and commercial manuals from which information can be extracted. Information can also be collected from educational institutions such as colleges and universities that have many reports and research. Business information sources also contain first-hand information on economic developments, political agendas, market research, population segmentation and similar topics. Newspapers and magazines are also an important source of archival research. Using desktop research might seem easy, but it takes a lot of time and effort to find the right documents and data sources.

The researcher took the following steps in conducting the research. First, the subject purpose and objectives of the research were determined. Second, the sources of information that would provide most of the information and data that applied to the research were identified. Third, data related to the search from different sources (such as public libraries, governmental and non-governmental organisations and other sources which have been previously mentioned) were collected. Fourth, previous data that is closely related to the topic was checked. Fifth, the data was merged into a usable format and compared. Finally, the data collected was analysed to answer the research questions.

3.2 Qualitative research approach

Qualitative research is a kind of social science research that works with non-numerical data and seeks answers to the research question by understanding the problem and gathering evidence (Ospina, 2004). This study examined the documents from the different sources as a source of data in qualitative research, in which the analysis of the policy documents is one of the basic materials for which qualitative research is used. Qualitative methods allow the researcher to study selected issues in detail without being restricted to predefined categories of analysis (Patton, et al., 2013). The qualitative research approach focuses on the explanatory social science model. Qualitative research begins with the collection of data on a real phenomenon or problem, which is then analysed and then theoretically revised (ibid).

Qualitative research is effective in the study and analysis of energy policies in South Africa. The selection of a qualitative research methodology has enabled the discovery and knowledge concerning energy issues in South Africa and thus allowed an understanding of the current energy crisis in the country from multiple perspectives, especially for the informal settlement population. Using the qualitative methodology made it possible to gather information from energy policy documents that represent the policy

perspective in South Africa. Policy data were combined with data collected from various literature sources to answer the research question. Qualitative research is usually used in historical, social, cultural and political research, when it is used to verify results or to provide evidence from different sources (Bowen, 2009). "When there is a convergence of information from different sources, readers of the research report usually have greater confidence in the trustworthiness (credibility) of the findings" (Bowen, 2009, p. 30). Analysis of policy documents is a systematic procedure, which is implemented by reviewing printed and electronic documents and studies for the purpose of data examination, interpretation and the knowledge of the problem (ibid). Qualitative research refers to investigative research, while its focus is on words rather than numbers and depth rather than breadth. This requires a more in-depth involvement of the researcher.

3.3 Document Analysis

The study and analysis of documents is a form of qualitative research in which the similarities and differences between the content of the documents are interpreted by the researcher in order to give a voice and meaning on the subject of evaluation (Bowen, 2009). Documents can be either public, private or personal documents. The sources of public documents include any government publication such as annual reports from ministries or departments, statistical bulletins, published laws and amendments, policy statements. Private documents include documents which are sourced from civil society organisations and entities such as private sector businesses and individuals where such documents often include annual reports, minutes of meetings, training manuals, advertisements, and press releases. (Mogalakwe, 2006)

Qualitative research relies heavily on document analysis as this is an important research tool and an effective social research method (Research Methodology in Education , 2016). “In order to seek convergence and

corroboration, qualitative researchers usually use at least two resources through using different data sources and methods" to provide a body of evidence that generates credibility (ibid). Thus, the researcher can use a large number of written research papers to look at converging and different perspectives (O'Leary, 2014). Bowen (2009) has stressed the importance of the quality of the documents rather than the quantity, but he has also pointed out that the multiplicity of documents that must be collected by the researcher should contain a wide range of documents, which provide a comprehensive and broader clarity of the subject. The repetition of information that a researcher finds when analysing documents will document the number of events for a particular topic within the research (O'Leary, 2014).The documents contain a variety of different opinions, ideas, and perspectives, so content analysis can help to paint a comprehensive picture of the subject (Bowen, 2009). Bowen sums up the overall concept of document analysis as "a process of evaluating documents in such a way that empirical knowledge is produced and understanding is developed" (2009, p. 33). "It is not just a process of lining up a collection of excerpts that convey whatever the researcher desires. The researcher must maintain a high level of objectivity and sensitivity in order for the document analysis results to be credible and valid" (Research Methodology in Education , 2016).

There are several reasons why researchers choose to analyse documents. "Document analysis is an efficient and effective way of gathering data because documents are manageable and practical resources" (Research Methodology in Education , 2016). The diversity and multiplicity of document forms for the same subject make the research report much more reliable. "Obtaining and analysing documents is often far more cost efficient and time efficient than conducting your own research or experiments" (ibid). Documents can be referred to several times without changing as they are non-reactive data sources (Bowen, 2009). Documents can include sometimes

data which is no longer noticeable or of focus and that provide information which was forgotten or missed by the informants. Document analysis can be beneficial in identifying the questions that need to be asked or the situations that need to be assessed and analysed, making the use of document analysis very critical and important in order to have a comprehensive and objective research. (Bowen, 2009)

The analysis of current data accelerates the search. For example, information about technology is constantly changing, so the use of current information allows the project to be completed and to produce the results faster, which helps to keep up with knowledge and development timeously. “Additionally, in the area of information policy, utilizing existing data can allow the researcher to answer important time-sensitive policy related questions quicker" (Johnston, 2014, p. 624). Document analysis offers methodological benefits as it generates new knowledge from a different perspective.

This research report is about South Africa's energy policy and investigates the accessibility of renewable energy to all South Africans by 2025. The researcher relied on public documents published on the South African archive on energy policy in the government gazette and was also based on data from governmental and non-governmental organisations and documents from the Department of Energy and the Department of Human Settlements of the republic of South Africa. The private documents were collected from reports, books and publications from educational institutions, in addition to some documents from Internet sources.

3.4 Limitations of the study

Archival research consumes considerable time to extract information (Administration, 2009). This creates challenges in finding and interpreting archival documents related to the research. Archival records can be unique, some of which can only be found online or in libraries. However, there is the

possibility of having insufficient data when the document is not in the public domain. It is possible that some records have not been published or have been closed for public access for reasons of confidentiality. (ibid)

Some documents may only provide a small amount of useful data so the document might not provide all the information required to answer the research questions. Also, some information might be limited to what already exists as it is possible that the information is outdated and does not serve what the researcher needs in his research. Moreover, some documents are not easily accessible, or might be unavailable. Other documents might be incomplete or inaccurate, creating gaps in the research. Therefore, this will require and lead to further research and reliance on additional documentation. (Bowen, 2009)

One of the problems or limitations when starting to analyse a document is the issue of bias either from the document creator or from the current researcher (Research Methodology in Education , 2016). “The researcher must consider the subjectivity of the author and also the personal biases he or she may be bringing to the research" (ibid). When analysing content, it may be found that the document has embedded content which is not clear. As Bowen (2009, p. 33) said "documents should not be treated as necessarily precise, accurate, or complete recordings of events that have occurred". Often, researchers do not use all existing data, because of the inability to know and cover all the documents. However, to overcome the limitations and maintain effective research work, honest efforts have been made by the researcher of this research study.

3.5 Ethics consideration of the study

Due to the continuous and persistent change in the demands of the people and communities in addition to the continuous transformation of the trend of knowledge production, researchers have been pushed to adopt much more

objective and comprehensive approaches in their conducted research. Qualitative research method is increasingly used in many of the academic fields to investigate the “why and how of the process of a developed concept” (Sanjari, et al., 2014). Sometimes, qualitative research can be described as interpretive research, and where interpretations can be incorrect, illogical or biased, results and findings might be questionable and disputable (ibid). However, qualitative research can be the solution to evaluate these issues by validating the results or by providing different insights and viewpoints of the same matter.

Since the researcher is considered as the instrument of the research within the qualitative research, and will be responsible for developing and modifying the research plan and needs as the research study progresses, the qualitative researcher therefore cannot be biased and should be credible and objective during the entire study. The potential biases in a document or from the researcher are a serious concern that both the reader and the researcher should be aware of before starting the analysis of the document. As both Bowen (2009) and O’Leary (2014) have advised, it is crucial to always investigate and analyse thoroughly the subjectivity of the analysed document to eliminate any potential bias that might exist in the document and assure the high quality, credibility and objectivity of the conducted research. However, the consultancy reports are usually easy to validate and evaluate as they are usually sourced from reliable unbiased sources which are often the consumers of these reports such as government departments and entities. Thus, it is easy to establish these documents' authenticity. (Bowen, 2009)

Authenticity of the evidence for the analysis of the document is considered as integral and the core of the credibility and integrity of the research. Therefore, the researcher should always ensure that only credible documents from reliable sources and dependable origin are used and consulted to ensure the

overall integrity and objectivity of the research. However, there are many instances when the sourced documents are found to be forged and not what they purport to be. This puts additional responsibility on authors and researchers to validate the authenticity and originality of documents, ensuring they are not forgeries and can be relied on. (Bowen, 2009)

Documents should therefore not be taken for granted. According to Mogalakwe (2006, p. 225), circumstances may arise that necessitate a close scrutiny of a document. Such circumstances include the following:

(i) When the document does not make sense or has obvious errors;

(ii) When there are internal inconsistencies in terms of style, content and so on;

(iii) When there are different versions of the same document;

(iv) When the version available is derived from a dubious, suspicious or unreliable secondary source; and

(v) When the document has been in the hands of a person or persons with vested interest in a particular reading of the text.

3.6 Conclusion

This chapter described the research methodology and outlined how the research was conducted including the method used to collect data, the approach used in analysing the texts as well as strategies used to ensure the ethical standards have been followed and the reliability of the study. The next chapter will provide the analysis process and describe the findings of the research.

CHAPTER 4: ANALYSIS AND FINDINGS

Data analysis is "the use of existing data, collected for the purposes of a prior study, in order to pursue a research interest which is distinct from that of the original work". (Heaton, 1998, p. 1) Data analysis is a process that helps to understand the constituent parts and the circumstances behind a particular problem and thus provides additional explanations, conclusions or knowledge about the investigations presented in previous reports (Johnston, 2014). "Document analysis is particularly applicable to qualitative case studies—intensive studies producing rich descriptions of a single phenomenon, event, organisation, or program" (Bowen, 2009, p. 29).

This chapter will provide an understanding of how energy policies affect sustainable development, where the researcher should be able to answer the research question on the effectiveness of current energy policies to achieve clean and sustainable energy for all by 2025. The analysis includes: the shift towards sustainable energy, infrastructure and investment in renewable energy, and the different methodologies and strategies of governments on energy policy approaches, while each government having its own objectives and interests**.**

4.1 The question of the research

The main question was: How adequate is South Africa’s rate of change in transforming the electricity sector into sustainable sources of generation, and therefore will current efforts foster/succeed in achieving a sustainable energy transition within the specified timeframe?

The main question will be answered by the following sub-questions:

Q1: What are the barriers to achieving sustainable energy in South Africa?

Q2: Do investment in renewable energy and lack of infrastructure affect the sustainable energy transition in South Africa?

4.2 Q1: What are the barriers to achieving sustainable energy in South Africa?

Traditional energy continues to dominate South African markets and the type of energy used by the informal settlement inhabitants, and it continues to create barriers to renewable energy entry into the South African market. South Africa is one of the leading countries investing in the domain of renewable energy. In 2014, South Africa was ranked among the top 10 countries in the world in renewable energy investment (Murombo, 2016). Despite this impressive information, the transition to renewable energy sources still faces many obstacles and barriers that must be overcome. Legal, political and regulatory barriers are a key challenge for renewable energy applications that should be addressed and given attention. Also, there are other barriers and important challenges which include economic cost, cultural and behavioural challenges. The strategies used in each country vary in order to address these challenges according to the social, economic, political and contextual approach of each country. (Murombo, 2016)

Murombo (2016) asserts that, “Energy systems are complex sets of inter-related components, technical, social, and institutional, which have developed to support the dominant technologies" (p. 144), which require the transition of central energy systems that are currently heavily dependent on fossil fuel energy production, allowing the transition to a sustainable logical option. The Intergovernmental Panel on Climate Change (IPCC) also confirmed that “enabling legal and policy frameworks are key to reducing climate change in the energy sector by promoting renewable energy sources" (Murombo, 2016, p. 144). The following section illustrates barriers to economic, social, ethical, legal and political obstacles as a regulatory tool that prevents the empowerment of renewable energy sources. These barriers affect the

success of the access to clean and safe energy by the inhabitants of informal settlements (Murombo, 2016).

4.1.1 Economic obstacles to renewable energy

Continued economic growth in South Africa is a key factor in addressing the effects of apartheid, energy poverty and improving the quality of life. In the 1990s, the country's economic growth increased because of the adequate supply of energy which was provided from fossil fuels. But such energy had a direct impact on sustainable development (Ghoorah, 2010). Economic growth did not continue as expected; on the contrary, it got worse as demand for energy increased, leading to energy crises in 2007 and 2008. Economic growth slowed to 1.2 percent in 2015 (Murombo, 2016). South Africa is an economically divided country in which there is a dramatic disparity in the services provided for the rich and the poor. Many policies have been developed in South Africa in an attempt to solve the problem of energy poverty within a sustainable and unsustainable development path (Ghoorah, 2010).

Electricity generated from coal resources is considered cheap compared to electricity generated from renewable sources. The South African government is in a dilemma about how to continue to rely on cheap electricity generation and have economic growth while at the same time promoting and relying on renewable energy as a primary energy source required to reduce the emission of greenhouse gases and improve the quality of life of the inhabitants of informal settlements (Odhiambo, 2009). Economic policy is often intractable and affects the political perspective (ibid). The energy issue is a large and complex issue given the economic priorities and the position of government policies. Murombo (2016, p. 146) confirmed that the “economic obstacles are factors that make renewable energy technologies uneconomic, expensive and have a perceived negative effect on economic growth”. The sources of fossil fuels have proven their low cost, performance efficiency and

faster economic growth for the country in comparison with renewable energy sources. The shift towards renewable energy initially will lead to a temporary economic slowdown. Opinions differ as to whether the renewable energy revolution will create barriers to economic growth and economic interests on a permanent basis. (Murombo, 2016)

The South African government is concerned about the implications of its development agenda if the electricity industry relies on renewable energy sources and it also worries about how to deal with the expected economic slowdown in such a shift (Coetzee, 2016). However, the current signals indicate the unreliability of the traditional energy system because of its inability to secure and deliver energy to the entire population. This type of mistrust can greatly affect citizens' choices and their economic thinking then lead to a shift towards renewable energy. Many residents of informal settlements are hoping to have energy sources cheaper than coal (Ghoorah, 2010).

“The National Energy Regulator of South Africa (NERSA) has attempted to play its role by using price determinations to economically signal a shift towards charging realistic and cost-related rates for electricity" (Murombo, 2016, p. 145). The challenge lies in the ability of renewable energy to produce electricity that is relatively comparable to the energy produced from fossil fuels. This requires high efforts within a comprehensive market reform to address barriers to the renewable energy sector. At present, there is a mixture of fossil and renewable energy sources, but fossil fuel energy sources are dominant. As any new technology of its early time, renewable energy technologies are more expensive compared to traditional energy technologies. (Murombo, 2016)

Thus, the initial capital charges for renewable energy sources are expensive and it is most likely that at the beginning there will not be any profit and cost recovery. The cost of selling renewable energy is often priced at a high cost

to recover the actual cost plus a profit margin. Thus, “Cost competitiveness is therefore one of the major obstacles to the transition to renewable sources of electricity" (Murombo, 2016, p. 147). Measuring the cost of renewable energy sources such as solar, wind, geothermal and other sources over a long-term period is close to the cost of fossil fuels (ibid).

> “For instance, photovoltaic solar is expensive to buy and install but once installed it can go for over thirty years with miniscule maintenance costs. Similarly, the cost of buying and installing wind turbines are high, yet once towering up they stand for a long time with minimum maintenance and running costs compared to a coal, gas or nuclear-fired plant. Service maintenance and running costs is a key differentiator of the various energy sources and one of the factors that makes renewable energy feasible in the long term". (Murombo, 2016, p. 147)

Several studies show that renewable energy costs are high, but the high levels of subsidies governments pay for fossil fuels should be taken into account for cost comparison with renewable energy. Lang et al (2010) suggest that economically and on the basis of costs, the energy produced from fossil fuels is not cheaper than the energy generated from renewable sources. Krupa and Burch (2011) criticised the ESKOM's programme, which worked on building the Medupi plant to expand coal-fired power generation, saying that such investment could have been invested in renewable energy instead. With such expansion, the Medupi plant will add about 29 million tons of greenhouse gas emissions (ibid).

There is a great concern among policymakers because they lack complete control over the economic obstacles to renewable energy (Krupa & Burch, 2011). Governments often reverse the sources of economic support they have adopted to apply renewable energy sources and eventually argue that it is an impossible strategy to execute (ibid). Governments recommend the importance of moving towards renewable energy, but at the same time defeat their objective by demonstrating that renewable electricity is expensive and

uneconomical (Krupa & Burch, 2011). As noted by Murombo (2016), this creates concern for banks and other financial institutions because of the huge initial costs of renewable energy technologies, which makes them fear being able to recover their loans and investments. There is a perceived energy security by using fossil energy sources despite their negative effects on the environment. ESKOM was given R3 billion by the World Bank in order to build Medupi coal-based power plant project and in return a small part of the funding goes to renewable energy projects (ibid). Coal-based energy sources provide investment security supported by the legal environment which governs the financial institutions and investment laws (Murombo, 2016).

The South African government therefore needs to change its economic approach to promote investment in renewable energy (Odhiambo, 2009). Such interventions in the financing environment may force institutions to channel funds towards renewable energy projects. The government that takes the responsibility for environmental damage can have a significant impact on decisions on financing technology (ibid). When energy facilities are state-owned monopolies, the state is entirely responsible for the transformation and support of renewable energy technologies (Murombo, 2016). Governments that support fossil fuels and harm renewable industries must therefore bear the cost of the negative health effects and environmental damage caused by fossil fuels (ibid). “This could indirectly address the issue of subsidization of the fossil fuel industry as the full cost of remedying the environmental impacts could offset the subsidies given by the government" (Murombo, 2016, p. 149).

The fossil fuel-based energy industry is currently receiving significant support from the government because of these monopolies and therefore renewable energy sources cannot compete strongly with fossil energy (Ghoorah, 2010). "Privatization and removal of the monopoly power of state-owned energy utilities could open up the competitive space for renewable energy players"

(Murombo, 2016, p. 149). In addition, the South Africa government indirectly removes financial and regulatory support for the fossil fuel industry (ibid).

> “There have been arguments for Eskom to be restructured (privatized or unbundled) to improve its efficiency and possibly open it up to competition from private independent energy players. These seem not to have found favour with the government, which is set to continue supporting Eskom and afford it financial and economic privileges that the private energy industry cannot access". (Murombo, 2016, p. 149)

Instead, the South African government was supposed to direct such contribution to investments in renewable energy sources which could add more energy sources to help cope with the increased demand for energy supply by the residents of South Africa.

The process of determining the actual cost of electricity production from coal was not realistic since it did not calculate the cost of coal processing, the cost of health impacts and the cost of air and water pollution (Montmasson-Clair & Ryan, 2010). If compared effectively, renewable energy is considered less harmful and therefore less costly. NERSA points out that ESKOM rarely talks about the costs of the full coal cycle, which shows or proves that the final cost is separate from social, economic and environmental realities (ibid).

> “Arguably, there are possibly extensive information and data asymmetries that obstruct effective regulation of Eskom by NERSA. The price of electricity has invariably been artificially low to allegedly respond to the consumer needs and social circumstances, yet this approach forgets the consumers’ environmental and health needs". (Murombo, 2016, p. 150)

On the other hand, many South Africans, especially residents of informal settlements, are unable to afford electricity from coal sources. Despite the provision of free basic electricity, its high cost acts as a barrier to the economy and impedes environmental sustainability. Nevertheless, the residents of the informal settlements do not care about these negative effects, but rather focus on the comfort and decent life that fills part of their daily energy needs. It is clear that the social and environmental costs of fossil

energy remain opaque in terms of price. In contrast, the environmental, social and health benefits of renewable energy are not recognised and are not economically enhanced. (Murombo, 2016)

There is a great challenge for the South African government to move to a low-carbon economy because of the long-term consolidation of fossil fuel energy (Lang, et al., 2010). Despite attempts to promote renewable energy/electricity, many studies show that renewable resource capabilities are limited in the complete replacement of fossil fuels. This requires assurances that the opposite is true, and that renewable energy will boost South Africa's economic growth and complete the REIPPPP 's successes since 2011 (Du Plooy, 2017). It takes time to prove that these regulators' and consumers' uncertainties and concerns about the efficiency and quality of renewable energy are not valid and to prove that the opposite is true. Du Plooy (2017) argues that there is a regulatory context on which countries rely to compare the cost of fossil fuels with renewable sources of energy, and thus renewable energy sources are promoted according to the policies and regulations adopted by governments. Murombo (2016, p. 151) said that "most of the economic obstacles manifest in this regulatory inertia and resistance to change from the current electricity supply and pricing systems".

4.1.2 Social barriers

There are many societal concerns about moving towards sustainable energy sources as the unusual and new things usually take a long time to be accepted. This is in line with what Murombo said, that similar to the economic obstacles, "social obstacles originate from lack of knowledge and understanding of how renewable energy works judged by its own standards" (2016, p. 151). When non-renewable fossil energy is compared with renewable energy, an unfair advantage is created, and a large part of society is going to accept the fossil sources because of insufficient knowledge of their current impact and its harmful effects for future generations. Although there is

a lot of research that explains the disadvantages of the traditional energy sources, but the residents of informal settlement continue to rely on them as an initial energy source. There is a huge challenge for the country's government to raise awareness and build consumer confidence to rely on renewable energy sources as a primary energy source. Government's focus on technological and economic challenges of renewable energy is not enough as it also requires government's programmes to address social barriers as well. (Murombo, 2016)

Electricity has been generated from fossil fuel sources such as coal and paraffin by the residents of informal settlements for decades and has become part of the culture of people living in these areas (de Jongh & Ghoorah, 2014). Thus, the government has difficulty convincing people to abandon their use of such fossil fuel sources. Murombo (2016) criticises the position of the government of South Africa on promoting renewable energy sources for the inhabitants of informal settlements and argues that they can be persuaded to abandon alternative energy sources if renewable energy is provided in the manner required. This will greatly improve their social, health and environmental life. The choice of energy use must therefore be based on the right approach and take into consideration what communities need. Community education is needed to consolidate renewable energy by raising cultural awareness and building environmental awareness rather than only focusing on economic concerns, and through this creating confidence in renewable energy sources. (Murombo, 2016)

Many governments and social organisations in developed and developing countries have attempted to change cultural attitudes towards greenhouse gas emissions, energy use and lifestyles (de Jongh & Ghoorah, 2014). The lifestyle varies from one city to another among social groups. Some have a greater awareness of sustainable development, and this is manifested through cultural and awareness movements that encourage a change in

thinking, production and consumption patterns, thus facilitate social acceptance of renewable energy sources (Murombo, 2016). Renewable energy sources are seen as socially and economically attractive and this enables and supports energy producers and consumers to see environmental, social and economic opportunities. Murombo (2016) argues that consumers tend to assume that conventional energy is cheaper and more reliable than renewable energy, due to lack of awareness about the importance and benefits of renewable energy. Also, residents of informal settlements who rely on alternative energy sources “tend to believe that anything other than grid-based power is not sufficient to provide them with modernizing energy” (Murombo, 2016, p. 152). Many solar projects fail because consumers believe that non-grid power is less powerful than grid power (ibid).

“The perception of fossil-based energy as the key to development and a high standard of living is an obstacle that can only be dislodged by sustained education and awareness campaigns" (Murombo, 2016, p. 153). The idea that fossil fuels are the only ones capable of meeting the basic demand for energy must be reversed as, in reality, they are unable to do so. Millions of people still suffer from energy poverty in informal settlements (ibid). Governments should have more subtle policy changes to enhance the efficiency and capacity of renewable energy and rely on it as a primary source of energy (de Jongh & Ghoorah, 2014).

4.1.3 Ethical Challenge

The higher the energy consumption, the higher the gross domestic product (GDP), and this is evidence in the human development index (HDI) (Nkomo, 2007). “Energy language such as baseload, reliability, security of supply all betrays the anthropocentric ethical worldview that has shaped the existing regulatory frameworks. It is not impossible to think outside this centuries’ old box and make a mixture of renewable energy to replace the so-called

baseload capacity" (Murombo, 2016, p. 153). Governments are trying to implement renewable energy policies to ensure the safety and well-being of residents, meet their energy needs and improve their quality of life. Energy policies often talk about the security and reliability of energy supplies to all residents (ibid). But, “Energy security is itself a dynamic but nebulous concept. Until recently, energy security was not defined by reference to environmental sustainability, but only by reference to whether a particular resource is going to be reliably and continuously available to human beings". (Murombo, 2016:153)

The shift towards renewable energy sources is urgently needed to meet the needs of the residents and to anchor sustainability to protect the growing demand for energy in the future (de Jongh & Ghoorah, 2014). The South African Renewable Energy Policy approach seeks to bridge the gap which ESKOM made with regard to the supply of energy to all. Thus, “IPPs are given space to enter the sector only to the extent necessary to ensure keeping the grid up in times of extreme demand, hence the limit and control of how much should be generated by (IPPs)" (Murombo, 2016, p. 154).

REIPPPP has been recognised for its ability to provide renewable energy in South Africa, and there may not be any available renewable energy safeguards and incentives outside that programme (de Jongh & Ghoorah, 2014). Murombo said that the anthropological model works to support the ethical approach by respecting the environment and ecosystems and thus this model "could assist in the behaviour modification and the energy choices that people make" (Murombo, 2016, p. 154).

Murombo (2016, p. 154) noted that “behavioural choices are determined by values, identities and social norms and these are currently embedded in a human-centred value system". The current state of energy in South Africa has nothing to do with the behaviour of environmental sustainability because of the increasing use of fossil fuel sources. When NERSA sets the price of

electricity, it primarily considers the cost and economic implications only. Thus, the focus is on economic costs without regard to environmental and social impacts (Murombo, 2016). “Ethically, this removes environmental sustainability and resilience thinking from the decision-making processes" (Murombo, 2016, p. 154). The ethical approach plays an important role in the social acceptance of renewable energy sources when renewable energy sources are still socially unacceptable. Energy policies in South Africa are the source of energy laws and the ones that organise them. Therefore, these policies need to apply ethical codes that focus on sustainable development. What is confusing is that the South African government wants to have sustainability, but it does not seek to achieve it (ibid). In addition, there is a missing ethical framework for thinking about energy with the right values. People still hear every day about increasing greenhouse gases, but there is no strong deterrent to shifting social and economic values and standards towards sustainable energy sources.

“The social and cultural attitude towards energy sustainability is a reflection of the generally apathetic attitude towards environmental problems and regulation" (Murombo, 2016, p. 155). This is evidenced in South Africa where extreme poverty and informal housing are widespread, limiting the importance of sustainable energy and the difficulty of reducing carbon emissions. Behavioural interventions may help in the widespread use of renewable energy as “behavioural interventions could be necessary to shift from the socially normal to the ethically fine and the law is one tool that could be used to enable this shift" (Murombo, 2016, p. 155).

4.1.4 Legal and Policy barriers

Governments and associations face increasing social, economic and behavioural challenges of transition to renewable energy. The fossil fuel industry is dominant in South African markets and therefore there is a huge challenge to work to remove them from the legal and the governmental

framework. Government energy institutions have an interest in the continued dominance of the fossil fuel energy system (Murombo, 2016).

Current energy laws in South Africa do not support and encourage the existing institutions within the energy sector to invest in the new renewable energy technologies. Instead, the laws allow them to be in favour of the existing non-sustainable energy solutions and maintain their organisation structures and used legacy technologies (Murombo, 2016).. Thus, such institutions do not feel the necessity to transform their organisations' structures and their technology investments to grow the renewable market (ibid). Therefore, it is extremely important that the state should remove such institutional obstacles and bottlenecks that discourage the market players from evolving their energy technology solutions towards sustainable and renewable ones.

Institutions and governmental organisations are trying to apply the energy policy and energy regulations adopted by the policies to reach sustainable energy.

> "Existing energy laws structurally support existing institutional design and energy governance structures, emboldening these institutions to be averse to supporting new technologies and the institutional changes they require. The state must remove institutional bottlenecks to grow the renewables market and wean state power utilities that perpetuate the current regulatory inertia". (Murombo, 2016, p. 155)

Energy responsibilities in South Africa are shared by the Department of Public Enterprises (DPE), the DoE, the Ministry of Finance, the environmental management which works to reduce carbon emissions, ESKOM which has a monopoly for energy production and transmission and finally NERSA, which is responsible for price regulation and licensing of electrical activities (Murombo, 2016). As can be noted from the above list of energy responsibilities in South Africa, it is highly important to include the Department

of Mineral Resources in the list due to its critical role within the energy industry from a national constitutional legislative perspective.

Going through the several different institutions available within the energy and electrical industry, the DoE is considered the dominant institution that impacts and controls the shape and evolution of the energy industry (de Jongh & Ghoorah, 2014). The critical fact which is impacting the efficiency and right usage of such influence and power is the fact that the regulators are appointed directly or indirectly by the minister which make them follow the orders and wishes of the minister, thus they lack the dependence and balance that they need to have constructive results and decisions (Murombo, 2016). Within the same context, the state exercises similar control over ESKOM's plans and decisions as the state remains the main shareholder of ESKOM (ibid). This results in biased energy plans, decisions and directives, which cause the loss of having rational and balanced decisions. Also, a consequence of such control is the fact that new energy rivals and other non-controlled energy institutions will face difficulties and huge challenges in breaking into the energy industry. This has resulted in lost opportunities of having such institutions in the market which can support the development and growth of the country's economy.

The institutions responsible for the electricity sector in South Africa can reduce the level of pollution by developing a policy that allows only the production of energy from high quality coal, while supporting investment in renewable energy. Non-governmental organisations and institutions often try to apply sustainable energy technologies, but they have little influence as their power and dominance are not comparable to the institutions responsible for the energy sector (Du Plooy, 2017). The institutional development of the energy sector plays a key role in enabling and integrating the renewable energy system and without political and institutional reforms this cannot be deployed (Murombo, 2016). In other words, energy sector institutions play a

structural role in the electricity supply industry. Sustainable development is not supported by energy sector institutions as required, as energy institutions tend to focus on fossil fuels, creating legal barriers to the sustainable energy sector (de Jongh & Ghoorah, 2014). The plans of sustainable development institutions, current energy institutions and environmental institutions must be in line with each other to promote sustainable energy sources as these institutions are still largely fragmented. “The internal and external regulatory fragmentation means that renewables and institutions that drive them currently are seen as unstable, weak and therefore less of a threat to the established energy industry" (Murombo, 2016, p. 159).

Renewable energy sources also face legal obstacles. There are only a few renewable energy organisations and associations in South Africa because “the South African government does not have a dedicated institution to champion renewable energy outside the Department of Energy or NERSA" (Murombo, 2016, p. 159). Thus, this creates obstacles to the transition to renewable energy. It is likely that the DoE does not have the skills required to support sustainable energy projects (de Jongh & Ghoorah, 2014). Therefore, a new revolution is needed to achieve the transitional phase required for successful implementation of renewable energy and regulation of the energy industry (ibid). This will change the course of studies and research that show that renewable energy is expensive, unreliable and intermittent. “This institutional conservatism cannot be reformed without appropriate legal transformation of the energy industry first" (Murombo, 2016, p. 159).

Current energy laws are described as an obstacle to renewable energy when the “current law and policy grew out of, and in turn supports an energy industry intertwined with fossil fuels while wholly unsuitable for renewables" (Murombo, 2016, p. 160). The laws on power generation from fossil fuel sources are clearer than renewable energy laws, which are often obscure or essentially non-existent (ibid). “From a policy perspective, the current

approach expects renewable sources to fit into the existing legal and policy environment or else stay in a regulatory vacuum" (Murombo, 2016, p. 160). Ghoorah (2010) argued that if there were strict and effective renewable energy laws, there would not have been this many current problems. Thus, the amendment and reform of the National Energy Act No. 34 of 2008 is essential to shift from the use of traditional energy and create the arena for renewable energy sources and technology (ibid). In fact, more attention has been paid to the economic and social viability of renewable energy sources than to the legal framework needed to implement renewable energy technologies; Murombo (2016) says that the legal and policy framework has been largely forgotten. The absence of the Renewable Energy Act is a barrier to effective transition to renewable energy applications in the country.

IPPs are concerned about the continued dominance of ESKOM in the production of coal energy and therefore there are fears of confrontation and lack of investment in renewable energy sources (Murombo, 2016). “One of the most difficult challenges faced by renewable energy is gaining the support and confidence of politicians who ultimately make law and policy and head the responsible government" (Murombo, 2016, p. 160). The lack of will and the lack of political management create barriers and impediments to the integration of renewable energy sources in many developing countries (de Jongh & Ghoorah, 2014). The power of will and political management works as a powerful force to remove all barriers to the application of renewable energy technologies (ibid). “Political commitment must be informed by a political paradigm shift from the traditional regulatory state approach" (Murombo, 2016, p. 160). The government of South Africa is in a critical position between addressing historical grievances and challenging the application of sustainable development and thus the legal and political environment in South Africa remains uncertain and fragmented (Du Plooy, 2017). The National Energy Act No. 34 of 2008 does not full implement the

Renewable Energy White Paper especially when it comes to the promotion of the transition towards renewable energy sources and technologies (Murombo, 2016).

The Ministry of Energy and NERSA have tried in recent years to reform the legal and political environment to remove obstacles to renewable energy sources. REIPPPP has successfully implemented some renewable energy technology projects, but there are no indications of a long-term future (Murombo, 2016). However, as long as only the monopolistic electricity supplier ESKOM is allowed to buy the electricity produced from renewable energy sources, there is considerable uncertainty among renewable energy project developers. “Reliability of profits as the most important incentive of the feed-in-tariff scheme is lacking" (Murombo, 2016, p. 162). “To see the real financial benefits of some renewables requires long periods in an environment where an independent buyer mediates among generators and distributors" (Murombo, 2016, p. 162). Environmental policies are aimed at providing renewable energy sources and developing strategies that protect and reduce greenhouse gas emissions, while energy policies focus on providing reliable, safe and uninterrupted energy from fossil fuel sources (Lang, et al., 2010). In certain circumstances, laws and policies create an organised strategy that avoids renewable sources of energy and reduces their feasibility and credibility in return for enabling and legitimising fossil energy sources. This legal framework is supposed to be reformed and transformed into a framework that recognises the role of diverse energy sources, helping to gradually enable renewable energy in the market and then shift to a greater proportion of reliance on renewable energy rather than traditional energy sources. In summary, there are economic, social, ethical, legal and policy barriers to achieving sustainable energy in South Africa.

4.2 Q2: Does investment in renewable energy and lack of infrastructure affect the sustainable energy transition in South Africa?

In 2003, the national government put a target of 10 000 gigawatts of renewable energy to be generated by 2013, but no effort was made to reach the target (Eberhard, et al., 2014). The National Development Plan (NDP) was developed in 2010 to eliminate poverty and inequality in South Africa by 2030 (ibid). This was done by encouraging development in all sectors of society, economy and the environment. Rennkamp (2013) argues that the policy framework is not ideally suited to promote the full potential of renewable energy. The DoE participated in the energy planning process with the Integrated Resources Plan (IRP) to work on the use of renewable energy technologies to produce electricity (ibid). The plan included access to 9.6 GW of nuclear power, 17.8 GW of renewable energy sources, 8.6 GW of other energy generation sources and 6.3 GW of coal generation in 2030 (ibid). IRP clearly articulates the objectives but does not disclose details of the implementation and funding of the proposed energy mix. The path to achieving these objectives is therefore not clearly defined and this creates uncertainty in the implementation of other policy plans. Rennkamp (2013)

The failure to protect South Africa's rand currency and its devaluation creates fears of investments in renewable energy (Kruger, 2017). Poor investment and infrastructure are major obstacles to renewable energy growth, where the investment growth was around 1.6% between 2014 and 2017 and this is expected to fall further in coming years (ibid). The quality of infrastructure and energy supplies in South Africa is worse than in the US, UK, China, Japan, Denmark and Germany, as can be shown in Figure 3.1. Thus, poor quality infrastructure and weak supplies hinder renewable energy growth.

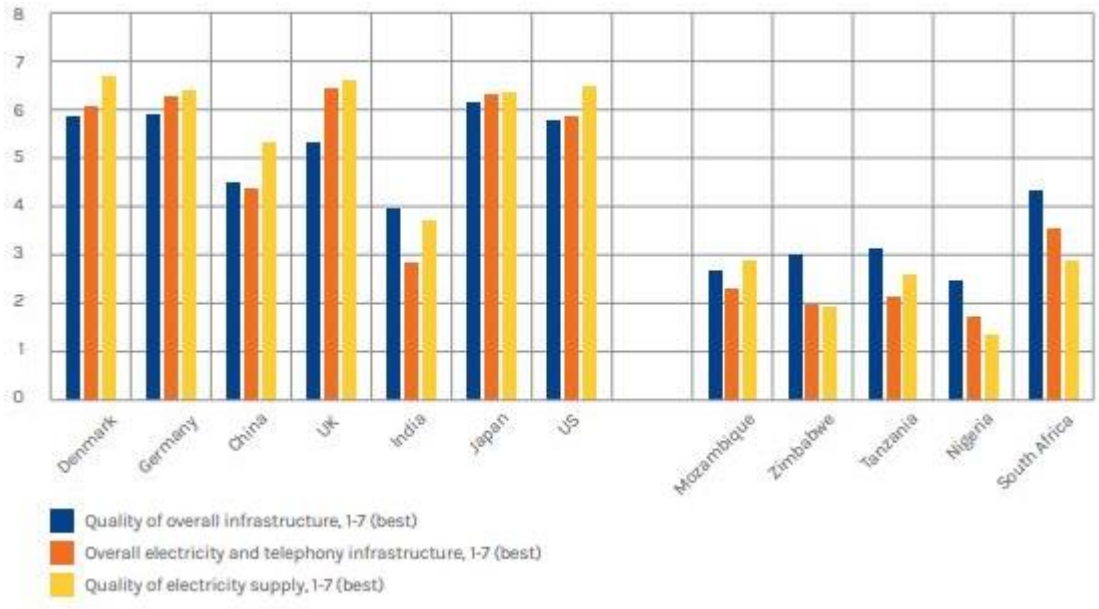

Figure 3.1: A comparison of the quality of the electricity infrastructure between South Africa and some of the key developed countries in the world between 2015 and 2016 (Kruger, 2017, p. 2)

As noted by Kruger (2017) South Africa's energy demand is 226-gigawatt hours per year and is expected to generate 32% of the overall generated energy from renewable energy by 2030. As part of the REIPPP programme, South Africa plans to provide 3.7 gigawatts of renewable energy by 2020, with a greater focus on solar and wind power production (ibid). REIPPPP has managed to attract an overall investment of R193 billion by 2014 (Kruger, 2017). As shown in Figure 3.2, REIPPPP has managed more than half the distance to reach the target.

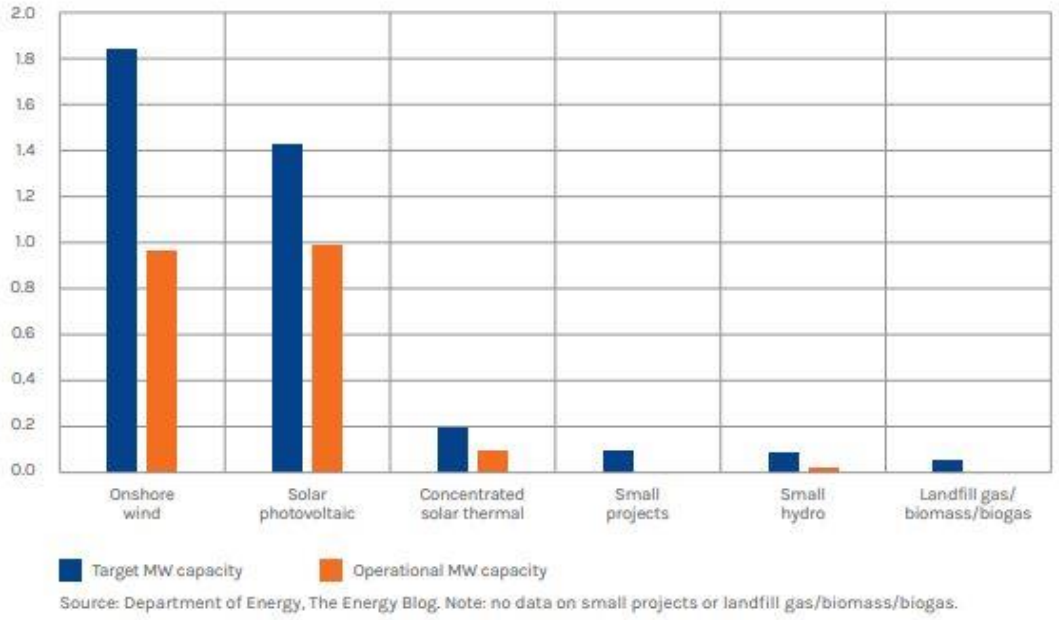

Figure 3.2: The DoE 2020 targets and the combined renewable energy capacity for the year 2015 from the REIPPPP applications in South Africa (Kruger, 2017, p. 4).

Moving towards a low carbon society with the help of renewable energy is an integral part of the transition plan towards sustainable development (Rennkamp, 2013). But it is clear that the progress in implementing renewable energy in the country is declining (ibid). Infrastructure development plays an important role in the success of South Africa's energy future and this directly affects the success of supplying the residents of informal settlements with renewable energy (ibid).

According to IRP's vision, coal will remain a primary energy source for the next 20 years in South Africa. However, it is estimated that by 2030 the demand for energy will be 29 000 gigawatts, so there is an urgent need to resort to renewable energy sources, otherwise, there will be a big shortage in electricity supply if it remains coal-based only (Rennkamp, 2013). The

process of strengthening the infrastructure for the electricity sector requires significant investment (Smith & Stirling, 2008). Limited long-term funding with reasonable cost in developing countries limits the spread of renewable energy technologies (Glemarec, et al., 2013). Renewable energy technologies require high investments at the beginning as they have high initial operating costs. However, in the long term, they recover the capital invested in addition to profits and they satisfy the aim of having renewable energy sources which do not harm the environment, unlike the use of harmful fossil fuels (Oosthuizen, 2016).

Private sector investments can help the success of renewable energy in South Africa. Oosthuizen (2016) stressed that the relationship of infrastructure and investment is a positive one that works together for the success of renewable energy. Private sector investments in the renewable energy field can help the success of establishing the infrastructure to generate the renewable energy in South Africa. “Removing the barriers related to infrastructure investment is critical for policymakers seeking to facility renewable energy implementation in developing countries" (Oosthuizen, 2016, p. 45). In the past, ESKOM was the dominant electricity producer in South Africa, but now there must be private sector intervention is needed to meet the huge electricity needs. There are five issues that directly affect investors in the renewable energy industry (Oosthuizen, 2016, p. 42):

(1) government support or other available provided supports;

(2) financial attractiveness of the investment;

(3) expected duration of the policy frameworks that are in place;

(4) maturity of the technologies that are involved; and

(5) the likelihood of governments changing the policies and incentives that currently exist.

The success of renewable energy technologies in developing countries can be greatly influenced by private sector investment if the processes are well designed and supported by the government and if there is a reasonable rate of profitability (Eberhard, et al., 2014). It is easy for renewable energy in developed countries to compete with fossil fuels because of the lower financing costs compared to developing countries. Figure 3.3 shows the 2012 comparison of cost differentials between developed and developing countries for wind and gas projects (Oosthuizen, 2016). The figure also shows the higher ability of developed countries to compete financially compared to the developing countries; it can be seen that the wind power project in developing countries costs 40% more due to increased investment costs (ibid).

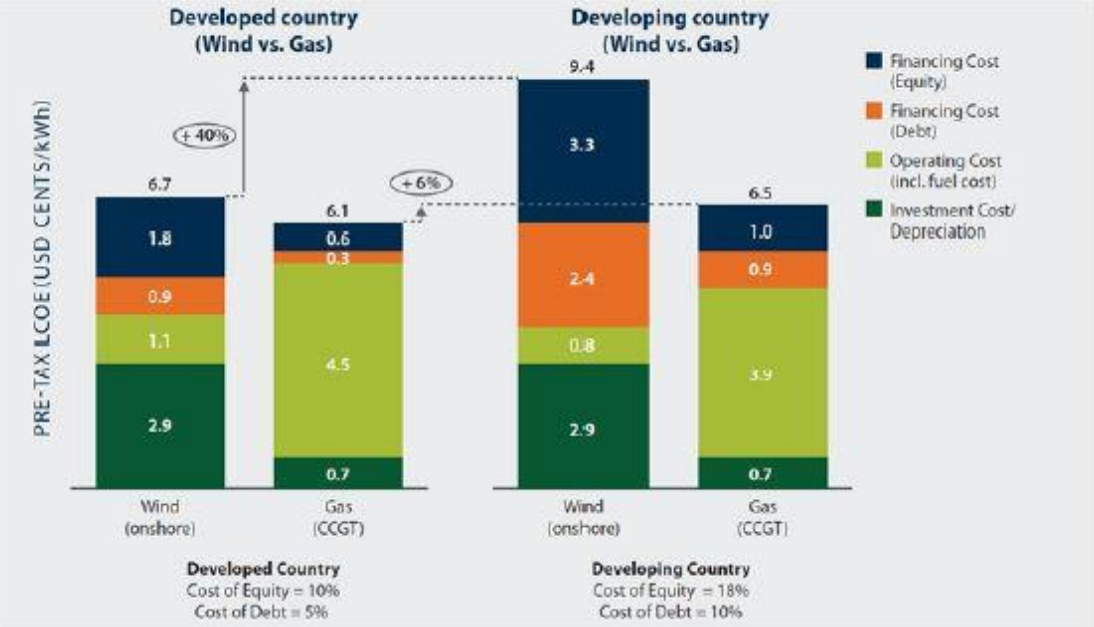

Figure 3.3: The effect of financing costs on wind and gas power projects (Oosthuizen, 2016, p. 46) .

Financing and investment costs are the highest in developing countries which create barriers to sustainable energy success (Glemarec, et al., 2013).

Governments not only need to implement appropriate policies for investments in renewable energy, they must also ensure that these policies attract the private sector to invest in renewable energy projects (Oosthuizen, 2016). The mere existence of restrictions on government funding shows a contradiction in the credibility and effectiveness of South African policy actions and places more obstacles in the way of the success of renewable energy projects (ibid).

Achieving a balance between development and sustainability is a challenge as development is concerned with the rapid economic growth of the state, while sustainable transformations are concerned with the achievement of development goals and time is needed to reach the goal. “A sustainable transition is rooted in literature from systems’ innovation, sociology of technology and evolutionary economics" (Du Plooy, 2017, p. 44). "Socio-technical transitions are complex and occur over a long period of time and result in deep structural changes to a system" (Du Plooy, 2017, p. 44). The growth of sustainable development is evidence of the increased investment in renewable energy, infrastructure, technology efficiency, technology use, management power and the strength of political laws (ibid). Environmental economists point out that economic improvements are the result of tremendous progress in labour productivity due to high energy quality in equipment and technology (Steven, 2010). Moving to a sustainable energy sector in South Africa is a complex and multidisciplinary problem (Du Plooy, 2017). Du Plooy (2017) asserts that state capacity creates and leads structural changes and promotes sustainable development, thus achieving a sustainable transition for South Africa.

In assessing the level at which South Africa's energy is moving towards sustainable energy, it can be noticed that most of the government's energy achievements are dominated by new coal plants in addition to consumer practices and use of fossil fuel energy which makes it difficult to reach the goal of having clean and sustainable energy, for all in the near future. It is

important to design an innovative, effective and consistently balanced policy to suit the era that accompanied it (Grubler, 2012). Addressing energy shortages and social, political and economic challenges requires an effective infrastructure to achieve a sustainable energy transition (Swilling, et al., 2016). Achieving low-carbon growth requires sustainable transition and development transformation (ibid). The government must therefore balance the ability to provide services to the inhabitant of informal settlements and abide by domestic and international laws protecting the environment (ibid).

Du Plooy (2017) stressed that, in order to achieve equal energy supply to all members of society, a balance must be struck between development and sustainability. Du Plooy (2017) proposed four ways to help society move to sustainable energy. The first is to increase fossil fuel prices to force consumers and producers to resort to renewable energy. The second track is the seriousness of politics and organisations as they are the role models and the main promoters of the transition towards renewable sources of energy. The third track is forced transformation. The fourth track is investment in renewable energy technologies.

Community acceptance is a key dimension in decision-making in the energy sector, in which REIPPPP compels bidders to explain and clarify their social development plans before starting the project (Du Plooy, 2017). In decision-making processes, it is necessary to look at and consider at all levels: political, economic, social and environmental. These four main dimensions of energy policy are complex and not easy to implement (Bertsch & Fichtner, 2016). (See Figure 3.4.)

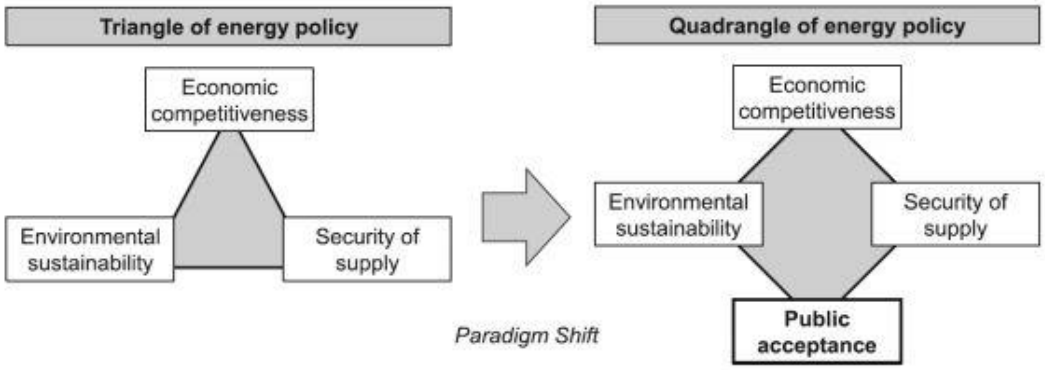

Figure 3.4: The paradigm shift for energy policy (Du Plooy, 2017, p. 49).

Furthermore, “sufficient policies are necessary in order to steer the transition to sustainable consumption habits in all sectors, while still maintaining increasing economic growth" (Du Plooy, 2017, p. 50). The transition to sustainable energy requires a dynamic, multidisciplinary dimension to achieve multiple goals, such; as increasing economic growth, social equity, energy supply security and reducing greenhouse gas emissions. Successful transition to sustainable energy depends not only on policy implementation but requires all actors to work together and commit to sustainable practices (ibid). Du Plooy (2017, p. 50) states that “without an understanding of the political dynamics, the expected ‘just’ transition to developmental and sustainable assimilation will not succeed".

There is a set of criteria that measure progress towards sustainable energy in South Africa (Du Plooy, 2017). The first criterion is energy efficiency, which is an important strategy complementary to renewable energy sources that effectively mitigates the energy crisis in the country. To date, the South African government has responded by “implementing policies and legislation to provide industries with incentives that support transport, improve energy efficiency and change consumption patterns" (Du Plooy, 2017, p. 54). The Rio Conference in 2012 emphasised the importance of improving energy efficiency, increasing investment in renewable energy and improving

infrastructure, with all these factors supporting the transition to sustainable development (United Nations, 2015). The second criterion is the reduction of Greenhouse gas (GHG) emissions where South Africa aims to reduce its emissions and thus allow emissions to rise by only 550 tonnes per year by 2025 (Du Plooy, 2017). The third criterion is the ability of developing countries to compete economically. This criterion is critical, and risky if it is not applied in a way to balance the different basic needs of sustainable development as it can cause environmental degradation and depletion of resources (ibid). The economic competitiveness of renewable energy is measured by the amount of successful financial investments and the ability to deliver that energy to the population through a qualified infrastructure. This is not currently the case for South Africa, where 15% of the population still suffers from energy poverty despite the success of the RIEPPP programme. However, clean and safe energy supplies have not reached the entire population. (Du Plooy, 2017)

The fourth criterion is the security of supply and generation. “The issue of supply security revolves around fuel prices and fuel imports, as well as looking at the amount of locally generated MW capacity (locally procured resources being coal, solar or wind etc.) supplied to the grid" (Du Plooy, 2017, p. 55). The DoE aims to provide diverse, safe and clean energy resources in South Africa at affordable prices to alleviate energy poverty in informal settlements and support economic growth (Department of Energy, 2015). As South Africa's energy system is complex, energy security cannot be accessed without a multidisciplinary approach to address the challenges (Murombo, 2016). South Africa lacks energy security, and this is evidenced by knowing that inhabitants of informal settlements who form 15% of the population of South Africa is dependent on coal, paraffin and other alternative sources for their energy generation. South Africa currently depends on coal as the main source of energy, at the time where mixing the different energy sources is required to reduce energy poverty (Du Plooy, 2017).

Understanding the relationship between economic growth and energy consumption is one of the key factors contributing to energy security in any country (Strydom, 2016). The fifth and final criterion is resilience, which is the ability of the system to adapt and to recover in whole or in part in crises (Du Plooy, 2017). Resilience is a success if it mitigates catastrophic risks which endanger the environment, the economy and society (Harrison, et al., 2014). Resilience is a factor in many unpredictable events; it also “incorporates the rebound effect of certain events" (Du Plooy, 2017, p. 55). South Africa is far from applying this standard at present.

Du Plooy argues that indicators of transition to sustainable energy “include such factors as technology adoption rates, learning rates and the amount of investment" in research and development of new sustainable technologies (2017, p. 55). As a key criterion, the strength of politics and laws set by the government of the country is the basis for the transition towards sustainable development (Bertsch & Fichtner, 2016). The lack of infrastructure and the inability to connect all residents to the grid are technological barriers to renewable energy (de Jongh & Ghoorah, 2014). The lack of technology funding in South Africa, which supports renewable energy technologies, is forcing investors to import renewable energy technologies from abroad because they are not cheaply manufactured domestically (ibid). Investors tend to invest more in specific known technologies than others such as solar photovoltaic and wind power, limiting the widespread of all renewable energy technologies (ibid). Du Plooy (2017) emphasised the limited manufacturing capabilities of South Africa (in terms of infrastructure and innovation of renewable energy technologies). Most renewable energy technologies are therefore imported from abroad, putting investors to face high cost and thus reducing their desire to invest (de Jongh & Ghoorah, 2014). The risk of economic investment in South Africa makes it difficult for renewable energy projects to continue or expand (ibid).

The price of oil fluctuates significantly, and the higher the price of oil the greater the opportunity for renewable energy sources to progress and become more attractive to invest in, and vice versa; the lower the price of oil, the less attractive renewable energy investments will become (de Jongh & Ghoorah, 2014).

In terms of renewable energy technologies' investments, investors tend to consider in their investment decisions to consider the investment cost and maturity levels of renewable energy technologies (de Jongh & Ghoorah, 2014). From the perspective of investment in South Africa, solar and wind power are more mature than other energies, and thus investors tend to limit their investment choices to these technologies (ibid). Investors will not invest in any kind of technology if it is not financially viable. The financial viability of investments is related to a number of factors such as "capital, operational costs, market, selling price and foreign currency risks" (de Jongh & Ghoorah, 2014, p. 20). There is a strong relationship between investment decisions in renewable energy and renewable energy technologies. The South African government therefore needs to find technologies suited to the local market and at competitive offered prices (Murombo, 2016).

To provide competitive opportunities for renewable energy investments, requires political interventions, tax exemptions and the promotion of renewable energy technologies (Murombo, 2016). The political climate plays an important role in influencing investment decisions in renewable energy (de Jongh & Ghoorah, 2014). The reasons for the weak political climate are the lack of "clear regulations and government support, a preference for conventional fossil-fuel based energy, and the use of political forces to shape the energy industry with the government's own monopoly" (de Jongh & Ghoorah, 2014, p. 20). If there is no consensus between the political objective and its various tools, investment in renewable energy technologies will remain less than fossil fuel technologies (ibid).

Poverty and the low level of education in South Africa are also factors that hinder the adoption and investment of renewable energy technologies (Murombo, 2016). De Jongh and Ghoorah (2014) assert that with high levels of poverty, informal settlement residents' resort to cheaper energy alternatives such as paraffin and coal, making renewable energy less attractive. Although coal-based electricity was 85% of the overall generated energy in 2014, however, around 15% of the population still suffers from energy poverty (ibid). Consequently, large numbers of people are still not connected to the network, which confirms the importance of investing in renewable energy (ibid). “South Africa ranked 129th for primary education and 75th for secondary education out of 139 countries in 2009" (de Jongh & Ghoorah, 2014, p. 22). These low education rankings create concerns among investors and increase their fears that the society will not accept new technologies. This requires adequate education so that people can understand the benefits of renewable energy and are aware of the negative impacts on society and the environment when using fossil fuel energy (de Jongh & Ghoorah, 2014). The European Conference on Local Energy in 2007 stressed that traditional school curricula do not integrate these materials into the taught subjects (Sebitosi & Pillay, 2008). “According to the Global Competitiveness Report 2010/2011 released by the World Economic Forum, South Africa ranked 76th in technological readiness out of 139 countries in 2009" (de Jongh & Ghoorah, 2014, p. 22).

4.3 Conclusion

The shift and transformation to a more sustainable electricity sector requires the use of renewable energy technologies in energy supply. Technological transformations include a wide range of actors, including environmental, economic and social sectors. The energy sector, especially the electricity sector, will play an important role in the transition to sustainable development. The South African government has pledged to transform the electricity sector

into a more sustainable sector by developing plans to expand renewable energy implementation through REIPPPP. Wind, solar, biogas and natural gas technologies are well suited to conditions in South Africa. The creation of government investment and financing is essential to expanding renewable energy in South Africa while “financing such technology transitions remains one of the biggest hurdles" (Oosthuizen, 2016, p. 49). Funding must come from regional and national governments, private investors, and institutional investors. Governments do not only play a role in financing electricity sector transitions, but they also play an important role as regulators and policymakers (ibid). Most housing and policy documents in South Africa include the efficiency of natural resources and environmental sustainability in their policy objectives. In practice, however, the requirements posed by Environmental Impact Assessments (EIAs) go beyond the development planning process, so few implementers include environmental sustainability or sustainable use of resources in their development objectives.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This research discussed the challenges of the residents of informal settlements in terms of energy poverty and the resulting dangerous health issues, bad social conditions and devastating environmental impacts. It also considered the challenges of applying renewable energy policies to achieve the required sustainable development. The research also highlighted that the absence of stringent policies on reducing the use of fossil fuel energy and the lack of community knowledge and culture of the destructive damages of the use of fossil fuel sources are all considered as negative and frustrating factors in achieving a good and sustainable standard of living. The researcher argued and provided evidence concerning the uses of unsustainable energy and their impact on the progress towards sustainable development. The interrelationships between the environment, society, economy and politics have created complex interactions and multidisciplinary dimensions. It is therefore important to apply flexibility as a fundamental aspect of a large-scale system. South Africa's ability to move towards sustainable energy depends not only on meeting renewable energy standards, but on addressing the challenges surrounding policies and legislation. It is therefore important to integrate experience and skills from all stakeholders to facilitate a faster and successful transition.

South Africa's energy sector is undergoing a major transition to renewable energy sources. The energy sector has faced many challenges that reduce its efficiency, such as government corruption, lack of infrastructure and the absence of energy supply and generation security.

However, the South African government has developed policies to promote the transition to sustainable energy. Yet, and according to the author of this

research, renewable energy policies have not been properly implemented due to state corruption, in addition to the environmental, economic and social challenges in the country. Establishing of renewable energy sources has created challenges and successes for the South African energy sector which can be observed through the REIPPP programme, which is the main evidence of South Africa's successes in the transition to sustainable energy. Despite the success of many REIPPPP projects, there are still many barriers and challenges facing South Africa, without clear and explicit planning to resolve them. It is therefore not clear whether South Africa is actually promoting the transition to sustainable development.

The author of this research argued that the economic cost hurdles result from not counting the full actual cost of fossil fuel energy production versus renewable energy production. The lack of knowledge and individuals' environmental responsibility are also evident among consumers.

Most of them are unable to make informed choices in the field of energy, and most of them resort to fossil fuels as long as they are reliable and not intermittent. Coal remains a major energy source in South Africa, although South Africa is characterised by its geographical location and abundant renewable energy sources such as wind, solar energy, biomass and biogas energy, but the location has not been utilised as required. This requires changes in the framework and energy policy in order to realise the importance of renewable energy and apply it before it is too late. It is clear that there are still political, economic, social and technical challenges to renewable energy technologies.

It is known that fossil fuel energy is an industry which has existed for centuries and thus cannot be disposed of and it is not easy to transform to renewable sources of energy. Thus, it requires clear and well-studied strategies and strict policies. Despite the many barriers and challenges facing renewable energy in South Africa, as a first step, legal and policy barriers to

energy need to be addressed because this will make it possible to address social, economic, technical and institutional challenges. Thus, legal and policy interventions can create a faster implementation framework for renewable energy projects.

The challenge of providing clean and sustainable energy in South Africa remains to date, so it will be impossible to achieve sustainable energy access for all South Africans, as well as for the informal settlements' inhabitants, by 2025. The problem of energy poverty needs time to reach the desired results. To achieve an effective and integrated policy framework, stakeholders, policymakers and the community must work together to reach the possible solutions.

The political, social, environmental and economic obstacles limit the success of renewable energy projects. Also, investors fear not getting a return on their renewable energy investments due to the high cost of capital to invest in renewable energy compared to the lower cost of traditional energy projects. As a result, this creates obstacles to the success of renewable energy projects. The lack of social and cultural awareness and the lack of education in South Africa on the importance of renewable energy are additional obstacles that threaten the success of renewable energy projects. These challenges are compounded by the dependence of informal settlements residents on fossil fuel resources such as firewood, paraffin and coal, which are among the most used for cooking and heating. Unsustainable energy resources cause adverse environmental, health, and social impacts on the population of these settlements and on society, and thus significantly affect the progress towards SD. The lack of commitment by the government and non-governmental organisations to implement planned energy policies puts the NDP at serious risk of not reaching its goals. Analysis has shown that South Africa is far from effective in planning for sustainable development and that current government planning and commitment is inadequate. Hence the

lack of investment in renewable energy due to the impact of non-supportive energy policy frameworks. South Africa continues to suffer from energy poverty and continues to face several obstacles to the implementation of renewable energy because energy policies have not adequately addressed these constraints.

5.2 Recommendations

1. Government, community and non-governmental organisations should be involved to work together as partnerships are necessary to reach the goal.

2. Encouraging the participation of the private sector in the investment in renewable energy and thus providing similar subsidies to those in traditional energy, or even more, and also offering tax exemptions for such renewable energy investments.

3. Policymakers must adopt an integrated approach to have a successful implementation of renewable energy policies.

4. During this research analysis, the author did not come across any tangible awareness program on renewable energy and their relation to sustainable development, hence it is important to create one.

5. Governments must commit to a clear and resilient plan of action (i.e. the system's ability to adapt and recover in whole or in part in crises) to ensure the continued progress of renewable energy sources.

6. It is better to clarify the expansion plans and programmes of the renewable energy network to the community to increase the belief in energy security.

7. Each administration should clarify the effectiveness of its future plans and how it will contribute to achieving the goals of sustainable development within the framework of energy policy.

8. Keeping abreast of renewable energy technologies and their ongoing innovations to achieve energy efficiency and performance efficiency and create their competitiveness in the markets.

5.3 Recommendations for future studies

- Further studies should reveal energy storage solutions for renewable energy systems to ensure energy security and stable, not intermittent, energy.
- The need to verify the expected time for access to significant investments required to create renewable energy.
- Research on the development and the design of a more appropriate energy policy system to support the generation and distribution of renewable energy taking into account the local national circumstances.
- Investigate the effects of the green economy and green infrastructure on the growth of the renewable energy sector.
- Research on technological development of renewable energy technologies.

Finally, it is highly recommended to have further studies and research that identify the external environmental opportunities and threats for renewable energy technology infrastructure implementation, using some of the powerful strategy tools such as PESTEL in addition to the SWOT strategy tool to identify internal strengths and weaknesses of the renewable energy industry and build a practical action plan on a timely manner that overcome the weaknesses and threats and capitalize on the opportunities and strengths.

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