FROM COAL TO RENEWABLE ENERGY: PERSPECTIVES ON SOUTH AFRICA'S ENERGY TRANSITION FOR A SUSTAINABLE FUTURE.

Temperance Sebele

Student Number: 1618297

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Supervised by:

Prof. Mulala Danny Simatele

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Declaration

I, Temperance Sebele, proclaim that this thesis and the tables and figures used are my original work. I declare that where other authors' ideas were used the sources were acknowledged through paraphrasing and quotation marks and referenced accordingly.

Furthermore, this thesis is being submitted for the Doctor of Philosophy degree at the school of GAES, University of the Witwatersrand, Johannesburg for the first time and was never submitted before for degree or examination purposes at any other University.

Signature of candidate

28/05/2024
Date

Braamfontein, Johannesburg, South Africa.
Place

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Abstract

South Africa has been experiencing an unstable electricity supply for years, leading to periods of load shedding from 2007 up to the present date. The electricity shortages have been attributed to distinct reasons, ranging from inefficient coal supply, skills shortages, sabotage by employees and lack of maintenance for nearly sixteen years. In addition to the electricity supply shortages, coal-fired electricity generation is responsible for roughly 80 per cent of South Africa's total greenhouse gas emissions due to fossil fuel dependence, leading to many health, climate, and environmental challenges. To address the challenges related to fossil fuel dependency, moving to Renewable Energy sources that are climate and environmentally friendly is a necessity.

The aim of this study was to investigate the optimal approaches that South Africa can embark on for a successful transition from coal to renewables. The institutional, policy, and strategic frameworks that exist within which South Africa can embark on for a successful transition were explored. Furthermore, the study sought to identify the challenges, and opportunities that exist or hinder the transition in South Africa. Lastly, the study explored how developments in the international policy frameworks influence South Africa's ambitions to transition to renewables.

The study is best suited to the pragmatism approach, and data were collected through the reviewing of literature, key-informant interviews, and questionnaires. A mixed-methods strategy that involved gathering both qualitative and quantitative data was employed and primary and secondary sources of data were used. The primary data sources used included key informants from various private and public institutions with an interest in South Africa's energy matters such as ESKOM, SANEDI, SANEA, SAREC, SAPVIA, SAWEA, SAIPPA and NECSA. The non-probability sampling method was used in the participants' selection from the sampled study institutions, with a combination of judgmental, snowballing and convenience sampling procedures employed at distinct phases of the research. Data collected was analysed both quantitatively and qualitatively, with interviews text data transcribed and analysed through manual tabulation and thematic analysis, and presented in graphs generated from Microsoft Excel, and the data from questionnaires analysed through the IBM Statistical Package for the Social Sciences (SPSS) software.

The study revealed that the government played mainly four leading roles in the energy transition, which were providing financial support, legislative direction, institutional direction, and project oversight. Financial support is provided through financing projects and setting up financing policies that promote renewable energy investment, and legislative direction is provided through policy development and ensuring efficient implementation. Providing institutional direction is ensured through ensuring coordination across all spheres of government and capacitating institutions involved in the transition, and project oversight is provided through setting out renewable energy capacity determinations. The study further identified key energy transition elements, namely infrastructure, governance, legislation, stakeholders' perceptions, and skills and strategies for a successful transition, which included channelling adequate financial resources to the renewable energy sector, privatisation of the electricity utility, diversification, rolling out bid windows, improving the legislative framework, improving grid access and integration, skills development, localisation of RE components manufacturing, providing incentives, and increasing consumer awareness about renewables. Several barriers to the transition were also identified, which included political interference and corruption, lack of financial investment, policies/legislation inadequacy, inconsistency in rolling out bidding windows, ESKOM's monopoly, high cost of renewables, deficiency of incentives, skills and technology, labour unions, and deficiency of awareness on alternatives. The study recommends multisector reskilling of employees, since not all employees in the coal value chain may be interested in or able to be absorbed in the Renewable Energy sector. Furthermore, the government should fund and support progressive technologies and business models, improve the quality of institutions through merit-based appointments and uprooting corruption, privatisation of ESKOM to create opportunities for new entrants in the electricity market and improve stakeholder engagement and community support programmes. The UNFCCC must develop and ensure the implementation of enforcement strategies for holding countries accountable for their climate commitments for the transition to be realised.

Key Words: *Energy transition strategies. Sustainability. Renewable energy. Climate change. Sustainable future*

LIST OF ABBREVIATIONS AND ACRONYMS

AfCFTA	African Continental Free Trade Area
AI	Artificial Intelligence
ANC	African National Congress
CCC	Committee on Climate Change
CCS	Carbon Capture and Storage
CEO	Chief Executive Officer
CO2	Carbon Dioxide
COP	Conference of the Parties
COSATU	Congress of South African Trade Unions
COVID	Coronavirus disease
CSIR	Council for Scientific and Industrial Research
CSP	Concentrating Solar Power
DBSA	Development Bank of South Africa
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DMRE	Department of Mineral Resources and Energy
DPE	Department of Public Enterprises
EAF	Energy Availability Factor
EIA	Environmental Impact Assessment
ENGO	Environmental Non-government Organisation
ERA	Electricity Regulation Act
ESG	Environmental, social, and governance
ESKOM	Electricity Supply Commission
EU	European Union
EWSETA	Energy & Water Sector Education Training Authority
FiTs	Feed-In-Tariffs
FNER	Fund for Renewable Energies and Cogeneration
FTE	Full-time equivalent
FY	Financial Year
G20	The Group of Twenty
GDP	Gross Domestic Product
GHG	Greenhouse gas
GW	Giga Watts

IBM	International Business Machines Corporation
IDC	Industrial Development Corporation
IEA	International Energy Agency
IEEFA	Institute of Energy Economics and Financial Analysis
IGCAR	Interim Grid Capacity Allocation Rules
IGCC	Integrated Gasification Combined Cycle
ILO	International Labor Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producers
IPPPP	Independent Power Producer Procurement Programme
IREA	International Renewable Energy Association
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
ITSMO	Independent Transmission System and Market Operator
JET	Just Energy Transition
JETP	Just Energy Transition Investment Plan
LPG	Liquefied Petroleum Gas
MJ	Mega Joules
MNC	Multinational Corporation
MOU	Memorandum of Understanding
MW	Mega Watts
NASA	National Aeronautics and Space Administration
NDC	Nationally Determined Contribution
NDS	National Development Strategy
NECSA	South African Nuclear Energy Corporation
NEDLAC	National Economic Development and Labour Council
NERSA	National Energy Regulator of South Africa
NIP	National Infrastructure Plan
NO	Nitrogen Oxide
NRA	National Regulatory Authority
NREL	National Renewable Energy Laboratory
NTC	National Transmission Company
NUM	National Union of Mineworkers

NUMSA	National Union of Metalworkers of South Africa
OECD	Organization for Economic Co-operation and Development
PCC	Presidential Climate Commission
PCFTT	Presidential Climate Finance Task Team
PPA	Purchase Agreement
PRF	Powering the Regions Fund
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
REI4P	Independent Power Producers Procurement Programme
REIPPPP	Independent Power Producer Procurement Programme
RERE	Renewable Energy-based Rural Electrification Programme
RES4A	Renewable Energy Solutions for Africa
RISE	Regulatory Indicators for Sustainable Energy
RMB	Rand Merchant Bank
RPS	Renewable Portfolio Standard
RSA	Republic of South Africa
SA	South Africa
SABC	South African Broadcasting Corporation
SAHPA	South African Hydropower Association
SAIPPA	South Africa Independent Power Producers Association
SANEA	South African National Energy Association
SANEDI	South African National Energy Development Institute
SAPVIA	South African Photovoltaic Industry Association
SAREC	South African Renewable Energy Association
SARETEC	South African Renewable Energy Technology Centre
SAWEA	South African Wind Energy Association
SDG	Sustainable Development Goals
SETA	Sector Education and Training Authorities
SMART	Specific, Measurable, Achievable, Realistic, and Time based
SMR	Small Modular Reactors
SO2	Sulfur dioxide
SONA	State of the Nation Address
SPSS	Statistical Package for the Social Sciences

SWOT	Strengths, Weaknesses, Opportunities, and Threats
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USEIA	United States Energy Information Administration
US	United States of America
USD	United States Dollar
VAT	Value Added Tax
WEC	World Energy Council
WEF	World Economic Forum
YCLSA	Young Communist League of South Africa
ZAR	South African Rand
ZPC	Zimbabwe Power Company

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CHAPTER ONE: INTRODUCTION

1.1 Background to the study

The African continent faces an enormous energy challenge attributed to several factors, which include a rapidly growing population, skills deficiency, slow technological development, lack of political will, a weak regulatory environment, and a deteriorating economy, making it extremely difficult to invest in infrastructure for energy generation (IRENA, 2015). Africa also has a low energy production capacity, which is reported to be 43 per cent less than that of any other region in the world (Blimpo and Cosgrove-Davies, 2019). Demand also outweighs supply, with as many as 30 countries in Africa facing frequent electricity outages and load shedding (IRENA, 2020). In addition to the above, coal is currently the leading energy source worldwide, and Africa still invests heavily in energy from it (IRENA, 2020). The burning of coal results in elevated levels of gaseous emissions with intrinsic health impacts and environmental problems (Munawer, 2018). The U.S. Energy Information Administration (2020), states that fossil fuels combustion results in various emissions such as sulfur dioxide, nitrogen oxides, particulate matter, carbon dioxide, mercury and other heavy metals, and ash. These gaseous emissions contribute to acid rain, smog, and haze, as well as respiratory, lung, and in some cases neurological and developmental damage, in humans and other animals (United States Energy Information Administration, 2020). Within this context of vast challenges, numerous scholars have placed emphasis on sustainable energy generation (Csereklyei, Rubio-Varas, and Stern, 2016; Lloyd, 2017; Jain& Jain, 2017; Mutombo and Numbi, 2019).

Energy is also key to any development, and a foundation for industrialisation (IRENA, 2020). Having a reliable energy supply goes beyond just championing development but ensures the critical basic services provisions (IRENA, 2020). In relation to the above, the World Bank (2019) also states that energy is the engine of development and enables investments, creativity, and the birth of new industries that can create jobs and grow the economy. In support of that, the United Nations Sustainable Development Goals show that any action in one goal can impact results in others and that a balance is required in social, economic, and environmental aspects (UNDP, 2020). The seventh SDG, for example, advises economies to prioritize inclusive access to dependable, inexpensive, current, and efficient energy, as it is critical to the achievement of most of the Global Sustainable Development Goals (SDGs) of 2030 (World Bank, 2019). This observation speaks to the fact that all these goals are related to each other, as if the energy goal is achieved it will ease the achievement of the rest. Given this, countries are challenged to ensure energy production is prioritised and in line with international climate goals (World Bank (2019).

In a bid for Africa to complement the global Sustainable Development Goals and bring about social and environmental transformation, there has been an effort to develop the Africa Agenda 2063 (African Union, 2020). For example, goal number seven of Agenda 2063 focuses on the attainment of environmentally sustainable and climate change-adaptable states and communities, and within such a goal, the provision of clean energy is prioritized (African Union, 2020).

The IEA (2021), states that the stress on the energy supply is not going to ease shortly; the energy sector currently contributes around three-quarters of the greenhouse gas emissions which contributes to a rise in global average temperatures with levels of 1.1 °C higher being recorded since prior industrialisation, and effects seen on weather and climate patterns. The energy sector should be in the lead in resolving climate change impacts by transitioning to low-carbon alternatives (IEA, 2021). This transition has proven to be possible in countries like Iceland, Paraguay, and Costa Rica with 100% of their energy supply met by renewables and countries such as Ethiopia, Norway, Namibia Tajikistan, Uruguay, and Kenya, which currently generate over 90% of power from renewables (IREA), 2018).

1.2 Thematic Considerations

South Africa has diverse energy generation technologies (Integrated Resource Plan (IRP), 2019). However, despite the energy mix, the country is still not immune to the continent's energy challenges (Africa Energy Outlook, 2019). According to various media sources, the Republic of South Africa has experienced an unstable electricity supply for more than a decade, leading to periods of load shedding in 2007-2008, 2014-2015, 2019, 2020, 2021 and 2022 (News24, 2008; Business Day, 2014; Moneyweb, 2019; Eyewitness News, 2019; The Citizen, 2020; News 24; 2022). The electricity shortages have been attributed to distinct reasons ranging from coal supply, skills shortages, sabotage by employees, lack of maintenance, and neglect over the past twelve years, according to the ESKOM Chief Operations Officer, Jan Oberholzer in a public statement in December 2019 (City Press, 2019).

In addition to the supply shortages, the energy sector due to its dependence on fossil fuels contributes around 80 per cent of South Africa's total greenhouse gas emissions, leading to many health, climate, and environmental challenges (Department of Energy, 2019; Eberhard, 2021). To address the challenges associated with reliance on coal, South Africa is making strides to move away from it to renewable energy systems that are climate and environmentally friendly. These ambitions to transition to renewable energy are encapsulated in the Integrated Resource Plan (IRP) (2019) of South Africa and various government reports, conference papers and media statements (South Africa Energy Report, 2021; Fossil Fuel Foundation Carbon Coal Conference paper, 2022; Engineering News, 2022). In the SONA, 2022, SA President Ramaphosa, admitted that the country's unstable energy supply and dependency on coal severely impact the growth of the economy and climate change, and he committed to speedily increase the generation capacity outside the dominating coal sources to renewable energy (SONA, 2022). Further commitment to reducing greenhouse gas emissions is also shown in South Africa's participation as a member of international bodies that fight climate change such as the Kyoto Protocol and IPCC (DEA, 2011).

Despite the above commitments and ambitions, South Africa faces several challenges, among which include the ageing coal infrastructure managed by a heavily indebted entity ESKOM, a lack of skills, corruption as revealed in the state capture report, a deteriorating economy as evident in a series of downgrades by rating agencies, and climate change issues. Furthermore, transitioning presents numerous challenges and uncertainties, spanning from technical feasibility and regulatory structures to financial limitations and socio-political factors. Additionally, the effectiveness of transition strategies can be impacted by evolving international policies, market fluctuations, and technological advancements, adding layers of complexity for decision-makers including policymakers, industry representatives, and civil society members. Addressing these multifaceted challenges requires a comprehensive understanding of the socio-economic, political, and environmental factors shaping South Africa's energy landscape and necessitates the identification of optimal strategies and approaches to facilitate a seamless transition to sustainable energy systems while mitigating risks and maximizing opportunities for inclusive economic growth and environmental sustainability. The study, therefore, assessed strategies for South Africa to smoothly shift from coal to renewable energy sources amidst these obstacles while leveraging emerging prospects and adhering to changing global policy priorities.

1.3 Research Questions

Given the thematic consideration stated above, the following research questions directed the research process:

i. What institutional, policy and strategic frameworks exist to support a successful shift from coal to renewable energy sources?
ii. What challenges and opportunities hinder the shift from fossil fuels to renewable energy in South Africa?
iii. In what ways can developments in the international policy frameworks on renewable energy influence ambitions for South Africa to transition from fossil fuels to sustainable energy?
iv. What are the implications of the findings in a broader context, particularly in Southern Africa?

1.4 Research Aim and Objectives

The aim of the research was to explore the optimal strategies or approaches that South Africa can embark on for a successful shift from coal to renewable energy.

Given the aim stated above, the objectives of the study were:

i. To explore the institutional, policy and strategic frameworks for supporting a successful shift from coal to renewable energy sources.
ii. To identify challenges and opportunities that hinder a transition from fossil fuels to renewable energy.
iii. To explore ways in which developments in the international policy frameworks influence ambitions for South Africa to transition from fossil fuels to renewable energy.
iv. To explore the implications of the findings in a broader context, particularly in Southern Africa.

1.5 Summative perspective of theoretical considerations and key literature of the study

This section summarises the existing literature on strategies or approaches for a successful shift from fossil fuels to sustainable energy sources. The section engages with the existing literature on the topic and outlines the gaps that exist within the literature to justify or position this study. A wider perspective of the literature reviewed is detailed in Chapter Two of this thesis.

Literature suggests that there are various definitions for energy transition, among which the ones more applicable for the study are by Cleveland and Morris (2015), who define energy transition as a "*change in the primary form of energy consumption of a given society towards a more efficient and cleaner energy supply*", and another by Energy Cities (2014), which defines energy transition as a "*shift from a system dominated by finite energy towards a system that uses mainly renewable energy sources*". Other important definitions looked at in the study are renewable energy, sustainability, and climate change, where renewable energy is defined as a "*non-polluting source of energy that is naturally replenishing*" (EIA, 2021), and sustainability is defined as "*economic development activity that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (United Nations, 1987). Climate change is defined as a "*long-term change in the average weather patterns that have come to define Earth's local, regional, and global climates*" (NASA, 2020).

Several sources of literature were also reviewed to understand the global, regional, and local energy transition strategies context and it is evident that energy transition is unique, and its management and governance is characterized by large uncertainties and ambiguities (Valkenburg and Gracceva, 2016). Despite the transition process's uniqueness, energy transition must be prioritised to prevent drastic impacts on climate which are presented by the prolonged use of fossil fuels (Waskow and Gerholdt, 2021). The IPCC (2021) report shows that the world will reach or go over 1.5 degrees Celsius of warming within the next two decades, and this temperature rise is attributed to high greenhouse gas emissions. If no effort is made to bring the emissions down, it is predicted that the world will warm by as much as 4.4 degrees Celsius by 2100, leading to catastrophic results. In relation to the above Waskow and Gerholdt (2021) state that keeping the warming to 1.5 degrees Celsius and preventing severe climate effects will depend on the actions taken this decade.

In South Africa, the demand to shift the energy sector to sustainable energy is mentioned in various government documents for example, the Presidential Climate Commission Just Energy Transition Framework and the South Africa Energy Sector Reports, and coupled with the main goals of transitioning to a reduced carbon path, preventing job loses, and promoting resource efficiency. Literature suggests that transitioning towards an energy generation mix is critical for greening the economy, given that over 80% of the electricity in South Africa is generated from fossil fuels (Keneilwe and Ramaano, 2022). It is suggested by Swilling and Annecke (2012) that "*the transition must be just, based on a mode of production that is not dependent* *on resource depletion and environmental degradation and tackles global socio-economic inequalities in terms of consumption and access to power*". Swilling and Annecke (2012) further go on to assert that "*such a transition requires deep structural changes with an approach to governance that is about minimization as well as restoration, reconstruction, and redistributive justice*". Another critical step in a just transition is ensuring that stakeholders mutually understand the challenges ahead and reducing uncertainty through addressing knowledge gaps, and making sure that the transition knowledge is accessible to all concerned parties (Strambo *et al*., 2019).

Different theoretical perspectives on transition will also be discussed in depth in Chapter Two, which include the Bridges Transition Model, Schlossberg's Transition Theory, Perpetual Transition Management Model, Loorbach Transition Management Cycle, Energy Ladder Model, Path Dependency Theory, and the Energy Stacking Model.

1.6 Summary of methodological considerations

This section summarises the methodology that was used in the attainment of the study aim, which was to investigate strategies that South Africa can embark on for a successful shift from fossil fuels to sustainable energy. The section pre-empts a detailed discussion on the methodology that will be presented in Chapter Three.

The study employed a combination of methods where qualitative and quantitative data were collected. This approach was beneficial to the study in that it increased the scope and range of research and allowed the research questions to be scrutinised from many perspectives (Regnault, Willgoss, and Barbic *et al*., 2018). The research used primary and secondary sources of data with primary data including key informants from various South African private and public institutions with an interest in energy matters such as ESKOM, SANEDI, SANEA, SAREC, SAPVIA, SAWEA, SAIPPA, and NECSA.

The key informants from the energy institutions provided valuable information on strategies that South Africa can embark on for a successful shift from coal to sustainable energy. In addition to the above, energy experts from various other energy institutions were identified on the LinkedIn professional networking platform and requested to shed light on the strategies, barriers, challenges, and opportunities that exist in the shift from fossil fuels to sustainable energy in their various countries around the world.

Qualitative and quantitative data was gathered by use of unstructured virtual Microsoft Teams and telephonic interviews, as well as self-administered online questionnaires. The study participants were contacted through emails and telephonically where study aims were explained and authorisation to either interview or complete questionnaires were solicited. The questionnaire was developed on the SurveyMonkey online portal and shared with the relevant participants mentioned above for completion.

Non-probability sampling was employed in the selection of participants from the sampled study institutions, with a combination of convenience, judgmental, and snowball sampling procedures employed at distinct phases of the research. Data collected was analysed both quantitatively and qualitatively, with interview text data transcribed and analysed through manual tabulation and thematic analysis and presented in graphs generated from Microsoft Excel. The analysis of the data from the questionnaires was conducted by use of the IBM SPSS software. A broad presentation of the methodological considerations for this study is outlined in Chapter Three.

1.7 Scope of the Study

The energy sources dominant in South Africa include finite sources such as coal, petroleum products, and gas, and sustainable sources such as solar, wind, and biomass. Such sources are used in diverse sectors such as industry, transport, agriculture, commerce, and public services, both residential and others (Department of Energy Balances, 2016). Coal is predominantly used for electricity generation, with several coal-fired power plants across the country and petroleum products, including gasoline and diesel, are widely used as fuels in transportation. Coal in addition to electrification is utilized in various industrial processes, including manufacturing, mining, and chemical production together with gas. Sustainable energy sources such as solar, wind, and biomass are increasingly being utilized primarily for electricity generation to cushion citizens from load shedding and for providing off-grid solutions to rural areas where grid connections are not feasible. Biomass energy, particularly from agricultural waste, is utilized in community-based projects for cooking and heating. The study focussed on the strategies by which South Africa can move away from coal to sustainable sources of energy across all diverse sectors mentioned above. Challenges, barriers, and opportunities to the shifting from fossil fuels to sustainable energy in South Africa were also explored. Though the study focused on South Africa, global perspectives were also sought to explore ways in which developments in the international policy frameworks could influence ambitions for South Africa to shift from fossil fuels to sustainable energy. The selection of research institutions was limited to those institutions involved in energy matters in South Africa, from energy policy development and research to independent power producers and their support institutions. The research participants were experts directly involved in energy advisory or research roles within the selected institutions.

1.8 Ethical Considerations

Ethical considerations can be specified as "*one of the most important parts of the research and dissertations may even be doomed to failure if this part is missing*" (Dudovskiy, 2018). The researcher was quite aware of the responsibility to ensure participants took part in the research voluntarily and were notified of their liberty not to continue with the study whenever they wished to do so. Informed consent was ensured through the provision of adequate information that allowed participants to understand the implications of participation without feeling coerced (See Appendix F). The questionnaires and interview questions contained no offensive, discriminatory, or a foul language and the anonymity and privacy of respondents were guaranteed. The work of other authors was acknowledged using the Harvard referencing system, and a prominent level of objectivity was maintained in discussions and analyses throughout the research. Only publicly available information was used, and no secretive information was required from the participants. The conditions set out in the authorisation letters issued by the research organizations in the study were respected, and data collection began after receiving ethical clearance from the Human Research Ethics Committee (Non-Medical) of the University of Witwatersrand (See Appendix G). The research was fully compliant with the research ethics and norms.

1.9 Structure of the Thesis

The thesis is comprised of six chapters. **Chapter One** presents the research conceptualisation where the research focus is defined and articulated. **Chapter Two** presents the theoretical perspectives and the literature review. In this chapter, the existing literature is engaged with a view of systematically articulating what has previously been discussed on studies of a similar nature The chapter then identifies the gaps in knowledge to identify or justify the position of the present study within the existing literature to conclude the chapter. In **Chapter Three**, we engage with the step-by-step process of how the study was designed and the data collected and analysed which is the methodology chapter. **Chapter Four** is the empirical evidence chapter that presents the institutional, policy, and strategic frameworks that exist within which South Africa can embark on a successful shift from fossil fuels to sustainable energy sources. The challenges, and opportunities, that exist or hinder the transition are also exposed. Furthermore, the chapter details ways in which developments in the international policy frameworks on renewable energy can influence ambitions for South Africa to transition from fossil fuels to sustainable energy. **Chapter Five** contextualises the findings of the study with the literature review by speculating, analysing, and repositioning the findings of the study as presented in chapter four. The thesis then concludes by drawing conclusions based on the research findings and outlining recommendations for further research and policy interventions in **Chapter Six.**

CHAPTER TWO: THEORETICAL CONSIDERATIONS AND LITERATURE REVIEW

2.1 Introduction

This chapter discusses the theoretical perspectives and a review of the literature that exists on the topic that was investigated. For a study of this nature, it is imperative to engage with existing discussions to contextualise the current study within the broader existing knowledge on studies of a similar nature. Snyder (2019) describes a literature review "*as a systematic way of collecting and synthesizing existing scholarly sources on a specific topic*". McCombes (2022) also argues that a "*literature review provides an overview of current knowledge, allowing the researcher to identify relevant theories, methods, and gaps in the existing research*". In view of the above definitions, a literature review is an analysis, synthesis, and critical evaluation of literature to understand the available knowledge on the subject; it aligns the study with existing literature and justifies the need for the present study.

The chapter reviews the literature on institutional, policy, and strategic frameworks for a successful transition shift from fossil fuels to sustainable energy sources. In addition, the literature on challenges, and opportunities that exist or hinder the shift from fossil fuels to sustainable energy is also examined. The chapter is divided in this order, where Section 2.2 engages and explains the key concepts/ terms that will be repeatedly used. Section 2.3 outlines the theoretical perspectives or arguments on energy transition. In Section 2.4, discusses the global perspective on energy transition, within the context of first-world states such as the United States, France, Germany, and China. The section further investigates the African perspective on energy transition strategies concerning countries like Uganda, Zambia, Kenya, and many others, and ends with the South African perspective. The chapter then concludes in Section 2.5 by identifying the gaps in existing knowledge, with the view of positioning and justifying the value of the present study and making suggestions for future research focus.

2.2 Definition of Key Concepts

Various key terms pertaining to the topic were employed repeatedly in the study. These terms are defined according to how they are used in the thesis and include the following:

i. **Energy Transition:** Although the concept of energy transition has been much discussed, there is no consensus on its definition, with several scholars suggesting different definitions depending on their interests, disciplines, and fields of study. A widely accepted definition is that by Cleveland and Morris (2015), who suggest that "*energy transition is a change in the primary form of energy consumption of a given society towards a more efficient and cleaner energy supply*". Although this definition is widely accepted, various authors still present their definitions, with Energy Cities (2014) defining energy transition as "a *shift from a system dominated by finite energy towards a system that uses mainly renewable energy sources*" and Sung and Park (2018) describing it as "*a collective, complex, and long-term process comprising multiple actors for social changes, involving far-reaching societal changes"*.

Serrano and Zaveri (2020) acknowledge the various definitions and conclude that the concept of energy transition is understood by some as a "*transformation of the energy sector and by others as a broad transformation of society*". Serrano and Zaveri (2020) further suggest that the "*energy transition might not only be the replacement of fossil fuels with renewable energy, but a comprehensive change in society regarding how energy is perceived*", citing examples of authors such as Bjørner and Jensen (2002), and Ruszel, Młynarski and Szurlej (2017), who take a policy analysis perspective by looking at "*governmental action and institutional change*", while others such as Sattich (2014) take an economic perspective by focussing on "*the energy sector and economic aspects*". Ruszel, Młynarski and Szurlej (2017) define energy transition as a "*transition of the economy into a low-emission economy*", and Sattich (2014) describes it as "*an increase in the share of renewables in the energy mix"*. In relation to the different definitions, Meadowcroft (2009) concludes that several energy transition definitions imply a "*different mix of energy technologies and orientation for policy intervention*".

In the energy transition discussion, there is also a concept of just transition, which is described as "*a political campaign to ensure that the costs of environmental change are shared, ensuring that the workers in targeted industries and their communities benefit from the transition*" (Eisenberg, 2018). This suggests that a just transition must balance the preservation of jobs and the protection of the environment (Canadian Labour Congress, 2000). In view of these different discussions, the current study adopts the widely accepted definition of energy transition by Cleveland and Morris, (2015) as the study focuses more on a change from coal to renewable and sustainable sources of energy.

ii. **Renewable Energy:** Several scholars have different definitions of renewable energy. According to Nelson (2011), renewable energy is a sustainable, infinite, and non-depletable form of energy that can be found anywhere across the world, with examples including solar, wind, bioenergy, geothermal, hydro, tides, and waves. This definition is supported by the USEIA (2021), which suggests that "*renewable energy is energy from sources that are naturally replenishing and virtually inexhaustible in duration*". In addition, Ellabban, Abu-Rub and Blaabjerg (2014) give a broader definition that suggests that "*renewable energy sources are continually replenished by nature and derived directly from the sun (such as thermal, photo-chemical, and photo-electric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy)*". A clearer picture of renewable energy sources is also given by Brown, Muller and Dobrotkova (2011), as indicated in Figure 1 below:

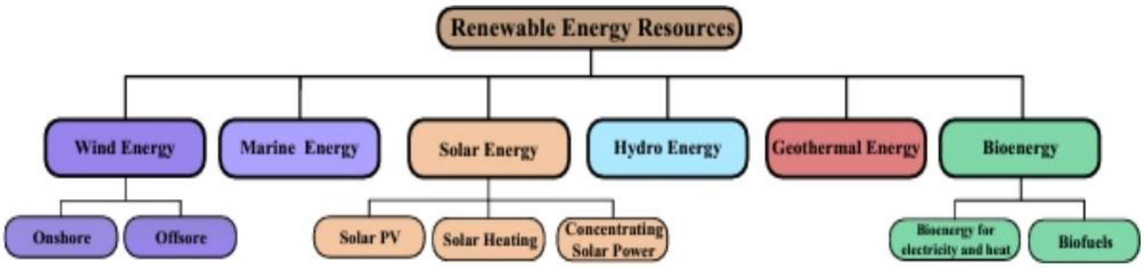

Figure 1: An overview of renewable energy sources.

Source: Brown, Muller and Dobrotkova (2011)

There is also an ongoing debate on whether nuclear must is a renewable source of energy or not. According to Inspire Clean Energy (2022), energy from nuclear power reactors is renewable though the fuel used in the process is not renewable, which makes classifying it as renewable complicated. Despite the debate on whether nuclear is renewable or not, nuclear energy is mostly accepted as a sustainable and clean form of energy, as it produces zero emissions and does not cause any air pollution or release harmful gases (Nuclear Energy Institute, 2022). Renewable energy will be considered a non-polluting source of energy that is naturally replenished in the context of this study.

iii. **Sustainability:** The concept of sustainability has been engaged with constantly in this thesis, and by origin is suggested to have originated in the forestry industry, "*where it denotes never harvesting more than what the forest yields in new growth*" (Wiersum, 1995). The concept was later adopted in the Brundtland Report, giving it the widespread recognition it enjoys today (Portney, 2015). In the Brundtland Report, sustainable development is famously defined as "*economic development activity that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (United Nations, 1987). Since then, the concept has evolved over the years to have several meanings and different applications to countries, businesses, governments, communities, and people (Portney, 2015).

Among the various definitions, Shigayeva and Coker (2015) define sustainability as *a 'process' rather than an 'outcome', which incorporates concepts of adaptation, learning and continuous development. Sustainability must be viewed as a change process that can be influenced by individuals throughout initiatives by continuing to develop and adapt in response to the needs of the system* (Shigayeva and Coker, 2015). Another definition is by Kuhlman and Farrington (2010), who suggest that sustainability is maintaining well-being over a long time or an indefinite period. UNESCO (2022) further expands on the concept, suggesting that "*sustainability is a paradigm for thinking about the future in which environmental, societal and economic considerations are balanced in the pursuit of an improved quality of life*" (UNESCO, 2022). In view of these discussions, the current study adopts the famous definition of sustainability from the Brundtland Report and UNESCO's interpretation that seeks harmony between the social, economic, and environmental dimensions.

iv. **Climate Change:** Climate change is "*a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates*" (NASA, 2020). Such changes are mainly attributed to "*human activities, particularly the burning of fossil fuels, which increases heat-trapping greenhouse gas levels in the atmosphere thereby raising the Earth's average surface temperature*" (NASA, 2020). Similarly, the United Nations (2022) suggests that climate change refers to natural and man-made long-term shifts in temperatures and weather patterns, with human activities since the 1800s being the main driver of climate change, primarily due to burning fossil fuels like coal, oil, and gas. In addition to the above, the United Nations Framework Convention on Climate

Change (UNFCCC) (1992) also defines climate change as a change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere. All the above definitions align with the study and are adopted as they are.

2.3 Theoretical Perspectives on energy transition

Transition research is common in diverse disciplines, realms, and research fields that look into ways and places where change takes place for example "*technological, institutional, social, ecological, economic, or cultural leading to the development of theories and perspectives on different types and dimensions of transitions based on the societal problems or desired solutions*" (Loorbach, Frantzeskaki and Avelino, 2017). This section discusses some theoretical perspectives on transition, specifically in terms of how a transition process occurs and engages with the work of authors from various research fields. It begins with the work of William Bridges, who developed the Bridges Transition Model to help organisations and individuals understand and effectively manage and work through transition. The model suggests that there are three stages individuals experience during a transition, which are Ending What Currently Is, The Neutral Zone, and The New Beginning, as indicated in Figure 2 below. In this model the transition process is described as "*the inner psychological process that people go through as they internalize and come to terms with the new situation brought about by change*". The model recognises that change can put people in crisis and suggests that dealing with a transition must start with introducing people to the ending they will experience with the change, and support them through the shift for change to work as planned (William Bridges Associates, 2022).

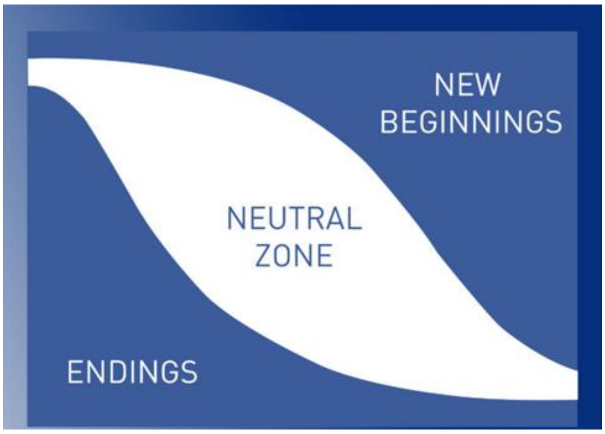

Figure 2: Bridges Transition Model

Source: Willian Bridges Associates (1988)

As indicated in Figure 2, the transition steps begin with an ending, where people identify what they are losing and learn how to manage the losses, which may include relationships, processes, team members, or locations. The second step of transition is the neutral zone, where the old is no longer active but the new is not fully established. It is at this stage that critical mental realignment happens, as people may be feeling confused and distressed. People then progress to new beginnings after finding new understanding. If the transition is well-managed, people establish new roles and participate effectively at this stage (William Bridges Associates, 2022). In addition to these transition stages, William Bridges (2022) further suggests steps for successful transition management, which include communication of the need for change, collecting information on those affected and the impact, gaining investment in the outcome, conducting a transition readiness audit, training people who will lead the transition, monitoring progress, and helping individuals understand how they can contribute to the change.

In relation to the Bridges Transition Model, Schlossberg's Transition Theory also puts people in the middle of the transition activity. In this theory, a transition is described "*as any event, or non-event, that results in changed relationships, routines, assumptions, and roles*". In the transition process, perception plays a key role; for the transition to be understood, "*the type, context, and impact of the transition must be considered*". Schlossberg suggests four major sets of factors that influence a person's ability to cope with a transition, which are "*self, support, and strategies*". The Situation factors include the triggers for the transition, *"timing, control, role change, duration, previous experience, concurrent stress, and personal assessment of who or what is seen as responsible for the transition"*. The Self factors include *"personal and demographic characteristics, and psychological resources, and Support factors include intimate relationships, family, networks or friends, and institutions and communities"*. The Strategies, or coping responses, are divided into three categories, *"which are those that modify the situation, those that control the meaning of the problem, and those that aid in managing the stress in the aftermath of the transition"* (Chavez and DiBrito, 1999).

Expanding from individuals to organisations, Buchanan and McCalman (1989) suggested a model for Perpetual Transition Management, which highlights organisational change triggers and responses to change. The framework proposed four critical layers and the connecting management processes that bring change in organisations, which are "*the trigger layer, vision layer, conversion layer, and the maintenance and renewal layer"*, as indicated in Table 1 below.

Table 1: The Perpetual Transition Management Model

THEORY Interlocking Processes	PRACTICES
Trigger layer	Opportunity, threat, crisis. Clarify, express, communicate
Vision layer	Define the future (including structure) Challenges, excitement, innovation
Conversion layer	Persuade, recruit disciples Detail the structure
Maintenance and renewal layer	Sustain and enhance belief Reinforce and justify Regression avoidance (ritual)

Source: Buchanan & McCalman (1989)

The trigger layer is concerned with identifying the need, creating avenues for change, and introducing them as opportunities instead of threats. In the vision layer, the futuristic vision of the organization is outlined and communicated using directional strategies and action road maps. In the conversion layer, support is mobilised to realise the vision, and the final layer is the maintenance and renewal layer which involves introducing a change in the values, attitudes, and behaviours to experience the advantages of change (Buchanan & McCalman, 1989). In conclusion, the Perpetual Transition Management model suggests that a successful transition requires effective planning, resources management, and communication of the outcomes of change and management involvement throughout the four interlocking processes or layers.

The Perpetual Transition Management model is supported by Loorbach (2010), who presents the Transition Management Cycle for sustainable development with four related governance activities, which are "strategic, tactical, operational, and reflexive". The "*strategic activities deal primarily with the culture of a societal system, and among these activities, the processes of vision development, strategic discussions, and long-term goal formulation are important*". Tactical activities are "*interest-driven and relate to the dominant structures of a societal system, which include rules and regulations, institutions, organizations and networks, infrastructure, and routines*". Operational activities are "*experiments and actions with a short-term horizon such as innovation projects and programmes, and reflexive activities relate to monitoring, assessments, and evaluation of ongoing policies, and ongoing societal change*" (Loorbach, 2010). These four governance activities are presented in the four blocks of the cyclical process model in Figure 3.

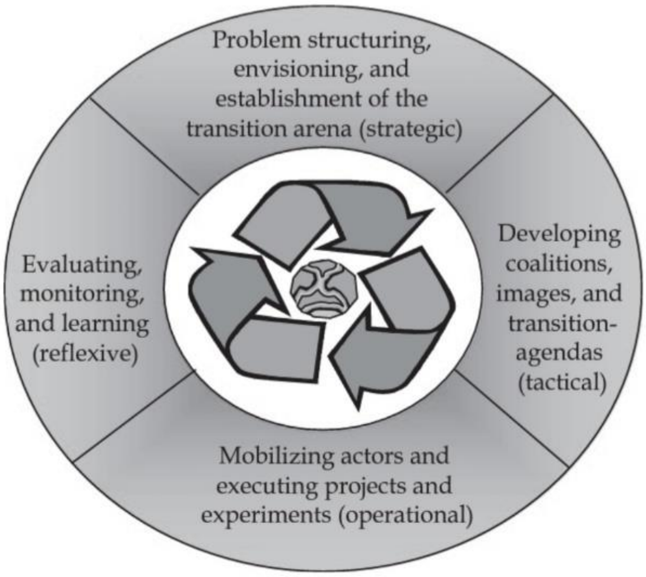

Figure 3: The Transition Management cycle

Source: Loorbach (2010)

In the strategic block, the problem at hand is structured, a long-term vision for sustainability is developed, and the transition scene is established and organised. The transition scene is established by a network of experts from various backgrounds, with knowledge of the problem being looked at and suggest solutions. In the tactical block, "*future images and a transition agenda are developed, and necessary transition paths are derived*". According to Sondeijker *et al.* (2006), focus on this tactical level must be "*the structural barriers to development in the desired direction, which can be explored through developing transition scenarios, and such barriers may include regulatory, institutional, and economic conditions, consumer routines, physical infrastructures, and specific technologies*".

In the operational block, transition experiments are conducted, and transition networks are mobilised. The "*new transition experiments are derived from the sustainability vision, and transition objectives, or can be linked to innovation experiments that are already taking place, as long as they fit into the context of the transition*" (Loorbach, 2010). Once the experiment has successfully been completed, it can be redone in different settings and scaled up. The reflexive block is for measuring, evaluating, and extracting lessons from the transition experiments, and aligning the vision, program, and coalitions. At this stage, monitoring of the transition steps and transition management takes place and where needed physical changes are made to the system being dealt with, and the movements of individual and collective actors. Progress is also monitored as well as the barriers, and areas of improvement. Monitoring the transition management involves monitoring the "*actors' behaviour, networking activities, alliance forming and responsibilities, and their activities, projects, and instruments*". It also involves monitoring the transition scene about "*the actions, goals, projects, and instruments that have been agreed upon, and the transition experiments in terms of specific new knowledge and insight and transfer*" (Loorbach, 2010).

In addition to Loorbach's transition model, another concept exists in the transition space, named the path dependency theory. The path dependency theory is when people are caught between the desire to utilise fresh and engaging ideas and the difficulty of shaking off the past (Grube, 2016). This is usually because it is often simpler or more cost-saving to continue with an already established path than to develop a new one from the beginning (Damawan and Azizah, 2020). In path dependency, what happened in the past matters, and change is usually resisted when it has financial reparations or policymakers' hesitations or lack of information and failure to learn from previous experiences (Damawan and Azizah, 2020). According to Sydow and Schreyögg (2015), "*path dependency can contribute to a reluctance or inability to invest in forward-thinking innovations and can influence strategies within companies, sometimes to their detriment"*. A deviation from the path becomes highly difficult, and competing paths can be locked out (Clausen, Göll and Tappeser, 2017). Nill (2009) suggests that transformation is usually locked out by various factors, which include irreversible investments in the established technology, switching costs due to technological complementarities, uncertainty about the quality of the new technologies, high set-up costs of the new technology, coordination problems among the actors promoting the new technologies, and institutional barriers to change.

In addition to multidisciplinary transition models, two transition models exist related to energy, which are the Energy Ladder and the Energy Stacking Framework. The Energy Ladder framework explains how an energy transition takes place, from the choice of one energy source to the next, as indicated in Figure 4 (Leach, 1992). The model also describes how fuel choices are dependent on household affordability and shows that contemporary fuels such as electricity and bottled gas are considered "*superior fuels due to their high efficiency, cleanliness, and convenience of storage and usage, and are located higher up the ladder than traditional fuels, or inferior fuels"* (Leach, 1992). The model suggests that consumers move from inferior energy systems to superior energy systems on the ladder at a pace determined by household earnings, system costs, whether the fuels are within reach, dependability of the superior fuel and fuel prices (Masera *et al.*, 2000).

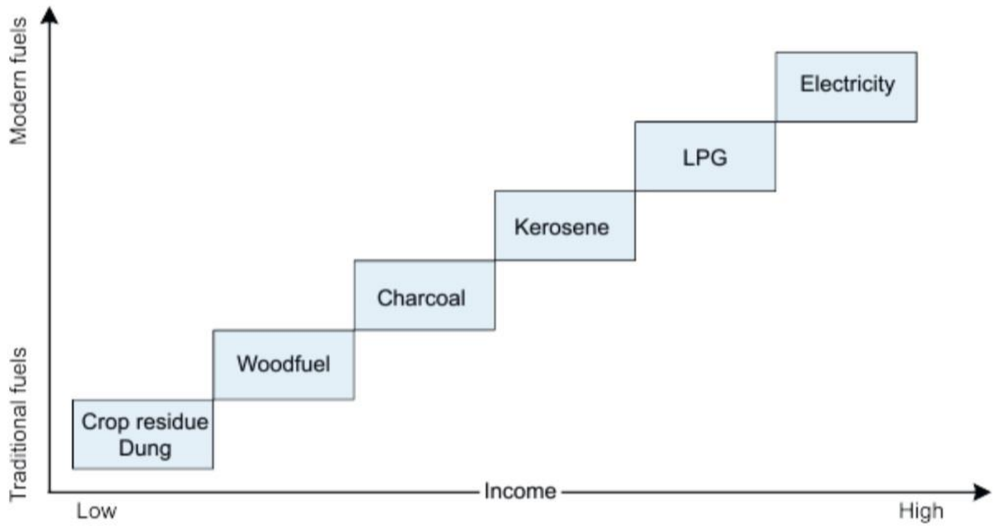

Figure 4: The Energy Ladder Model

Source: Leach (1992)

The energy ladder framework is however disputed by various researchers who are in support of the Energy Stacking framework which suggests that fuel switching does not follow any direction as people switch between traditional and modern energy sources, or combine fuels based on affordability, personal choice, and household demand (Heltberg, 2004; Pachauri and Spreng, 2003). The Energy Stacking model suggests that traditional fuels are usually retained for different tasks, even after modern sources are adopted, as indicated in Figure 5.

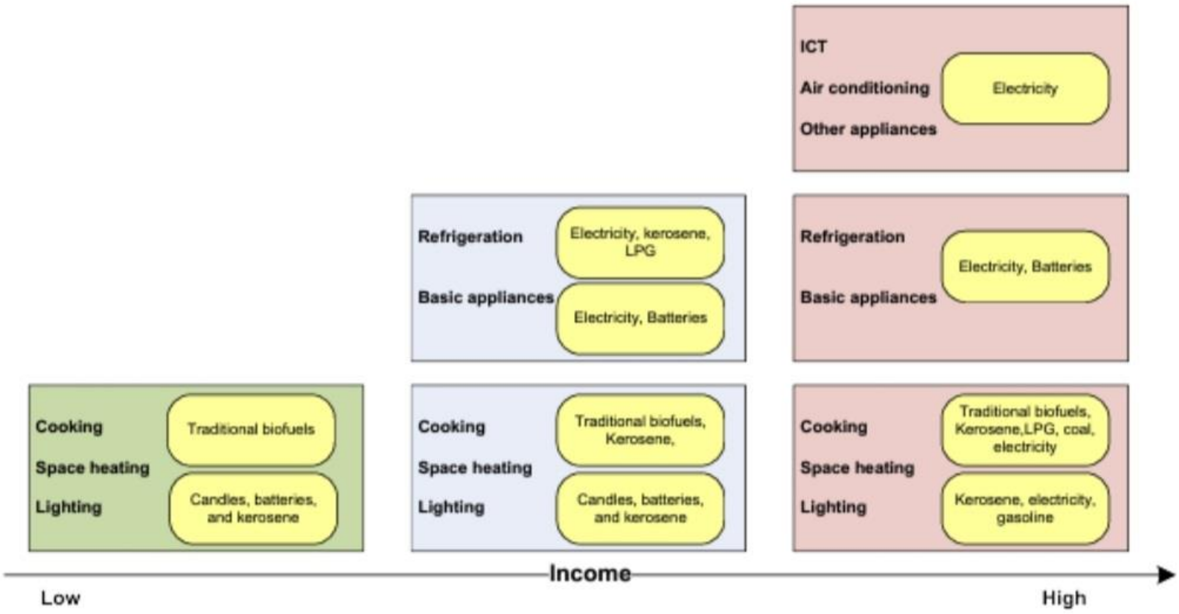

Figure 5: Energy Stacking Model

Source: IEA (2002)

The different models discussed in Section 2.3. highlight how the transition process occurs in individuals, institutions, or households. Concerning the energy transition in South Africa, we will adopt Loorbach's transition management cycle, looking into the "*strategic, tactical, operational, and reflexive activities*" that can hasten and direct a successful shift from fossil fuels to sustainable energy in South Africa.

2.4 Contextualising literature on energy transition

The IRENA (2023) defines an energy transition as a necessary step towards mitigating climate impacts and attaining a sustainable tomorrow. Various studies speak to the catastrophic impacts of the using fossil fuels in energy generation (US EPA, 2022; Environmental and Energy Study Institute, 2022). According to the IPCC (2021), the world predicted that it will reach or go above 1.5 degrees Celsius within the coming 20 years, and this rise in temperature is attributed to high greenhouse gas emissions. It is also predicted that if nothing is done to reduce the high emissions, the world may warm by 4.4 degrees Celsius by 2100, leading to catastrophic results (IPCC, 2021). According to Waskow and Gerholdt (2021), curbing temperature rises to 1.5 degrees Celsius and preventing severe climate impacts depends on the actions taken this decade. Paramati, Alam, Hammoudeh, and Hafeez (2020) state that fossil-based fuels emit the highest share of greenhouse gases, with crude oil contributing about 45%, natural gas at 31% and coal at 24%. The abandonment of fossil fuels, with emphasis on the adoption of sustainable alternatives to match the energy requirements, can drastically reduce greenhouse gas emissions (Alam, Apergis, Paramati, and Fang, 2020).

In relation to the above, Adua, Xuan, Zhang, and Clark (2021) state that energy efficiency and the adoption of RE technologies can assist in conquering the imminent climate crisis. It has also been proven by many researchers that developing and adopting affordable sustainable energy sources can address the greenhouse gas emissions problem (Spillias, Kareiva, and Ruckelshaus *et al*., 2020). Other than just reducing greenhouse gas emissions, renewable energy also presents an alternative for enhancing energy security, improving air quality, and creating new job prospects in the sustainable energy sector (Li and Shao, 2021).

The transition to sustainable energy sources is gaining momentum globally, with several countries adopting low-carbon alternatives and committing to various international and internal treaties such as the Paris Climate Agreement amongst others, to address the climate change impacts (Carley, Baldwin, MacLean, and Brass, 2016). The International Energy Agency (IEA), states that the use of sustainable sources in electricity generation was the fastest-growing in 2020, with wind and solar photovoltaics (PV) leading the way (IEA, 2020). The IEA also projected that sustainable sources will be the most dominant in electricity generation by 2025, with governments and businesses around the world adopting renewable energy to facilitate an energy transition (IEA, 2020).

Countries such as Canada and Finland have even gone to the extent of stopping coal use by specific years as per their targets, and most European states committing to not building any new coal power stations after 2020 and attaining balance between gases released and removed from the atmosphere by the year 2050 (International Energy Agency, 2016). China also pledged to reach carbon neutrality by 2060, and companies like Google, Amazon, and Apple have committed to using 100% renewable energy for their operations (International Energy Agency, 2023). Japan had a national policy that hails coal as a dependable and affordable baseload power (Trencher, Healy, Hasegawa and Asuka, 2019); however, in 2021, there was an unexpected turn of events, with them joining the forty nations such as Poland, South Korea, Ukraine, Indonesia, and Vietnam, which had devoted themselves to getting rid of coal use for electricity generation by 2030 and 2040 (International Energy Agency, 2021). Such commitments contribute to a rise in global demand for renewable energy sources, thereby reducing the climate change impacts (IEA, 2016).

Though renewable energy capacity additions are predicted to be on an upward trend its growth is off schedule to attain the IEA Net-Zero target set for 2050, with factors such as policy uncertainties and finance-related implementation challenges, authorisations, acceptance by people, and deficient grid capacity contributing to missing the 2050 targets (The International Energy Agency, 2021). Increases in commodity prices, "*availability of raw materials, and rising electricity prices in some markets also pose additional challenges to renewable energy adoption*" (IEA, 2021). Globally there is also a trusted belief that coal power is superior to other sources, and the important role it plays in promoting the international competitiveness of local industries through affordable costs of electricity (Strielkowski, 2021). Coal and nuclear are promoted as the only realistic sources that provide baseload power at reduced costs (Matek and Gawell, 2015). In addition to the above, Baer (2016) states that "*coal was, until very recently, normalised as positive in popular social, cultural, and economic discourse*". Transitioning to clean energy versus maintaining an economy reliant on coal makes the decision difficult (Valck, Williams & Kuik, 2021).

Another challenge to energy transition is renewable energy intermittency for wind and solar, where solar energy production is restricted to daylight hours and impacted by weather conditions, and wind energy generation is determined by wind speed and direction, which varies based on the time of the day and daily weather patterns (NREL, 2019). This variability in energy production can pose challenges for grid operators and energy system planners, who must make sure there is an adequate energy supply to match the demand. To address solar energy intermittency, energy retention systems and smart grid systems are being developed to store extra energy during high generation times and use during low generation times (NREL, 2019). Additionally, the use of hybrid systems, which combine many energy sources at one site, can help address intermittency and ensure a more reliable energy system (NREL, 2019).

The transition from long established energy sources to modern and infinite energy sources requires significant financial investment and infrastructure upgrades (IRENA, 2021). According to IRENA (2021), the total investment needed to attain the world sustainable energy targets by 2050 is around US$ 110 trillion, or an annual average of US$ 4.4 trillion. This investment is required for renewable energy technologies, upgrades of the transmission and distribution infrastructure to feed more infinite energy to the grid, and energy retaining solutions (NREL, 2021). Despite the high financial cost, the NREL (2021) states that the benefits of such a transition, which include reduced greenhouse gas emissions and energy security, will make it a worthwhile investment.

In addition to the financial investment and infrastructure upgrades, literature highlights that policies and government also play a crucial role in energy transition (Daszkiewicz, 2020). According to Kong, Cheng, and Jiang (2021), government officials who are the decision-makers have a significant amount of power within their jurisdictions to influence policy changes and affect economic activities. Broto (2019) further emphasises the important role the local politicians and government play in energy transition, both globally, regionally, and nationally. According to IRENA (2015), policymakers must create a stable policy environment, provide regulatory certainty, and attract the involvement of the business sector in sustainable energy development. In support of the above, the International Energy Agency (2019) also highlights the vital position of policymakers in shaping the energy transition landscape, stating that policymakers can create the necessary conditions for renewable energy investment, through target setting, and supportive policy implementation. In relation to policies, IRENA (2018) indicates that policy development and implementation are needed to guide the world energy system towards sustainable systems The effectiveness of the shift to sustainable sources in many sectors such as automobiles, equipment, machinery, wind, lighting and photovoltaic (PV) systems is dependent on policies that support it (Daszkiewicz, 2020).

There is also a need for collaborative governance between multiple stakeholders, such as "*government, industry, and civil society, to facilitate the energy transition*" (WEF, 2021). According to the WEF (2021), this collaboration must involve the creation of public-business partnerships and various stakeholder initiatives to leverage the expertise and competencies of different actors to accelerate the growth of sustainable energy. In support of the above notion, Egmond, Arentsen, and Kruit (2013) explored the place of governance in championing the shift towards sustainable energy arguing that governance is critical in allowing the deployment of sustainable energy technologies and creating the right conditions for investing in sustainable energy systems. Egmond, *et al. (*2013) further identified several governance challenges, such as the need for long-term policy stability, regulatory certainty, and institutional capacity building that must be addressed to facilitate the energy transition. Egmond, *et al.* (2013) also highlighted the value of stakeholder participation and collaboration in renewable energy systems governance, as well as the need for innovative governance models that can leverage the competencies and knowledge of different actors.

The European Commission (2021) stated that energy transition can be easily achieved in politically stable countries without violence or terrorism. Regularly changing governments can disrupt long-term energy planning and make it difficult for organisations and potential investors to make well-briefed decisions about renewable energy projects, which can hinder the shift to sustainable energy sources (Foxon and Bolton, 2017). In addition to the above, Oseni and Pollitt, (2016) state that, in politically unstable countries, financial institutions may be hesitant in providing loans or financing energy projects, which slows down the deployment of renewable energy infrastructure. Furthermore, political instability can result in weak governance structures and ineffective regulatory frameworks, which can create challenges for implementing and enforcing energy policies, regulations, and incentives necessary for the energy transition (Bhattacharyya, 2017). In addition to the above, political instability can hinder the ability of countries to engage in international agreements, collaborations, and partnerships related to clean energy, thereby limiting access to technology transfer, knowledge sharing, and financial support from international organizations and donor countries (Kivimaa and Kern, 2016).

In support of the above, it was evident from the war between Ukraine and Russia that political instability can affect the transition. According to Zakeri, Paulavets, and Barreto-Gomez *et al*. (2022), "*the war left the world with energy price hikes and energy security challenges and the physical blockade and sanctions imposed on Russia disrupted the energy trade and increased energy prices, proving that the geopolitical conflict can worsen the energy crisis in the world*". This proneness of the world energy landscape and variability in fossil fuel prices in world markets brought to light that the energy system is susceptible to unexpected events such as geopolitics, hence the importance of understanding how such disruptions can affect the shift to sustainable energy, and the requirement for evolving policies to cater for such impacts (Zakeri *et al.*, 2022).

Like political stability, technology transfer and information sharing are also critical in the energy shift as a wide range of technical, analytical, and problem-solving skills to manufacture, install, operate, maintain, regulate, and use renewable energy technologies are required to manage the changing energy landscape effectively (Geels, Sovacool, Schwanen, and Sorrell, 2017). Specialised skills are required in various sectors such as generation, energy efficiency, grid integration, energy storage, and smart grid technologies (IRENA, 2021). Countries must engage in a multi-faceted approach to develop these skills through involving educational institutions offering programmes that focus on renewable energy, energy efficiency, and related disciplines (IRENA, 2021). To complete the skills development discussion, the workforce in the fossil fuels sector must be reskilled or upskilled and employed in the sustainable economic sectors (Healy and Barry, 2017).

2.4.1 Energy transition: A global perspective

A shift from a fossil fuel-dominant energy systems towards a larger portion of sustainable energy in the mix is considered a vital precondition for a sustainable world future (Sung and Song, 2014). In Germany, dating back as early as 1990, governments developed an energy policy to promote the establishment and integration of sustainable energy which made Germany the pioneer in transforming the traditional energy system (Frondel, Schmidt, and Vance, 2014). To comply with world trends, Germany developed a plan to protect the climate, which aimed to reduce the country's greenhouse gas emissions by 40% in the year 2020 compared to 1990, and by up to 80 to 95% in year 2050 (Federal Ministry of the Environment Nature Conservation and Nuclear Safety, 2016). Most importantly, in that plan, commonly referred to as the "Energiewende", the vital groundwork for the transformation of the energy sector was laid, and an example of an energy shift practice for the world was set (Gao, Fan and Liao, 2018). The "Energiewende" "*is an integrated policy framework, covering all sectors of energy and economy, including the targets and policy measures for carbon dioxide emission reduction, renewable energy development, phasing out nuclear energy by 2022, and improvement of energy efficiency*" (Haas, 2018). German also later introduced various policy measures to support renewable energy deployment, such as the Renewable Energy Sources Act (REEG) of 2000, which made provisions for feed-in tariffs as incentives for the adoption of sustainable energy projects (Li and Shao, 2021).

Following Germany, China is currently the leading emitter of greenhouse gases in the world (UNEP, 2020). Therefore, China's position in the world energy transition is very vital (Zhou *et al.*, 2021). China's notable transition journey dates back to 2012, where the Chinese then President Hu Jintao, in one of the national congresses mobilised for an "Energy Revolution" which focussed on lowering the energy consumption, adding more supply, growing energy technologies, and reforming institutions (International Energy Agency, 2017). The transition drivers include the need for air quality improvement, fight climate change impacts, and limit fossil fuels dominance (International Energy Agency, 2017). In line with global efforts towards climate governance, in 2016 China outlined their energy-related targets for 2030, which were "*to peak CO2 emissions by 2030, lowering carbon intensity of GDP by 60%–64% compared to 2005 levels by 2030, and increasing and achieving the share of non-fossil energy consumption of total primary energy consumption to around 20%*" (National Development and Reform Commission, 2018).

In addition, China has vast energy transition strategies. These include the "*Made in China 2025 plan*", which promotes the growth of sustainable energy, advanced power systems equipment and electric vehicles and the "*Work Guidance of Energy Sector 2018*", which promotes a shift in the direction of less-carbon, and clean heating systems and reducing fossil fuel consumption. In addition to that, China also has several energy policies at city level (Yuan, Lyu, Wang, Liu and Wu, 2018). To date, China's rolling out of renewable energy has exceeded the target, with various projects added to the grid at an accelerated rate compared to the entire world united in 2022 (International Energy Agency, 2022).

Having established the energy transition angle of China, the United States of America's energy transition on the other hand has been an ongoing process that has been evolving over the years (US Energy Information Administration, 2021). Historically, the United States relied more on fossil fuels, especially coal and oil, to meet its energy needs, since it had domestic fossil fuel resources in abundance (US Energy Information Administration, 2021). To reduce coal dependence and move to a cleaner alternative, the United States invested in nuclear power, with nuclear power plants built across the country providing a significant portion of electricity generation. However, the safety concerns, use in weapons of war, and waste management concerns led to a decline in nuclear power development since its inception in the mid-20th century. Schneider and Froggatt (2018) state that "*despite occasional calls for a "nuclear renaissance, civilian nuclear energy is hardly a growing sector in the United States and much of Europe"*. Most of the existing nuclear plants were constructed before the 1980s and produce approximately twenty percent of the country's electricity (U.S. Energy Information Administration, 2022). However, the U.S. has shut down many nuclear reactors and plans are in place to shut down more as years go by (Lordan-Perret *et al.*, 2021). The need for decommissioning is attributed to the decline in natural gas prices, heightened availability of sustainable energy, raised awareness on community health and safety risks, with reference to incidents at "*Three Mile Island in 1979, Chernobyl in 1986, and Fukushima in 2011, higher operational costs, expensive safety upgrades, a changing regulatory environment, and changes in utility business models*" (Cardwell, 2017; Soni, 2018).

Furthermore, the adoption of renewable energy in the United States has been growing in the past 10 years with wind, solar, hydroelectric, and geothermal energy gaining traction (United States Energy Information Administration, 2019). This growth is attributed to technological advancements, declining costs, environmental concerns, and enabling policies. The "*federal and state-level incentives, such as tax credits and renewable portfolio standards, have been seen to encourage the adoption of renewables"*. In addition to that, initiatives such as the Clean Power Plan and the Paris Agreement, and legislation such as the Domestic Energy Act of 1978, the Clean Air Amendment Act of 1990, the Energy Policy Act of 2005, and the Clean Energy and Security Act of 2009, promote the reduction of greenhouse gas emissions and increase renewable energy deployment (US EIA, 2020). In 2020, "*renewable energy sources (including wind, hydroelectric, solar, biomass, and geothermal energy) generated a record 834 billion kilowatt-hours (kWh) of electricity, or about 21% of all the electricity generated in the United States. Only natural gas (1,617 billion kWh) produced more electricity than renewables in the United States in 2020. Renewables surpassed both nuclear (790 billion kWh) and coal (774 billion kWh) for the first time on record in 2019*" (United States Energy Information Administration, 2020).

The most significant growth was recorded by the wind sector with offshore wind playing a significant role (Musial *et al*., 2022). Several states, including New York, New Jersey, Massachusetts, and California, have put forward wishful targets for offshore wind establishment, and have made progress in building the required infrastructure and supply flows (Burdock *et al.*, 2022). The United States also set a goal of deploying thirty gigawatts of offshore wind capacity by 2030, and one hundred and ten gigawatts or more by year 2050 (Krauland *et al.*, 2023).

In addition to offshore wind, the United States is also investing in energy storage projects, with more than fivefold its storage capacity expected in the next three decades (Hicks, 2020). The Western United States occupies a leading role in energy storage and policy development, with the state of California operating a large hydro pumped storage of a capacity of 4.5 gigawatts

(California Energy Commission, 2015). According to Hicks(2020) "*other energy storage technologies currently being deployed across the Western United States include utility-scale battery energy storage systems, and distributed energy resource projects, such as behind-the-meter residential batteries, microgrids, and peak flow reduction programme*s". Unconventional technologies such as "*advanced batteries, compressed-air energy storage, flywheels, thermal and ice, hydrogen, and behind-the meter demand-side management are also emerging*" (Lin, 2020).

Despite the notable strides, the energy transition in the United States still faces challenges, which include the need for grid modernization, infrastructure limitations, and ensuring the communities and workers in the fossil fuel value chain livelihoods are not impacted (US Department of Energy, 2023). Entrenched coal interests are also slowing down the transition. In 2015, West Virginia, the second-largest coal producer after Wyoming, led by the American Legislative Exchange Council (ALEC) a group that protects fossil fuel interests, repealed the renewable portfolio standard which they criticised to be unfavourable to the state's economic growth (Farrell, 2016; Stokes, 2020).

Europe similar to the U.S. is making good progress in transitioning from fossil fuels to renewables with different programs being rolled out and implemented to reduce greenhouse gas emissions (Tagliapietra, Zachmann, Edenhofer, Glachant, and Loeschel, 2019). The initiatives include the "*Missions program, focused on facilitating 112 European cities to achieve Climate Neutral and Smart Cities status, by implementing multidimensional and systemic decarbonization strategies through a holistic and long-term approach*" (European Commission, 2022). "*The Missions program's goal is to transform these cities into experimentation and innovation hubs, inspiring other cities in terms of technologies, markets, user practices, policies, governing institutions, and cultural practices*" (Krupnik, Wagner, Koretskaya, and Rudek *et al*., 2022). Another initiative in operation is the "TOwards Multi-stakehOldeRs transition Roadmaps," popularly known as the TOMORROW project. The TOMORROW initiative began in 2019 to empower the cities involved to upgrade their transitioning capabilities and encourage civil society and relevant stakeholders' participation in greening the process (Pellicer-Sifres *et al.,* 2018). These above mentioned tools have proven their potential to influence policy transformation in most parts of Europe (Escario-Chust *et al.,* 2023).

In addition to the above initiatives, Europe outlined intention to lead in becoming a climate-neutral continent by 2050 as stipulated in the European Green Deal (European Commission, 2019). Targets for 20230 were also established in line with the Paris Agreement and as a response to Russia and Ukraine war, leading to the establishment of the REPowerEU energy transition plan (European Parliament, 2022b). Other EU targets include the "*energy efficiency target to achieve a 36% reduction for final energy and 39% for primary energy consumption reduction by applying the European Green Deal, compared to 1990 figures*" (European Parliament, 2022b). Despite the crisis boosted by many factors, such as the financial collapse, migrant crisis, Brexit, and the Russia and Ukraine war that brought energy security issues to the forefront globally, the European continent still leads in sustainability (Dragomir, Dumitru, and Perevoznic, 2023). Instead of shocking the system, the crisis put energy transition at the forefront of Europe's key agendas and uncovered opportunities for collaboration, and improving the policy responses to speed the energy transition (European Commission, 2022).

Other notable EU policy orientations include "*the Regional Policy and Innovation Policy*". Regional and innovation policies characterise energy systems based on the state of the economy and progress in each specific region as some electricity systems are more advanced than others with states such as "*Sweden, Finland, Denmark, Latvia, Lithuania and Austria*" being 90% carbon-free and those still heavily reliant on coal such as "*Poland, Czechia, Bulgaria, Germany and Greece*" (Science Advice for Policy by European Academies, 2021). Another notable policy initiative was that of moving energy and climate change matters to the local levels of government through a model named "*Energy Communities*" (Reis, Gonçalves, Lopes, Henggeler and Antunes, 2021). The "*Energy communities*" model places energy actions in the hands of citizens where local communities are actively involved in the energy transition and efficiency initiatives thereby lessening depending on the grid (Brummer, 2018).

Similarly, since the late 1970s, the energy system outlook for the United Kingdom has gradually changed moving from being state-directed, coal-dominated, and geared towards exports to becoming market-driven, gas-heavy, and import-dependent (Li and Pye, 2018). Coal use declined drastically, with coal dominance in electricity supply reduced to below 5% in 2019, compared with 40 percent almost a decade ago (United States Energy Information Administration, 2019). According to the World Economic Forum (2023), a record amount of energy was generated from renewable sources in 2022, where 40 percent of the UK's electricity was made up of solar, wind, biomass, and hydropower.

According to Van Egmond, Arentsen and Kruit (2013), this growth in renewable energy is driving the United Kingdom’s comprehensive policy framework to support its energy transition. The Climate Change Act (CCA) of 2008, which establishes legally binding goals for cutting greenhouse gas emissions, is one of the enabling policies. With the passage of the CCA, the UK became the only nation in the world to have legally-mandated long-term obligations to cut greenhouse gas emissions (Van Egmond *et al.,* 2013). In addition to emphasising institution building, the CCA called for a minimum 34% reduction in the release of greenhouse gases by 2020 and a decrease of 80% by 2050. Along with establishing annual limits for allowable emissions and carbon budgets, the Act also included provisions for the creation of a Committee on Climate Change (CCC). The CCC is an impartial panel of experts that advises the government on the best way to achieve the 2050 goal (Van Egmond *et al.,* 2013). The group consists of a chief executive, a chair and five to eight senior scientists who hold significant influence in both business and politics. The CCC performs a crucial role in the United Kingdom's shift to a carbon-neutral economy by providing recommendations and advocating new policies to speed the transition (Van Egmond *et al.,* 2013). In addition to policies, membership in international agreements like the Paris Agreement also reinforce the UK's commitment to combatting climate change and achieving net-zero emissions by 2050 (Van Egmond *et al.,* 2013).

Van Egmond *et al.* (2013), further states that the United Kingdom is also an international leader in energy transition, with remarkable progress noted in the expansion of offshore wind power, with installed offshore wind capacity of almost 3 GW in 2022, greater than the entire global population, excluding China (IEA, 2023). Due to legislative obstacles and local opposition, onshore wind and solar power have also grown, though at a slower pace (IEA, 2023). Although the amount of renewable energy used to generate power has increased, the UK's overall energy production is still highly carbon-intensive and highly centralised (WEF, 2023). However, there are steps being taken to alter this situation. The UK government has stated that it intends to phase out coal entirely in the country by 2025 and cut greenhouse gas emissions by 78% by 2035 when compared to 1990 levels (IEA, 2023). Additionally, the UK established a Carbon Budget to guarantee adherence to the Paris Agreement's temperature target of keeping global warming to below 2°C (IEA, 2021).

In India, while renewable energy generation is increasing, more than 60% of the current generation capacity is still derived from fossil fuels with coal and oil championing India’s industrial growth and modernisation (Institute of Energy Economics and Financial Analysis (IEEFA), 2023). The Global Energy Monitor's (GEM) data for 2022 reveals that India has 55GW of coal capacity in the pipeline, of which 31GW are now under construction and the remaining 24GW are awaiting regulatory permission in various planning phases. This continued fossil energy consumption makes India the third-highest carbon dioxide emitter. To change this trajectory, India is however, on a course to achieve carbon neutrality by 2070, with most planned coal projects amounting to approximately 607GW cancelled, and some coal fleet retired (Institute of Energy Economics and Financial Analysis, 2023). Additionally, a lot of bankers and investors have abandoned coal power projects in preference to energy sources that are renewable and clean (IEEFA, 2023). Furthermore, more aggressive goals were set for 2030, including the installation of 500 gigawatts of renewable energy capacity, a 45% reduction in the economy's emissions intensity, and a billion tonnes of carbon dioxide reduction (IEEFA, 2023).

Amidst the recent tough years, filled with policy headwinds, increases in commodity prices, unclear policies and the COVID-19 pandemic, which slowed down the global expansion of renewable energy capacity, India added a record 15.5 GW of new renewable energy capacity in the fiscal year (FY) 2021–2022 (IEEFA, 2023). India has also to date, exceeded its target made at the Paris Summit of COP 21 by meeting 40% of its energy needs from non-fossil fuels, with the proportion of solar and wind power in the energy mix increasing significantly (Institute of Energy Economics and Financial Analysis, 2023). This growth is attributed to technological developments, steady policy support, and cheaper set-up costs for solar power plants. India has ambitious goals to increase the adoption of contemporary bioenergy and is among the most prominent producers of it worldwide (IEEFA, 2023).

Furthermore the IEEFA (2022), alludes that affordability, security, and sustainability trade-offs may be limited by meticulously designed legislation. India has several governmental policies that if completely implemented, might hasten the transition to cleaner and more efficient technology and establish India as a global leader in renewable energy (IEEFA, 2022). To reduce the consumption of energy and emission levels from buildings, transportation, and major industries, India implemented initiatives like the removal of subsidies for petrol and diesel in early 2010, providing of fuel gas for heating and cooking purposes to millions of households and the removal of subsidies for electric vehicles in 2019 (IEEFA, 2022). In terms of financing, Indian producers of renewable energy now have access to foreign loans and equity funding; in addition to that, sovereign green bonds backed by the government offer a bigger pool of funds related to sustainability and environmental social and governance. However, the currency risk raises the cost of financing for green bonds provided in US dollars, the Indian renewables finance industry needs to have access to local capital through green bonds denominated in rupees (IEEFA, 2022).

Continuing with the global perspective, Australia is one of the countries that are still reliant on fossil fuels. According to the IEA (2022), fossil fuels comprised 92% of Australia's energy needs in 2021, indicating their substantial dominance in the country's energy mix with 36% of energy consumption coming from oil in 2020, comprising of refined products, liquefied petroleum gas (LPG), and crude oil. Though coal still dominates electricity generation, its share has significantly decreased, from 71% in 2010 to 53% in 2021. The decrease is attributed to the retirement and shutdown of several old coal-fired power facilities in addition to the nation's worldwide pledges to cut back on emissions from fossil fuels (IEA, 2022). Since 2012, twelve power plants, which is approximately one-third of the total number of plants, have been shut down and more plant closures are anticipated (Burke *et al*., 2018). To recover from the loss from the coal fleet closures, Australia was compelled to develop regulations for switching to cleaner, more sustainable energy sources and quickly build alternate ways of energy supply (Goddard and Farrelly, 2018).

To date, solar energy tripled between 2018 and 2021, contributing to the current rapid growth in renewable energy output (IEA, 2022). Australia generated 29% of its total electricity in 2021 from renewable energy sources, which included hydropower (6%), wind (10%), and solar (12%). The proportion of renewable energy in all electricity generated in 2021 was the most significant recorded; with the prior record being 26% in the middle of the 1960s (Australian Department of Climate Change, Energy, the Environment and Water (DCCEEW), 2022). Renewable energy sources such as wind and solar are readily available, and advances in photovoltaics (PV) have made the production of solar energy much more efficient. Additionally, advances in battery efficiency have made wind and solar power more viable (Panagoda *et al*., 2023).

In a bid to meet its environmental and climate change obligations, the Australian government through its Powering Australia plan, committed to an unprecedented budget of about 25 billion Australian dollars, including support for initiatives that open up opportunities for investors in clean energy and other low-carbon technology (IEA, 2022). To extend and update Australia's electricity infrastructure and accommodate more renewable power, an additional 20 billion Australian dollars was made available as low-cost financing. According to this plan, it is projected that the percentage of renewable energy will rise to 82% by 2030. Other funds include the Powering the Regions Fund (PRF), which is intended to aid in the current industries' decarbonisation and the creation of new clean energy industries, and the National Reconstruction Fund for supporting renewables manufacturing and the deployment of low-emissions technologies, including clean energy component manufacturing, and hydrogen electrolysers (DCCEEW, 2022). In addition to the above, funds were also allocated for specific clean energy technologies such as regional hydrogen hubs, community solar batteries and banks, equity to support the establishment of a battery manufacturing precinct, electric vehicle charging infrastructure and hydrogen highways and RE financial incentives are available under the Renewable Energy Target scheme, which is administered by the Clean Energy Regulator (DCCEEW, 2022).

In contrast to Australia, New Zealand enjoys a low-emissions energy system, with more than 85% of its electricity sourced from renewable sources in 2023 (Zhang *et al.*, 2022). Geographically advantageous conditions, such as being an island nation with mountains, lakes, somewhat constant wind and rainfall, and access to geothermal resources, are primarily responsible for the high percentage of renewable electricity. Due to its oceanic location, tidal energy is abundant and New Zealand also boasts sizable regions of farmland and forests, which are excellent sources of biofuels. With this geographical location advantage, New Zealand can lead the world in incorporating very large shares of renewables while preserving energy security. Currently, New Zealand occupies the third-ranking among the leading countries with a high renewable energy share in roughly 30 member nations that make up the OECD (Zhang *et al.*, 2022). Despite the enviable renewable resource base, New Zealand still has reliance on fossil fuels for transportation and industrial sectors, which it seeks to reduce through by implementing several laws to encourage the advancement of renewable energy sources (Zhang *et al.*, 2022). In addition, New Zealand has set high goals to cut greenhouse gas emissions, one of which is to achieve net-zero emission levels by 2050 (IEA, 2023).

2.4.2 Contextualising literature on energy transition: A sub-Saharan perspective

Developing countries are following the developed countries' lead in terms of the transition. Tagliapietra *et al.*, (2019) suggest that an efficient energy transition is increasingly becoming both technically and financially possible in developing countries, as renewable energy technology is becoming available, and the costs are declining. It is anticipated that with appropriate policies and regulations, the cost of the transition will be equal to that of maintaining the existing fossil fuel-based system (Tagliapietra *et al*., 2019). Though there are notable strides, a lot still needs to be done, as many developing countries still have coal-powered plants planned, some undergoing major upgrades and expansion, and some under construction (Shearer *et al*., 2019; Normile, 2018; Webb and Parra, 2018). In relation to the above, Edenhofer *et al.,* (2018) states that the latest African investment trends indicate emissions-intensive coal dominance to meet the energy demand. The massive investment in fossil fuels may lead to severe climate impacts (Pfeiffer *et al*., 2016).

To address the climate impacts, Africa needs to make the most of its abundant natural resources, including wind, biomass, sun, and hydropower, since the development of renewable energy may provide workable and reasonably priced solutions that are good for the environment, economy, and public health (Aliyu, Modu, and Tan, 2018; Hermann *et al.*, 2014). According to Adenle (2020), various African countries have varying potential for concentrating solar power, solar photovoltaic, and wind; however, the adoption of renewable energy is still hampered by low funding for renewable energy research and development, government incapacity to draw in private capital, unclear regulations, and issues with governance. Other challenges hindering the development of potential renewable energy projects include the absence of standard and quality control mechanisms, lack of initial financial investments, and lack of a reliable infrastructure (Wirba *et al.*, 2015).

African countries can learn from countries such as Morocco, which is a leading energy-secure country in the continent, with almost 100 percent of households having reliable electricity (IRENA, 2020b). Morocco is one of the African nations with a reasonably high percentage of installed renewable energy capacities and a long-term plan for an energy transition towards a renewable-based power system, even if the majority of the country's electricity demand remains satisfied by fossil fuels and natural gas (IRENA, 2022). According to Okpanachi, Ambe-Uva and Fassih (2022), Morocco is rewriting the story of Africa's reliance on the Global North by spearheading the development of renewable energy technology and regulations and is a key player in several attempts to produce sustainable energy, either politically or through policy. Along with renowned EU nations like Germany, Spain, France, and Portugal, Morocco is a part of the Sustainable Electricity Trade Roadmap, which aims to integrate energy systems across regions to enable the export of excess renewable electricity generated in one nation to a neighbouring nation with lower production levels to balance out fluctuations in supply and demand. (Okpanachi, Ambe-Uva and Fassih, 2022). Furthermore, Morocco is offering helpful support through capacity-building and technical assistance programmes to aid in the development of renewable energy projects for roughly 20 African nations as well as other neighbouring countries (Bakkoury, 2020).

Year 2018 saw Morocco introduce wind and solar energy as its first sources of renewable energy (The Moroccan Ministry of Energy, Mines and the Environment (MMEME), 2023). To date, with hydropower making up the majority, renewable sources currently make up over 30% of installed electricity output and the target is to reach 50% by 2030 (MMEME, 2023). Morocco is also considering biomass as part of its plan to diversify its energy sources, in addition to solar, wind, and hydro power, given the country's significant biomass potential (IEA, 2022). Competitive bidding for utility-scale Independent Power Producer projects has been credited for this recent increase in the capacity of renewable energy generation. Through linkages with the Spanish networks, Morocco has been able to enhance its electricity exports to Europe owing to the presence of these Independent Power Producers (REE, 2020).

According to UNEP (2014), in developing nations there is typically a shortfall of up to 8% of GDP needed for the setting up of energy systems; for this reason, private sector involvement in renewable energy production is essential. More broad participation from additional funding sources, including private sources, international financial institutions, and multilateral development banks, will be needed to deploy renewable energy at the scale required to meet Morocco's ambitious ambitions (Mazzucato and Semieniuk, 2018). The implementation of renewable energy is expected to require an investment of about USD 30 billion, according to the Moroccan Ministry of Mines, Energy, Water, and Environment and fortunately, Morocco has had financial support from the World Bank and European Development Banks for its sustainability efforts (Hochberg, 2016).

In addition to funding, the establishment of clear policies is also proving to be key in supporting switching to clean energy sources. In this perspective, Morocco enacted Law 13-09 of 2010, which permits any commercial operator to generate and feed electricity into the national grid from any renewable source (MMEME, 2023). Large-scale private green electricity developers now have access to the national grid owing to Law 13-09, which also allowed private developers to build independent transmission lines for their use in cases where the national electricity grid's capacity and interconnections were insufficient. These innovations completely changed the energy landscape (MMEME, 2023). The Law 13-09 was later updated to Act No. 58-15, raised the installed capacity thresholds for small hydroelectric power plants from 12 to 30 MW. It also allowed the low-voltage market to connect to the grid, opening up a vast array of opportunities for small-scale projects like solar pumps, biomass, and photovoltaic solar panels on rooftops. This supportive legislation promotes private investments in renewable energy, resulting in unrestricted competition and rapid market expansion (MMEME, 2023). In addition to the enabling laws, Morocco has enabling institutions to support the transition which include the Moroccan Agency for Solar Energy, which guarantees the development of integrated projects for producing sustainable energy from solar, wind, and hydro energy; the Moroccan Agency for Energy Efficiency, which focuses on energy efficiency; and the Research Institute for Solar Energy and New Energy which seeks to combine the needs of various stakeholders and ensure the implementation and improvement of various research projects (MMEME, 2023).

Another country with almost universal availability of electricity is Egypt. Though Egypt’s energy generation capacity is still largely based on fossil fuel, the nation is making great efforts to use its natural gas reserves, as well as solar, wind, and hydropower capabilities, in order to lessen its reliance on fossil fuels and cut down on greenhouse gas emissions (IRENA, 2020). Egypt established a national goal to generate 20% of its electricity from renewable sources by 2022 and 37% by 2035 in the 2018 Voluntary National Review of the High-level Political Forum on Sustainable Development. To date Egypt’s sustainable energy transition model is the front runner in the African continent, and through simple deeds performed with a higher level of accountability and sheer drive Egypt has demonstrated that spectacular performances do not always need accomplishing something completely novel. Egypt implemented a strategy of energy diversification by strategically rehabilitating the existing grid infrastructure and rapidly growing the markets for renewable energy (IRENA, 2020). The nation also started modernising plans and regulations to strategically advance the targets of renewable energy, and impressive results have been observed within a short period (IRENA, 2020).

According to Ley, Gaines and Ghatikar (2015), fossil fuels and conventional biomass dominate Nigeria's energy sector, with natural gas power plants accounting for the majority of on-grid generation. In addition to the fossil fuels, large hydropower projects are also found in Nigeria; however, the operational performance of these power plants has been significantly hampered by machine failures, seasonal water shortages, and inadequate grid capacity (Yetano Roche *et al.,* 2020). Unlike Egypt and Morocco where there is a blend of energy generation, Nigeria has very low access to energy and acute shortages of electricity (Tambari, Dioha and Failler, 2020). Inadequate funding, comparatively high investment risks, policy uncertainty, shoddy transmission and distribution infrastructure, restrictions on the supply of gas, and governance may be contributing factors to the electricity shortages (Latham and Watkins, 2016). Various programmes have however been initiated to address these challenges (Tambari, *et al.,* 2020). There have been numerous initiatives and discussions in politics recently to transition families from biomass to modern energy by 2030, and increase electricity access to around 75% by 2020, and to 90% by 2030 (Tambari, *et al.*, 2020). Interventions in policy include new metering rules and guidelines that permit large consumers to buy electricity directly from generating businesses, as well as feed-in tariffs (Tambari, *et al.*, 2020). In addition, the government eliminated import taxes on some solar component imports and established the mini-grid legislation in 2016 (Nigerian Department for International Development, 2019).

Nigeria's main source of revenue is largely the exportation of crude oil. According to Africanvault, (2015), Nigeria is the world's eighth-largest crude oil exporter and thirteenth-largest producer. Nigeria has demonstrated its commitment to the global transition to a sustainable energy future and raising the share of renewables in the energy mix despite its fossil fuel-dependent economy. Nigeria pledged to build its energy system following these objectives when it signed and ratified the Paris Agreement, which aims to cut greenhouse gas emissions worldwide and keep temperature increases below 2°C (IRENA, 2023). Nigeria committed to reducing emissions by 20% in an unequivocal manner in a scenario where business as usual prevails by 2030 and to increase its conditional pledge of reduction from 45% to 47% if adequate funding, technology transfer, and capacity building are provided. In addition, Nigeria promised at the 26th COP to reduce emissions to net zero by 2060 (IRENA, 2023). Nigeria will need the government's strong political will, unified backing, and diversification of policies to fulfil these ambitions promises (Dioha and Kumar, 2020).

Another country with an economy strongly dependent on fossil fuels like Nigeria is Algeria. Himri *et al.*, (2022) state that Algeria's economy is mostly reliant on the export of fossil fuels like petroleum and natural gas. Algeria is the world's leading producer of natural gas with a high heating value and the purest crude oils, with sulphur content of under 0.05%. Algeria is the eighth-largest exporter of natural gas (NG), ranks third in terms of recoverable shale gas resources, and is among the top ten producers of NG worldwide (IEA, 2020). Algeria is one of the major carbon dioxide emitters in Africa, ranking third after South Africa and Egypt, as a result of its reliance on fossil fuels (Statistical Review of World Energy, 2019).

Algeria is one of 192 countries that are members of the Kyoto Protocol and part of 114 countries that have ratified the Copenhagen Accord as part of its dedication to decreasing greenhouse gas emissions (UNFCCC, 2012). Algeria is progressively expanding its installed capacity for renewable electricity to facilitate the shift to a more sustainable and clean energy system. By 2030, Algeria intends to have installed about 22 GW of renewable energy capacity, comprising 1 GW of waste-derived biopower, 13.5 GW of solar PV, 2 GW of CSP, 15 MW of geothermal, 400 MW of cogeneration, and 5 GW of wind (Himri, Rehman, Mostafaeipour, Himri, Mellit, Merzouk, and Merzouk, 2022). Furthermore, Algeria is investing in technologies to convert coal into clean energy utilising carbon capture and storage (CCS) or integrated gasification combined cycle (IGCC) due to its substantial coal reserves (Himri, Rehman and Mostafaeipour *et al.*, 2022).

According to Blal, Belasri and Benatillah, *et al.* (2018), Algeria established several favourable laws, programmes, and awareness campaigns related to renewable energy, backed up by the relevant institutions, to accelerate the transition to clean energy. The enabling institutions include the Renewable Energy Development Centre, a scientific and technological organisation whose primary goal is to carry out applied scientific studies and develop technologies in the field of renewable energy. Algeria's renewable energy initiative is being carried out by the electricity and renewable energy business (SKTM), a power generation corporation. SKTM is in charge of managing, maintaining, and engineering power facilities that fall under its authority as well as developing the nation's electrical infrastructure and issuing permits for the use of isolated electricity networks. In addition to the above, there is the Ministry of Environment and Renewable Energies that is in charge of development projects related to energy efficiency and conservation, including building thermal insulation, solar water heater promotion, encouraging the widespread use of energy-efficient lamps, integrating energy performance into public lighting, and advancing energy efficiency in the industrial sector (Bouraiou *et al.*, 2020).

The laws of energy control, public gas distribution by pipeline, promotion of renewable energies, creation of the National Fund for Renewable Energies and Cogeneration (FNER), the law of supplementary financing, and establishing the criteria for allocating allowances for the costs of diversifying production power are among the favourable legal framework supporting the development of renewable energy in Algeria (Belfedel, 2020). In addition, Algeria enacted executive directives that established the guidelines for the National Fund for Renewable Energies' operations and specified the processes for certifying the origin of renewable energy and using such certificates. Above the decrees, Ministerial Orders were established by Algeria to connect to the electricity transmission network, regulate the technical aspects of photovoltaic modules (PV) with crystalline silicon for use on land, determine the amount to be deducted from the National Fund for Renewable Energies, and set guaranteed purchase tariffs and the terms under which they can be applied to electricity produced from solar, wind, and cogeneration energy installations (Belfedel, 2020).

Though there are notable strides towards transition, Bouraiou *et al*., (2020) state that the absence of applications and insufficient provisions for the reduction of VAT on the importation of equipment and components for renewable energy, foreign investment policies requiring Algerian partners to retain 51% of the capital, a lack of diversity in incentives, and the costly nature of financing loans and equity are some of the obstacles sabotaging Algeria's transition. In addition to the above, Algeria lacks awareness of the advantages of renewable energy, has a poor support system for renewable energy technology, and provides insufficient training and education to satisfy the demands of the country's renewable energy plan (Bouraiou *et al*., 2020).

The Southern African part of the continent, like the North African countries discussed above, also has a coal-dominated energy system. According to Maswabi, Chun, and Chung (2021), Botswana currently relies heavily on coal for its electricity generation. The energy expansion plan for 2020–2040 in Botswana indicates a rise in local electricity output from diverse sources, including new coal plants. Botswana has enormous potential for renewable energy, particularly in the areas of wind, solar, and bioenergy. Nevertheless, these resources are now mostly untapped with solar power accounting for less than 1% of the nation's overall energy supply. Nonetheless, Botswana has big intentions of incorporating renewable energy sources into its electrical grid. Botswana declared in the December 2020 launch of the Integrated Resource Plan (IRP) that renewable energy must make up at least 15% of the country's energy mix by 2030 and the country's Vision 2036 stipulates that renewable energy must make up 50% of the energy mix by March 2036 (IRENA 2021). Furthermore, in 2020, the Department of Energy unveiled the Integrated Resource Plan (IRP) for electricity, which had as its strategic goals diversifying electricity generation sources, fostering industry competitiveness, ensuring supply security, achieving self-sufficiency in electricity generation, turning into a net exporter of electricity, and reducing environmental impact (Government of Botswana, 2020).

Botswana relies mostly on electricity imports to cover its energy demand (IRENA 2021). As a result of the supply shortage to meet demand, the nation must embrace cleaner energy generation possibilities and address the climate impacts related to fossil fuel dependence (Economic Consulting Associates, 2018). Botswana committed to taking part in the Paris Agreement and shared responsibility for addressing the international pressures to cut emissions, particularly in the power production sector, which is the one that contributes the most to emissions. In addition to the above, the government of Botswana intends to increase grid-tied energy production by 2026 through the use of solar photovoltaic and concentrated solar power, wind by 2027, and coal bed methane by 2025 (Government of Botswana, 2020). In addition, the government of Botswana is investigating decentralised renewable energy solutions to provide electricity to regions that are not serviced by the national grid and are presently dependent on Botswana Power Corporation's diesel fuel (African Union Development Agency, 2017).

Botswana’s transition efforts, like other countries discussed above, are not immune to challenges. Using a semi-structured narrative technique and documentary analysis, Maswabi, Chun, and Chung (2021) evaluated the obstacles to Botswana's energy transformation. The study analysed how current policy tools could promote the intended shift and identified obstacles that obstruct transition initiatives, drawing on the literature on energy transition. The study's primary hypothesis was that if a regime-based structural configuration existed to enable the intended system modification, an effective energy transition would occur. The challenges that were found by the study were divided into three categories: regime, niche, and landscape. The use of supply push tactics and policymakers' lack of commitment were among the landscape-level challenges. Regime-level challenges included a lack of appropriate institutions and organisations, a vague roadmap for the development of renewable energy, ambiguous roles for major players, a lack of implementation expertise, an incorrect approach to solar power, poor project planning and management, a lack of incentives for private sector development, and a lack of consumer financial support. Lastly, poor and faulty statistical data as well as a lack of funds for research and development were the impediments at the niche level. (Maswabi, Chun, and Chung, 2021).

With not much success, the government of Botswana introduced solar water heaters and standalone PV systems in the past in an attempt to encourage solar energy (African Union Development Agency, 2017). A solar PV rural electrification master plan was then created in 2003 to promote the use of solar energy in government agencies and rural communities followed by the Renewable Energy-based Rural Electrification Programme for Botswana (RERE) in 2005 which were both poorly implemented and ended up failing, leading to their termination in 2011 (African Union Development Agency, 2017). Following the 2015 adoption of the Paris Agreement, a number of initiatives and plans were also introduced to support the low-carbon development of the energy sector. These included the Sustainable Energy for All Action Agenda, the National Energy Efficiency Strategy, the Renewable Energy Strategy of Botswana, and off-grid solar action plans for homes and institutions (Economic Consulting Associates, 2018; World Bank, 2017). If these solutions are successfully implemented, Botswana's energy-related emissions might be reduced by 21% between 2015 and 2030 under the business as usual scenario (African Union Development Agency, 2017).

Continuing with the Sub-Saharan perspective, Zimbabwe’s energy situation is no different to many African countries, as the nation faces more significant problems with energy insecurity and climate change (Reid and Simatele, 2021). Zimbabwe’s demand for electricity has always been way above what the country can supply since the late 1990s and this shortage is attributed to increased urbanisation and insufficient investment in energy expansion (Makonese, 2016). Most of Zimbabwe's electricity is from the Kariba Hydropower Station and the Hwange Coal Power Station, which have been impacted by ageing infrastructure, lack of maintenance, limitations of diesel generator fuel, and cyclical drops in Kariba Dam water levels (Zimbabwe Power Company (ZPC), 2020). These difficulties have caused Zimbabwe to produce far less electricity than its existing capacity, which is insufficient to meet the nation's demand (Reid and Simatele, 2021). Similarly, Mambondiyani (2023) states that, the reduction in water levels behind the Kariba Dam makes it impossible for the country to reliably generate power with hydropower being the primary source of electricity, producing nearly 70% of the country’s electricity in Zimbabwe, leading to rolling blackouts lasting up to 20 hours per day. Due to these ongoing electricity-related issues, operating sectors or services including residential, commercial, and institutional have been battling to run at maximum efficiency (Wenga, Chinyama, Gwenzi, and Jamro, 2023).

According to Mukeredzi (2019), from over 2,000 megawatts (MW) generation capacity the Kariba South Power Station is currently producing a mere 238 MW, while Hwange Thermal Station, the second-biggest power generator, is producing 374 MW, leaving the country with a massive power deficit. Other challenges include the declining coal reserves as Zimbabwe had only 502 tons of coal reserves left as of the end of 2017 (Sean, 2018). To shield itself from these challenges, Zimbabwe imports most of its energy from South Africa, Mozambique, and the Democratic Republic of Congo, however, this arrangement partially meets the demand (Wenga *et al*., 2023). The cost of importing 150 MW and 400 MW of electricity from Mozambique and South Africa, respectively, is at least $19.5 million for the nation (Velusami and Mkwena, 2022). To exacerbate the situation, Zimbabwe has a contractual duty to supply Namibia with 80 MW of electricity (Kruger, Alao and Eberhard, 2019). Due to the unpredictability of the country's energy supply, a large number of Zimbabweans have turned to more independent sources of energy, primarily wood fuel (66.8% of the population) and contemporary fuels like petrol or kerosene (32.8%) (Mzezewa and Murove, 2017). This excessive reliance on wood as a fuel has resulted in deforestation across the country (Mzezewa and Murove 2017).

Zimbabwe must diversify its energy strategy by searching for alternative renewable energy sources to tackle the issues of rising energy demand, a shortage of conventional fossil fuel options, and strict environmental rules on greenhouse gas emissions. Hossen, Rahman, Kabir, Hasan and Ahmed (2017), alludes that because of biomass's abundance, accessibility, affordability, and carbon-neutral qualities, which includes wastes produced in a variety of sectors was identified as a potential and sustainable source of alternative energy. Zimbabwe can generate a total of 1000 MW from biomass, including bagasse, forest residue, and garbage from agricultural and urban areas. Forest residue from commercial forests has been calculated to approximately 70,000 tons, which can generate almost 150 MW of power (IRENA, 2020). According to Mambondiyani (2023), there were over 700 biogas installations in the country as of 2021. These rather modest residential units, which are utilised for cooking and water heating, demonstrate an opportunity for biogas to have a larger role in Zimbabwe's energy mix.

In addition to biomass, Zimbabwe has an array of renewable energy resources that are mostly unexplored, including solar, geothermal, and to a smaller extent, wind power (Mukeredzi, 2019). According to Chikwama, Manyuchi and Sukdeo (2022), untapped geothermal energy resources in Zimbabwe total about fifty megawatts, and wind speeds of three metres per second which though not significant for producing electricity can be used for water pumping. In addition to that, Zimbabwe also has solar potential in several regions of the country of 16-20MJ/m2 /day, which is vastly unexploited (Chikwama *et al.*, 2022). Njovana, Yu, Shen, Li, Zhu, and Liu (2022) state that Zimbabwe receives roughly 3000 hours of sunlight annually, which is sufficient for solar energy production and Zimbabwe's networked solar capacity was however only five megawatts as of 2018, considerably short of the potential. According to Njovana *et al.* (2022), Zimbabwe can guarantee a more dependable electricity supply by constructing solar panel arrays connected to battery storage devices.

Several barriers have hindered the growth of the energy sector in Zimbabwe, which include lack of enabling policies, politics, and corruption (Mukeredzi, 2019). Due to Zimbabwe's controversial political profile, the development of the 2,400 MW Batoka Gorge Hydroelectric Power Station on the Zambezi River close to Victoria Falls, which was originally planned in partnership with Zambia, has been pushed back for a long time (Mukeredzi, 2019). Other projects that fell victim to corruption included the 100 MW Dema Diesel Power Plant, which was established in 2016 to supply the nation with emergency power but shut down in 2018 due to operating costs, and Intratrek Zimbabwe, which was given a contract by the Zimbabwe Electricity Supply Authority in 2015 to construct a 100 MW solar plant; the company received $5 million for pre-commencement works but was unable to move forward with the project. (Mukeredzi, 2019).

According to Njovana *et al*. (2022), the national policies that control the pricing and integration of renewable energy into transmission systems need to be changed in order to address the nation's energy issues. Recently, Zimbabwe unveiled a number of energy regulations in addition to the National Development Strategy 1 (NDS1), the country's blueprint that includes a detailed strategy for renewable energy. The development of affordable, dependable, and sufficient power will be given top priority under the National Development Strategy 1 (NDS1), which took effect from 2021 to 2025 (NDS 1, 2020). The primary goal of NDS1 is to build an extra 280 km of transmission and distribution network in addition to increasing power supply from the existing installed capacity to 3467MW by 2025 (NDS 1, 2020). In addition to the NDS, he National Renewable Energy policy and Biofuels policy were introduced to prioritise the exploitation of renewable energy (Official Government of Zimbabwe Web Portal, 2023). It is hoped that these two crucial and eagerly anticipated laws will encourage investments in renewable energy and broaden the nation's energy portfolio. It is expected that the private sector will lead and supplement the production of electricity (Mukeredzi, 2019). These good policies to bring about the needed change will need to be implemented, the currency crisis must be resolved, and Zimbabwe ought to work on lowering its risk profile as it has been a significant barrier to international investment in the energy industry (Mukeredzi, 2019).

Additional efforts made by Zimbabwe to improve its energy trajectory include participating in the Paris Agreement in 2017, which mandates members to report their Nationally Determined Contribution (NDC), describing their commitment to combat climate change and minimise global temperature increases to significantly below 2 °C and the introduction of several investment incentives to promote renewable energy (IEA, 2016). In Zimbabwe, import duties are waived for solar and electrical equipment, including inverters, solar lights, energy-efficient lightbulbs, and electricity generators. Furthermore, investors in the energy, water, sanitation, and transportation sectors are eligible for a ten-year income tax holiday, which can be beneficial for renewable energy developers (IEA, 2016).

In conclusion, the African continent in its entirety committed to increasing the share of renewable energy (wind, solar, hydro, bio, and geothermal) in total energy production by at least 10% through the Africa Agenda 2063 Renewable Energy Target (African Union Commission, 2015). This will be attained through developing and implementing policies, strategies, and regulations that support the energy sector's sustainable growth, encouraging the development and adoption of clean energy sources and energy-efficient technologies, and financing the adoption, education, and use of renewable energy technologies (African Union Commission, 2015).

2.4.3 Contextualising Literature on energy transition: A South African perspective

According to IRENA (2020), although 91% of South Africans have access to electricity, there are still significant issues with supply security and quality. 2023 saw generation deficits of 4,000–6,000 MW, in part because of outages brought on by aged infrastructure, a dearth of new capacity, and maintenance constraints with ESKOM coal-fired power plants (ESKOM, 2023). According to estimates from the South African Council for Scientific and Industrial Research (CSIR), the ensuing outages caused a USD 6 billion decline in GDP (Pierce and le Roux, 2023). Over the past three years, the country has experienced yearly power outages that have broken all previous records. The highest recorded number of outages was 852 hours in 2015, and the highest number was 1169 hours in 2022. The country has had to endure 205 days of rolling blackouts as a result of ongoing malfunctions in ESKOM's ageing coal-powered energy facilities (African Energy Chamber, 2023). With the ESKOM fleet Energy Availability Factor (EAF) continuing its downward trend in 2021 with an average EAF of 61.8% for 2021, compared to EAFs of 65% for 2020, 66.9% for 2019, and 71.9% for 2018, the issue is predicted to continue getting worse (Pierce and le Roux, 2023). In addition, South Africa intends to decommission roughly 45,000 MW of fossil fuel capacity by 2050, which will only exacerbate the situation if sustainable alternatives are not provided (IRENA, 2020). As per the 2019 Integrated Resource Plan of South Africa, seven facilities with a combined 11.3 GW of coal power are set to be retired by 2030; the Komati Power Station has already been discontinued as of November 2021 (Centre for Research on Energy and Clean Air (CREA), 2023). According to Magome (2023), President Cyril Ramaphosa confirmed that the shutting down of these Power Stations may exacerbate the electricity crisis.

In addition to the energy security issues, like the rest of Africa, the energy system in South Africa is coal-dominated with around 80% of installed power generation capacity (African Energy Chamber, 2023). According to Ratshomo and Nembahe (2019), until other power generation sources, such as nuclear and renewables, are developed, coal-fired power plants will continue to dominate the market in terms of energy-generating capacity. Nearly 60% of South Africa's electricity will still come from coal by 2030, according to the Integrated Resource Plan (IRP) (2019). At a briefing on the electricity blueprint in October 2019 to support the Integrated Resource Plan for 2019, the present DMRE Minister, Mr Mantashe, stated that coal will continue to play an integral part in the production of electricity because the nation has an abundance of the resource (Department of Energy, 2019). Minister Mantashe further indicated that there was a plan to build additional and smaller coal-powered stations, and preparations for a nuclear plant were also said to be under consideration at a rate and extent that the nation can handle (Department of Energy, 2019).

According to the Emissions Database for Global Atmospheric Research (2019), South Africa is currently the greatest GHG emitter in Africa, ranking 14th globally for GHG emissions, with the majority coming from the energy sector and limited effort is being put into decreasing the emissions. To reduce emissions, the South African Department of Environmental Affairs (DEA) published a set of Minimum Emission Standards (MES) for significant pollutants in 2010. These standards went into effect in 2015 and were scheduled for enforcement in April 2020 (Department of Environmental Affairs (DEA), 2010a). However, major South African coal users ESKOM and Sasol submitted applications in 2013 to delay and, in certain situations, be exempted from complying with the Minimum Emission Standards (Pretorius, Piketh, Burger and Neomagus, 2015). For the fourth time, ESKOM requested an extension of time to comply with South Africa's Minimum Emission Standards (MES) in January 2019. In certain instances, the company also requested permission to not comply at all for the remaining period that some of the older power plants are in operation (Centre for Environmental Rights, 2019). The National Air Quality Officer denied the exemption request in 2021, but ESKOM is adamant that this will result in the loss of roughly 16000 megawatts of capacity since the financially distressed company cannot pay the anticipated 300 billion rand cost of compliance (Mail and Guardian, 2021).

Millions of people are impacted by this pollution, and their rights are constantly violated as a result of ESKOM's coal-fired power plants' persistent and severe violations of air pollution restrictions (Centre for Environmental Rights, 2019). In relation to the above, Tladi *et al*. (2024), assert that pollution from ESKOM's coal-fired power plants has been estimated to be the reason for the early deaths of over 2200 people annually. It also causes thousands of cases of asthma and bronchitis in adults and children, which has a yearly cost to the nation of over R33 billion due to missed workdays and hospital admissions. In addition to the above, Modi, McDade, Lallement, and Saghir (2005) state that above to contributing to climate change, harming natural ecosystems and the environment, using water resources, and altering land use patterns, emissions from fossil fuels also impair human health and prevent sustainable development.

In relation to the above, Kreft, Eckstein, and Melchior (2017) indicate that South Africa is highly sensitive to the effects of climate change, hence an urgent need for sustainable use of environmental resources. During April 11–12, 2022, South Africa's eastern coast was hit by heavy rains that were linked to climate change. These rains caused flooding and landslides throughout the provinces of KwaZulu–Natal and the Eastern Cape, resulting in the loss of over 12,000 houses and the forced relocation of more than 40,000 people (Tandon, 2022). According to a study conducted by Singh *et al.* (2022), the greenhouse gas and aerosol emissions were responsible for the flooding event. Singh *et al.* (2022) further stated that as global warming levels rise, it is anticipated that these periods of intense rainfall will occur more frequently and with greater intensity, necessitating the development of strategies for lowering greenhouse gas emissions.

In the Integrated Resource Plan (2019), South Africa aims to reduce its carbon footprint by diversifying its energy mix to satisfy growing global energy demand and ensure an equitable shift for all by 2030. The REIPPPP in South Africa has also cleared the path for the expansion of renewable energy in the country (Van der Merwe & Brent, 2020). As of September 2023, South Africa had about 34 wind farms contributing over 3,400MW to the country's electricity grid (SAWEA, 2023). The Integrated Resource Plan 2019 established a target that by 2030, 39.7% of the electricity generated must come from renewable sources (IRENA, 2020). To date, the REIPPPP has been successfully implemented in six rounds, which has led to the acquisition of about 9.7 GW of capacity from IPPs (African Energy Chamber, 2023).

IRENA (2020) highlights that South Africa is ranked the 12th most desirable nation for investments in renewable energy. South Africa is hailed as a leader in Africa when it comes to laws and policies supporting renewable energy and energy efficiency scoring the third-highest RISE score on the continent (IPPPP Office, 2019). In addition to the above, South Africa is rich in natural resources including integrated policymaking, robust regulation, well-thought-out incentives for attracting private low-carbon investment, greater efficiency, and regional connectivity (IEA, 2023). Given all the above positives, South Africa can diversify the energy supply away from coal and enjoy vast benefits (IEA, 2023). According to Mirzania, Gordon, Balta-Ozkan, Sayan, and Marais (2023), the efforts of South Africa to transition, however, are hindered by many obstacles. These difficulties include popular resistance, a lack of democratic standards, corruption, and inadequate institutional capability (Jewell and Cherp, 2020). In addition to the above, there are techno-economic constraints such as limited resources and inadequate infrastructure (Jewell and Cherp, 2020). Jain and Jain (2017) further pointed out that a lack of grid infrastructure and electrical supply, unstable political environments, inconsistencies in energy policies, and a lack of technical expertise are among the main obstacles to the growth of renewable energy in South Africa. In addition, Nacke, Cherp and Jewell (2022) state that entrenched fossil fuel interests also hinder the efforts to transition to renewable energy.

Another challenge that can be a hindrance to the transition is the mismanagement of energy and water resources interdependency dynamics in South Africa. Mathetsa, Simatele and Rampedi (2022) state that water and energy interdependency can threaten the security of these resources. The current fossil-fuel-burning technology is dependent on water, and this connection must be well-managed (Mathetsa, Simatele and Rampedi, 2022). In relation to the above, Flörke, Onigkeit and Oppel (2021) claim that the lack of sufficient water can also impede the transition because it is necessary to build hydropower, which is a significant source of clean energy with minimal emissions of carbon and cannot be generated without it.

The high debt of ESKOM was also identified as a barrier to the transition. According to Tyler and Mgoduso (2022), the prospect of South Africa navigating the energy transition successfully is compromised by ESKOM's financial crisis. ESKOM's massive debt of roughly 423 billion rand as of February 2023 makes it tough to pay for necessary maintenance and improvements, which undermines supply security and energy transformation initiatives. The International Monetary Fund (IMF) confirmed this remark in a statement, stating that ESKOM poses a significant risk to South Africa's economic growth (The South African, 2019). This great financial pressure is attributed to delays in major potential revenue-generating projects and defaulting in paying for the electricity supplied by several municipalities (Baker and Sovacool, 2017).

In relation to the above, Todd and McCauley (2021) reviewed policy barriers impeding the energy transition in South Africa by assessing the literature on energy policy barriers and conducting 28 semi-structured interviews with energy experts that ranked the obstacles according to priority. The study found and concluded that the main policy barriers included the institutional, which were mainly related to the state electrical utility ESKOM, and national and municipal governments. Corruption, excessive salaries and inadequate corporate governance were shown to be institutional hurdles impeding the shift to renewable energy (Todd and McCauley, 2021). The second most critical category of barriers to the energy transition was the role of the South African government and municipalities, and these included poor policies and institutions, a lack of strategic direction, and insufficient consultation (Todd and McCauley (2021). Under the third category, the mining industry and its labour unions' combined political influence were mentioned as barriers to the switch to renewable energy (Todd and McCauley, 2021).

To address the challenges to the transition cited above, Tyler and Mgoduso (2022) in their study on critical stakeholders involved in the transition alluded that relevant energy transition stakeholders must work in unison. Various stakeholders were highlighted as crucial in the energy transformation process, including the government, financial institutions, civic society, businesses, international development organisations, consumers, and research and advisory bodies. The PCC, PCFTT, and NEDLAC are among the advisory groups. NERSA, provincial and local governments, metropolitans, local and district municipalities, and government agencies including the National Treasury, DMRE, DFFE, and DPE are examples of regulators. Business Unity SA, the National Business Initiative, the Minerals Council SA, petrochemicals, coal mining, IPPs, energy industry organisations, energy user groups, and the South African Energy Forum are some of the business organisations. Both domestic and foreign commercial banks are included in this category, including the World Bank, AfD, IMF, Africa Development Bank, RMB, IDC, DBSA, Standard Bank, and Development Finance Institutions. The Climate Justice Coalition and the Green Economy Coalition are examples of civil society. The international development agencies include donor agencies, international governmental treaties, and intergovernmental organisations. Research and advisory organisations include South African Labour, academia, and government-funded institutions such as CSIR and SANEDI (Tyler and Mgoduso, 2022). Institutional quality which includes accountability, effectiveness, rule of law, and good governance can accelerate the transition to renewable energy (Inglesi-Lotz, 2021).

2.5 Identifying the Gaps in Knowledge

There is a plethora of information available regarding local and global energy transition arguing that a successful transition can be attained through increasing investment in clean energy instead of fossil fuels, developing new RE technologies, capacitating relevant institutions, and creating enabling policies, prioritising decentralized energy systems, and improving energy efficiency (Newton and Rogers, 2020; Bridle *et al.,* 2019; Henry, Bazilian, and Markuson, 2020; Zakeri, Paulavets, and Barreto-Gomez, 2022). In addition to the above, literature also argues that an energy transition is possible if there is investment in energy storage technologies (Kittner, Lill and Kammen, 2017), the government is taking a leading role (Solomon and Krishna, 2011), the transition is undertaken at city level (Yuan *et al*., 2018), and consideration is given to incentives and funding options for the switch to renewable energy

(Qadir, Al-Motairi and Tahir, 2021). These arguments however do not consider the vast challenges faced by developing countries that make it extremely difficult for investment in infrastructure for energy generation. Understanding how to facilitate the energy transition in developing nations with inadequate infrastructure and resources requires research. Therefore, this study investigated how a transition can be accomplished in the setting of a developing nation, such as South Africa, which faces numerous obstacles like inadequate infrastructure and resources, slow economic growth, financial constraints, structural unemployment, corruption, a lack of skills, a slow rate of technological advancement, and a lack of political will.

Furthermore, it was clear from the literature that policies are crucial to the transition. Bouyghrissi *et al.* (2022) propose that appropriate policies should be adopted by governments to assist the countries in overcoming the current obstacles to the switch from non-renewable to renewable energy use. Similarly, Hainsch *et al*. (2022) declare that to expedite the energy transition, transition initiatives including technological development and deployment must be coordinated with strict enforcement of the law. In addition, Chen *et al*. (2022) attest that well-crafted energy policies, in particular focused plans to direct the course of energy development, rules that are overseen and carried out by reliable authorities, and laws upheld by the legal system to improve actions and national goals are all necessary for the realisation of sustainable energy systems. In addition to the development of appropriate policies, implementation mechanisms are also critical. Chen *et al.* (2022) state that over the past 20 years, the majority of nations have passed numerous energy-related laws, yet the energy transition continues to progress slowly. This is an indication that further research is necessary to identify the best legislative and policy frameworks to turn around the current trajectory in the policy space and accelerate the move away from coal to renewable energy. Thus, in the context of South Africa, this study examined the appropriateness and effectiveness of the existing policies and made recommendations for improvement in the consistencies and implementation of policies.

Moreover, a majority of studies are available on barriers in the energy transition, pinpointing barriers such as economic, technological, political, personal, social, and infrastructural (Haddadian, Khodayar and Shahidehpour, 2015; Liu and Santos, 2015; Sierzchula, Bakker, Maat and van Wee, 2014; Kasten and Hacker, 2018; Azadfar, Sreeram and Harries, 2015; Barisa, Rosa, and Kisele, 2016; Barlag, 2015; Tobiasson and Jamasb, 2016; Šahović and Silva, 2016; Persson and Grönkvist, 2015; van Doren *et al.*, 2016; Ponce *et al.*, 2016; Karner, *et al.*, 2016). According to Biresselioglu, Demir, Kaplan and Solak (2020), barriers, often disregarded, are critical as they have the potential to impede, delay, or negatively impact a process or one of its phases. Furthermore, barriers typically lie outside the control of decision-makers and span multiple tiers of decision-making. Therefore, their elimination or reduction necessitates meticulous planning and precise identification to create the most appropriate and customised systems to address them (Biresselioglu, Demir, Kaplan and Solak, 2020). Despite the rich literature on barriers to the transition, a gap exists on how renewable energy can be maximised amidst the vast known barriers to the transition in the context of South Africa. It is in the context of this gap in knowledge that the study has been developed to identify the barriers and challenges to the transition and suggest ways in which such barriers can be addressed.

Global literature additionally made it explicit that nations are turning to less common forms of alternative energy such as green hydrogen, onshore wind, tidal, and waves, which are not yet widely exploited in South Africa. These uncommon energy sources have the potential to play a vital role in the energy transition, particularly in sectors that are difficult to electrify. The Department of Energy (2015) claims that there have been major global changes in the energy sector since the oil crisis that South Africa can benefit from. The biggest change is that more supply diversity and flexibility have become necessary to achieve energy security (Department of Energy, 2015). Similarly, Simon (2020) states that a diverse energy portfolio may help countries overcome short- or long-term energy shortfalls and soften possible economic blows. In relation to the above, Ndlovu and Inglesi-Lotz (2019) further attest that South Africa should investigate means to diversify its generating capacity to meet demand and tackle climate change impacts. It is in light of this disparity that this research sought to investigate alternatives and policy frameworks available internationally that can impact SA's aspirations to transition from coal to renewable energy sources.

Furthermore, the literature reviewed above indicates that the energy structure of South Africa is still dominated by coal, and the continued use of coal leads to catastrophic climate impacts. According to the Pierce and le Roux (2023), the impacts of climate change in South Africa are already being felt and it is predicted that multiple related challenges are imminent. These climate impacts have been evident in the recent devastating floods that took place around the country in April and May 2022, killing over 440 people and leaving many people homeless in the KwaZulu-Natal Province (KwaZulu-Natal Provincial Government, 2022). In addition to the impacts on climate of coal use, South Africa also faces the challenge of an unstable electricity supply, with the country having been subjected to load shedding for over 13 years (SABC News, 2022). In a media briefing on 22 April year 2022, the then-CEO of ESKOM, Mr de Ruyter mentioned that ESKOM is battling to maintain its liquidity, with a debt repayment of thirty-six billion Rands per annum (SABC News, 2022). This lack of finance makes it difficult for the entity to maintain its ageing power infrastructure to avoid load shedding. This unstable electricity supply affects numerous dimensions of South Africa's expansion and advancement, including the economy, with estimated economic output losses of about R700 million and a loss of over one million job opportunities per stage of load shedding per day (Engineering News, 2022). To ensure an adequate supply of electricity for South Africa and to transition to green technologies to address the effects of climate change, a well-resourced energy transition plan is required.

Strambo, Atteridge, and Burton (2019) assert that much research is required to better understand how energy security can be preserved or attained while embarking on the transition and uncover the prospects and risks associated with the transition process. Furthermore, designing context-specific transition strategies that speak to the economic conditions and challenges of South Africa is critical (Strambo *et al.,* 2019). It is in the quest to find better strategies for transitioning to renewable energy while maintaining energy security in a country that is already battling with the security of supply and has abundant coal reserves that coal lobbyists advocate for its continued use, that this study has been developed.

CHAPTER THREE: METHODOLOGICAL CONSIDERATIONS

3.1 Introduction

This chapter discusses the methodology that was applied in this study. According to Al Kilani and Kobziev (2016) a research methodology is a crucial component of the study since it elucidates every step taken to accomplish the study's goals. To obtain data that addresses the research question, a research methodology is essential to any kind of investigation. Alshenqeeti (2014) asserts that the use of research methodologies is crucial to any social science study since it affects the project's legitimacy, dependability, and effectiveness. A method of investigation lends credibility to the study and yields reliable scientific results (Kshetrimayum, 2021). For a study of this kind, to answer the research questions and accomplish the goals and objectives of the study, it is critical to use an appropriate methodology.

Given the definitions above, the following is the outline of this chapter: Section 3.2 discusses the approach of the study. This section defines the research approach that was used to approach the research participants. It starts with a general explanation of the various research approaches that are available in the social sciences and ends with the approach that the researcher employed. In Section 3.3, the research design is described. The data sources or research material, and population and sampling procedures are described in this section. Section 3.4 engages with the data analysis employed for the study. The final section, Section 3.5, presents an overview of the research methodologies that were intended and applied in the study.

3.2 Research approach

As pointed out above, in this section we engage with the research approach which according to Chetty (2016), is defined as "*a plan and procedure that consists of the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation based on the nature of the research problem being addressed*". The research approach is also referred to as a basic philosophical perspective regarding the universe and the nature of research that a researcher brings to a study. This orientation develops depending on discipline, perspectives, learners', supervisors', or mentors' interests, and prior research experiences (Creswell, 2014). Any research needs to define a philosophical approach, as it defines and influences how a researcher approaches the research participants. For studies of this nature, different approaches can be employed such as "*post-positivism, pragmatism, transformative, and constructivism*" (Guba, 1990; Creswell, 2014).

The authors of the 19th century, including "*Comte, Mill, Durkheim, Newton, and Locke*", are the source of the post-positivist tradition (Smith, 1983), and subsequently from authors like "*Burbules and Phillips"* (2000). The philosophy that followed positivism is known as post-positivism, and it questions the conventional wisdom that knowledge is absolute (Phillips and Burbules, 2000). This type of approach is commonly employed in quantitative research (Teddlie and Tashakkori, 2009). Post-positivists maintain that all observations are grounded in theory and that the perspectives and experiences of individuals can influence the methods used in research (Trochim; 2006). Creswell (2014) maintains that this method is restrictive as it aims to condense the concepts into a narrow, distinct collection of concepts for testing, such as the variables that make up research questions and hypotheses.

Constructivist ideas came from writers such as Berger and Luekmann (1967), Lincoln and Guba (1985), and Lincoln *et al*. (2011) and Mertens (2010) have provided summaries of them later. According to Scotland (2012), constructivists view everything as having an interpretation, and thus frequently employ qualitative research techniques and believe that reality does not exist. Constructivism focuses on people's perceptions of the situation being studied to the greatest extent. It asks open-ended, generic questions that allow participants to create their unique views of the situation, which are usually formed through conversations or interactions with other people (Creswell, 2014).

The transformative approach is a view that addressing social oppression at all its manifestations, requires that political action and research inquiry be integrated (Mertens, 2010). The research needs to include an improvement action plan that could impact participants' lives, the institutions where people reside or work, and the investigator's own life (Creswell, 2014). Based on a variety of ideologies, including post-colonial, feminist, critical, race-specific, and Marxist theories, this transformative approach is focused on groups or communities (Mertens, 2010). Through the identification of the problem and all aspects of the study, participants are integral to the transformative approach (Mertens, 2010).

Pragmatism was first introduced by "*Peirce, James, Mead, and Dewey*" (Cherryholmes, 1992). The pragmatic paradigm is based on situations, actions, and outcomes rather than preconditions and is more interested in problem-solving techniques and practical applications (Patton, 1990). The pragmatic approach is most appropriate for this investigation. This strategy takes advantage of the best available research method (Feilzer 2010). Delport, Fouche and Strydom

(2011) state that under the pragmatic approach, researchers are allowed to use whichever methodology they see fit for their research, keeping in mind that every methodology has benefits and drawbacks. The use of mixed research methods is appropriate as long as the research issues are addressed (Johnson and Onwuegbuzie, 2004). In the same vein, mixed methods were used in this study to provide the best comprehension of the research questions by using qualitative and quantitative techniques in conjunction. Pragmatics anticipate that inevitably, through interaction with research participants, their study will adopt a more subjective stance, and at another an objective approach with no interaction with research subjects (Tashakkori and Teddlie, 2009). Hence, the current study employed both interactive interviews and non-interactive questionnaires in data collection.

According to Creswell (2014), pragmatism is not confined to a particular ideology or reality system. The researcher used an identical approach in this investigation, not committing to a single philosophy but allowing subject experts from around the globe and from diverse sectors to provide input into the study on perspectives on energy transitioning strategies from coal to renewables. The pragmatist approach holds that what is true at any given moment is what is practical (Creswell, 2014). Similarly, the current research topic on energy transition strategies can take numerous turns within the study period as new international and national policies or treaties get introduced, therefore this approach gave the researcher the flexibility of utilising what was available when this research was being performed.

The pragmatist researcher looks at ways of conducting the research based on the intended consequences (Creswell, 2014). Pragmatism also involves conducting research that benefits people and finds solutions for the problems people face, influenced by the researcher’s doubts and beliefs (Kivunja and Kuyini, 2017). Thus, the current research seeks to identify barriers, challenges, and prospects for South Africa's energy shift for a sustainable future, helping to address the nation's energy, environmental, and economic problems. In conclusion, the pragmatic approach is most appropriate for this study, as according to Creswell (2014), it provides access to a variety of techniques, perspectives, presumptions, and approaches to data gathering and analysis, all of which are extremely helpful to the research.

From a methodological perspective, pragmatics has been critiqued for failing to define "what works" in terms of research methodologies, contending that the usefulness of research methodologies cannot be determined before the completion of the study (Hall, 2013). However, the criticism is not substantial, as a pragmatic researcher can determine which research method serves their research purpose, utilising both qualitative and quantitative approaches while avoiding their drawbacks (Maarouf, 2019). From an axiological perspective, pragmatists have also been criticised by Biddle and Schafft (2015), who suggest that a pragmatic researcher downplays the significance of values in research. They state that the statement "what works" prompts the inquiry "to what extent and for whom does it work?" This too is a poor argument, because the pragmatic researcher can use his findings to serve whoever he chooses, depending on whatever goals need to be achieved (Maarouf, 2019). Furthermore, pragmatism is thought to be excessively permissive for the conduct of research using mixed techniques (Modell, 2010). Despite this criticism, the pragmatic approach provides an alternative that accommodates the constructivist and post-positivist paradigms and the research questions that describe the extent to which quantitative and/or qualitative techniques are employed (Teddlie and Tashakkori, 2009).

3.3 Research Design

According to Trochim (2006) a research design in an overarching plan to integrate the various study components systematically to successfully answer the research problem. A research design is further described as the structure, strategy, model, or road map for gathering, calculating, and interpreting data (Pandey and Pandey, 2015). For this study, a robust research design was selected to avoid distortion and enhance the dependability of the data gathered and reviewed. This section describes the research design that was used for this investigation.

3.3.1 Description of Research Materials and Data Sources

When determining the sources of data for this research, it was essential to interact with the South African institutions with a constitutional mandate of providing and managing energy matters in South Africa as mentioned below. These institutions were selected using the following parameters:

i. It must be involved in energy research, advocacy, development, or supply.
ii. The mission statement must clearly state the organisation’s involvement in energy matters.
iii. It must be recognised by the South African government; and
iv. It must be geographically located in South Africa.

In searching for the relevant institutions to take part in the study, the Google search engine was used, where a total number of fifteen entities were identified to meet the selection criteria stipulated above. Of the fifteen entities identified and contacted, only the eight entities indicated below were willing to participate in the study.

i. **ESKOM:** It is the primary electricity supplier in South Africa with primary duties involving producing, distributing, and transporting electricity for South Africa and its surrounding nations. ESKOM runs several power plants, the most of which burn coal, significantly increasing air pollution and greenhouse gas emissions. In addition, the organisation oversees hydropower facilities, a nuclear power plant, and renewable energy facilities including solar and wind. It owns a vast distribution and transmission network. The challenge facing ESKOM as it strives to meet its climate change obligations under the Paris Agreement is to shift from coal-fired power plants to alternative sources of energy by increasing the use of clean energy sources like wind, solar, and hydropower. By creating jobs, developing skills, and implementing community development programmes in the various regions where ESKOM operates, the organisation contributes significantly to the advancement of social welfare and economic growth in South Africa. It is in this context therefore that ESKOM was approached to engage in the research, with experts drawn from the Just Energy Transition (JET) office, which is the department responsible for energy transition matters. In addition to the data collected from the JET office General Manager, several engagements were also made with people from other departments within ESKOM, such as finance, planning, environmental, and engineering.

ii. **SANEDI:** SANEDI is a government institution that works under the oversight of the DMRE. It was founded to oversee, manage, and carry out energy-related research and development, foster creativity, and implement initiatives to advance energy efficiency in South Africa. In addition to conducting research and development, SANEDI is in charge of offering technical assistance and knowledge to both public and private sector players in the energy industry. The organisation oversees many projects and programmes that support renewable energy and energy efficiency in South Africa. Examples of these projects and programmes include the bioenergy and solar water heating efforts. Due to its involvement in the testing and adoption of renewable energy solutions that enhance energy availability and reduce the nation's carbon footprint, SANEDI is crucial in the discourse around the energy transition, hence its relevance to the current study. One programme director took part in the key informant interview, and questionnaires were distributed for completion by other stakeholders within the organisation.

iii. **SANEA:** SANEA is a not-for-profit organization promoting the growth of sustainable energy in South Africa. SANEA provides a platform for dialogue, collaboration, and knowledge-sharing among energy professionals, academics, civil society, and industry stakeholders. In addition, the association seeks to encourage the creation of creative energy solutions and raise public knowledge of issues on energy. The organisation is a member of the WEC committee, which serves as a focal point for impartial thought leadership on issues on energy. Being a member of the WEC allows SANEA to participate in international energy discussions and collaborate with energy professionals from around the world. Through interventions like interacting with significant role models, fostering discussion and knowledge exchange, fortifying the professional energy network, raising awareness of energy-related issues, and supporting talent development in South Africa, the organisation works to transform the country's energy sector. Another important role that SANEA plays is to advocate for policies and initiatives that support the development of clean energy technologies. This entails pushing for the establishment of energy efficiency goals, the adoption of renewable energy targets, and the creation of a legal framework that facilitates the application of clean energy technologies. It is within this background that SANEA was selected as one of the research organisations. One expert interview was conducted with the Project Manager, and questionnaires were distributed for completion by other members within the organisation.

iv. **SAPVIA):** SAPVIA is a non-governmental association for promoting the increased deployment of Solar PV technology in South Africa through providing coherent input to the government’s clean energy policy initiatives. In South Africa and sub-Saharan Africa, the association promotes the growth, regulation, and promotion of solar photovoltaic systems. In addition to serving as an industry association, SAPVIA gives its members a forum for networking, knowledge and skill sharing, and teamwork on initiatives and projects that promote the expansion of the solar PV market in South Africa. The association also offers educational and training initiatives to support the development of South Africa's solar photovoltaic workforce's competencies. SAPVIA is involved in the study because it is a significant voice in the nation's transition to a more sustainable and low-carbon energy system and plays a vital role in fostering the growth and development of the solar PV industry in South Africa through advocacy, education, and networking. One expert interview was conducted with the Programmes director, and additional input was provided by the organisation's diverse members through the completion of questionnaires.

i. **SAWEA: I**n South Africa, businesses and organisations engaged in the creation, application, and management of wind energy technologies are represented by this non-profit business association. The association is a prominent voice in the nation's wind energy industry. The organization's main goals are to promote wind power investment, foster socioeconomic development and change through wind power, disseminate relevant information about the wind power sector in South Africa, and advance renewable energy for both large- and small-scale applications. SAWEA's mandate includes creating a favourable regulatory and policy environment for wind energy, as well as promoting awareness and understanding of the benefits of wind energy. In its capacity as an industry association, SAWEA offers its affiliates a forum for networking, knowledge and skill sharing, and cooperation on projects and initiatives that foster the expansion of the wind energy sector in South Africa. The organization also provides training and education programmes to help build the skills and capacity of the wind energy workforce in the country. The transition from high reliance on coal compared to clean energy sources for the production of electricity requires the involvement of organisations such as SAWEA to promote the growth of alternative industries such as wind and solar PV, hence its selection to take part in the study. One expert interview was conducted with the Chief Executive Officer, and additional input was provided by members through the completion of questionnaires.

ii. **SAREC:** Under SAREC's leadership, the South African renewable energy sector and its affiliates, including SAPVIA, SAWEA, and SAHPA, are collectively safeguarded and given a voice. The primary goals of SAREC are to provide expert resources that the government can use in the development and implementation of energy policy, and to collaboratively remove obstacles to the entry of renewable energy. Furthermore, the association encourages collaboration between the public and private sectors to optimise the cost of producing clean energy and to localise the renewable energy sector. SAREC also collaborates with other South African organisations working in the wider areas of sustainable development and climate change mitigation/adaptation, including the private sector and civil society, to advance shared objectives and interests. It also disseminates information on behalf of the sector to the general population, the government, and the media outlets. SAREC offers its members a forum for working together on ideas and projects that promote the expansion of the renewable energy sector. SAREC is central in the energy transition debate, hence its selection to take part in the study. One expert interview was conducted with an executive committee member, and additional input was provided by its members through the completion of questionnaires.

iii. **NECSA:** NECSA is a state-owned enterprise operating under the DMRE's purview. To support sustainable social and economic growth, the organisation conducts and promotes research and development in the areas of nuclear energy, radiation sciences, and technology. NECSA's main activities include the operation of the Safari-1 research reactor, which is used for research, isotope production, and radiation-based applications, as well as the production of medical isotopes for diagnostic and therapeutic purposes. In addition, NECSA oversees South Africa's nuclear safeguards programme and manages the nation's nuclear waste. NECSA works on other nuclear research initiatives, such as the creation of new fuel cycles and small modular reactors (SMRs). SMRs are seen as a potential technology that can help integrate intermittent renewable energy sources into the grid and satisfy the energy needs of rural or remote areas. It was vital to involve NECSA in the study to gather information on alternative clean energy solutions that are not intermittent like solar and wind. Within NECSA, one expert interview was conducted with the executive manager, and additional input was provided by other researchers through the completion of questionnaires.

iv. **SAIPPA:** The non-profit industry body SAIPPA works to advance and defend the interests of IPPs as a group in South Africa. In an effort to promote energy security in Southern Africa, the organisation regularly engages legislators, government officials, planners, and regulators. In addition to providing a forum for information sharing among its members, SAIPPA supports the development and execution of public policy. Companies engaged in the design, building, and management of power production projects employing conventional energy sources like natural gas and diesel in addition to renewable energy sources like solar, wind, and hydropower make up SAIPPA's membership base. The organisation promotes laws and policies that encourage the expansion of South Africa's independent power producer market. SAIPPA also provides a forum for its members to share information, best practices, and experiences in the development and operation of power generation projects, which helps to build a sense of community among IPPs in South Africa, and fosters collaboration and cooperation in the sector. It is in this context that SAIPPA was selected to take part in the study, with one expert within the organisation taking part in the study and additional input provided by members through the completion of questionnaires.

The study also involved a review of different research material selected from the DMRE’s website, and the web based on their relevance to the study. These documents were identified using keywords including the laws and regulations on energy, renewable energy policies, and energy transition policies. The Integrated Resource Plan 2019, the White Paper on Energy Policy of the Republic of South Africa 1998, the White Paper on Renewable Energy, the National Development Plan, and numerous conference papers, government reports, and media statements on energy were among the primary documents that were brought up and examined. The IRP is a development plan for energy infrastructure that takes environmental and supply security into account while calculating the least-cost electricity supply and demand balance. The production, distribution, and consumption of energy are among the topics covered in the White Paper on Energy Policy concerning the growth and use of energy. The National Development Plan is a policy document that defines a desired destination and identifies the role various sectors of society need to play in achieving that goal. The White Paper on Renewable Energy affirms government backing for the growth, demonstration, and actualization of sustainable energy sources for both small and large-scale applications (Keneilwe and Ramaano, 2022). These research materials provided valuable input with regard to energy policy, renewable energy development, and plans to transition from coal and reduce South Africa’s carbon footprint, hence their selection for review.

3.3.2 Study Population and sampling procedures

The study cohort and sampling techniques are presented in this section. A research population is the total set of people, things, or events that the researcher is interested in examining. Sampling processes in research relate to the techniques used to choose participants or subjects for research projects (Alvi, 2016). The process of choosing the population to be investigated and sampling is essential to ensure that the results of the investigation are representative of the subjects being studied and that the findings can be expanded to a larger group (Creswell, 2014). The choice of sampling method is reliant upon the research question, population under investigation, and available resources and sampling processes can impact the precision and dependability of the study findings (Polit and Beck, 2017).

Sampling techniques fall into two categories *"probability and non-probability sampling"*. Random selection techniques are used in probability sampling to select subjects from a population so that every person in the sample has a comparable likelihood of being chosen for the study. The most popular types of random sampling are *"simple random sampling, stratified random sampling, and cluster sampling"* (Bryman, 2016). Bryman (2016) further states that, with simple random sampling, the selection procedure is carried out at random and each participant of the group being studied has a comparable likelihood of being chosen for the study. Stratified sampling involves the division of the population into subgroups or strata according to certain attributes like age, gender, wealth, or level of education. Subsequently, each subgroup or stratum is individually sampled to guarantee that it is represented in the overall sample (Bryman, 2016). When using cluster sampling, the population is separated into groups or clusters according to organisational structure, geography, or other characteristics and thereafter the clusters are chosen at random, and the study includes every member of the chosen clusters (Bryman, 2016).

In non-probability sampling, the sample population is chosen using a non-systematic procedure which does not ensure that every subject in the intended group has a comparable likelihood of being chosen (Elfil and Negida, 2017). The selection of participants is reliant upon availability, convenience, or judgement. Convenience sampling, quota sampling, purposive sampling, and snowball sampling are the most often used methods (Straus, 2019). Convenience sampling involves the researcher choosing participants based on their accessibility and desire to engage in the study without the need for pre-established criteria. These people may be nearby or part of a readily accessible group (Straus, 2019). In quota sampling, the researcher ascertains the salient features of the population under investigation and chooses volunteers who meet those features in predefined ratios, or quotas (Straus, 2019). Purposive sampling is a method typically employed in qualitative studies when the researcher aims to comprehend a specific phenomenon or notion. In this approach, participants are chosen based on predetermined criteria, such as their knowledge, experience, or skill in the field being examined (Straus, 2019). When using snowball sampling, the researcher selects a handful of participants who fit the study's requirements and requests them to recommend other volunteers who might also fit the requirements. This procedure is repeated until an appropriate sample size is obtained, with each person recommending other participants (Straus, 2019). A researcher may employ mixed sampling which is a combination of probability and non-probability sampling techniques to get a representative sample (Creswell and Clark, 2017).

The non-probability sampling procedure is quick, inexpensive, and more convenient than the probability sampling procedure (Sharma, 2017). Despite the disadvantages of subjectivity and lack of generalizability, when choosing tiny samples, frequently from a constrained geographic area or a narrow population definition, non-probability sampling is considered to be the most suitable method (Maxfield and Babbie, 2014). Non-probability sampling, according to Bryman (2016), "*is criticized for having a delicate ethical path to navigate and the impossibility of determining the sampling error; however it best suited and was adopted for this study due to its ability to recruit hidden populations, and its cost and time effectiveness*".

A combination of three non-probability sampling methods at distinct phases of the research in selecting the study population were employed, which are purposive or judgmental, convenience, and snowball sampling. The purposive sampling procedure was used in selecting the research entities based on their involvement in energy matters in South Africa. Using the Google search engine, the words "organisations involved in energy generation, policy, regulation, advocacy, research and management in South Africa" were keyed in and over 1000 results came up. The 1000 search results were scanned and a total number of fifteen entities that directly met the criteria were identified through reading their mission statements. The fifteen identified organisations were then contacted telephonically to take part in the study, and only eight of the organisations as mentioned in Section 3.3.1 above were open to taking part in the investigation. Further engagements were then made with the administrators of the willing organisations to request interviews with subject experts who have more than ten years industry experience, and sufficient knowledge on energy transition matters within the organisations.

In ESKOM, the CEO's office administrator was contacted, and the researcher was referred to the JET office. Within the JET office, one key informant interview was conducted with the General Manager, who indicated that the energy transition discussion will not be complete without soliciting the views of other departments within the organisation, and referred the researcher to experts within the other departments including planning, engineering, environment, maintenance, and finance departments, thereby applying the snowballing sampling technique in the research. Thirty survey questionnaires were then emailed to the various departmental and power station heads within ESKOM as referred by the JET Office and the entity provided 10 responses in total.

The same snowballing sampling technique was used to identify respondents from SANEDI, SANEA, SAPVIA, SAWEA, NECSA, SAREC and SAIPPA, where upon contacting the company administrators, the researcher was referred to subject experts who met the selection criteria and engaged in interviews as experts; thereafter they referred the researcher to their colleagues to whom survey questionnaires were distributed. A total of three questionnaire responses from each of the above-mentioned organisations were received. In total, ten key informant interviews and thirty-one questionnaire responses were received from the above-mentioned organisations in the study.

To complement the responses received from the purposefully selected study organisations, the study leveraged technological advancement and used the web to identify additional individual subject experts within diverse entities. A Google search was made for platforms that showcase individuals working in different professions by keying in words "platforms that show individual professions or job titles" and various job search platforms such as LinkedIn, Indeed, Glassdoor, AngelList, Monster and CareerBuilder came up. Of the six platforms that came up, the researcher purposefully decided to use LinkedIn, as it was the only one that clearly outlined people's job titles and skills, and allowed users to connect with other professionals more than the rest of the platforms.

LinkedIn is an online social network for seeking employment, advancement in career, and professional interactions, and can be accessed on https://linkedin.com/. Within the LinkedIn platform the researcher keyed in the following words "energy experts" and 343 000 professionals came up. Realising that reaching out to so many experts would be time-consuming, the researcher decided to narrow down the search and keyed in the words "energy experts directly involved in transition" and 3000 professional profiles came up. On scanning through the 3000 professional profiles, 1000 experts were identified to meet the selection criteria of over ten years industry experience and having direct involvement in energy transition matters. The 1000 experts were sent invitations to connect and 512 responded, thereby creating the study population. A link to the questionnaire created on the SurveyMonkey portal was then shared with the 512 energy transition experts on their LinkedIn InMail, and a total of 119 South African and 40 global responses were received and retrieved for analysis, bringing the total number of study responses to 200. In this instance, a mix of convenient and intentional sampling techniques were used. The thesis is therefore based on the views expressed by the 200 research respondents and several policy documents reviewed.

3.3.3 Data Collection Tools

For the study, both primary and secondary approaches were employed to gather both qualitative and quantitative data. Secondary data sources included published and unpublished scientific papers, research reports, media reports, and government plans, policies, and legislation. Primary data sources included questionnaire surveys and in-depth somewhat structured interviews with professionals in the field. The data collection instruments employed in secondary data collection are as described below:

i. **Interviews:** A research interview is a method of collecting data through a guided conversation between a researcher and one or more participants, designed to elicit in-depth information about the participants' experiences, beliefs, attitudes, or perceptions related to a specific topic of interest (Guest, Namey, & Mitchell, 2020). Buriro, Awan, and Lanjwani (2017), further clarify that during an interview, the researcher engages with the respondent face-to-face and asks questions. Types of interviews include "*focus group interviews, unstructured interviews, semi-structured interviews, and standardized open-ended interviews*" (Mann, 2016). The most effective method for gathering data on participants' opinions on energy transition strategies from fossil fuels to clean energy was identified to be semi-structured interviews. Semi-structured interviews enable the researcher to critically examine the discussions and the initial superficial responses to draw multi-layered findings and foster in-depth conversations (Ritchie and Lewis, 2003). Furthermore, they enable the researcher to probe further into all spoken and nonverbal reactions, including hunches, laughs, and silences, to uncover information that may be useful when analysing the final data and extracting various themes from the conversation (Ritchie and Lewis, 2003).

   Although interviews are often criticised for needing more resources than other data gathering techniques, the information gathered from them is frequently far richer and more insightful (Hawkins, 2018). To limit the disadvantage of interviews requiring plenty of resources, only subject experts were identified as potential interviewees, and interviews were subsequently conducted with ten key informants.

These key informants were selected within organisations engaged in South African energy issues, as noted in Section 3.3.1, and contacted through email and telephone. Upon their acceptance to take part in the interview, the interview schedules containing interview questions tailored to each participant's expertise were developed and shared with interviewees a week before the interviews, to allow the interviewees time to prepare. There were two parts to the interview schedule: background information was requested in the first session, and subject-specific questions were asked in the second. The questions were designed to elicit feedback from participants regarding the efficiency of the energy policies, as well as obstacles, possibilities, and challenges and solicited opinions on how to expedite the shift from coal to renewable energy sources. Other questions were asked soliciting respondents' opinions on the significance and function of governmental entities in the energy transition debate. A total of 60 to 120 minutes were spent on each interview, and English was the main language of communication. Six interviews were recorded to facilitate subsequent transcription, and detailed notes were taken for those who were not comfortable with being recorded, to protect their anonymity. The Interview Schedule used for this study is presented in Appendix A.

i. **Questionnaires:** A questionnaire is a research instrument with various questions used to gather information from participants in the absence of the researcher (McLeod, 2018). According to Babbie (2016), the common types of questionnaires include structured questionnaires, semi-structured questionnaires, unstructured questionnaires, standardized questionnaires, behavioural questionnaires, and demographic questionnaires. Structured questionnaires contain closed-ended questions with predetermined response options, such as multiple-choice or Likert-scale questions, and semi-structured surveys combine open-ended and closed-ended questions, allowing for some flexibility in the participant's responses. Exclusively open-ended questions are included in unstructured questionnaires, enabling participants to submit more thorough and customised answers and standardized questionnaires use validated measures or scales to assess a specific construct, such as anxiety or depression. Behavioural questionnaires ask about specific behaviours or actions, such as dietary habits or exercise routines, and demographic questionnaires collect data regarding the participant's background, including gender, age, and educational attainment (Babbie, 2016).

A semi-structured questionnaire was employed for this study. According to Bernard (2017), semi-structured questionnaires have several advantages that make them a popular choice for researchers, which include allowing for flexibility in the participant's responses and allowing participants to provide more detailed and personalized responses. Semi-structured questionnaires also allow the participants to have some input into the direction of the conversation and allow the researcher to triangulate the data or compare the responses across different types of questions (Bernard, 2017). McLeod (2018) further reiterates that questionnaires are quick, easy to use, inexpensive, and capable of gathering a wealth of data from a large sample of people over a wide geographic area hence they were chosen for the study. They can also contain both closed and open-ended questions, which can produce rich quantitative and qualitative data. Although questionnaires are criticised for having drawbacks including poor response rates and respondent bias, these drawbacks are offset by the benefits.

A web-based semi-structured and self-administered questionnaire was created on the SurveyMonkey online survey tool which can be accessed on https://www.surveymonkey.com/ and distributed to identified subject experts mentioned in Section 3.3.2 above to gather study related information. The questionnaire was composed of a combination of multiple-choice and open-ended questions ranging from broad to more specialised in nature. The questionnaire focused on the respondents' perception of the existing energy policies and solicited insights on barriers, challenges, opportunities, and recommendations for a successful transition from coal to renewable energy in South Africa. The survey's average completion time was seven minutes. The questionnaires employed for this study are presented in Appendix B and C.

3.4 Data Analysis:

The process of data analysis involves arranging data, deriving meaning from the information gathered, and drawing reliable conclusions. Since mixed methods were employed for data collection, a combination of qualitative and quantitative data analysis methods were employed. Quantitative data analysis involves analysing numbers-based data without losing any meaning.

Quantitative data analysis is commonly used in social science research, market research, and many other fields, to understand trends, patterns, and relationships in data. It involves collecting data using structured methods such as surveys, experiments, or observations, and the analysis and interpretation of the gathered data using statistical methods (Creswell, 2014). Qualitative data analysis is analysing data based on words, phrases, and expressions that cannot be reduced to numbers (Jansen and Warren, 2020). Qualitative data analysis involves data collection, transcription, coding, categorisation, interpretation, drawing conclusions, and making inferences about the phenomenon being studied (Braun and Clarke, 2019).

The study employed a combination of manual tabulation and thematic analysis to examine the qualitative data that was gathered. The process of manually counting or tallying the frequency of responses or occurrences of a particular variable or group in a dataset is known as manual tabulation. In manual tabulation, the researcher goes through the data, often in the form of transcripts, surveys, or other documents, and counts the number of times a particular response, theme, or variable appears. Manual tabulation allows for increased familiarity with data, flexibility, greater control, and reduced errors and is the low-cost option for data analysis that requires only pen, paper, and spreadsheet software (Kabir and Alam, 2020). Manual tabulation is criticised for being time-consuming and having limited scalability; however, combined with thematic analysis in this study, it gave the researcher a better comprehension of the information and revealed patterns that automated techniques would have overlooked. A qualitative research technique called thematic analysis entails finding, examining, and summarising patterns in data (Braun and Clarke, 2006). According to Erlingsson and Brysiewicz (2017), significant volumes of text data are methodically turned into a highly structured and brief summary of important findings through thematic analysis. The process involves reviewing and reading repeatedly of raw data to comprehend the information provided by the participants, gathering the main points or ideas, condensing the meaning into codes, and then grouping the codes into categories, or even further into themes (Erlingsson and Brysiewicz, 2017). When applied to written texts, thematic analysis is adaptable and does not require adherence to any strict guidelines (Eastwood, O'Connell, and Considine, 2009). In addition, due to its lack of restrictions and formalities, thematic analysis can be quickly and easily understood (Braun et al., 2019). Though thematic analysis is criticised for being time-consuming, subjective, and posing reliability and validity problems, it remains widely used in social science research (Elo, Kääriäinen and Kanste *et al.*, 2014).

The thematic analysis process followed in this study involved reading through the data multiple times to become familiar with the content, identifying meaningful segments of data, and assigning a code to each segment, as suggested by Erlingsson and Brysiewicz (2017). The themes that appeared from the data and the group codes associated with each theme were then determined, reviewed, and clearly defined. In addition to the above process, the data analysis for interviews began with carefully listening to the interview recordings and transcribing them, by writing down the responses provided. The transcribed notes were then reread to get a better understanding of the information provided, then divided into meaning units and condensed into themes without losing the core meaning of the content.

Table 2 below shows the matrix used in the manual tabulation and thematic analysis process, with the rows representing the different groups of common responses, columns representing the different themes, and the cells containing the common responses grouped from the responses relating to the research questions.

Table 2: Manual Tabulation and Thematic Analysis matrix

Theme 1: Energy Transition and Governance	**Theme 2: Energy Transition and Legislation/Policy**	**Theme 3: Energy Transition and Infrastructure Development**	**Theme 4: Energy Transition and Skills Development**
Set 1: Opportunities	*Set 2: Opportunities*	*Set 3: Opportunities*	*Set 4: Opportunities*
Feedback 1	Feedback 2	Feedback 3	Feedback 4
Feedback 5	Feedback 6	Feedback 7	Feedback 8
Feedback 9	Feedback 2	Feedback 10	Feedback 11
Group A: Barriers	*Group B: Barriers*	*Group C: Barriers*	*Group D: Barriers*
Feedback 33	Feedback 2	Feedback 45	Feedback 10
Feedback 46	Feedback 47	Feedback 48	Feedback 49
Feedback 50	Feedback 6	Feedback 51	Feedback 52

Source: Based on field surveys (2021)

Microsoft Excel and the statistical programme IBM SPSS 29 were used to examine the quantitative data acquired for the study, and tables, charts, and graphs were utilised for displaying the results.

3.5 Methodological Reflections

Data collection was based on a detailed plan drawn before embarking on the fieldwork; however various significant challenges emerged as the process progressed. A number of organisations had employees working from home because to the COVID-19 pandemic which made reaching study organisations and potential interview respondents very difficult, as most office telephone lines would not be answered. Interview respondents also took a long time to respond to emails. Adherence to the COVID-19 Protocols also meant limiting physical contact with people. As a result, the researcher had to use virtual interviews instead of the originally scheduled in-person interviews. Though conducting interviews virtually can save time and money, there are several drawbacks, including the possibility of network outages or outside interference that could prevent the researcher from observing crucial behaviour or gestures that could be essential to the study. In-person interviews yield richer data and relevant interactions, thus an investigator can opt to use these for future studies instead of online interviews.

Another challenge included tedious protocols that needed to be followed to obtain permission to interview people from government departments such as the DMRE, and NERSA. Attempts to get interviews from several government departments were futile, as the people contacted indicated that the organisation protocols did not allow them to take part in interviews without permission letters, and only a few of them knew which departments within the institutions were responsible for granting such permission. Numerous attempts to get representatives from the national, and all provincial, offices of the DMRE as the guardian of the country’s energy and mineral resources, and NERSA, the energy regulator, to take part in the study were made to no avail, as these departments did not respond to any emails or telephone calls, and the few that responded took the researcher from pillar to post. For comprehensive insights into the energy transition strategies that South Africa can embark on from coal to renewables, cooperation from all private and public organisations involved in the energy space is critical.

Another difficulty was the selected study organisations' lack of cooperation. Fifteen private and public companies within the energy sector were to be interviewed as part of the original data collection plan; however, seven of these organisations declined to participate in the study. Eight entities consented to participate in the study subject to the requirement the study uses solely the data that is readily available to the public.

Furthermore, the researcher anticipated to have a discussion with climate and renewable energy activists and unions such as the Climate Justice Coalition, Right2know, Life After Coal, Groundwork, and the energy and mining trade unions. The researcher required both time and financial resources to reach them for in-person meetings, as most of them did not understand the researcher's intentions and were not comfortable with virtual interactions. Further research can focus on unions and climate and renewable energy activists' energy transition perspectives.

Another challenge was in the distribution of the questionnaire. The survey was distributed via a webpage link made on the Survey Monkey website to experts identified on the LinkedIn professional portal, which is a portal accessible only to technologically savvy professionals, and not all professionals who join the portal keep their profiles updated with their latest information or role changes. This method of distribution excluded many potential respondents that could add valuable insights to the study. Future research can broaden the means of identifying respondents and distributing the questionnaire for more inclusive representation.

The experts identified to take part in the study were mostly those in the renewable energy sector, and little focus was put on other sectors such as agriculture, mining, transportation, and petrochemical manufacturers such as Sasol. A broader scope may provide holistic views into the transition from coal to renewables. In addition to that, only ten key informant interviews were conducted, and a wider range of expert interviews may have yielded a more heterogeneous outcome. Despite the challenges mentioned above, the data collection tools employed fortunately yielded useful data that added immense value to the study.

CHAPTER FOUR: EMPIRICAL EVIDENCE

4.1 Introduction

The empirical evidence from the data gathered for the study is presented in this chapter. Important findings are outlined and the chapter demonstrates how the findings answer the research questions, collated into narrative prose, data visualisations, and charts. It is in this chapter that the statistical analysis is performed, and findings are reported and clearly described without any interpretation. Through the process of data synthesis, various themes were drawn in light of the study questions to determine the best approaches that South Africa can embark on for a successful shift from coal to renewable energy. There are four segments in this chapter. The first section presents the empirical evidence on the institutional, policy, and strategic frameworks for energy transition from coal to sustainable energy in South Africa. It is in this section that several strategies and the function of different institutions, existing policies and strategic plans, and their importance in the energy transition discussion are outlined. In the second section the empirical data on the barriers, challenges, and opportunities that exist, or hinder the shift from coal to clean energy in South Africa is presented. The third section discusses the developments in the international policy frameworks on renewable energy that can influence South Africa's intentions to shift from coal to renewable energy sources. The chapter concludes with Section 4.4.

4.2 The institutional, policy and strategic frameworks for energy transition

Understanding the institutional framework that South Africa's meaningful energy transition can be accomplished within was one of the study's focal points. In general, through the recurring responses, the findings showed that the government played mainly four leading roles, which were providing:- 1) financial support, 2) legislative direction, 3) institutional direction and 4) project oversight to the energy sector. Having identified these four leading roles, the respondents were asked to rank them according to priority. As evident in Figure 6 below, the most important role of the government as identified by the respondents was to provide oversight or institutional direction to the South African citizens, followed by the provision of legislative direction, financial provision; the least important was providing project oversight.

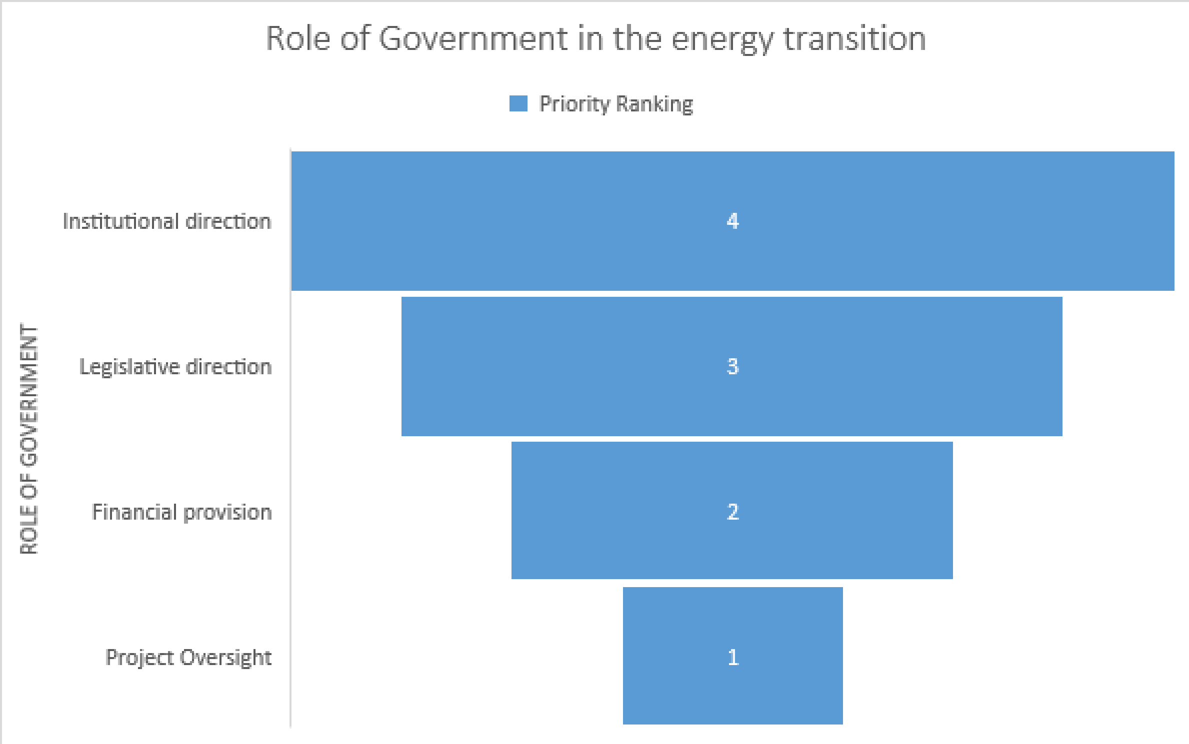

Figure 6: Functions of governmental entities in the energy transition

Source: Based on field surveys (2021)

In unpacking the role of providing institutional direction, it was explicit that various institutions are critical to the transition discussion, with the Department of Mineral Resources and Energy being identified as the major player. One research participant from ESKOM indicated that:

> *The Department of Mineral Resources and Energy holds the responsibility of regulating all energy matters and leading in the provision of energy to all citizens. It is literary the custodian of the energy and mineral resources in South Africa, hence the expectation that it plays a major role in spearheading the transition. The degree of functionality of this department will determine the transition pace (Pers.com, 2021a).*

The interview respondents further explained that the Department of Mineral Resources and Energy however does not work alone, as various other institutions support it, with the key ones being NERSA, ESKOM, Local and Provincial Government/Municipalities, and the IPPPP office. The support organisations include banks, civil society, business organisations, international development agencies, and research and advisory entities. The relationship between the various government departments, according to the respondents, is as depicted in Figure 7 below:

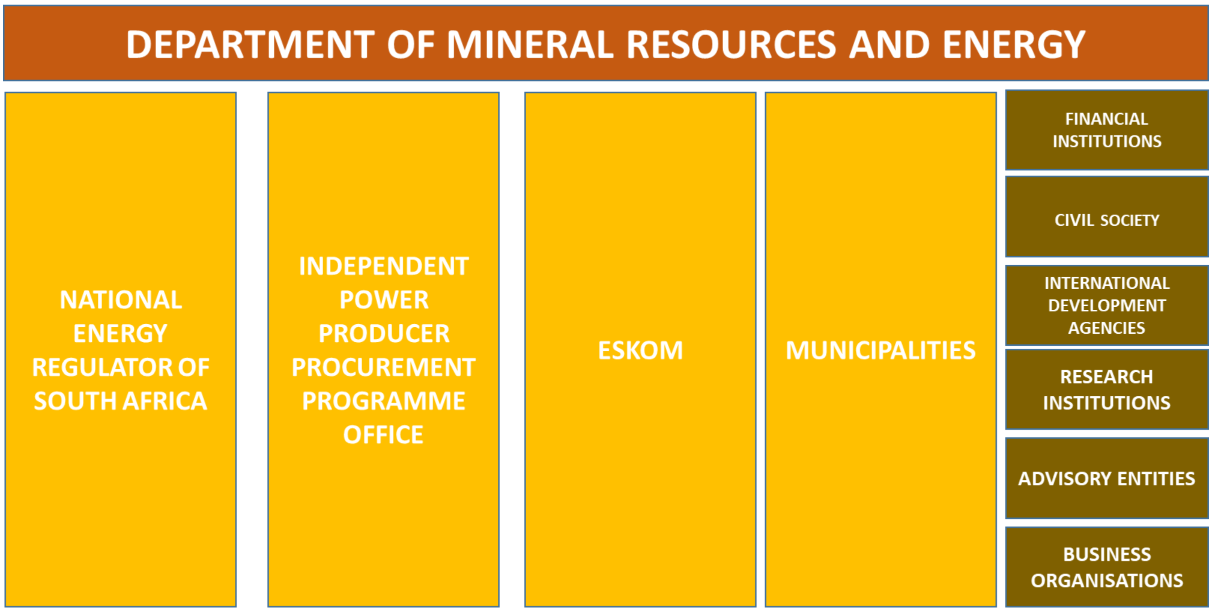

Figure 7: Key institutions spearheading the energy transition

Source: Based on field surveys (2021)

NERSA regulates the price of electricity, enforces the Electricity Regulation Act, grants permits for a range of activities, establishes and authorises tariffs and fees, and arbitrates disputes on energy. ESKOM is the main electricity generator in South Africa, producing over 70% of the nation's electricity. ESKOM is also currently in charge of the transmission and distribution of electricity with the help of municipalities in South Africa, though significant strides are being made towards unbundling it into several sectors for distributing, transmitting, and generating. Through an auction system, the IPPPP office guarantees private sector participation in the electrical industry. Performing an essential function in the energy transition, the IPPPP office procures both environmentally friendly and fossil-fuelled generation capacity from private companies, thereby ensuring a varied energy mix. For a successful transition to be realised, all government institutions must work together in unison. To emphasise this, one research participant from SANEDI cited that:

> *When all government institutions work together to promote cooperative decision-making and ensure that policies and activities across all institutions are aligned, the transition will be accelerated (Pers.com, 2021b).*

Another role of the government, as captured in Figure 6 above, was that of providing legislative direction. Most respondents unanimously indicated that the government, in addition to providing institutional direction, had a legislative mandate of drawing up of laws and policies. It was identified that the same institution cited as the custodian of all energy matters, which is the DMRE, was also the guardian of the energy policies, and was in charge of overseeing the development and acquisition of generation capacity from renewable energy resources in South Africa.

The DMRE, together with the institutions mentioned in Figure 8 above, were designated to spearhead the execution of the numerous energy-related regulations and policies which regulate the energy industry. These included, and were not limited to, *"the National Energy Act, Electricity Regulation Act, National Energy Regulator Act, White Paper on Energy Policy, Renewables White Paper, Climate Change Response White Paper, and the Integrated Resource Plan"*. Continuing with the policy development discussion, most respondents repeatedly mentioned that for an effective transition to be accomplished, there was an immediate need for legislative and administrative change and the reorganisation of the electrical supply sector.

Further engagements were also made on the third leading role of the government, as captured in Figure 8 above, with respondents showing that government involvement in capacity building was essential and providing financial support in the energy sector. A research participant from SANEDI stated that:

> *The government funds various infrastructure projects; however, the continued economic challenges in the country make it difficult for the government to fund renewable energy projects and at the same time keep bailing out ESKOM which is currently inundated with debt and failing to deliver on its mandate (Pers.com, 2021c).*

It was explicit in the responses that the government allocates funding for the construction of energy infrastructure and enables residents' access to inexpensive and dependable electricity, though it is currently falling short due to various economic challenges.

The fourth role of government identified by the respondents was that of providing project oversight to the energy sector. In providing project oversight the government determines how much renewable energy capacity must be added to the electricity grid. This process is managed by the IPP Office. Respondents further mentioned that project oversight is also provided by various institutions and stakeholders, which include government departments like the Treasury and parliament, project funders, environmental organisations, and civil society.

Having examined the institutional and policy framework for a successful transition, it was important to establish what elements the respondents thought would be key in spearheading the transition if prioritised, and why. The respondents identified five key transition elements namely infrastructure, governance, legislation, stakeholders' perceptions, and skills, and ranked them according to priority. As evident in Figure 8 below, out of the 160 respondents, a larger percentage of respondents (35%) indicated that infrastructure development was most critical to the transition, followed by legislation at 26%, governance (20%), skills (13%) and the least being stakeholders' perceptions, at 6%. Figure 8 rendered it clear that infrastructure development would be essential to the transition.

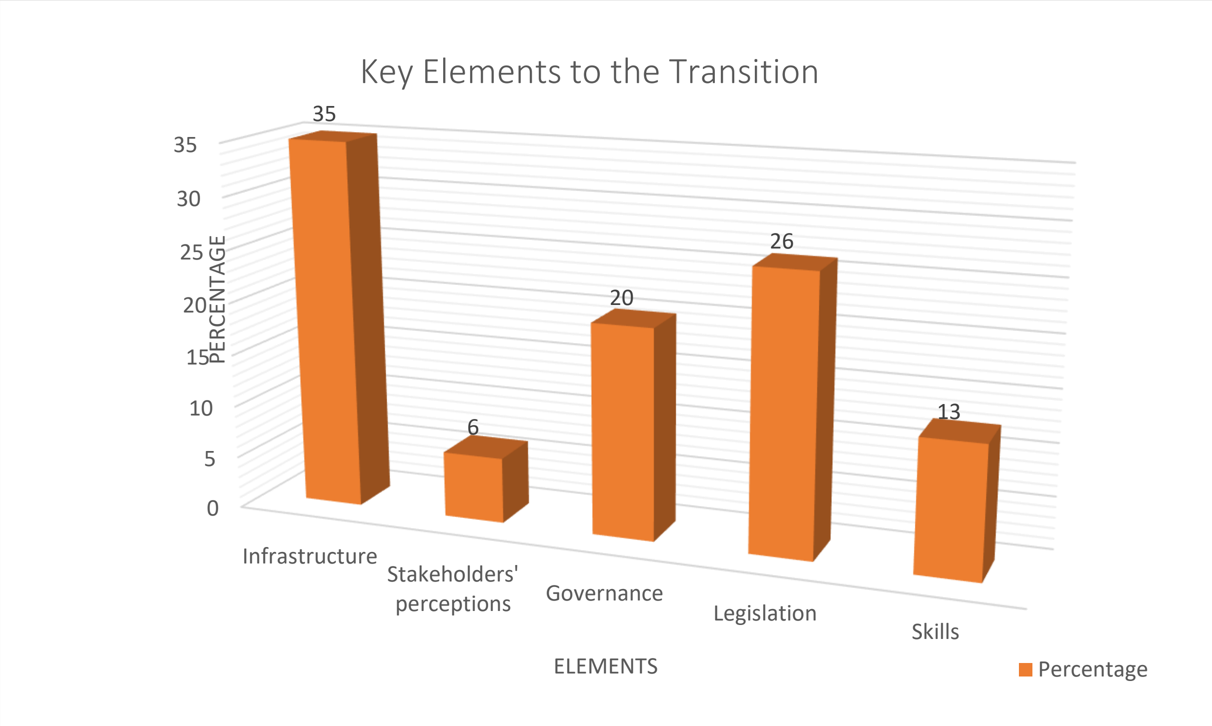

Figure 8: Key elements to the energy transition

Source: Based on field surveys (2021)

Respondents reiterated that developing and improving various components that make up the energy system, such as the generation infrastructure through new power plant builds, and systematic maintenance of existing infrastructure, improving transmission infrastructure through strengthening existing substations and optimising them to allow the feeding-in of other alternative forms of energy, and expanding the distribution infrastructure, would be highly transformative in the transition. A research participant from ESKOM cited that:

> *Energy infrastructure is highly linked and interdependent; focusing on the weakest parts such as electricity wheeling infrastructure would vastly contribute to the transition in South Africa (Pers.com, 2021d).*

Another research participant from ESKOM added that:

Metering infrastructure will also play a critical role in enabling utilities to generate revenue. In addition to that, the development of other forms of infrastructure such as roads and rail which can complement the energy infrastructure can accelerate the transition (Pers.com, 2021e).

Another research participant from ESKOM further emphasised that:

The development of new transmission infrastructure will vastly contribute to the growth of renewable energy as this will tackle challenges such as unpredictable marginal loss factors and curtailments associated with RE projects (Pers.com, 2021f).

In addition to the infrastructure, respondents identified legislation as another critical element to spearhead the transition, stating that clear renewable energy policies and implementation can drive the transformation in the energy sector. Most respondents mentioned that South Africa has good energy policies within the African continent, but is lacking in implementation. Furthermore, the South African legislation was criticised for being inefficient in addressing the country’s energy challenges and being outdated. Other legislative short-falls identified include making energy procurement solely dependent on the discretion of the DMRE minister making determinations and making ESKOM the sole purchaser of electricity for IPPs.

Another critical element identified by respondents to spearhead the transition is the quality of governance. According to the respondents, only government authorities have the power to change the course of investments, accelerate or slow down the process of decarbonisation, and support or restrict competing technologies. Respondents further emphasised the importance of having federal, provincial, and municipal governments working together for a successful transition. Any reform's probability of success or failure depends on how well-functioning the governance mechanisms are.

In addition to governance, respondents highlighted the need for skills to lead the transition, emphasising that shifting to a new energy system will necessitate more than just energy production but also a complete overhaul of the labour market. Respondents also indicated that understanding the skills content of low-carbon jobs in comparison with fossil fuels or generic jobs is a challenge due to data limitations. Furthermore, a concern about the lack of reskilling initiatives to help close the skills gap between jobs requiring fossil fuels and those in the alternatives sector.

Another key element to spearhead the transition identified by the respondents was stakeholders' perceptions and they identified South African stakeholders which included the national state-owned entities, government agencies, and local government, including local municipalities, business industry bodies, and organised labour and civil society which are community, education, research, and faith-based and youth groups. Respondents further indicated that misperceptions may also arise from fossil fuel-based communities and employees who will not be sure about prospective skill requirements, and fear of regional despondence and job losses leading to resistance against renewables.

Having established the key elements for spearheading the transition, the study also aimed to define the strategic framework within which the nation could transition from fossil fuels to alternatives. Respondents were asked to identify strategies for a successful transition and rank them according to priority. As evident in Figure 9, a higher percentage of research respondents (25%) cited channelling adequate funds to the alternative clean energy sector as the leading strategy for a successful transition, followed by privatisation, and diversification at third place. Other strategies identified included consistency in rolling out bid windows, improving the legislative framework, improving grid access and integration, skills development, localisation of RE components manufacturing, providing incentives, and increasing consumer awareness about renewables, with the former being the more critical than the latter.

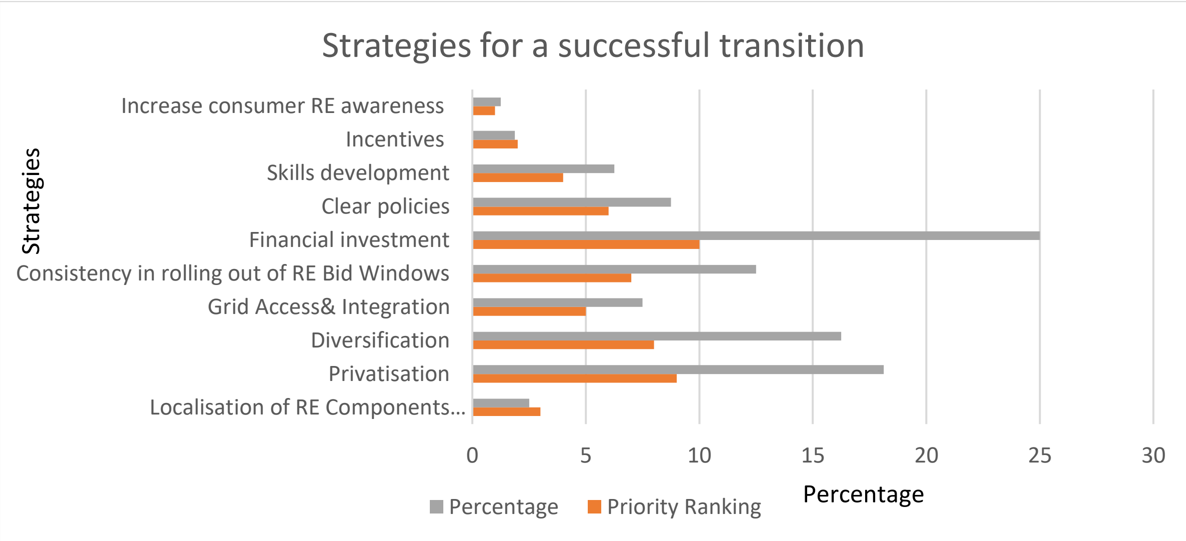

Figure 9: Strategies for a successful energy transition

Source: Based on field surveys (2021)

It is evident in Figure 9 that adequate financial investment in renewable energy could accelerate the shift from fossil fuels to alternatives. To support this, a research participant from SANEA cited that:

> *Renewable energy funding in South Africa is usually project-based, and popular funders such as banks usually fund projects at very high-interest margins, and this works against the growth of the renewable energy sector.*

He also cited that*:*

> *In some instances, all the major banks are involved in financing one renewable energy project, which limits competition in the financing sector (Pers.com, 2021g).*

Another research participant from SAWEA, in relation to the above, indicated that:

> *International banks are hesitant to finance South African renewable projects due to the fluctuations of its currency (Pers.com, 2021h).*

This suggests that the more available and affordable renewable energy finance is compared to conventional sources of energy, the more attractive its adoption and growth would be. Most interview respondents also alluded that creating competition among South African financial institutions may promote renewable energy lending and financing, thereby contributing to a successful transition from coal to renewable energy. As the finance discussion continued some respondents further indicated that financial investment is also required into battery storage solutions that can support variable renewable electricity, by storing surplus energy and releasing it when there is no sun or sufficient winds. A research participant from SAWEA stated that:

> *In as much as the transition from coal to renewables would be great, the move without adequate battery storage capacity would not be sufficient to meet base load requirements currently achieved from coal-fired power generation, hence the need for financial investment in battery storage solutions (Pers.com, 2021i).*

Generally, most respondents raised a concern with the high upfront costs associated with renewable energy, and indicated that a huge financial investment is required for the sector to grow and compete with conventional energy sources.

Another transition strategy cited and ranked second on the priority score was the privatisation of ESKOM. One research participant from SAREC stated that:

> *A self-sustaining electricity administrator is required to effectively shift from coal to alternatives, as ESKOM will always seek to protect its status quo, thereby slowing the rate of diffusion of renewable energy technologies (Pers.com, 2021j).*

The suggestion for privatisation could be driven by the view that government ownership is always less efficient than private ownership, as various respondents in support of privatisation kept citing the collapsing government-run entities, such as South African Airways and Denel, as evidence of poor government management.

Third on the ranking for leading strategies for an efficient transition from coal to clean alternatives was diversification. Respondents indicated that exploring diverse solutions and bringing various energy sources into the nation's energy portfolio would aid in the energy transition. One research participant from SAWEA stated that:

> *South Africa has a place for every form of energy generation. ESKOM in its current state with operational, financial and grid issues cannot do it alone. The challenge ahead of us is too complex to depend on only a few sets of technologies (Pers.com, 2021k).*

Continuing with strategies for a successful transition, respondents indicated that consistency in rolling out bid windows can aid the transition. The procurement of RE is managed through the REIPPPP. Through this programme, bid submissions are opened from one round to the next. Research respondents indicated that consistency and certainty in rolling out renewable energy bidding windows would contribute to an efficient transition from coal to RE in SA. Bidding window 3.5 took about 2 to 6 to wrap up, whereas the prior 3 bidding windows, from 2011 to 2013, typically took about half a year to take off after being awarded the bids, and bidding window 4 took approximately three years. The next bidding window that opened after the cancelled bid window 4.5 in 2015 was bid window 5, launched in August 2021. The gap of approximately six years created huge uncertainty in the market, and scared investors. Furthermore, since 2021 only 2 bid windows have been opened with the recent being bid window 7 where a request for proposals was issued in December 2023. The respondents mentioned that some renewable energy components manufacturing companies are forced to close due to this inconsistency.

In addition to consistency in rolling our bid windows, improving the legislative framework was also identified as one of the strategies for a successful transition. The respondents suggested that South Africa's energy legislative framework evolution has been slow, and marred by uncertainty. One respondent stated that the policy developments seem to be widely reactive when there is a crisis, and further mentioned that political leaders usually say encouraging policy statements and commitments in public gatherings, but these do not constitute legal policies or legislation. Respondents further mentioned that the IRP is biased, as it restricts energy planning to national competency, and privileges ESKOM and the fossil fuel sector.

Another strategy for a successful transition cited by the respondents was grid access and integration. Respondents alluded that the development of clean energy is hampered by capacity and connection issues with South Africa's national grid. The respondents further mentioned that South Africa faces issues with grid congestion, rising grid connection prices, and an outdated transmission grid infrastructure in addition to capacity restrictions. This suggests that insufficient electricity grid capacity has contributed to making the supply and demand imbalance in South Africa worse.

The respondents further cited skills development as one of the strategies for a successful transition. Building and operating renewable energy plants requires a wide range of standardised skills in addition to specialised knowledge of certain technologies needed for the manufacture of parts including solar systems, inverter devices, and wind components. These skills are currently lacking in South Africa. One research participant from SAREC stated that:

> *In as much as the renewable energy sector is growing the skills to support that growth are insufficient (Pers.com, 2021l).*

There is a need for more coordination between academic and research institutions, and relevant industries, to ensure skills development in the RE sector for aiding the transition. Reskilling centres must be established in coal towns, and employees in the fossil fuels industry and its associated value chains must be reskilled to work in the RE sector.

Localising RE components manufacturing was also identified as a strategy for a successful transition. Research respondents indicated that South Africa as an industrial country needs to stop importing renewable energy components, and manufacture the products locally. South Africa currently depends on imports which are expensive to procure. The government needs to encourage local renewable energy components manufacturing, especially in coal-dominated areas like Mpumalanga, to provide job opportunities to workers that may be affected by the transition.

Another strategy for a successful transition identified by the respondents was the provision of incentives. Respondents cited that several kinds of incentives subsidies, tax related benefits, R&D and FiTs can accelerate RE deployment. Until the new Taxation Laws Amendment Act

2023 signed into law in December 2023, South Africa had limited incentives in place to encourage RE deployment. Various incentives can be introduced, especially the Research and Development incentives, since only a limited few investors are keen on funding research and development projects because of their high degree of risk and unpredictability, which makes government assistance essential. In addition to incentives, increasing consumer awareness was also identified as one of the strategies for a successful transition. Respondents cited that consumers are likely to invest in something if aware of its benefits, hence the need to communicate accurate information to consumers.

Continuing with strategies for a successful transition, respondents were asked if they believed that energy diversification could solve the country's energy challenges. A higher percentage of respondents strongly agreed that a diversified energy system can solve the country's energy challenges, as indicated in Table 3 and Figure 10.

Table 3: Respondents' perspectives on energy diversification

	Number of Responses	Percentage
Agree	42	26,3
Disagree	5	3,1
Neither agree nor disagree	6	3,8
Strongly agree	105	65,6
Strongly disagree	2	1,3
Total	160	100

Source: Based on field surveys (2021)

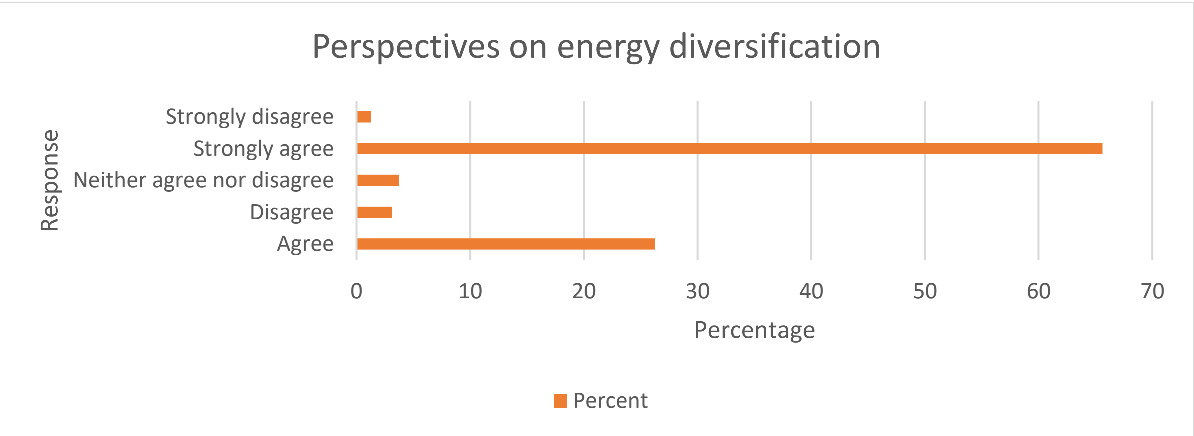

Figure 10: Respondents' perspectives on energy sources diversification

Source: Based of field surveys (2021)

Essentially, it was evident in responses that diversification could be a viable strategy for energy transition. Respondents repeatedly mentioned that diversification can allow citizens to absorb the shock in the current coal-powered system by increasing the use of other available alternatives, thereby giving such alternatives an opportunity to grow.

Having established that a significant percentage of respondents believed that diversification could accelerate the energy transition, it was important to establish whether the renewable energy sector was playing on a level field with conventional sources of energy. A question was asked whether respondents agreed or disagreed that renewable energy was given an equal opportunity to compete with conventional sources of energy. Most research respondents disagreed with the statement, insinuating that the renewable energy sector was not given an equal opportunity to compete with conventional energy sources, as illustrated in Table 4 and Figure 11.

Table 4: Renewable Energy versus Conventional energy sources opportunities

	Number of Responses	Percentage
Agree	13	8,1
Disagree	57	35,6
Neither agree nor disagree	7	4,4
Somewhat agree	14	8,8
Somewhat disagree	15	9,4
Strongly agree	16	10,0
Strongly disagree	38	23,8
Total	160	

Source: Based of field surveys (2021)

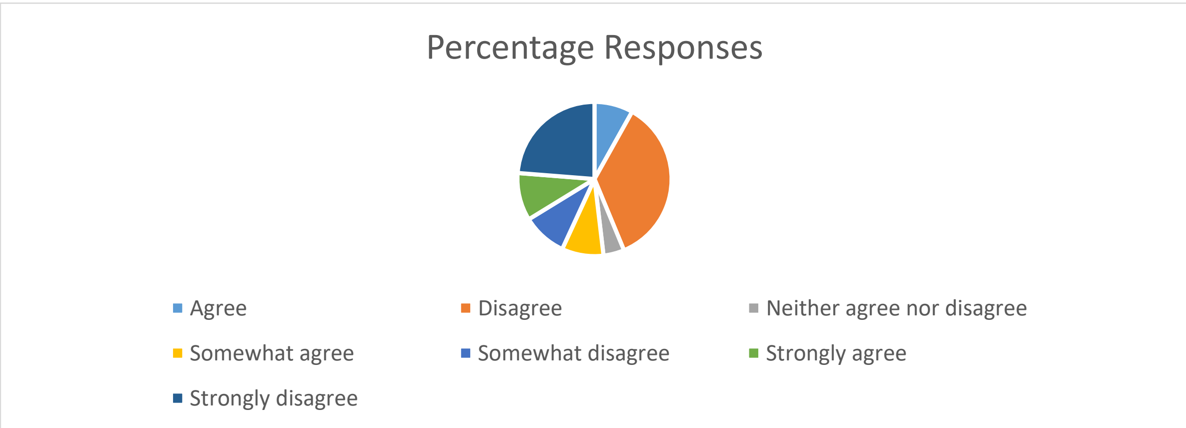

Figure 11: Renewable energy opportunities versus Conventional energy sources opportunities

Source: Based on field surveys (2021)

The general perception from respondents was that RE is not given equal opportunities to fairly contest with conventional sources in the sector. One research participant from SAPVIA cited that:

> *Renewable energy sources occur naturally and are widely available in South Africa, but their potential is not being fully harnessed for reasons best known to those politicians making decisions on top there (Pers.com, 2021m).*

From these conversations, it was explicit that various barriers and challenges exist in the adoption of RE, and these are explored in section 4.3 below.

4.3 The challenges and opportunities for the transition from coal to renewable energy in South Africa

One of the components the study was keen on was to investigate barriers and/or challenges that exist or affect the shift from coal to clean energy alternatives in South Africa. When this question was asked, an array of responses were captured, and the top ten barriers were ranked according to priority as depicted in Figure 12. Interesting to note is that a larger percentage of respondents identified political interference and corruption (21%) as the leading barrier to a successful transition, followed by lack of financial investment (19%), and policies and legislation inadequacy (18%) in third place. Other barriers included inconsistency in rolling out bidding windows, ESKOM monopoly, high cost of renewables, absence of incentives, inadequate technology and skills, labour unions, and ignorance of alternatives, with the former being the most critical and the latter being the least important.

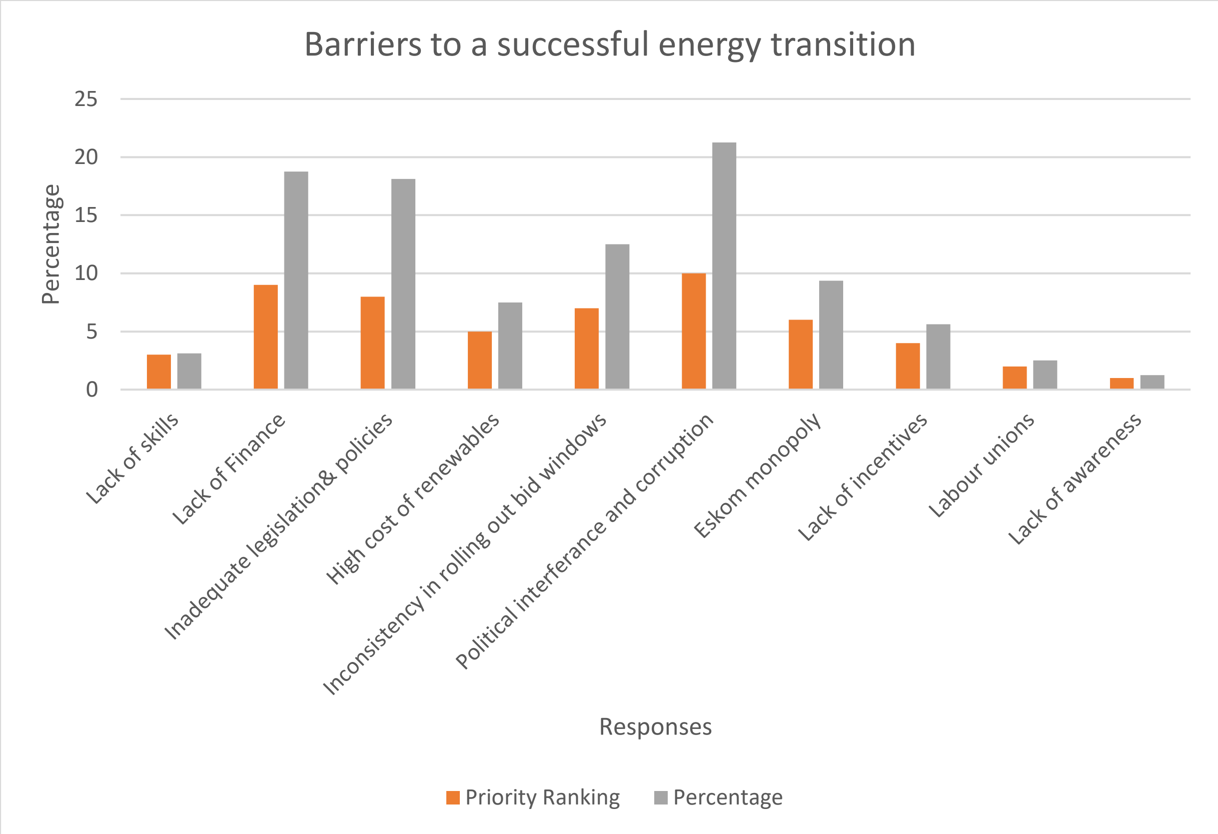

Figure 12: Barriers/challenges to a successful transition

Source: Based on field surveys (2021)

During the interviews, the respondents passionately voiced their distaste for the political interference and corruption taking place in the energy sector. One research participant from SANEDI cited that:

> *The self-enrichment by these political leaders in the energy sector is eating South Africa to the bone. Look at what is happening to ESKOM, the power grid has been brought to its knees because of political interface and corruption, and this is a huge barrier to the growth of the sector and the transition itself (Pers.com, 2021n).*

Another research participant from SAREC stated that:

> *Corruption is entrenched in the veins of most if not all state-run institutions in South Africa, and the sad thing is that it is difficult to reverse as people are now accustomed to it. Without political interference and corruption, a smooth and quick transition could be guaranteed for 2030, but I don't see it happening, even as far as 2050 if no systems are set up to uproot corruption in the energy sector (Pers.com, 2021o).*

Furthermore, respondents described how lack of finance is a hindrance to the transition. Most respondents referred to the financial challenges crippling ESKOM, and mentioned that a successful transition will not be realised if ESKOM, which is at the centre of the transition discussion, is not financially stable. Furthermore, emphasis was made on high initial investment costs of renewables for resources such as technology, skills, components, and social aspects, which require huge financial investment, where lack of it would be an obstacle to RE deployment. In addition to the high initial costs of renewables, respondents further indicated that financing renewables came with high borrowing costs. One research participant from SAWEA stated that:

> *Financing is a major barrier to renewable energy. High financing costs influence the competitive position of renewables, as renewable energy requires higher initial investment than conventional sources of energy. Renewable energy is also considered risky, and the lending costs of such projects do not usually come cheap (Pers.com, 2021p).*

President Cyril Ramaphosa in his speech at the COP 27 stated that South Africa needed approximately ZAR1.5 trillion in investment to support the just transition for the next five years. It would be difficult to see such plans coming to realisation with South Africa's continued deteriorating economic conditions that do not promise to improve due to various factors like continued load shedding, credit rating downgrades, and increased borrowing costs. Another research participant from SAPVIA stated that:

> *South Africa has vast challenges that require money, and it has been clear that the money currently available on the fiscus is not enough to address all the existing challenges. The figures mentioned in the transition plans, which run into trillions, are not a joke, finance unavailability will undoubtedly be a huge barrier to the transition being realised (Pers.com, 2021q).*

Continuing with the discussion on the barriers or challenges to the transition, the respondents were further probed on the issue of policies and legislation inadequacy which was cited as the third leading barrier to the transition. A higher percentage of respondents indicated that improvement was required on the existing energy policies and legislation, whereas a very low percentage indicated that the energy policies and legislation were adequate, as indicated in Figure 13 and Table 5.

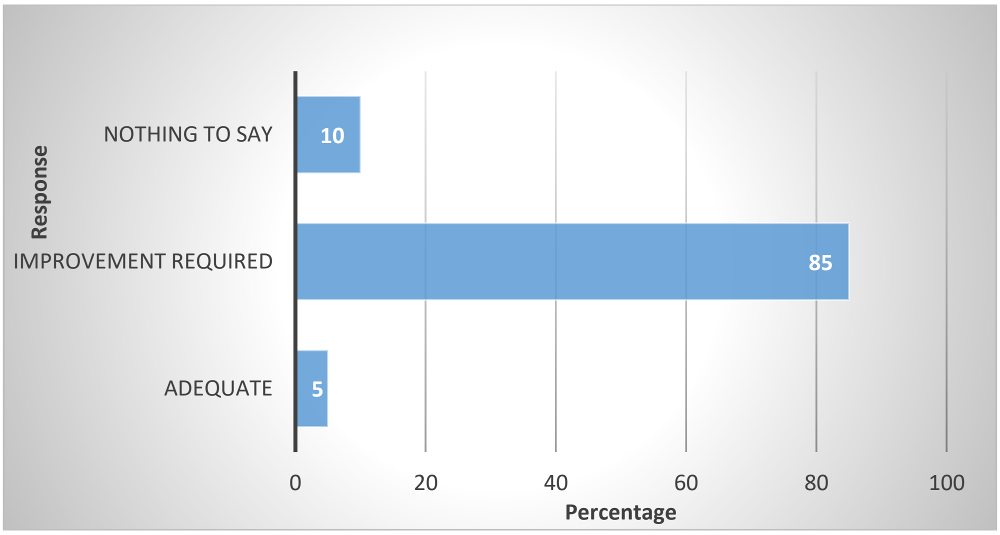

Figure 13: Respondents' views on the adequacy of the energy policies and legislation

Source: Based on field surveys (2021)

Table 5: Respondents' views on the adequacy of energy policies and laws

		Number of Responses	Percent
	Adequate	8	5
	Improvement Required	135	84
	Nothing to say	17	11
	Total	160	100.0

Source: Based on field surveys (2021)

It is evident in Table 5 and Figure 13 that the current policies were deemed to be insufficient, requiring the government to improve the existing or introduce new legislation to accelerate the transition. Through the interview discussions, one key research participant from NECSA mentioned that:

The South African government has somewhat well-written policies but policies are not enforceable. Policies are just political statements of intention of what the government would like to introduce, and such statements don't mean anything if they are not translated to law. So, in summary, I would say South Africa has few relevant policies but inadequate legislation to address the energy transition issue. The other issue is that the supporting mechanism or implementation of such policies or laws is lacking (Pers. com, 2021r).

Respondents further expounded on how the existing energy policies or legal framework facilitated or hindered the shift from coal to RE. In the interview discussions and questionnaire responses, the common sentiment was that the existing policies were contradictory and lacked integration across government spheres. One research participant from SANEA stated that:

> *The energy policies are outdated and lack synergy among government departments and other agencies. There must be integration between municipal and national policies, as currently many municipal bylaws are not favourable to domestic consumers wishing to make use of the grid* (*Pers. com, 2021s).*

Another research participant from SAREC in relation to the above reiterated that:

> *Energy policies need to be improved to make provisions for power wheeling and grid tying, and must also offer favourable tariffs for independent and domestic energy producers (Pers.com 2021t).*

It was evident from the recurring responses that the inadequacy of energy policies and legislation was a notable barrier to the transition, and improvement was required to address many issues such as harmonising the national and municipal policies, and giving direction on grid tying and power wheeling matters for a successful transition to be realised.

Another barrier cited was the inconsistency in rolling out bidding windows previously discussed in Section 4.2**.** Research respondents indicated that the inconsistency in rolling out renewable energy bidding windows was a barrier to the transition. In addition to the inconsistency in rolling out bidding windows, respondents cited the monopolistic character of the energy sector, where the sole power utility is another barrier to the transition. Respondents further cited that the extensive start-up costs associated with RE are impeding the sector's expansion. When considering the initial investment costs for the individual consumer, for development and infrastructure, it can be concluded that high upfront costs can deter RE deployment.

Another identified hindrance to SA’s transition was the inadequate incentives. Respondents cited that the inadequacy of incentives to promote RE deployment is a hindrance to the advancement the RE sector. Above the lack of incentives, a lack of skills was also identified as an obstacle to the transition in South Africa. Respondents indicated there is limited skills available for the vacant jobs in the sector, and in some instances the skills and qualifications required are available but the experience in the industry is lacking. Labour unions were also identified as a barrier to the transition, with respondents indicating that transition efforts from coal to renewables are often faced with a backlash from labour unions due to inherent interests in the fossil fuels sector. On the least of priority on barriers was lack of public awareness. Respondents further mentioned that it is common practice for the public to reject or oppose reforms or plans they lack information about. This emphasises the importance of public engagement for a successful transition.

4.4 Developments in the international policy framework

The international view formed an important part of the study, with varying contributions made on how the international policy framework on renewable energy could influence South Africa's energy transition ambitions. Subject experts from various countries within the continents of Asia, Europe, America, and other parts of Africa, through interviews and questionnaires, shared their transition experiences and challenges that South Africa could learn from for a successful transition.

To kick-start the conversation, the respondents from other countries were asked what they thought of the adequacy of their respective countries' renewable energy policies. This question was asked to get the energy policy framework global view and ascertain opportunities for improvement in the South African energy policies or legislation. Surprisingly, as shown in Figure 14, 73 per cent of respondents indicated that their countries' renewable energy policies were inadequate, while 25 per cent deemed them adequate.

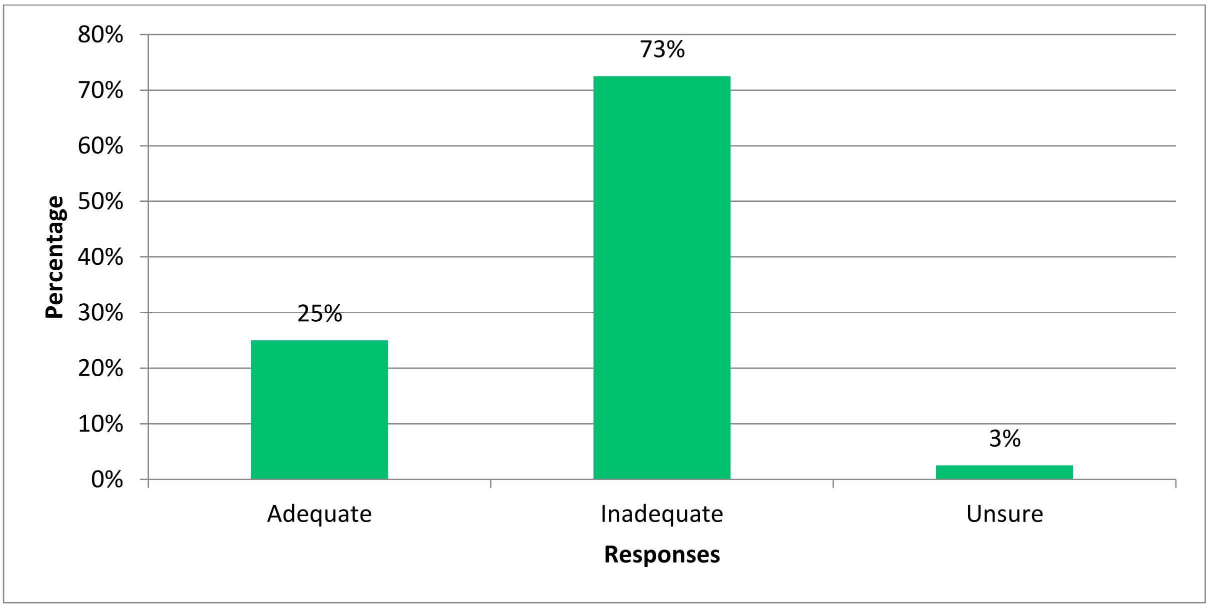

Figure 14: Global perspectives on policies/legislation adequacy

Source: Based on field surveys (2021)

Having established that the global respondents thought their countries' renewable energy policies and legislation were inadequate, it was important to establish the reasons for the inadequacy. Varying responses were brought forward, and the top five reasons are captured in Figure 15. As evident in Figure 15, lack of the implementation mechanism was cited as the leading reason, and lack of provision for incentives as the least reason for their inadequacy.

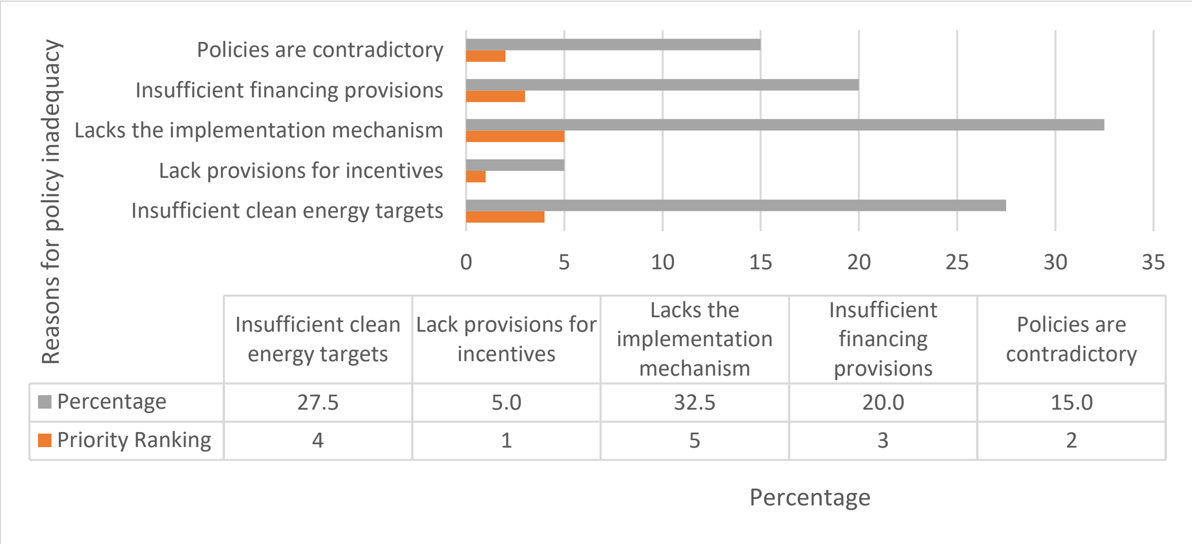

Figure 15: Global perspectives on energy policies/legislation adequacy

Source: Based on field surveys (2021)

The common sentiment from respondents was that the global renewable energy policies or legislation lacked an implementation mechanism. One research participant from Nigeria stated that:

> *Nigeria's renewable energy policies lack implementation; however I am not sure if the lack of implementation is driven by politics, as renewable energy threatens the country's economic existence which is dependent on oil and gas (Pers.com, 2021u).*

Another research participant, from Zimbabwe, stated that:

> *Zimbabwe has a well-written National Renewable Energy and Biofuels policy which, when properly implemented, could gradually help Zimbabwe to transition to a green and sustainable economy (Pers.com, 2021v).*

Interestingly, respondents from developed countries also cited renewable energy policy implementation as a common challenge, with one research participant from the United Kingdom citing that:

The United Kingdom has the best renewable energy policies in the world; however due to various reasons, the policies are somewhat not adequately implemented (Pers.com, 2021w).

It was clear from these recurring responses that the lack of policy implementation mechanisms was a global challenge that needed to be addressed.

Furthermore, respondents mentioned that ambitions for energy policy and their actualisation differ significantly. Many countries have good policies; however, they do not bring about any benefit if not implemented. In addition to the lack of implementation mechanisms, respondents mentioned that most policies in the world have insufficient clean energy targets, making reference to the Paris Agreement targets that fall short of keeping global warming within the 2-degree threshold. More ambitious clean energy targets are required globally for a successful transition. Respondents further mentioned that most global policies have insufficient financing provisions, as investment in renewables requires huge amounts of money to set up. Policymakers can enable countries to meet their targets by making relevant financial provisions in policies. Carefully thought-out policies can reduce RE costs, which will promote the deployment of RE. It is imperative that politicians take project funding into account when designing renewable energy policies. Global policies were also identified to be contradictory. Respondents cited that it is surprising that one country would set ambitious targets for reducing greenhouse gases and at the same time show increased appetite for coal, citing China which has been adding coal capacity as an example. The policies were also identified as having a lack of provisions for incentives. Respondents cited that their countries' policies lacked provisions for RE incentives. Incentives have been proven to promote RE deployment.

Having established the global respondents' views on the adequacy of their countries' policies, the study sought a global understanding of the strategies that countries could embark on for a successful transition. Diverse responses were brought forward, and the top five responses per continent are captured in Figure 16. As evident in Figure 16, the strategies cited across continents were somewhat similar, though their order of priority differed. Respondents from various African countries consistently indicated that having clear renewable energy policies would accelerate the transition, thereby ranking it the most important strategy. In the USA, the top priority was the development of green hydrogen, and the least important strategy was public awareness. The European respondents cited the mix of various energy technologies as the most important strategy for a successful transition, and clear policies was at the bottom of their priority ranking. In Asia, the development of RE technology was the leading strategy, with the least being manufacturing renewable energy components locally.

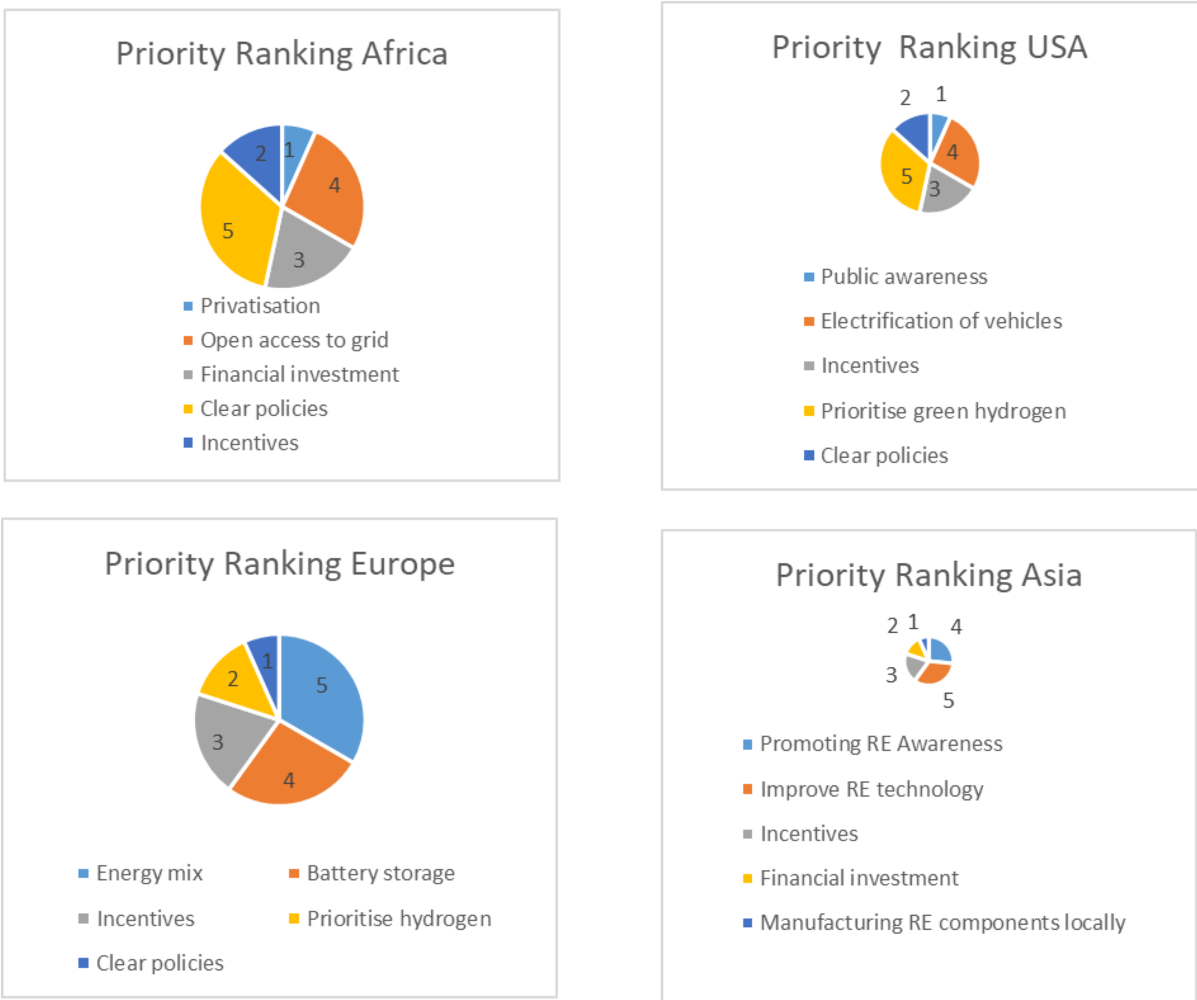

Figure 16: Global strategies for a successful transition

Source: Based on field surveys (2021)

The differences in priority rankings could be driven by the different developmental stages the different continents were currently at. In Africa, inadequate policies were still a major issue, as the transition subject was fairly new. In already developed continents, examples including the USA and Europe, with already established policies, green hydrogen technology and advancement in research on diverse energy sources respectively, were on top of the strategies list. The Asian respondents cited that their renewable energy technologies were lagging, as they always had to depend on Europe for the supply of RE components, hence the suggestion of the improvement in RE technology was identified as the leading strategy for a successful transition.

During the interviews and questionnaire surveys, it was also imperative to gather information on the global perspective on barriers to transition. The global respondents were requested to provide their viewpoints on the challenges or barriers that exist in the transition to renewable energy. The common responses ranked according to priority per continent are captured in Figure 17. As evident in Figure 17, in Africa, respondents cited the inadequacy of the legislative framework to be the leading hindrance to transition, while the USA, Europe and Asia ranked entrenched fossil fuel interests on top of the list of barriers to transition.

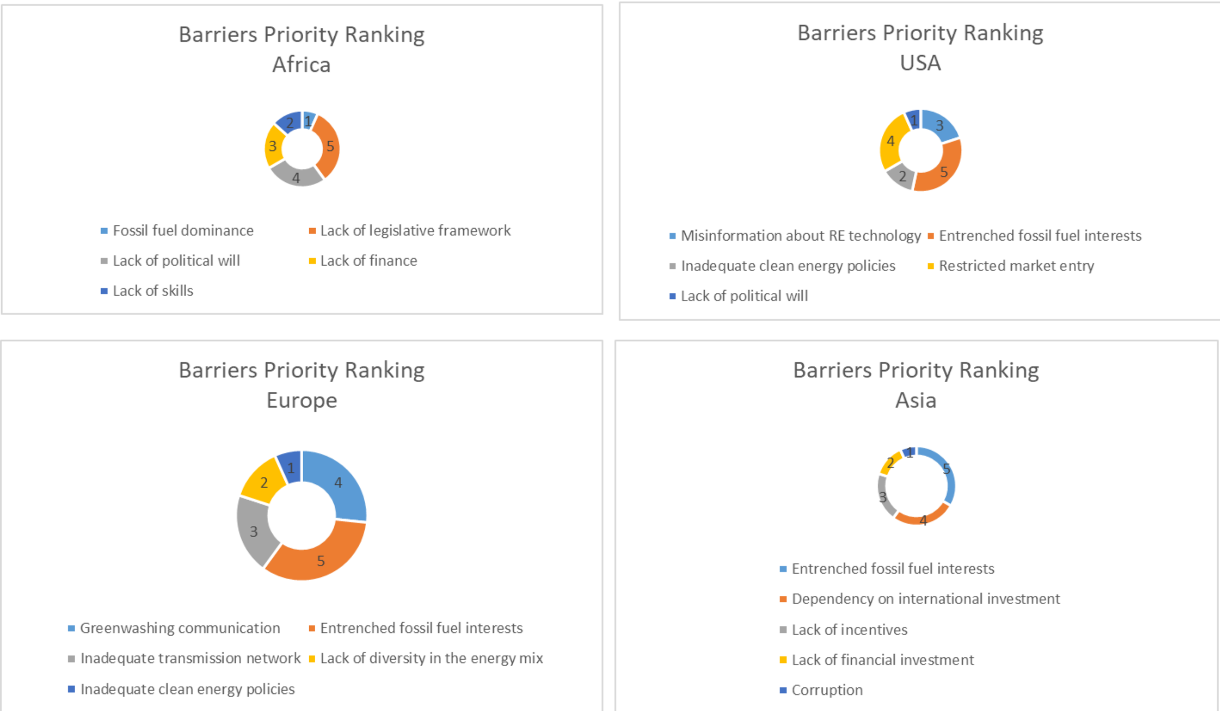

Figure 17: Global perspectives on barriers to the energy transition

Source: Based on field surveys (2021)

The African respondents repeatedly indicated that the weak legislative framework significantly hinder the implementation of renewable energy. One research participant from Zimbabwe cited that:

> *The weak energy regulatory framework and the inconsistencies among regulations create a huge confusion concerning implementation thereby hindering the deployment of renewable energy (Pers.com, 2021x).*

On the other hand, respondents from the USA, Europe and Asia repeatedly mentioned that the continued dependence and investment in fossil fuels makes the transition much harder to achieve. One research participant from Canada stated that:

The entrenched fossil fuel interests are a major hindrance to the transition. Many governments still depend on coal, oil, and gas for their economic existence, and fossil fuels remain a major source of wealth and power for many countries, which makes it difficult for politicians to act against such vested interests (Pers.com, 2021y).

4.5 Conclusion

The findings of the data collected by use of survey questionnaires and interviews with experts in the field are summarised in this chapter. The study's key focus was to establish the optimal strategies that South Africa could implement to facilitate the transition from fossil fuels to clean alternative sources of energy. The research further uncovered opportunities and obstacles to the shift, and developments in the international policy frameworks that may have an impact on SA's aspirations to switch from coal to RE. The important results are summarised as follows:

a) The results showed that the government played mainly four leading roles in the energy transition, which were providing financial support, legislative direction, institutional direction, and project oversight.
b) The respondents explained that the DMRE is the main role player in the energy transition. However it does not work alone, as there are various other institutions that support it, which include NERSA, ESKOM, municipalities, and the IPPPP office.
c) The respondents identified five key energy transition elements, namely infrastructure, governance, legislation, stakeholders' perceptions, and skills.
d) Most respondents were explicit that channelling adequate financial resources to the RE industry, privatisation of the power utility, and diversifying energy sources can accelerate the transition. Other strategies identified included consistency in rolling out bid windows, improving the legislative framework, improving grid access and integration, skills development, localisation of manufacturing RE component, providing incentives, and increasing consumer awareness about renewables.
e) Most respondents insinuated that the renewable energy sector was not given an equal opportunity to compete with conventional energy sources.
f) Political interference and corruption, lack of financial investment, and inadequacy of policies/legislation were identified as the top three leading barriers to a successful transition in South Africa. Other barriers included inconsistency in rolling out bidding windows, ESKOM's monopoly, high cost of renewables, insufficiency of incentives, skills and technology, labour unions, and public ignorance on alternatives, with the first being the most critical and the last being the least important.

g) The current South African energy policies were deemed to be insufficient, requiring the government to improve existing or introduce new legislation to accelerate the transition.
h) Most global respondents indicated that their countries' renewable energy policies were inadequate, lacking an implementation mechanism.
i) In various African countries, having clear RE policies was cited to be the leading strategy for accelerating the fossil fuels to RE shift.
j) In the USA's top priority strategy for the transition was the development of green hydrogen.
k) The European respondents cited the mix of various energy technologies as the leading strategy for an effective transition.
l) In Asia, the advancement of RE technology was cited as the leading strategy for a successful transition.
m) Global respondents cited the lack of a legislative framework in Africa as the leading barrier to the transition, while the US, Europe and Asia ranked entrenched fossil fuel interests on top of the list of barriers to the transition.

CHAPTER FIVE: DATA ANALYSIS AND DISCUSSIONS

5.1 Introduction

The main findings presented in Chapter 4 of the study are critically analysed and discussed in this chapter. The chapter presents an extensive synthesis, overarching abstraction, evaluation, and interpretation of the research findings directed by the goals and objectives of the research, and showcases the researcher's reflections about the findings and their implications. The chapter begins with discussing the findings on the institutional, policy, and strategic frameworks that exist within which South Africa can embark for a successful transition from coal to RE sources. The following segment discusses findings on obstacles and opportunities that exist or hinder the transition from coal to RE in South Africa. The concluding section discusses ways in which developments in the international policy frameworks influence SA's ambitions to shift from coal to RE.

5.2 Institutional, policy and strategic frameworks that exist within which South Africa can embark on for a successful transition from coal to renewable energy sources

5.2.1. The function of Government in energy transition

To unpack the institutional, policy, and strategic frameworks that exist within which South Africa can embark on for a successful transition from coal to RE sources, it was critical to discuss the government's function in the energy transition. The findings showed that the government fulfilled four main leading roles in the energy transition, which were providing institutional direction, legislative direction, financial support, and project oversight to the energy sector. According to Singh (2023), solid institutional capacities have allowed nations like China, Germany, and Denmark to effectively execute ambitious renewable energy programmes and make the shift to sustainable energy systems. Furthermore, these nations have built systems for monetary backing, legal frameworks, and administrative ability to promote the development of RE.

Of all the government responsibilities, providing institutional direction was ranked the most critical role in the transition discussion, with study respondents indicating that the quality and effectiveness of government institutions determines the rate of change in the energy system. This notion is supported by Inglesi-Lotz (2021), asserts that economies with higher-quality institutions manage transitions more skilfully because they can foster innovation and effective resource allocation. Similar thoughts are also shared by Sovacool and Dworkin (2014), who state that quality institutions are required to develop and carry out policies that support the utilisation of clean energy sources, encourage innovation, mobilise capital, and guarantee fair access to energy benefits. According to Kaufmann and Kraay (2023), governance and institutional quality indicators consists of dimensions such as voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, control of corruption, and ease of doing business. With the prolonged instability of the power grid, which has seen load shedding or power cuts being a feature in the SA's energy landscape for close to 15 years, it is clear that SA's energy institutions' quality needs to be enhanced.

The study findings suggested that the energy transition discussion calls for a combined effort of many institutions, with respondents identifying various institutions that are critical to the transition discussion in SA, with DMRE identified as the major player. One research participant indicated that:

> *The DMRE holds the responsibility of regulating all energy matters and leading in the provision of energy to all citizens. It is the custodian of the energy and mineral resources in South Africa, hence the expectation that it plays a major role in spearheading the transition. The degree of functionality of this department will determine the transition pace*.

The DMRE works with various individual and sector-specific institutions that support it, with the key ones being NERSA, ESKOM, the Local and Provincial Government/Municipalities, and the IPPPP office. The support organisations include commercial and development banks, civil society, business organisations, international development agencies, and research and advisory entities. Respondents iterated that both major and support institutions need to work together to promote cooperative decision-making and ensure that policies and activities across all institutions are aligned for the energy transition to be accelerated. This is often not the case, as most government institutions have been found to work in silos, which contributes to delays in achieving the institutional mandates.

One research participant indicated that:

> *When all government institutions work together to promote cooperative decision-making and ensure that policies and activities across all institutions are aligned, the transition will be accelerated.*

To support this notion, Hvelplund, Østergaard and Meyer (2017) citing Denmark's experience transitioning to green electricity as an example emphasises the significance of solid institutional capacity and collaboration among several parties, such as the public, commercial, and civil society. This highlights the importance of effective collaboration between different agencies of government, all parties involved, and various levels of government structures. Similar thoughts are shared by Jordan *et al*. (2018), who assert that for policymakers to successfully manage the challenges in the energy transition, priority must be given to developing institutional capacity and encouraging collaboration among all actors. It is clear that countries with less developed institutions, particularly the majority of developing nations in Africa and Southeast Asia, have difficulty putting their energy transition strategies into execution (Jordan *et al.*, 2018).

The study respondents further indicated that government institutions in South Africa often fail to deliver on their mandate due to several reasons, such as the political placements of incompetent officials and inadequate financial provisions. According to Peters (2018), effective institutions have competent public officials and adequate financial resources. This notion is supported by Singh (2023), who asserts that organisations with administrative capabilities are necessary for the energy transition to guarantee efficient execution and cooperation among diverse stakeholders. The above-mentioned institutions must therefore be capacitated with a competent workforce and adequate financial resources, to enable them to deliver on their mandate for a successful energy transition. Most South African institutions are criticised for their incompetence, which is attributed to, among many reasons, cadre deployment, which is the appointment of party officials to important positions of authority inside government organisations. As indicated by Swanepoel (2021), cadre deployment has significantly contributed to the blurring of the lines between the State and the ruling party and has given rise to corruption and various forms of lawlessness within critical government institutions in South Africa. There is a need to relook into the cadre deployment policy to ensure the effectiveness of the government institutions is not hampered by it.

While the study findings showed that the overall responsibility to drive any transition or change lies with the government institutions, Olsen (2009) argues that institutions are often seen as an impediment to change. This notion is supported by the path dependency theory discussed in Section 2.3 of the thesis, which suggests that even when more modern and effective substitutes are available, organisations may be reluctant to adapt and stick with a product or procedure due to past preferences. According to Banton (2021) this is typically because continuing down an established road is frequently easier or more economical than starting from scratch. Similar thoughts are shared by Sydow and Schreyögg (2015), who argues that path dependency may impact company strategies, sometimes negatively, and can be a factor in people's unwillingness or incapacity to invest in innovative ideas. Furthermore, a deviation from the path becomes highly difficult and competing paths are locked out (Clausen, Göll and Tappeser, 2017). Looking at SA's energy landscape, where the country finds comfort in having only one entity (ESKOM) running all facets of producing, conveying, and distributing electricity for the country, and the entrenched fossil fuel dependency where over 70% of electricity generation is still from coal, it is evident that path dependency in government institutions can hinder development and progress, which in turn affects the pace of transition.

A synopsis of the main conclusions regarding the function of providing institutional direction by the government in the energy transition is presented in Fig 18 below. The Figure presents the challenges and necessary qualities institutions must possess to ensure a smooth transition.

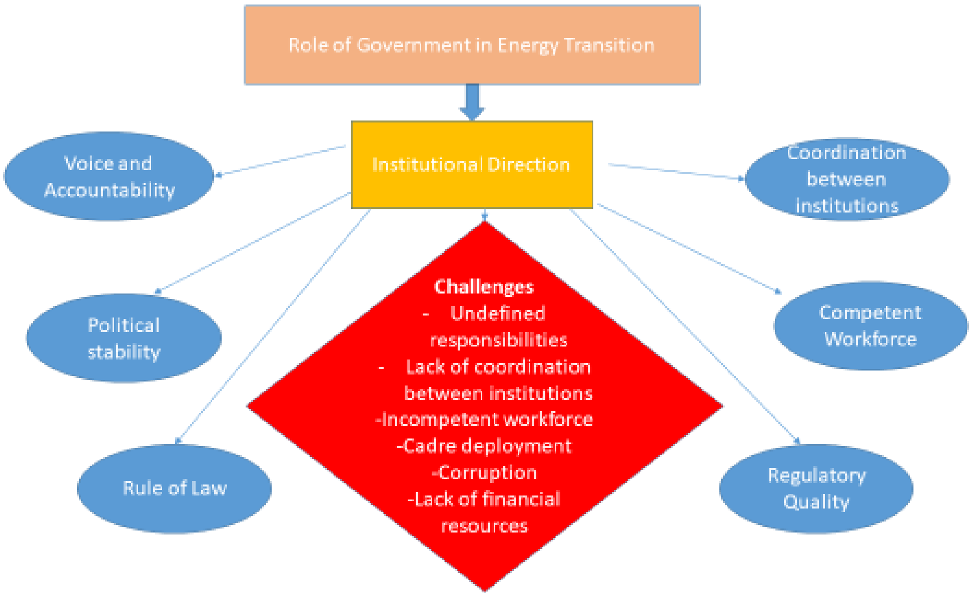

Figure 18: Role of institutional direction in the energy transition

Source: Based on field surveys (2021)

The study respondents indicated that, in addition to providing institutional direction, the government has a legislative mandate of drawing up laws and policies. To support this notion, Singh (2023) argues that the strength of a government is in its regulatory capacity, and goes on to emphasise that regulatory capacity generates investment, improves the business climate, and promotes economic expansion. A government with inadequate regulatory competence may find it difficult to establish and implement laws, which could result in problems including distortions in the market, corruption, and an absence of protection for consumers (Singh, 2023). These problems could have a detrimental effect on the transition. In the same vein, Andreoni *et al.* (2022) indicate that a government's capacity to successfully design, execute, and oversee energy transition policies and initiatives can have a significant influence on the transition's speed, scope, and success.

In South Africa, all laws are enacted by the Parliament. However, the DMRE is in charge of establishing energy policies and overseeing the development and acquisition of generation capacity from RE resources. The DMRE, together with the institutions mentioned above such as NERSA, were determined to be the driving forces behind various energy legislation and policies that regulate the energy industry. These laws include, but are not limited to, "*the National Energy Act, Electricity Regulation Act, National Energy Regulator Act, White Paper on Energy Policy, Renewables White Paper, Climate Change Response White Paper, and the Integrated Resource Plan*". The NERSA is a regulatory body created by the NRA, which oversees the pipeline industries for petroleum, pipeline gas, electricity and RE. NERSA also regulates ESKOM tariffs under the ERA. The NRA, coupled with corresponding notices, regulations, rules, and guidelines, grants regulatory authority to the regulators. This authority includes the ability to endorse tariffs and issue, alter, and repeal licences (Fontana and Wing, 2019). In terms of the ERA, The DMRE Minister may decide that additional generation capacity is required to guarantee the continuous, uninterrupted supply of electricity, as well as the kinds of energy sources that must be used and the proportion of those sources that must be used, the purchasers and sellers of such electricity, and the procedures to be followed in the procurement process and this determination ought to be made in consultation with the NERSA (Fontana and Wing, 2019).

Various media sources (Sunday World, 2023; Mail and Guardian, 2023) suggest that the current Minister of DMRE, Mr Mantashe, by declaring that *"coal is going to be with us for many years"* and mentioning in various public addresses that he believes there are cheaper options than renewables, is protecting his interests in the coal value chain. In the same vein, Oxford Analytica (2022) also mentions that on numerous occasions, it is alleged that Mantashe does not support the efforts to transition. According to the Mail and Guardian (2023), at one moment Mantashe was refusing to sign a MOU with European RE investors, and has reiterated his unequivocal backing for coal on multiple occasions; the latest being on March 7, 2023, at the Africa Energy Indaba in Cape Town. If these accusations are proven to be true, the legislative arrangement of having the DMRE responsible for directing energy policy and setting renewable energy targets may derail the transition pace. The responsibility of developing and implementing energy policies may need to be assigned to a body with no vested interests.

Continuing with the government role of providing the legislative direction, respondents unanimously mentioned that the electrical supply industry needed to be restructured and that legislative, regulatory, and policy reform were urgently needed for a successful transition. This notion is supported by Fontana and Wing (2019), who claims that the government's regulatory and tax incentives to promote renewable energy are extremely limited. Fontana and Wing (2019) further goes on to state that "*the current regulatory regime in South Africa does not allow for excess electricity from renewable sources, such as residential or rooftop solar, to be sold back to the grid, and a reform to allow for this would stimulate and promote faster growth in the rooftop solar market*". In addition, the legislative structure forbids any tariff top-up arrangements similar to those found in other African renewable energy schemes, such the effectively executed "*GET FiT*" programme in Uganda. Together with the present REIPPPP, which has been incredibly successful in SA, these FITS have the potential to significantly encourage notable growth of RE (Fontana and Wing, 2019).

ESKOM, the national utility, is assigned as the off-taker in the REIPPPP under the present legislation. In addition, it serves as a distributor, network administrator, generator, and NTC. Although this arrangement has been criticised as hindering the transition, with ESKOM being accused of lacking capability to champion the transition due to several reasons including its dire financial state and vested coal interests, the positive development is that ESKOM's unbundling is underway to separate the generation and transmission divisions to improve the entity's function. In addition to the unbundling process, the generating and selling of power from RE facilities and developing embedded generation projects has been permitted for IPPs, with the caps removed, in 2022 (ICLG, 2023). There have also been notable improvements in the policies recently, with the most welcome one being the relaxation of the licencing requirements for producing power independently from 1 megawatt (MW) to 100 MW in June of 2021, which is believed will promote more growth in the RE sector (Keneilwe and Ramaano, 2022).

The development in South Africa's transition supports Loorbach's transition management cycle for sustainable development, with four related governance activities which are strategic, tactical, operational, and reflexive. According to Loorbach (2010), transitions occur when intrinsic creativity and external social change exert pressure on the prevailing regimes or systems in society. The need to transition may have been triggered by the energy crisis, which has seen South Africa struggling to fulfil its energy needs for the previous decade and a half. Loorbach's transition management model argues that the transition should begin with strategic tasks like solving issues, conceiving, and creating the transition arena, and then proceed to tactical tasks like creating the transition agendas, followed by the operational activities, which include mobilising actors and executing projects and ends with the reflective activities, where the progress is evaluated and monitored, and the lessons learnt applied to improve the process. Following the Loorbach transition management model may help improve South Africa's pace of transition.

Figure 19 below suggests transition actions that South Africa can implement under each activity of Loorbach's transition management model for a successful transition.

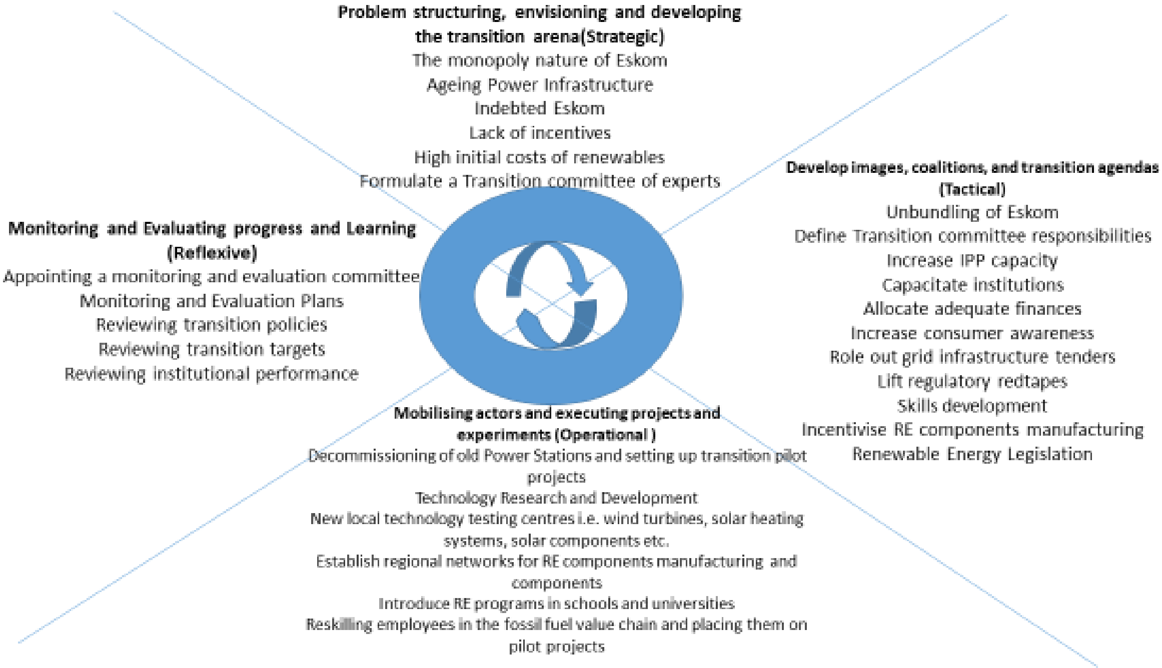

Figure 19: Energy Transition Management Cycle

Source: Based on field surveys (2021)

Continuing with the role of government in the transition, respondents indicated that government fulfils a critical function in capacity building and providing financial support in the energy sector, with one research participant stating that:

The government funds various infrastructure projects; however, the continued economic challenges in the country make it difficult for the government to fund renewable energy projects and at the same time keep bailing out ESKOM that is currently inundated with debt and failing to deliver on its mandate.

In the same vein, Winkler *et al.* (2023) state that the nation's finances are being strained by ESKOM's financial difficulties with its increasing public debt. The government may need to adopt other means of supporting renewable energy projects that do not involve ESKOM, to fast track the transition.

According to the African Development Bank Group (2022), every change necessitates the strategic development and execution of an intentional, comprehensive funding plan. Similarly, Lowitt (2021) argues that governments must take into account the perspectives of both the public and private sectors when determining how to mobilise and deploy energy transition funding for all sectors and regions. To support this notion, Johnson (2015) highlights the need to expand creative partnerships between public and private financing. Long-term organisational capital, including sovereign wealth and pension schemes, is a key growth market for energy capital, and green bonds have demonstrated potential and are expanding quickly on a worldwide scale.

The South African government has an initiative called the JETP, a collaboration between SA and five developed nations to assist SA in transitioning from an economy dependent on coal to one based on RE. A total of $8.5 billion was committed for this initiative's initial round of funding using a variety of channels, such as investments, subsidies, loan concessions, and risk-sharing tools like enlisting the private sector. According to the African Development Bank Group (2022), by placing the JET at the forefront of the country's policy agenda, SA made it possible for this effort to emerge. In addition to the JETP, President Ramaphosa set up the *"Presidential Climate Finance Task Team (PCFTT)"* in February 2022 to create SA's investing plan, raise funds for the JET, and advise an Inter-Ministerial Committee on the funding programmes.

Other renewable energy financing options available in South Africa include a combination of equity and debt from local commercial lenders, lease funding, in which the borrower hires the facility with the opportunity to buy it, and consumer loans in which the borrower purchases the facility on credit, and local and foreign development finance institutions (Polzin and Sanders, 2020). While some experienced portfolio developers are able to finance projects on an institutional finance basis, the majority of REIPPPP projects have long-term project funding arrangements where the borrower pays from the project's revenue and assets (Polzin and Sanders, 2020). The new pre-commercial ventures that are small-scale, more risky, and centred on emerging innovative technologies frequently face financial difficulties since private equity firms are hesitant to take on the technological and developmental risks that come with these kinds of projects (Lowitt, 2021). Similarly, the ICLG (2023) asserts that unclear regulations make it more difficult for IPPs to obtain external debt from commercial lenders. Normally, external debt financiers only offer debt funding after the RE facility has received all necessary licences and is up and running, avoiding risk associated with development and regulatory requirements. The government has a responsibility to ensure the regulations encourage funding from research and development stages of the projects. South Africa’s financial ecosystem must be changed to ensure funding is available for all types of projects for a successful transition to be realised.

Another way the government can encourage the advancement of the RE sector is to provide government grants; however, only limited grant funding is available in South Africa. According to Lowitt (2021), “*few grants are accessible from national line departments such as the Department of Forestry, Fisheries and the Environment, and the Department of Trade, Industry and Competition, through their budgets, or the Industrial Development Corporation (IDC) or the Development Bank of Southern Africa (DBSA) administering funds on the department’s behalf”*. The South African government will need to improve grant funding, owing to the nation's current restricted fiscal capacity, grant funding is currently difficult to obtain (Lowitt, 2021). In addition to grants, tax related benefits can also contribute positively to the transition. The Taxation Laws Amendment Act, 2023, were recently published which offers both short-term and long-term tax benefits to encourage the purchase or sale of utility-scale RE. One such incentive allows businesses to deduct up to 125% of the upfront costs of acquiring qualifying assets used in the production of electricity, including supporting infrastructure, from their taxable income, and another was the allowance for energy efficiency savings, and a carbon tax for NERSA licensed entities(National Treasury, 2023). Once the renewable energy incentive taxations laws amendment bill is passed, these tax incentives are expected to encourage renewable energy uptake by businesses, thereby aiding the transition.

The fourth role of government identified by the respondents was that of providing project oversight to the energy sector. In providing project oversight, the government in the IRP determines how much renewable energy capacity must be added to the electricity network, with the latest official revision being the IRP 2019 as of 2023. The most prevalent RE projects in the IRP 2019 are solar and wind PV technologies. The wind technology allocation is fixed at 1,600 MW per year, starting in 2022 and increasing to 14,400 MW by 2030, and the solar PV allocation is variable at 1,000 MW per year, increasing to 6,000 MW by 2030. In addition, the government commits to an execution arrangement to show government support over each project, concluding a PPA as part of the REIPPPP, and changes policies and cooperates with other governments to facilitate the efficient processing of all permits, authorizations, licences, and approvals (ICLG, 2023). Diversifying the renewable energy portfolio beyond the common technologies may open opportunities for further development of other less common technologies such as the Solar CSP, which were not included in the IRP 2019.

The REIPPPP is a programme where a government agency or a state-owned company serves as the purchasing entity, and all RE projects are acquired using an open, fiercely competitive clear, and unbiased public bidding procedure with highly prescribed qualifying and assessment standards (ICLG, 2023). It is through the REIPPPP that the IRP determinations are realised. According to ICLG (2023), "*as of March 2023, a total of 99 RE projects had reached commercial close under rounds 1 to 5 of the REIPPP Programme, with a mix of technology ranging from onshore wind, solar PV, solar CSP, landfill gas, biomass, and small hydro projects. Under this REIPPPP, the DMRE minister is the procurer, and ESKOM is the buyer that purchases energy from IPPs".* Making energy procurement solely dependent on the discretion of the minister making determinations, and permitting only ESKOM to purchase electricity from independent power producers, is a hindrance to the advancement of RE, which needs to be revisited.

The main findings on the function of government in the energy transition is presented below in Figure 20. Figure 20 presents the four critical roles fulfilled by the government, and the activities carried out by the government in each role. It also highlights challenges and opportunities for improvement in each transition role the government fulfils.

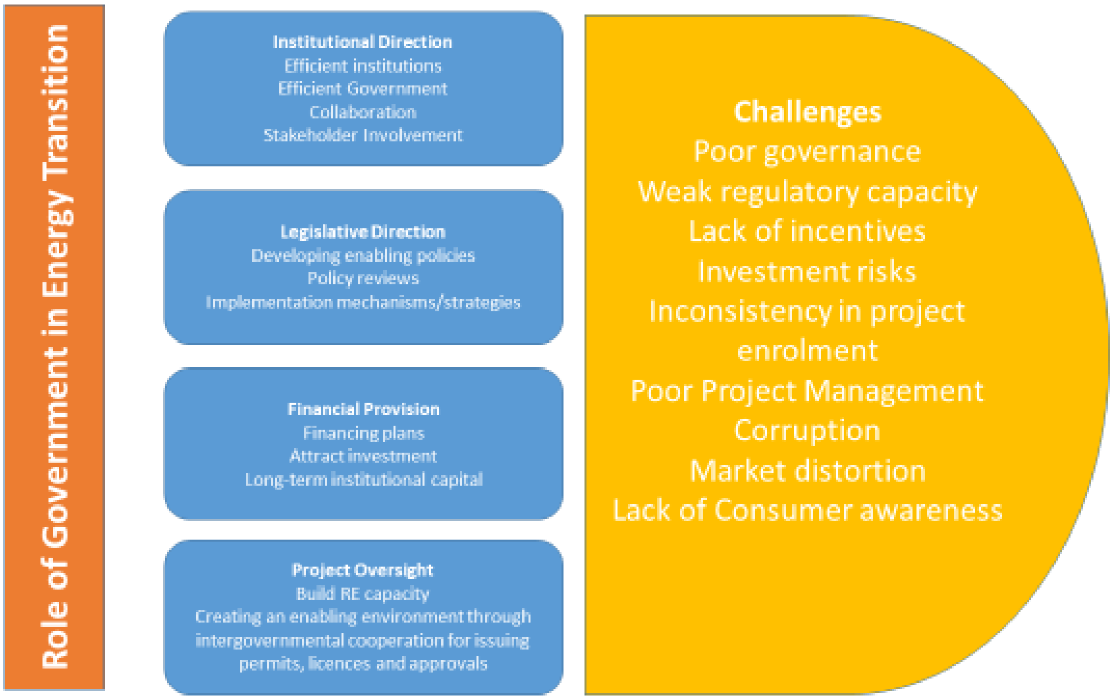

Figure 20: Role of government in the Energy Transition

Source: Based on field surveys (2021)

5.2.2 Key elements to spearhead the transition.

Having examined the institutional and policy framework for a successful transition, it was important to establish what elements the respondents thought would be key in spearheading the transition if prioritised, and why. The respondents identified five key transition elements namely infrastructure, legislation, governance, skills, and stakeholders' perceptions, and with the first being more important than the latter.

Infrastructure development was identified as the most critical element for the transition, with respondents reiterating that developing and improving the different parts of the energy infrastructure such as the generation infrastructure through new power plant builds and systematic maintenance of existing infrastructure, improving transmission infrastructure through strengthening existing substations and optimising them to allow the feeding in of other alternative forms of energy, and expanding the distribution infrastructure, would be highly transformative in the transition. One research participant cited that:

> "*Energy infrastructure is highly linked and interdependent, focusing on the weakest parts such as electricity wheeling infrastructure would vastly contribute to the transition in South Africa.*"

Another stated that:

> *"The development of other forms of infrastructure such as roads and rail which can complement the energy infrastructure can accelerate the transition."*

Similar sentiments are shared by Pandey (2020), who states that a contemporary expanding society needs an energy infrastructure. Furthermore, La Camera and Bekele-Thomas (2023) introduced the regional integration element by stating that it is imperative that the right infrastructure be established to distribute and utilise Africa's RE resources among the continent's many regions to guarantee economical, sustainable, and effective energy access throughout the continent.

Respondents also mentioned that the energy infrastructure challenge requires large financial investment. "*The International Energy Agency estimates that $44 trillion is required globally for new energy supply infrastructure in the period up to 2040*" (IEA, 2023). According to the South African Presidency (RSA, 2023), South Africa needs to invest in decommissioning and repurposing coal plants, remediating and repurposing associated coal mining infrastructure, upgrading the transmission grid, building new generation and storage capacity, and updating the distribution network infrastructure for a successful transition to be realised. "*In the National Infrastructure Plan 2050 (2050 NIP) Phase 1, published by the Department of Public Works and Infrastructure in 2022, the SA government committed to reduce coal reliance and build more renewable energy infrastructure"* (ICLG, 2023). Investing in energy infrastructure can turn around the SA energy landscape in terms of GHG emissions, security and access for the better.

In addition to the infrastructure, respondents identified legislation as another critical element to spearhead the transition, stating that clear renewable energy policies and implementation can transform the energy sector. This notion is supported by Huhta (2022), who states that The law is crucial to the governance of the energy industry and has a significant impact on efforts to achieve the low-carbon transition. Most respondents mentioned that South Africa has well thought of energy policies in the African continent, however is lacking in implementation.

Literature however disputes this notion, with Buthelezi (2022) reiterating that, "*apart from the development of the White Papers on the Renewable energy Policy of South Africa in 2004, there has been very little development of a structured legal framework particularly promoting renewables in South Africa"*. In the same vein, Kessides (2020) states that the current policies are problematic in that they are preserving ESKOM's monopolistic control of the electricity supply market, and to some degree excluding the private sector. The South African legislation is also criticised for being inefficient in addressing the country's energy challenges and outdated. According to Kessides (2020) at each phase of the change, laws and policies must be adjusted, as renewable energy policy frameworks are constantly evolving, which is not happening in South Africa.

Continuing with legislation, Buthelezi (2022) states that for large scale transition to occur, careful legal reform needs to occur, as the current legal reforms to encourage RE in SA are ambiguous, discretionary and uncertain making them not conducive for transition. Buthelezi (2022), further goes on to mention that the fragmented policy interventions, which include, the IRP and the ERA, have all proven to be inconsistent instruments to promote renewable energy. Furthermore, the National Energy Act, other than stating that it is necessary to increase the use of RE, has no specific provisions on how more RE would be generated and utilised, particularly in terms of incentives and legislative certainty. Other legislative shortfalls identified include making energy procurement solely dependent on the discretion of the DMRE minister making determinations and making ESKOM the sole purchaser of electricity for IPPs. If South Africa is to successfully transition to renewables, such regulatory limitations must be addressed. Buthelezi (2022) suggests that the South African legal provisions should be amended by creating precise renewable energy laws aimed at renewables.

Despite Buthelezi (2022)'s criticism South Africa is praised for its REIPPPP policies that have proven a success in encouraging the growth of renewables in the country. Other welcome strides included Schedule II of the ERA, amended in June 2021, to allow the wheeling of electricity to several consumers by raising the licencing limitation for energy-producing projects to 100 MW and subsequently removing the limit in December 2023. This policy move is hailed for unlocking a deep pipeline of investments in the renewable energy market, as private off-takers were for the first time able to conclude corporate purchase agreements with IPPs for the supply of renewable energy by way of wheeling arrangements.

Another critical element identified by respondents to spearhead the transition is the quality of governance. This notion is supported by Kessides (2020), who states that stable, reliable governance and solid leadership from legislators and energy regulators are essential for the energy transition's ease, acceleration, and eventual achievement. It is only the regulators that can change the path of investments, accelerate or slow down the process of decarbonisation, and support or restrict rival technologies. A framework that allows markets to operate, technology to advance, and relevant industry players to work together to advance decarbonisation can be formed and developed with the help of good governance, thereby facilitating the transition (McQueen, 2022). Respondents further emphasised the importance of having collaboration between all governmental levels, including local, provincial, and federal for a successful transition to be realised. This notion is supported by Hoppe and Miedema (2020), who provides an example of the EU where decentralised spheres like regional and local governments are actively engaged in establishing federal government low carbon targets and setting new climate legislation, programmes, and policies. Within the EU, local governments have the authority to create and implement innovative climate programmes, assuming various roles such as initiator, regulator, and facilitator. The national government solely establishes the framework for governance and policy instruments that local administrations can utilise to customise their initiatives and policies to local circumstances (Hoppe and Miedema, 2020). It is evident from the strides that the EU has made in the transition that the multi-level type of governance can yield substantial progress in the transition.

Continuing with the above notion, Caprotti, Essex, Phillips, de Groot, and Baker (2020) mention that the national government's funding for policy implementation, in particular, limits the authority of South Africa's province and municipal governments. Given the vital function that local governments perform in providing energy services, it is critical to grant them the authority to manage the infrastructure, establish new connections, determine pricing, and establish levels of subsidies for low-income clients. Furthermore, Caprotti *et al*. (2020), go on to state that municipal involvement in energy administration had been largely disregarded until recently. However, the political relevance of climate change, resistance to changes in the power industry, and a shortage in the supply of electricity have forced municipalities to reassert and broaden their position in energy governance. A successful transition could be achieved if the roles and duties of this multi-scalar administration relationship are clearly established (Caprotti *et al*., 2020).

In addition to governance, respondents highlighted the need for skills to lead the transition, emphasising that a change to a new energy economy would necessitate a complete transformation of the labour market rather than just focusing on energy production. This notion is supported by Saussay, Sato, Vona and O'Kane (2022), who mention that reaching a transition will require a deep transformation of all economic sectors. On a similar note, UNEP (2023) states that as the gradual move towards a low-carbon economy takes place, there will be a shift in the kind of jobs that are generated, replaced, eliminated, and changed. In the same vein, Hanna, Xu, and Victor (2020) state that labour markets are reshaped by the shift to low-carbon economies as workers are redirected towards low-carbon activities, potentially leading to the loss of skills required for high-carbon activities through job displacement. This suggests that workers will need to be adaptable in order to keep their employment opportunities open in the face of job market changes.

Respondents also indicated that being aware of the skill requirements for low-carbon occupations in comparison with fossil fuels or generic jobs is a challenge, due to limited data. Marin and Vona (2019) support the notion, and go on to point out that while assessing the labour market effects of the shift, the reallocation costs related to workers' reskilling and income losses are frequently disregarded. Misunderstanding of the labour market impacts could be the reason why there is resistance to the transition plans by fossil fuel-based sector employees and labour unions. Labour organisations in SA have attacked the JETP for failing to provide a detailed plan on how job losses linked to power plant retirement and the granting of RE contracts to IPPs will be prevented. According to the Mail and Guardian (2023), unions and opposition parties objected to the Just Energy Transition plan because of potential job losses, particularly in Mpumalanga, where numerous communities rely on coal for their livelihood; they also objected to the lack of deep consultation. The JETP is also criticised by Mr Mantashe, the present DMRE minister, who was recently quoted describing the plan as a foreign concept originating from developed nations, asserting that it does not apply to South Africa (Mail and Guardian, 2023). This may suggest that the JETP is not ready for implementation until all stakeholders are satisfied that all their concerns have been addressed, including those of job losses and reskilling. Additional consultations with unions may be required.

Respondents also raised a concern about the lack of reskilling initiatives to bridge the gap between the skills required in the renewables sector and those of fossil fuel-based jobs. The same concern was raised by Vona, Marin, Consoli, and Popp (2018) who indicated that more specialised, engineering, and supervisory abilities are needed in greener occupations, in their study measuring occupational exposure to green technology and productions. It is challenging to guarantee that workers laid off from pollution-intensive industries, especially those in less skilled and primarily manual positions, find new positions with comparable pay and working conditions (Vona, *et al.*, 2018). Investment in intensive and structured employee reskilling and retraining is required for a successful transition to be realised.

Another key element to spearhead the transition identified by the respondents was stakeholders' perceptions. The South African stakeholders identified included the national state-owned entities, government agencies and local government, including local municipalities, business industry bodies, organised labour and civil society, which are community, education, research, and faith-based and youth groups. Though ranked the least according to priority, respondents indicated that stakeholders' perceptions are important in the transition, with perceptions determining rejection or acceptance of transformation. To support this notion, Newig, Challies, and Jager *et al.* (2018) state that project implementation is highly dependent on the views of stakeholders. Furthermore, studies have indicated that the public's perception of planned projects is significantly influenced by their closeness to the energy infrastructure (Newig, Challies, and Jager *et al*., 2018). In the same vein, Gölz and Wedderhoff (2018) indicate that the embrace of energy transformations is thought to be significantly influenced by spatial factors. The installation of wind turbines and transmission lines is often perceived to bring severe intrusion to the existing landscape which may impact the establishment of wind projects and the subsequent transition.

Respondents further indicated that misperceptions may also arise from fossil fuel-based communities and employees who will not be sure about prospective skill requirements, and fear for regional despondence and job losses, leading to resistance against renewables. Misperceptions may have disruptive impacts on the transition, hence it is important to consider ways to overcome them. Mirzania, Gordon, Balta-Ozkan, Sayan and Marais (2023) suggest that the mitigation measures may include community participation, and skills transfer and training, as the majority of people believe they would forfeit their jobs and be unable to undergo retraining for employment in the RE or any other area of society. There ought to be lobbying and education on the realities of RE projects and their probable socioeconomic advantages, as well as strategies for resolving displacements and coping with the temporary nature of the majority of jobs related to RE (Mirzania *et al*., 2023).

On the contrary, Reusswig, Braun, Heger, Ludewig, Eichenauer and Lass (2016) suggest that "*socio-institutional factors, such as the national political climate, the local perceptions of the project's economic impacts, social variables such as trust, and institutional variables such as equality and openness of the project's planning and execution, are more likely to influence people's perceptions than things like the height of wind turbines, the distances between energy infrastructures and residential areas, or the fear of losing employment*". The same notion is shared by Lange and Cummins (2021), who imply that the refusal of renewable energy projects is frequently a result of ongoing problems with the regulatory framework's openness and the developers' inability to live up to community expectations. Introducing structures and procedures to ensure that stakeholder interests are taken into account can improve results because it is clear from the research that stakeholder perceptions are shaped by involvement, openness, justice and inclusivity, and agile leadership (Chilvers, Pallett and Hargreaves, 2018). This suggests that trust in the government or governance structures involved in the energy transformation can determine the acceptance of any renewable energy project, and we can therefore conclude that participatory governance can improve stakeholder perceptions and the transition outcomes.

The main findings on the key elements spearheading the energy transition are presented below in Figure 21.

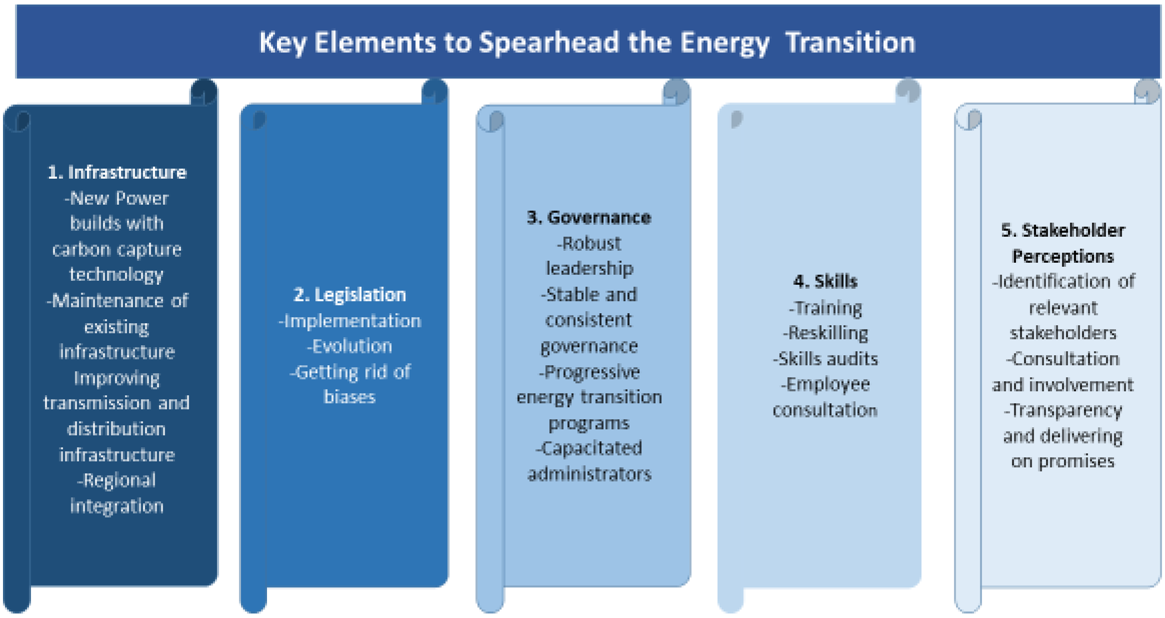

Figure 21: Key elements spearheading the transition

Source: Based on field surveys (2021)

5.2.3 Strategies for a successful transition

Having established the key elements for spearheading the transition, the study also sought to establish the strategies for the shift from coal and advancement of RE sources. Respondents pointed out strategies for a successful transition and ranked them according to priority. Channelling adequate funds to the RE sector was identified to be the leading strategy for a successful transition, followed by privatisation, and diversification in third place. Other strategies identified included consistency in rolling out bid windows, improving the legislative framework, improving grid access and integration, skills development, localisation of RE components manufacturing, providing incentives, and increasing consumer awareness about renewables.

Most respondents emphasised that adequate financial investment in renewable energy could accelerate the transition. One research participant cited that:

> *In SA, financing for RE is typically project-based, and well-known financiers like banks typically fund projects at extremely high-interest margins, which hinders the expansion of the RE sector.*

He also cited that

> *In some instances, all the major banks are involved in financing one renewable energy project, which limits competition in the financing sector.*

To support this notion, Moss and Kincer (2022) state that "*investments in emerging markets come with higher borrowing rates, and this has been worsened by the average Country Risk Premium for African nations that have risen more than 500 basis points, doubling since February 2022*". This suggests that the current financing mechanisms available in Africa come with high-interest rates, which may make the implementation of RE projects challenging. According to the IEA (2023), "*affordability constraints make it less likely that projects will be commercially viable, making concessional and private finance creation such as equity financing vehicles (such as Beyond the Grid Fund for Africa), piloting innovative off-balance sheet financing approaches (as in Togo), supporting commercial banks to provide more affordable long-term debt (as in Kenya), and financing productive uses (as in Uganda), more crucial"*. The sector can see significant progress and transition support from a variety of funding mechanisms and more inexpensive capital.

Another research participant also indicated that:

> *International banks are reluctant to finance South African renewable projects due to the volatility of its currency.*

In line with this notion, the IEA (2023) mentions that there is a shortage of public capital due to the debt crisis in many African countries, which creates room for private capital. However, due to significant perceived and real dangers, many private investors are hesitant to enter African markets. This suggests a need for more available and affordable renewable energy finance for the transition to be realised.

Respondents further indicated that financial investment is required in renewable energy infrastructure, including battery storage solutions that can support variable renewable electricity by storing surplus energy and releasing it when it is cloudy and there is no wind. One research participant stated:

> *In as much as the transition from coal to renewables would be great, the move without adequate battery storage capacity would not be sufficient to meet base load requirements currently achieved from coal-fired power generation, hence the need for financial investment in battery storage solutions.*

In line with this notion, the Department of Trade, Industry and Competition (2023) mentions that South Africa is investing in storage solutions through procuring battery energy-storage systems for ESKOM's distribution and transmission sites from international suppliers and Independent Power Producers. Injecting finance into such infrastructure projects will yield long-term benefits for the renewable energy industry.

Most respondents raised a concern about the exorbitant set-up costs of RE and indicated that a huge financial investment is required for the sector to grow and compete with conventional energy sources. On a similar note, Moss and Kincer (2022) state that all clean power sources have a high start-up expense and are extremely susceptible to rising interest rates. To support this notion the IEA (2023) mentions that a wide range of funding mechanisms, such as grants and equity during the earlier and riskier stages of a project's development, and debt once the project enters construction or operation, are lacking in Africa, making it difficult for projects to proceed through the development cycle. To lower the initial expenses of RE projects, a variety of finance sources are needed to assist pre-construction operations.

According to Tagliapietra *et al.*, (2019) an efficient energy transition is increasingly becoming both technically and financially possible in developing countries, as renewable energy technology is becoming available, and the costs are declining. It is anticipated that with appropriate policies and regulations, the cost of the transition will be equal to that of maintaining the existing fossil fuel-based system (Tagliapietra et al., 2019). This cost decline may attract investors and assist in the growth of the sector.

Another transition strategy cited and ranked second on the priority score was the privatisation of ESKOM. One research participant stated that:

> *An impartial entity with no government interference is necessary for a successful transition from coal to renewables, as ESKOM will always seek to protect its status quo, thereby slowing the rate of diffusion of renewable energy technologies.*

According to Bridle, Muzondo, Schmidt, Laan, Viswamohanan, and Geddes (2022), ESKOM received government financial bailouts of ZAR 56 billion (USD 3 billion) in the financial year 2020/21, and these bailouts have strained government resources. Furthermore, ESKOM had accumulated a debt of ZAR399 billion as of the end of March 2023, which it is currently failing to repay (ESKOM, 2023). Most state-owned institutions in South Africa have collapsed due to maladministration, financial mismanagement, and inefficiencies, brought about, amongst others, by corruption and cadre deployment, which sees politically connected people occupying positions of authority without experience or competence. The suggestion for privatisation could be driven by the view that government ownership is always less efficient than private ownership, as various respondents in support of privatisation kept citing the dwindling SOEs such as Denel and SAA as bad government ownership examples. The privatisation of ESKOM can aid in its function, and once ESKOM is functional, any attempts to transition from coal to renewables will not be marred by opposition, or seen as a threat to its existence.

Third on the ranking for leading strategies for a successful transition was diversification. Respondents indicated that exploring diverse solutions and bringing various energy sources into the nation's energy configuration would aid the transition. One research participant stated that:

> *South Africa has a place for every form of energy generation. The challenge ahead of us is too complex to depend on only a few sets of technologies.*

Essentially, it was evident in responses that diversification could be a viable strategy for energy transition. Respondents repeatedly mentioned that diversification can allow citizens to absorb the shock in the current coal-powered system by increasing the use of other available alternatives, thereby allowing such alternatives to grow. A large amount of literature supports this notion, that the use of multiple sources of energy at a national scale can improve energy supply (Dyer and Trombetta, 2013; De Rosa, Gainsford, Pallonetto, and Finn, 2022; Oleg, Rębilas, Aranchiy, Yasnolob, Boiko, and Padalka, 2020). Diversification may assist citizens to meet their energy needs through the Energy Stacking model, where they may be able to switch between various energy sources, or employ a variety of fuels based on their requirements, preferences, and financial situation. South African needs to diversify, grow all forms of renewable energy, and further research other possible alternatives for a successful transition to be realised.

Coal presently dominates SA's energy supply, followed by crude oil and renewables, as well as a small percentage of natural gas and nuclear (IEA, 2023). In terms of electricity supply, as of December 2022, ESKOM had 54 GW operational electricity capacity with 40GW generated by coal, 6.2GW by renewables, and 2GW by nuclear (Pierce and le Roux, 2023). The nation lacks between 4 to 6GW of currently operational capacity overall (ESKOM, 2023). ESKOM has been facing various challenges, which include poor power plant maintenance leading to the system not being able to meet the demand. It is clear that exploring hybrid solutions and bringing various energy sources into the system would aid in the transition, as ESKOM in its current state, with operational, financial, and grid challenges, cannot do it alone.

Continuing with strategies for a successful transition, respondents indicated that consistency in rolling out bid windows can aid the transition. The procurement of RE is managed through the REIPPPP in SA. Through this programme, bid submissions are opened from one round to the next. Research respondents indicated that consistency and certainty in rolling out renewable energy bidding windows would contribute to a successful transition. According to Zhao, Dvorkin, Delikaraoglou and Botterud (2023), "*certainty in renewable energy scheduling can significantly reduce system costs and market-price volatility. Between 2011 and 2015, four bidding windows were launched and completed which allowed the private sector and IPPs to invest in the SA renewable energy market. The first three bidding windows, from 2011 to 2013, each took around six months to close their projects after being announced as preferred bidders, while bidding window 3.5 took between two to six years to close, and bidding window 4 took approximately three years*". The next bidding window that opened after the cancelled bid window 4.5 in 2015 was bid window 5, launched in August 2021. Though recently, improvement has been noted from 2021, the gap of approximately six years created huge uncertainty in the market, and scared investors. The respondents mentioned that some renewable energy components manufacturing companies also closed due to this delay. To support this notion Writer (2020) mentioned that *"DCD Wind Towers was perfectly positioned to be a South African success story in the renewable energy field, but government indecision and delays crushed the company"*. The delays and uncertainty around the country's renewable energy future forced DCD Wind Towers to close its doors in May 2019, and auctioned off its assets in June 2020 (Writer, 2020). The opportunity to grow the renewable sector was missed during this period.

In addition to consistency in rolling out bid windows, improving the legislative framework was also identified as one of the strategies for a successful transition. The respondents suggested that South Africa's energy legislative framework evolution has been slow, and marred by uncertainty. One research participant stated that the policy developments seem to be widely reactive when there is a crisis, and further mentioned that political leaders usually say encouraging policy statements and commitments in public gatherings, but these do not constitute legal policies or legislation. To support this notion, Yelland (2020) affirms that SA's energy and electrical planning, legislation, and policy have been unclear, hesitant, bureaucratic and missing imaginative leadership. Yelland (2020) further reiterates that policies that facilitate non-discriminatory access to the grid, dispersed generation, individual generation, and transferring electricity, need to be restructured. On the contrary, some authors state that SA possesses well-thought-out energy policies in Africa but lacks implementation (Akinbami, Oke and Bodunrin, 2021; IRENA 2020). *"Recent positive policy developments include the restructuring and unbundling of ESKOM, the easing of regulatory red tape, the establishment of an independent transmission system and market operator (ITSMO), and the opening of the power generation sector to municipal generators, distributed generation, self-generation, and wheeling"*(Yelland, 2020). A successful energy transition crucially depends on clear policies and the implementation thereof; therefore, these new policy developments need to continuously evolve and be effectively implemented.

The Integrated Resource Plans (IRP) 2011 and 2019 have been criticized for constraining the growth of renewables with their limited renewable energy capacity projections and providing exorbitant wind and solar power costs than those on the latest bids. Respondents further mentioned that the IRP restricts energy planning to state responsibility, which benefits ESKOM and the coal sector. Furthermore, as evidence of its ongoing support for coal as a key energy source, the DMRE continues to put forward policies that encourage additional coal investment, cleaner coal technology, below-ground gasification of coal, and CCS (Yelland, 2020). This suggests that SA needs a regulatory reform that will not prioritize fossil fuels but promote RE.

Another strategy for a successful transition cited by the respondents was grid access and integration. Respondents mentioned that the advancement of RE is hampered by capacity and connection issues with the national grid. Furthermore SA faces problems related to grid overload, an ageing transmission network, and rising grid connection prices in above capacity limitations. To support this notion, Aggarwal and Chawla (2019) state that the inability of South Africa's system to accommodate increased generation from IPPs has made the country's widening supply-demand deficit worse. Projects are awarded to IPPs based on grid capacity. It is estimated that R235 billion is required for upgrading the national grid, construction of new transmission lines, and the installation of additional transformer capacity, which ESKOM is unable to finance due to its debt burden (Aggarwal and Chawla, 2019). Addressing the grid challenges will require significant governmental, policy, and regulatory intervention to unlock alternative funding mechanisms and private sector involvement (Aggarwal and Chawla, 2019).

According to SANEDI (2023), in rural SA, over three million citizens lack access to power, and with the country being an energy-intensive and growing economy, the grid access challenges are likely to increase. One respondent from ESKOM acknowledged that grid access and capacity were a challenge, and stated that ESKOM is working on it, with tenders having been advertised to improve grid access and strengthen the transmission and distribution network. According to ESKOM (2023), more grid capacity will be required to accommodate the renewable energy projects signed from Bid Window 5 that must come online by at least 2025. This suggests that the issue of grid capacity and access requires immediate attention from the government.

Grid access is managed by the ESKOM Grid Access Unit. This unit facilitates and manages the grid access entry of Independent Power Producers and other generators, to encourage viable grid connections and operations. In addition to grid capacity challenges, there seem to be other resource capacity challenges, which have led to a struggle in processing the backlog of grid connection applications in terms of the IGCAR, although the Interim Grid Capacity Allocation Rules (IGCAR) were changed from the ‘first come, first served’ approach to a ‘first-ready, first served’ to accommodate new generation from Independent Power Producers (IPPs) (Fraser, 2023). There is a need to capacitate this unit, or reallocate this responsibility to a capable department, for the application processes to be expedited.

Another strategy for a successful transition identified by respondents was skills development**.** There are many standardized skills needed for the building and implementation of RE facilities, as well as technology-specific specialized skills related to components manufacturing. These skills are currently lacking in South Africa. One research participant stated that:

> *In as much as the renewable energy sector is growing, the skills to support that growth are insufficient.*

This notion is supported by SARETEC (2023), which states that most artisans in the renewable energy sector receive generalized sector training from technical colleges or universities, and product training on installation or troubleshooting of certain renewable energy components does not happen (South African Renewable Energy Technology Centre, 2023). Though there is a MOU for the development of RE artisan skills in SA between SARETEC and ESKOM, to support the implementation of the ESKOM Just Energy Transition (JET) strategy, labour unions have criticised the government reskilling efforts as inadequate. There is a need for more coordination between academic and research institutions, and relevant industries, to ensure RE skills development to benefit the transition. Reskilling centres must be established in coal towns, and coal and other related sector employees must be reskilled for future jobs.

Localisation of RE components manufacturing was also identified as a strategy for a successful transition. Research respondents indicated that South Africa as an industrial country needs to stop importing renewable energy components, and manufacture the products locally. In line with this notion, Nkhonjera (2022) suggests that the manufacturing of components locally will create new industrial value chains, which will contribute to RE cost declines, expand productive capacity, and increase competitiveness. *"The value chains would include materials and components manufacturing and assembling of renewable energy technologies, such as solar photovoltaics (PV), wind turbines, and battery storage systems"* (Nkhonjera, 2022). Regional markets can also be opened up, and commitment to the AfCFTA may promote manufacturing and trading in renewable energy infrastructure regionally, thereby reducing costs (Nkhonjera, 2022). The government needs to encourage local renewable energy component manufacturing through various mechanisms such as incentives and duty-free imports.

In relation to the above, Morris and Walwyn (2023) state that SA RE manufacturing is currently dominated by global firms. The introduction of the REIPPPP in 2011 transformed the wind and solar energy space in SA. However, the auction process's loss of consistency and certainty led to the collapse of the local component manufacturing companies that had been established (Morris and Walwyn, 2023). The popular company closure commonly referred to in the media was that of DCD Wind Towers, an MNC Tower manufacturer, which was operating in Atlantis. Negotiations with international blade and nacelle MNCs also broke down, leading to global manufacturers withdrawing from setting up subsidiaries in South Africa, and local secondary suppliers of goods and services suddenly finding their market drying up and closing (Morris and Walwyn, 2023). To grow the RE value chain, there is a need for policy interventions to create investor confidence and consistency in rolling out bid windows.

Unlike the wind energy space, the solar landscape has much potential for faster growth. The SA solar PV panel assembly is currently dominated by a few Chinese manufacturers who export assembled modules, though recently a few Chinese companies such as ARTsolar and Seraphim have opened up subsidiaries in South Africa (Morris and Walwyn, 2023). A few local inverter manufacturers exist, for example, Enertronica Santerno, an Italian-based firm with a subsidiary in South Africa, though a majority of inverters are still being imported (Semelane, Nwulu, Kambule and Tazvinga, 2021). Minimal local battery production also takes place, with examples including Revov that refurbishes lithium batteries, and others assembling batteries such as Blue Nova, Freedom Won, BSL, SolarMD, and Hubble (Morris and Walwyn, 2023). The solar PV industry is rapidly expanding with the demand for solar panels, inverters, batteries, and installers exceeding the supply beyond current import and local manufacturing capacity. Currently regulation in this sector is lacking, and the government is behind in formulating adequate policies to enable some form of regulation (Morris and Walwyn, 2023). It is evident that with clear policies the local solar manufacturing industry can grow faster and contribute to accelerating the transition.

Another strategy for a successful transition identified by the respondents was the provision of incentives. Respondents mentioned that a variety of incentives can hasten the implementation of RE. This notion is supported by Zhao *et al.* (2016), who assert that focused incentives have been beneficial in promoting the execution of RE projects over time. According to Hayer (2017), *"fossil fuels have enjoyed various government subsidies such as direct financial transfers, preferential tax treatments, trade restrictions such as import duties and tariffs, and regulations such as price controls and rate caps, which are limited or non-existent in the RE"* sector. Curtin *et al.* (2017) proposed various incentives such as *"feed-in-tariffs (FiTs), energy usage quotas, grants, and tax incentives"* to successfully promote RE development.

Until the new Taxation Laws Amendment Act, 2023 signed into law in December 2023, SA had limited incentives in place to encourage RE deployment. The new Taxation Laws Amendment Act, 2023, "*sets out a few significant permanent and temporary tax incentives to promote investment in or sale of utility-scale renewable power, such as the tax incentive for businesses to claim an upfront deduction of 125 per cent of the cost incurred to acquire qualifying assets used in the generation of electricity, including supporting structures, against their taxable income. The incentive is only available for two years from 1 March 2023 up to and including 28 February 2025"* (National Treasury, 2023). There is also a rooftop solar tax incentive, *"where individuals can receive a tax rebate to the value of 25 per cent of the cost of any new and unused solar PV panels, up to a maximum of R15 000. This rooftop solar tax incentive will be available for one year and will apply to new and unused solar PV panels that are acquired by the individual and brought into use for the first time on or after 1 March 2023 and before 1 March 2024"* (National Treasury, 2023). The short-term nature of these incentives is intended to incentivize companies to act sooner by making investments in RE assets. The permanent incentives include the allowance for energy efficiency savings and a carbon tax for

NERSA-licensed entities. These incentives are expected to encourage renewable energy uptake by businesses and individuals, thereby aiding the transition. However, looking at other incentives available in other states such as Germany, the EU, Brazil, Australia, China, and the USA, South Africa is still lagging in this regard. Various incentives must be introduced, especially Research and Development incentives since only a limited few investors are keen on funding research and development projects due to their elevated degree of risk and unpredictability, which makes government assistance crucial.

In addition to incentives, increasing consumer awareness was also identified as one of the strategies for a successful transition. Respondents cited that consumers are likely to invest in something if they are aware of its benefits. To support this notion, Qadir *et al.* (2021) claim that people will typically invest in anything if they can see the returns on their investment. On the same note, the Bridges Transition Model, discussed in Section 2.3 of the thesis, says that the transition process is a mental process that individuals undergo on an internal level when they adjust to and accept the new circumstances brought about by change, starting with an ending where people identify what they are losing and learn how to manage the losses, then move to the neutral zone, and to new beginnings after finding new understanding. In this theory, William Bridges (2022) suggests steps for successful transition management, which include communicating the need for change, collecting information on those affected and impacted, gaining investment in the outcome, conducting a transition readiness audit, training people who will lead the transition, monitoring progress, and helping individuals understand how they can contribute to the change. Lack of support or opposition is usually because of inaccurate or incomplete information. The Bridges Transition Model steps can be used to ensure that adequate and relevant information about renewable energy benefits is provided to consumers to increase awareness and subsequent adoption.

The public can easily access information from conventional energy companies that criticise and depict RE as expensive and unpredictable (Geels *et al*., 2017). Furthermore, various studies deter the use of RE, contending that it will never be able to supply the world's energy needs (Brook and Bradshaw, 2015; Harjanne and Korhonen, 2019; Heard *et al.*, 2017). According to Diesendorf and Elliston (2018), these research biases have impacted and influenced how the general public views RE sources in terms of dependability, security, and cost. To improve consumer awareness, South Africa must be deliberate in communicating accurate facts regarding the advantages of RE to consumers to promote RE adoption.

The main findings on the strategies for a successful transition are presented below in Figure 22.

Figure 22: Strategies for a successful transition

Source: Based on field surveys (2021)

5.3 Challenges, and opportunities that exist or hinder the transition from coal to renewable energy in South Africa

Identifying the barriers and/or difficulties hindering SA from shifting from coal to RE sources was one of the study's areas of focus. Respondents identified political interference and corruption, lack of financial investment, inadequacy of policies and legislation, inconsistency in rolling out bidding windows, ESKOM's monopoly, the exorbitant costs of renewables, limited incentives, lack of skills and technology, the labour unions, and lack of awareness about alternatives, as the barriers to a successful transition, and ranked them according to priority, with the first being the most critical and the last being the least important.

Political interference and corruption were cited as the leading barriers to the transition. Respondents indicated that the SA energy sector is highly influenced by the political system, and political management interferes with many energy-related processes and decisions for their gain. One research participant reiterated that:

> *The self-enrichment by these political leaders in the energy sector is eating South Africa to the bone. Look at what is happening to ESKOM; the power grid has been brought to*

> *its knees because of political interference and corruption, and this is a huge barrier to the growth of the sector and the transition itself.*

Another respondent stated that:

> *Corruption is entrenched in the veins of most if not all state-run institutions in South Africa, and the sad thing is that it is difficult to reverse, as people are now accustomed to it. Without political interference and corruption, a smooth and quick transition could be guaranteed for 2030 but I don't see it happening, even as far as 2050 if no systems are set up to uproot corruption in the energy sector.*

On the same note, Basavarajappa (2020) states that political interference and corruption have profound impacts on economic development, and hinder the progress of nations. Basavarajappa (2020) further alludes that corrupt politicians inappropriately misallocate resources and siphon off public funds meant for service delivery for personal gain. Furthermore, much literature is available on how political interference negatively impacts the energy sector (Sayah, 2017; Shahab, 2019; Correa *et al*., 2019; Cheng *et al.*, 2020).

According to Ottens and Edelenbos (2018), transitions are inherently political, and politics may be very effective in shaping the terrain, strengthening or undermining regimes, and exposing or defending particular niches. Ethical political leadership can contribute positively to the transition; however, in South Africa, political leadership has not taken citizens into confidence in terms of how the power utility ESKOM has been managed. Nguyen (2023) mentions that ESKOM has been beset by accusations of corruption and state control, where political interference saw contracts being awarded to politically linked people and organisations, thereby severely affecting its performance. Furthermore, the Committee that was investigating the allegations of the capture of the state after numerous witnesses gave evidence about deals obtained with bribes and kickbacks, determined that the former President Zuma, despite rejecting such claims, willingly facilitated the brazen plundering at ESKOM during his nine-year term in office (Bloomberg, 2023). The former ESKOM CEO Mr De Ruyter also confirmed that high-ranking ANC members were illegally benefiting from corruption within the organisation (Bloomberg, 2023). The current dire state of ESKOM is evidence that political interference and corruption can bring an entity, and subsequently a country, to its knees. Efforts to uproot corruption and political interference in state-owned entities must be strengthened for a successful transition to be realised.

In addition to political interference, lack of financial investment was cited as the second most vital barrier to the transition. Respondents alluded to the high initial investment costs of renewables for resources such as technology, skills, components, land, infrastructure, and social aspects. In addition to high initial set-up costs, another aspect raised was the high borrowing costs for financing renewable energy projects. One research participant stated that:

> *Financing is a major barrier to renewable energy. High financing costs influence the competitive position of renewables, as renewable energy requires a higher initial investment than conventional sources of energy. Renewable energy is also considered risky, and the lending costs of such projects do not usually come cheap.*

On the same note, Kempa, Moslener, and Schenker, (2021) mention that the high costs of debt for younger technologies may restrict the investment desired for the revolution of the world's energy sector. This suggests that financing renewables may be more costly than conventional sources, thereby hindering RE deployment.

In his speech at the COP 27, President Cyril Ramaphosa indicated that South Africa needed approximately R1.5 trillion in investment to support the Just Transition for the next five years. It would therefore be difficult to see such plans coming to realisation with South Africa's continued deteriorating economic conditions that do not promise to improve, due to various factors like continued loadshedding, credit rating downgrades, and increased borrowing costs. One research participant stated that:

> *South Africa has vast challenges that require money, and it has been clear that the money currently available on the fiscus is not enough to address all the existing challenges. The figures mentioned in the transition plans which run into trillions are not a joke, finance unavailability will undoubtedly be a huge barrier to the transition being realised.*

Respondents further mentioned that since ESKOM is currently positioned at the centre of the transition, with it being the buyer of the electricity procured from the IPPs, its dire financial state will also hinder the transition since the money that must be invested in RE infrastructure is bailing out ESKOM instead. This notion is supported by the Global Wind Energy Council (2023) which mentions that the unstable financial situation of ESKOM poses a threat to the expansion of RE in SA. If the state of ESKOM remains the same, and ESKOM remains central to the transition, the transition goals will not be achieved in South Africa.

Continuing with the discussion on the barriers or challenges to the transition policies, inadequate legislation was cited as the third leading barrier to the transition. Respondents indicated that improvement was required in the existing energy policies and legislation. One research participant mentioned that:

> *The South African government has somewhat well-written policies, but remember policies are not enforceable. Policies are just political statements of intention of what the government would like to introduce and such statements don't mean anything if they are not translated to law. So, in summary, I would say South Africa has few relevant policies but inadequate legislation to address the energy transition issue. The other issue is that the supporting mechanism or implementation of such policies or laws is lacking.*

This notion is supported by the Climate Action Tracker (2023), which claims that in order for South Africa's climate policies and activities to be in line with the 1.5°C temperature limit set by the Paris Agreement, significant adjustments must be made. Respondents further indicated that the existing policies were contradictory and lacked integration across government spheres. One respondent stated that:

> *The energy policies are outdated and lack synergy among government departments and other agencies. There must be integration between municipal and national policies.*

Another further reiterated that:

> *Energy policies need to be improved to make provisions for power wheeling and grid tying, and must also offer favourable tariffs for independent and domestic energy producers.*

This notion is supported by Nguyen (2023), who claims that obsolete policies are one of the main problems behind SA's energy crisis. The 2019 IRP is already out of date, and an update is required due to the quick advancements in energy-generating technology (Nguyen, 2023). Referring to Minister Mantashe, who is expected to lead the development of policies that support renewable energy but is a fervent supporter of the coal, gas and nuclear sectors, the divergent views and priorities among government officials have made it more and more difficult to have a clear and unified approach to addressing the energy crisis (Nguyen, 2023). Such conflicting responsibilities can hamper the development and execution of cohesive energy policies and legislation. It is evident that the inadequacy of energy policies and legislation is a notable barrier to the transition, and improvement is required to address the many issues, such as the obsolescence of policies, harmonising the national and municipal policies, and giving direction on grid-tying and power wheeling matters for a successful transition to be realised.

Another barrier cited was the inconsistency in rolling out bidding windows**.** Research respondents indicated that the inconsistency in rolling out renewable energy bidding windows was a barrier to the transition. The SA RE market was opened to the private sector and IIPPs for investment between 2011 and 2015 through the completion of four separate bidding windows. After being named chosen bidders, the first three bidding windows from 2011 to 2013 each took about six months to complete their projects; bidding window 3.5 took two to six years, and bidding window 4 took about three years. The next bidding window that opened after the cancelled bid window 4.5 in 2015 was bid window 5, launched in August 2021. The gap of approximately six years created huge uncertainty in the market, and scared investors. To support this notion, Parker (2022) states that the continuous development and investment in RE were severely hampered by the delays and irregular procurement timeframes. Furthermore, Parker (2022) adds that the REIPPPP's irregularities had an effect on the rate of expansion of regional manufacturing as well as the prospects for general industrialisation that renewable energy offered. Consistency in rolling out the RE bid windows can encourage local manufacturing and investors, thereby leading to the advancement of the sector.
Respondents mentioned the monopolistic character of the energy system where the sole power company, ESKOM, is in charge of producing, transmitting, and distributing power as an impediment to the transition in addition to the inconsistent bidding windows rollout. Todd and McCauley (2021), mention that the transition is hampered by the fragile outlook of ESKOM, the electrical company that plays a key role in the national energy strategy. Respondents further cited concerns about ESKOM's financial challenges and the corruption taking place at the entity. On the same note, Mzolo (2018) states that ESKOM has been under great financial pressure, and its debt problem is the biggest risk to SA's economy. Furthermore, ESKOM has been blamed for acting as a conduit for the distribution of public funds to unscrupulous politicians (Mzolo, 2018). This plundering, according to Hofstatter (2018) brought the economy of South Africa to the brink of collapse. Amidst the problematic monopolistic structure, financial challenges and corruption, ESKOM still seeks to maintain its status quo as the main buyer of electricity from IPPs. In addition to being the main buyer, ESKOM's existence is dependent on fossil fuels. Any transition to renewables may be seen as a threat to its existence, which may slow down the pace of transition.

One significant obstacle to the transition was found to be the costly nature of RE. Respondents cited that the exorbitant start-up costs of RE are a deterrent to the sector advancement. This notion is supported by Scholey (2023), who mentions that the preferred bidders for the fifth bid round were announced in October 2021, but due to increases in financing costs and other charges, projects with a capacity of more than 1,000 megawatts remain hamstrung in South Africa. When considering the initial investment costs for the individual consumer, development, and infrastructure, it can be concluded that high upfront costs can deter RE deployment.

Contrasting views however exist, stating that renewable energy has grown over time to be cheaper than fossil fuels. IRENA (2023) alludes that "*renewables are currently the cheapest form of power. IRENA (2023) further states that almost two-thirds, or 163 gigawatts (GW) of newly installed renewable power, had lower costs than the world's cheapest coal-fired option in the G20 in 2021, and amid the climbing fossil fuel prices, investments in renewables saved US$55 billion in global energy generation costs in 2022*". On the same note, Dudley (2023) mentions that "*the cost of electricity from developing new fossil fuel plants ranges from $0.05/kWh to $0.15/kWh, and by comparison, hydroelectric power comes in at an average of $0.05/kWh, onshore wind, solar voltaic, biomass and geothermal below $0.10/kWh, and offshore wind at $0.13/kWh".* The Energy Information Administration (2023) also affirms that as the entire world becomes more adept at using natural resources, the cost of RE is becoming more affordable and competitive with fossil fuels each year. The EIA (2023) adds that by 2023, the levelized cost of offshore wind, which is a metric used to compare various energy generation techniques, had decreased to $127 per MWh, excluding subsidies, from almost $200 in 2014. On the same note, IRENA (2023) indicates that between 2010 and 2022, there was a notable deflation in the pricing of wind and solar power. "*The global weighted average of newly launched utility-scale solar PV projects decreased by 89% from USD 0.445/kWh to USD 0.049/kWh, while onshore wind projects decreased by 59% from USD 0.107/kWh to USD 0.033/kWh and offshore wind projects decreased by 59% from USD 0.197/kWh to USD 0.081/kWh"* (IRENA, 2023). The aforementioned figures demonstrate how, over time, the relatively reasonable operating costs of RE plants can counterbalance the extensive start-up costs. The figures also highlight the necessity of several funding mechanisms to provide project start-ups with a lifeline before their ventures become profitable.

Another identified hindrance to the transition was the deficiency of incentives. Respondents cited that the lack of incentives to promote RE deployment is a barrier to the growth of the sector. This notion is supported by Hayer (2017), who states that "*fossil fuels have enjoyed* *various government subsidies such as direct financial transfers, preferential tax treatments and trade restrictions such as import duties and tariffs, and regulations such as price controls and rate caps, which are limited or non-existent in the RE sector".* Until the new Taxation Laws Amendment Act, 2023 signed into law in December 2023, South Africa had limited incentives in place to encourage RE deployment. Sun and Nie (2015) suggest that the RE space has received growing support in several countries, with FiTs and RPS as the widely used regulatory measures. Furthermore, various countries have incentives such as tax or financial incentives, research and development incentives, market incentives, grid connection incentives, and incentives via regulations as suggested by Curtin *et al.* (2017) which South Africa can pursue to accelerate the transition.

In addition to lack of incentives, a deficiency of skills was also noted as an impediment to the transition. Respondents indicated the necessary skills to fill open positions in the industry are in limited supply, and in some instances the skills and qualifications required are available but the experience in the industry is lacking. This notion is supported by Mahama, Derkyi and Nwabue (2021), who assert that a lack of technical know-how to run and maintain the systems has caused many RE projects to collapse. On the same note, Lucas, Pinnington and Cabeza (2018) state that the distinct nature of RE production technologies requires highly unique sector-specific skills and RE experts are required to have a broad range of sector abilities in addition to their specialised knowledge, including environmental awareness and a deep comprehension of sustainability principles. Similarly, Malamatenios (2016) states that the RE sector requires skills such as RE technology design engineers, specialized turbine technicians, digital technologists, and support skills to handle legal, sales, economics and training, and social and environmental specialists. The peculiarity of the RE skill requirements impedes the industry's progress.

Another challenge related to skills in SA is the inaccurate reporting by entities to the relevant SETA. According to EWSETA (2023), RE skills reporting by entities does not present information on what skills South Africa requires, which leads to misallocated government funding and inadequate development of the correct skills. In addition to the challenges created by inaccurate reporting, the lack of skills drives RE projects' operational costs high as the sector is forced to import skills from other countries which usually come at a high cost. South Africa is currently relying on foreign skills from Germany, Denmark, the Netherlands, and other countries for RE technical expertise (Chetty, Davids, and Kanyane *et al*., 2023).

Interventions such as accurate reporting, adequate skills transfer programs to build South Africa's skills capacity, retraining and further training in RE for employees from other energy-related sectors and government support for training providers to get accreditation for RE-related training programmes may assist in dealing with the skills challenges.

Another barrier to the transition identified was labour unions. Respondents indicated that efforts to transition from coal to renewables are often faced with a backlash from labour unions, because of inherent coal interests. This notion is supported by Mirzania, Gordon, Balta-Ozkan, Sayan and Marais (2023), who mention that in South Africa, labour organisations wield such immense power to dictate the direction of energy policy or lack thereof. Similarly, Todd and McCauley (2021) add that "*one of the main political influences affecting the energy transition in South Africa is the labour movement, as represented by the National Union of Mineworkers (NUM)".* On the same note, Cheng, Lee and Murray *et al.* (2020) mention that *"the opposing interest groups, such as labour unions, have played a key role in undermining efforts to reform the power sector, and in cases of reform failure, strong opposition by influential labour unions is frequently present, but rarely exist in cases of successful reform".* The findings suggest that trade unions can be a powerful impediment to energy sector reforms, thereby hindering the transition. The reality on the ground confirms this narrative. Protest actions against transition plans have previously been arranged by affected unions, with examples such as the NUMSA and NUM protest on 17 November 2018, against the closure of coal mines and the Independent Power Producer Programme, and the COSATU and the YCLSA protest action against the closure of Komati coal power station, held on 08 September 2023 (NUMSA, 2018; COSATU, 2023).

Interestingly, in contrast to the widespread perception that labour unions are generally unscrupulous, the global trajectory seems to be different. According to Morena e*t al.* (2019), "*international union organizations are working with governments to promote a just transition, a concept which has been taken up by environmental justice groups and indigenous rights groups, businesses, and national governments, and now occupies a prominent place in global climate politics*". Furthermore, Stevis and Felli (2015) suggest that through the Just Energy Transition strategy, the idea that unions could balance worker fairness with environmental requirements has been at the heart of the global union movement for many years. The concept later gained support from the ILO and UNEP, which stated in their policies that affected areas would require aggressive support to withstand the shift to new industries and create alternative jobs and means of subsistence (UNEP, 2007). ENGOs have also been more involved with the idea, realising its potential to involve affected sector organisations that have historically impeded the implementation of climate change policies (Goddard and Farrelly, 2018). This opposing notion suggests that unions are not necessarily protecting their interests but are working to create a more balanced and sustainable way of economic and industrial activity, where the workers' rights are protected during the shift to sustainable energy.

It is evident that trade unions can focus policy attention on the need to create new jobs as the number of jobs depending on fossil fuels is reduced. According to Healy and Barry (2017), groups depending on fossil fuels will eventually oppose rapid decarbonisation unless robust measures are in place to promote a decent transition. Four South African trade unions, namely "*the Federations Congress of South African Trade Unions, the Federation of Unions of South Africa, the National Council of Trade Unions, and the South African Federation of Trade Unions, came together in November 2023 to launch a Just Transition research centre to develop the technical expertise to help the labour movement in addressing the potential risks posed to workers as a result of the restructuring that will accompany the transition to greater climate resiliency"* (News24, 2023). This move by unions is encouraging, and if the centre is used effectively, the research material from it will contribute positively to Just Transition policy formulation.

The least important barrier identified by the respondents was the lack of public awareness. Respondents indicated that the adoption of RE may be significantly hampered by the general public's ignorance about its advantages and possibilities. Kariuki (2018) supports this notion, by stating that ignorance of RE technologies and systems is a notable barrier to RE adoption, particularly to the uneducated population that does not understand the concept of renewable energy and is hardly oriented to the technical and environmental impacts associated with over-use of combustible fuels. Communities must be informed of the risks of continued fossil fuel use, educated on the available renewable energy options and empowered to make informed decisions about energy sources.

Respondents further mentioned that it is common practice for the public to reject or oppose reforms or plans they lack information about. This demonstrates how crucial public participation is to realising a successful transition. Madumere (2017) affirms this notion by asserting that generating popular backing for climate policies and programmes requires a sufficient level of public understanding and awareness. Khatibi, Dedekorkut-Howes, Howes and Torabi (2021) further introduced an interesting notion related to public awareness, suggesting that different types of knowledge exist, which are important in raising awareness and driving decision-making, namely *"individual, local, traditional, indigenous, and scientific"*. Local knowledge is that which has been passed down orally and informally through oral customs. It is a mixture of practical and scientific knowledge based on a belief system. Traditional or indigenous knowledge involves understanding the relationships within an ecosystem and using the environment following a code of ethics. Indigenous and ancestral wisdom, beliefs, and facts from science must be employed together to produce a genuine understanding for the public to acknowledge a transformation (Khatibi, Dedekorkut-Howes, Howes and Torabi, 2021). A combination of such types of knowledge can be employed to educate the public about RE technology, and once that knowledge is established, the transition process may be smoother.

A summary of the key findings on barriers that hinder the transition is presented below in Figure 23.

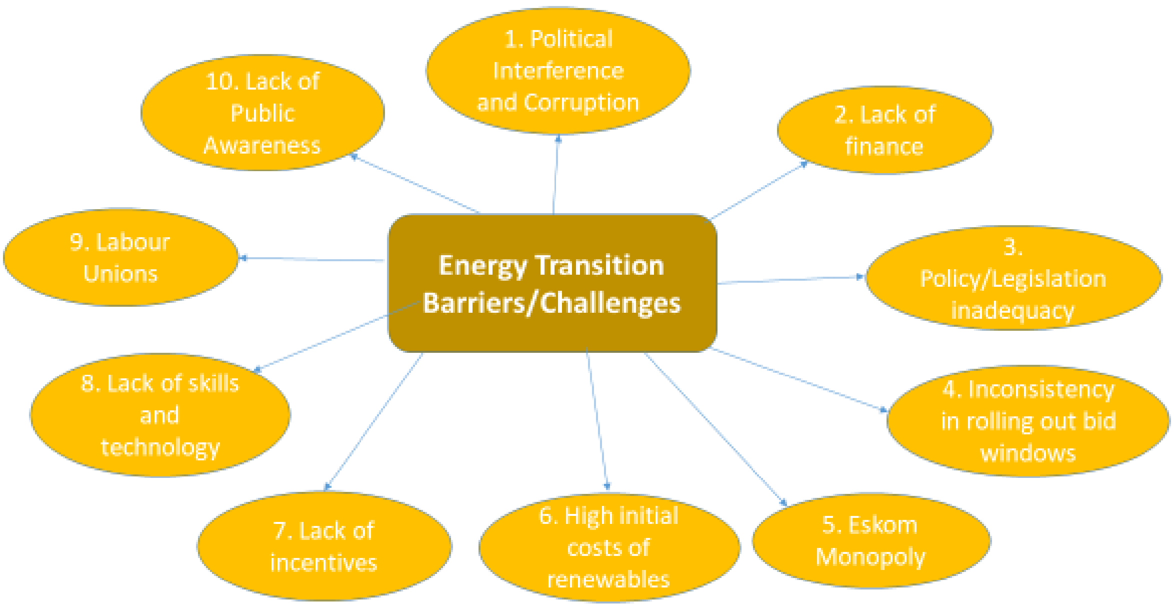

Figure 23: Barriers to the energy transition

Source: Based on field surveys (2021)

5.4 Developments in the international policy frameworks that can influence South Africa's transition ambitions

The international view formed an important part of the study, with varying contributions made on how the international policy framework on renewable energy could influence South Africa's energy transition ambitions. The global respondents were asked what they thought of the adequacy of their respective countries' renewable energy policies. Surprisingly, like South Africa, respondents indicated that their countries' renewable energy policies were inadequate. Policy challenges seem to be a global phenomenon that all governments need to address to achieve their transition objectives. Various reasons for policy inadequacy were cited and ranked according to priority, which included lack of an implementation mechanism, insufficient clean energy targets, insufficient financing provisions, contradictions, and lack of provisions for incentives, with the first being more important than the last.

The popular sentiment from respondents was that the global renewable energy policies or legislation lacked an implementation mechanism. One research participant from Nigeria stated that:

> *Nigeria's renewable energy policies lack implementation however I am not sure if politics drive the lack of implementation as renewable energy threatens the country's economic existence which is dependent on oil and gas.*

Another respondent from Zimbabwe stated that:

> *Zimbabwe has a well-written National Renewable Energy and Biofuels policy, which when properly implemented, could gradually help Zimbabwe to transition to a green and sustainable economy.*

Interestingly, similar sentiments were shared by respondents from both developed and developing countries. One research participant from the United Kingdom cited that:

> *The United Kingdom has the best RE policies in the world however for a variety of reasons the policies are somewhat not adequately implemented.*

It was clear from these recurring responses that the lack of policy implementation mechanisms was a global challenge that needed to be addressed.

Respondents mentioned that a varied gap exists between energy policy ambitions and execution. Numerous nations made commitments to the Paris Agreement and the reduction of greenhouse gas emissions, which are to be accomplished by creating and putting into effect a variety of national energy policies. The reality, however, demonstrates that many countries still face significant challenges in implementing the RE targets outlined in the Paris Agreement, with energy policies frequently being aspirations rather than what is practised (Petersen, 2018). According to Hess and Gentry (2019), it is one matter for a city or country to approve a plan or policy, and it is a different matter for it to implement the policy. On the same note, Lo (2014) mentions that policies and practices are often disconnected.

According to Wu, Zuidema, Gugerell and de Roo (2017), Policy scientists rarely addressed policy implementation until the 1970s. Rather, the belief was that policies with a strong design will accomplish their goals on their own. Nevertheless, research has shown that the combination of policy design and policy evaluation determines how well policies are implemented (Wu, Zuidema, Gugerell and de Roo, 2017). Marquardt (2017) identifies various obstacles for renewable energy policy implementation, which include ambiguous duties, contradictory regulations, inadequate local competence, ignorance of national intentions, and absent consultations. These obstacles can be addressed by ensuring policy implementation mechanisms such as implementation strategies are in place, and the required resources are provided.

In addition to the lack of implementation mechanisms, respondents mentioned that most policies in the world have insufficient clean energy targets. To support this notion, Liu and Raftery (2021) state that most countries signed the Paris Agreement and committed themselves to reducing GHG emissions in their NDCs. However, these NDCs or targets are inadequate to keep global warming below the 2-degree objective. According to the Climate Tracker (2019), Of the 31 NDCs that were monitored, 24 were deemed to be seriously inadequate, meaning that many countries' policies would not allow governments to fulfil the 2-degree objective by 2030. Hutchinson, Dennis and Grann *et al.* (2021) suggest that to promote the growth of RE, nations should set attainable goals, support them with specific strategies, and express them through long-term policies and incentives. More ambitious and SMART clean energy targets are required globally for a successful transition.

Respondents further mentioned that most global policies have insufficient financing provisions. According to the World Bank (2023), because of the nature of the core technologies, RE sources often have relatively high start-up costs and low ongoing operational expenses, therefore policies must make provision for long-term funding since obtaining this kind of funding can often be challenging or downright impossible because of regulatory and/or other constraints. On the same note Ivanova, Gamez and Angeles (2011) assert that because RE uses significantly different technology than conventional energy, new ways of thinking, managing risk, and raising finance are needed, and these needs must be taken into account when developing legislation.

Furthermore, Polzin, Sanders and Serebriakova (2021) state that due to the fear of risk among financiers and policymakers, and the pace and volume of finance needed, investment in RE falls far short of the scale required to satisfy global climate commitments. Policymakers can enable countries to meet their targets by making relevant financial provisions in policies. Neuhoff, May and Richstein (2022) add that renewable energy policies can facilitate the hedging of power price risks between producers and consumers. Carefully thought-out policies can lower the cost of RE, thus encouraging the deployment of RE. Legislators need to take project financing into account when designing RE policies.

Global policies were also identified to be contradictory. Respondents cited that it is surprising that one country would set ambitious targets for reducing greenhouse gases and at the same time show an increased appetite for coal, citing China that has been adding coal capacity, as an example. To support this notion, Hove (2020) affirms that climate policies and energy policies seem to be operating in parallel and contradictory directions, which results in failures in meeting the reduction in greenhouse gas emissions. Tyler (2010) also introduces another policy mismatch, where he mentions that het energy paradigm, institutional orientation, and capacity are fundamentally at odds with the mitigation vision from the perspective of policy paradigms. Tyler (2010) further goes on to suggest that the misalignments or contradictions may be caused by vested interests. In addition to vested interests, tensions and conflicts between policy priorities may arise from the fact that the transition to renewable energy involves a range of activities and players with varying desires, visions, wants, opinions, and understanding (de Boer and Zuidema, 2015).

According to Mabasa (2021), South Africa, like its global counterparts, has its fair share of policy contradictions. Mabasa (2021) states that the different ministerial departments in South Africa represent a contradiction in their energy policies. He further mentions that the policy inconsistencies in South Africa have hindered the progression of adaptations towards climate change through renewable energy, and have shown the indecisiveness of SA in tackling climate change and the inability to construct cohesive and coordinated state institutions. Mabasa (2021) goes on to mention that when contradictory policies are implemented, it leads to undesirable outcomes, and suggests that different departments' policies must be aligned to tackle climate change and the transition. On the same note, Burton, Lott and Rennkamp (2018) assert that encouraging the expansion of coal operations undermines the need for energy policies that are in line with climate change targets and that policies that favour additional coal investments represent a lack of political commitment to the clean energy transition. All government ministries' policies need to be in sync with one another and with the global climate change policy targets.

The global policies were also identified as lacking the provisions for RE incentives. Incentive policies have been proven to be an important force in driving the rapid development of RE (Boluk and Kaplan, 2022; Zhao, Chen, and Chang, 2016). Qadir, *et al.* (2021) suggest various incentives currently used in different countries to promote RE deployment such as "*Tax or Financial Incentives (Tax Support and Financial subsidy or loans) common in China, USA, India, Brazil, Australia and the EU; Research and Development Incentives (R&D Support and Establishment of R&D Institutions) common in China, USA, India, Brazil, Australia, and the EU; Market Incentive (Auctions and Quotas) available in Brazil, and Market Regulation and Development Plans used in China and Germany; Grid Connection Incentive (FiTs) and Net Metering (NM), common in China, Brazil USA, India, Australia, the EU, and Belgium, Incentive via Regulations (Green Certificates and Power Purchase Legislations) common in USA, India, Brazil, Australia, and the EU, and Defined Targets common in the Baltic States*". Countries can learn from each other and adopt various incentive policies that have been proven to be effective for a successful transition.

In addition to policies, the global respondents were further engaged on the strategies that countries could embark on for a successful transition. The strategies cited across continents were somewhat similar, though their order of priority differed. Respondents from various African countries consistently indicated that having clear renewable energy policies would accelerate the transition, thereby ranking it the most important strategy. Other strategies included grid access, financial investment, incentives, and privation, with the first being more important than the last. In the USA, on top of the list was the development of green hydrogen, followed by electrification of vehicles, incentives, clear policies, and the least important strategy being public awareness. The European respondents cited the mix of various energy technologies as the most important strategy for a successful transition, followed by battery storage, incentives, and prioritising hydrogen; clear policies was at the bottom of their priority ranking. In Asia RE technology development was cited as the leading strategy, followed by promoting RE awareness, incentives, financial investment, and the least being manufacturing RE components locally.

The differences in priority rankings may have been driven by the different developmental stages the different continents are currently at. In Africa, inadequate policies are still a major issue as the transition is in its early stages and still evolving. According to the RES4Africa Foundation (2023), for Africa to attract private-sector investment in RE, its legislative and regulatory frameworks need to be updated. Furthermore, Ambole, Koranteng, Njoroge and Luhangala (2021) add that Africa needs an enabling policy environment to foster RE growth and sustainability.

In already developed states such as the USA, with already-established policies, the development of green hydrogen and investment in diverse energy sources respectively were on top of the strategies list. Terra (2023) states that "*in recent years, most of the investments dedicated to the energy transition in the USA have gone towards solar, wind, energy storage, and electric vehicles; green hydrogen has been neglected, but it can be a key strategy to redefine the energy landscape towards the net zero path"*. In relation to Europe, Cavina, Milanesi, Milanesi, Tai and Winter (2023) state that by 2030, the EU wants to increase the share of renewable energy from the current 22 per cent of the final energy mix to 45 per cent.

The Asian respondents cited that their RE technologies were lagging, as they always have to depend on Europe, hence the suggestion of the improvement in RE technology was identified as the leading strategy for a successful transition. According to the WEF (2023), *"the Asia region is home to five of the 10 largest emitters in the world, which are China, India, Indonesia, Japan, and South Korea, and the continent accounts for about 45% of global greenhouse gas emissions due to its significant population"*. Furthermore, Asia is a diverse region that necessitates localised solutions therefore, investments in research and development of novel technologies, like green hydrogen, are necessary (WEF, 2023). Given Asia's significant contribution to global emissions, its climate impact must be taken into consideration when discussing global climate change response.

The global respondents further identified the challenges or barriers that exist in the transition to RE in their respective nations. African respondents cited the deficiency of legislative framework as the leading barrier to the transition, then a dearth of political will, deficiency of finance, shortage of skills and the least important being entrenched fossil fuel interests. USA ranked the entrenched fossil fuel interests on top of the list of barriers to the transition, followed by restricted market entry, misinformation about RE technology, inadequate clean energy policies, and lack of political will. In Europe, entrenched fossil fuel interests were identified as the leading barrier, followed by greenwashing communication, inadequate transmission network, lack of diversity in the energy mix, and inadequate clean energy policies as the least on the priority list. Asia also had entrenched fossil fuel interests as the leading barrier, followed by dependence on international investment, lack of incentives, lack of financial investment, and corruption as the lowest on the priority list.

The African respondents indicated that the weak legislative framework has a sturdy adverse impact on RE deployment. One research participant cited that:

> *The weak energy regulatory framework and the inconsistencies among regulations create a huge confusion with regards to implementation, thereby hindering the RE deployment.*

According to the ECA (2023), Africa needs to strengthen its policy and regulatory frameworks to ensure adequate investment in renewable energy. Furthermore, Ngulube (2023) alludes that since the 1990s, around 70% of countries across the developing world had established regulatory agencies and enacted new legislation to improve the performance of the power sector. However, numerous case studies show that the implementation remains a challenge in low- and middle-income countries. This in an indication that African countries similar to South Africa still battle with policy inadequacy and lack of implementation, which need to be addressed for a successful transition.

The USA, European and Asian respondents cited that the continued dependence and investment in fossil fuels make the transition much harder to achieve. One research participant stated that:

> *The entrenched fossil fuel interests are a major hindrance to the transition. Many governments still depend on coal, oil and gas for their economic existence, and fossil fuels remain a major source of wealth and power for many countries, which makes it difficult for politicians to act against such vested interests.*

According to Stoddard, Anderson, and Capstick *et al.* (2021), the global emissions curve shows an upward trend, with more carbon dioxide emitted in the past three decades than ever before throughout history. The purposeful political strategies of interest groups, particularly the fossil fuel industry and related sectors, are blamed for this growing trend. The majority of industrialised nations, including Germany, the United States, and Australia, have come under fire for refusing to acknowledge fossil fuels as the primary driver of climate change. Countries such as Germany have continued coal subsidies, and China has continued domestic and foreign investment in fossil fuels. In addition, numerous studies have demonstrated how governments with powerful interests have devised plans to quietly postpone the necessity of reducing dependency on fossil fuels and to openly refute the evidence behind climate change (Dunlap and McCright, 2015; Boon, 2019). Some hydrogen companies run programmes of misinformation (Grasso, 2019; Franta, 2018) and it is believed that nations including the United States, Australia, the United Kingdom, Canada, and Europe with strong fossil fuel interests have employed those tactics (Farrell, 2016; Hudson, 2020). The findings demonstrate that the barrier of firmly entrenched fossil fuels is not solely a South African problem but a global one that will require international cooperation to address it for a successful transition.

5.5 Conclusion

The first objective of the study was to explore the institutional, policy and strategic frameworks that exist within which South Africa can embark on for a successful transition from coal to renewable energy sources. The findings showed that the government played mainly four leading roles in the energy transition, which were providing institutional direction, legislative direction, financial support, and project oversight to the energy sector. It was also evident that the energy transition discussion calls for a combined effort of many institutions and stakeholders, such as the DMRE, NERSA, ESKOM, the Local and Provincial Government/Municipalities, the IPPPP, and support organisations such as commercial and development banks, civil society, business organisations, international development agencies, and research and advisory entities. According to Singh (2023), strong institutional capacities have allowed nations like China, Germany, and Denmark to successfully execute ambitious RE programmes and make the transition to sustainable energy systems. Furthermore, it was clear that executing energy transition plans is difficult for countries with poorer institutional ability, like the majority of developing nations in Africa and Southeast Asia (Jordan *et al.,* 2018). Institutions must be capacitated with a competent workforce and adequate financial resources to enable them to deliver on their mandate for a successful energy transition.

In addition to providing institutional direction, the findings showed that the government has a legislative mandate of drawing up of laws and policies. Andreoni *et al*. (2022) suggest that the speed, extent, and effectiveness of an energy transition can be significantly impacted by a government's capacity to successfully design, carry out, and oversee policies and programmes related to the transition. For an effective transition in South Africa, there is a dire need for policy, legislative and regulatory overhaul, and the reorganisation of the power supply sector (Andreoni *et al.*, 2022). In addition to providing legislative direction, the findings demonstrate the crucial function that the government plays in capacity building and providing financial support in the energy sector. Winkler, Tyler, Keen and Marquard (2023) suggest that ESKOM's financial difficulties are placing a burden on the national budget thereby impacting South Africa’s transition efforts. The government may need to adopt other means of supporting renewable energy projects, which do not involve ESKOM, to fast-track the transition. Another role of the government is that of providing project oversight to the energy sector. In providing project oversight, the government determines how much renewable energy capacity must be added to the electricity grid. The findings showed that the government provides project oversight through the REIPPPP where, according to ICLG (2023), under rounds 1 through 5 of the REIPPPP, a total of 99 RE projects with a variety of technologies, including onshore wind, solar PV, solar CSP, landfill gas, biomass, and small hydro projects, were in operation as of March 2023.

The findings further suggested five key transition elements, namely infrastructure, governance, legislation, stakeholders’ perceptions, and skills, with the first being the most critical and the last being the least. It is evident that developing and improving the different parts of the energy infrastructure, such as generation infrastructure through new power plant builds, systematic maintenance of existing infrastructure, improving transmission infrastructure through strengthening existing substations and optimising them to allow the feeding-in of other alternative forms of energy and expanding the distribution infrastructure, would be highly transformative in the transition.

In addition to the key elements, the study findings suggest allocating sufficient funding to the field of RE as the leading strategy for a successful transition, followed by privatisation, and diversification at third place. Other strategies identified included consistency in rolling out bid windows, improving the legislative framework, improving grid access and integration, skills development, localisation of RE components manufacturing, providing incentives, and increasing consumer awareness about renewables.

The second objective was to identify challenges and opportunities that exist or hinder the transition in SA. The findings suggested political interference and corruption, lack of financial investment, inadequate policies and legislation, inconsistency in rolling out bidding windows, the monopoly held by ESKOM, the costly nature of renewables, limited incentives, inadequate skills and technology, the labour unions, and lack of awareness about alternatives, as barriers to a successful transition, with the first being the most critical and the last being the least important. Given the most critical barrier of political meddling and corruption, Basavarajappa (2020) alludes that political corruption results in the misallocation of resources where money intended for services is taken from the government and used for personal benefit.

The third objective was to explore ways in which developments in the international policy frameworks influence SA's ambitions to transition from coal to RE. Findings show that challenges of policy inadequacy are a global phenomenon that all governments need to address to achieve their transition objectives. Various reasons for policy inadequacy were cited and ranked according to priority, which included lack of an implementation mechanism, insufficient clean energy targets, insufficient financing provisions, contradictions, and lack of provisions for incentives, with the first being more important than the last.

The findings further outlined the international strategies that countries could embark on for a successful transition. The strategies cited across continents were somewhat similar, though respondents differed in their order of priority. Respondents from various African countries consistently indicated that having clear renewable energy policies would accelerate the transition, thereby ranking it the most important strategy. Other strategies included grid access, financial investment, incentives, and privatisation, with the former being more important than the latter. In the USA, on top of the list was the development of green hydrogen, followed by electrification of vehicles, incentives, and clear policies; the least important strategy was public awareness. The European respondents cited the mix of various energy technologies as the most important strategy for a successful transition, followed by battery storage, incentives, and prioritising hydrogen; clear policies was at the bottom of their priority ranking. In Asia, the development of RE technology was the leading strategy, followed by promoting RE awareness, incentives, and financial investment, and the least was manufacturing renewable energy components locally.

The global challenges or barriers that exist in the transition to RE are outlined. In Africa, the inadequacy of the legislative framework was identified as the leading barrier to the transition, followed by the dearth of political will, deficiency of finance, and lack of skills, with the least important being entrenched fossil fuel interests. The USA ranked entrenched fossil fuel interests on top of the list of barriers to the transition, followed by restricted market entry, misinformation about RE technology, and inadequate clean energy policies, with a lack of political will being at the end of the priority list. In Europe, entrenched fossil fuel interests was identified as the leading barrier, followed by greenwashing communication, inadequate transmission network, and lack of diversity in the energy mix; inadequate clean energy policies was the lowest on the priority list. Asia also had entrenched fossil fuel interests as the leading barrier, followed by dependence on international investment, lack of incentives, and lack of financial investment, with corruption as the least priority. This research contributes to the knowledge on the institutional, legal, and strategic frameworks needed for South Africa to navigate an effective transition.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This closing chapter of the thesis is dedicated to concluding the study and putting forward recommendations for a successful transition from coal to RE. The chapter is divided into three main sections. The first section provides a summary of the main findings and their implications, as extracted from the study. The second section presents the policy recommendations on energy transition matters to inform decision-making. The final section outlines the future research recommendations informed by the identified knowledge gaps.

6.2 Summary of Key Findings

The study sought to address the following research questions: (1) the institutional, policy, and strategic frameworks that exist within which South Africa can embark on for a successful transition from coal to renewable energy sources; (2) the challenges and opportunities that exist or hinder the transition; (3) ways in which developments in the international policy frameworks on renewable energy can influence SA's ambitions to transition from coal to renewables; and (4) the implications of the findings of this study in a broader context, particularly in Southern Africa. To answer these questions, energy transition data from various sources was examined, and the main findings and their implications are summarised below:

i. To answer the first research question, the findings showed that the government played mainly four leading roles in the energy transition, which were providing institutional direction, legislative direction, financial support, and project oversight to the energy sector. The quality of institutions and the ability of governments to set appropriate regulations is crucial to the energy transition. Corruption, incompetent administrators, and political deployments, among others, reduce the effectiveness of government institutions, which in turn undermines the development or effectiveness of policies. The other government's role is to provide financial support, and findings showed that fulfilling this role requires an intentional and integrated financing plan to be strategized and implemented. The study identified various financing mechanisms such as grants, loans, and tax incentives that SA can introduce for a successful transition. Furthermore, the findings showed that the government provides project oversight by establishing an environment that is supportive of renewable energy projects, committing to support RE implementation and changing policies to allow for the expeditious consideration of all licences, permits, authorizations, and approvals. The South African government has been found lacking in fulfilling these roles, as evident in the continued rolling blackouts attributed to the mismanagement of ESKOM, lack of policy implementation, insufficient RE financing mechanisms, and inadequate project management, where projects are rolled out without sufficient grid infrastructure for the IPPs to connect to the grid.

ii. Continuing with the first research question, the study identified five key transition elements, namely infrastructure, legislation, governance, skills, and stakeholders' perceptions. Both literature and primary sources emphasised that developing and improving the generation, transmission, and distribution infrastructure would be highly transformative in the transition. In addition to the infrastructure, respondents identified legislation as another critical element to spearhead the transition, stating that clear renewable energy policies and execution can transform the energy sector. The findings also demonstrated that strong leadership from legislators and energy regulators, and solid, predictable governance, are essential for the energy transition's pace, and eventual success. Regulators have the power to change the course of investment, accelerate or slow down the process of decarbonisation, and support or restrict rival technologies. In addition to governance, the findings demonstrated the importance of skills in driving the change, noting that a shift to the new energy system would require a complete reconfiguration of the labour market. Stakeholders' perceptions are also crucial in the transition as they determine transformation rejection or acceptance.

iii. The study also identified ten strategies for a successful transition, namely channelling adequate financial resources to the renewable energy sector, privatisation, diversification, consistency in rolling out bid windows, improving the legislative framework, improving grid access and integration, skills development, localisation of RE components manufacturing, providing incentives, and increasing consumer awareness about renewables. It was evident that most financing mechanisms come with high-interest rates, which makes the establishment of renewable energy projects challenging. Making capital more affordable and coming up with diverse financing mechanisms can unlock significant development of the RE sector and aid in the transition. Findings also suggested that the privatisation of ESKOM can aid in its function, and once ESKOM is functional, any attempts to transition from coal to renewables will not be marred by opposition or seen as a threat to its existence. In addition to privatisation, diversification was also cited as one of the strategies that can allow citizens to absorb the shock in the current coal-powered system through use of other available alternatives. Another strategy was that of consistency in rolling out bid windows. The break in allocating IPP projects caused uncertainty in the market and slowed growth. Another strategy for a successful transition was the manufacture of renewable energy components locally. Both literature and primary sources suggest that the manufacturing of components locally will create new industrial value chains which will contribute to RE cost decline, expand productive capacity, and increase competitiveness. In addition to manufacturing components locally, the study showed that incentives have, over time, shown their success in encouraging the advancement of RE. It was found that the RE sector has limited incentives compared to fossil fuels that enjoy various government subsidies. In addition to incentives, increasing consumer awareness was also identified as one of the strategies for a successful transition. Consumers are likely to invest in something where they are aware of its benefits, hence the need to invest in increasing consumer awareness about available RE alternatives.

iv. In response to research question 2 of the study, ten barriers or challenges to the transition were identified, namely political interference and corruption, lack of financial investment, inadequate policies and legislation, inconsistency in rolling out bidding windows, ESKOM’s monopoly, high cost of renewables, dearth of incentives, deficiency of skills and technology, labour unions, and ignorance on alternatives. The study demonstrated that the energy sector in South Africa is highly controlled by the political system and political management, which interferes with many energy-related processes and decisions for their gain. Another notable barrier identified was the high initial investment costs of renewables for resources such as technology, skills, components, land, infrastructure, and social aspects. In addition to high initial set-up costs, another aspect raised was the exorbitant lending costs for financing RE projects. In addition, the study showed that policy inadequacy was a hindrance to the transition, citing that the existing policies were contradictory and lacked integration across government spheres. Delays and inconsistent procurement timelines for IPP projects were also cited as harming the continuous development and investment into renewable energy. Another barrier identified was the monopolistic nature of the energy system, where the sole power utility ESKOM is responsible for generation, transmission, and distribution, with suggestions for an independent system operator. Another hindrance to the transition in South Africa identified was the lack of incentives. Until the new Taxation Laws Amendment Act, 2023, signed into law in December 2023, South Africa had limited incentives in place to encourage RE deployment. A further concern was the lack of skills needed for work in the field; research has shown that the inability of people to run and maintain the technical systems in renewable energy projects has led to their failure. In addition to skills, the findings suggest that trade unions can be a powerful impediment to energy sector reforms, thereby hindering the transition. The study also showed that the general lack of knowledge regarding the advantages and potential of renewable energy was a hindrance to the transition.

v. In response to research question 3, the study showed that globally, a wide gap exists between energy policy ambitions and implementation. Literature and primary sources cited that many countries signed the Paris Agreement and committed to the reduction of greenhouse gas emissions, but struggle with meeting the implementation targets. The findings also showed that apart from policy implementation, global policies have insufficient clean energy targets, are contradictory and lack financial and incentive provisions. Other countries were identified to have better energy policies than others, and it was suggested that countries share the knowledge and adopt various policies that have been proven to be effective for a successful transition.

Based on the detailed findings presented in the study, the conclusion can be drawn that the energy transition in South Africa faces significant challenges and requires a multifaceted approach to overcome barriers and achieve success. The study emphasised the critical roles of the government in providing institutional direction, legislative support, financial backing, and project oversight for the energy sector. The study further highlighted the importance of clear renewable energy policies, strong governance, adequate financing mechanisms, and stakeholder engagement in driving the transition. Moreover, key strategies for a successful transition, such as channelling financial resources, privatisation, diversification, legislative improvements, skills development, local manufacturing of renewable energy components, incentives, and increasing consumer awareness were highlighted. In addition, the study outlined various barriers to the transition, including political interference, financial constraints, policy inadequacies, ESKOM's monopoly, high costs, lack of incentives, skills shortages, labour union challenges, and a general lack of awareness about renewable energy alternatives. Overall, the study underscores the need for comprehensive reforms, collaborative efforts, and effective policies to navigate the complexities of the energy transition in South Africa and globally.

6.3 Policy Recommendations

The study proposes several recommendations for a successful transition from coal to renewable energy, as listed below:

i. Several strategies that South Africa can implement for a successful transition were identified; however, South Africa's efforts alone will not change the world's impact climate without a combined effort from all countries. South Africa, as the 13th biggest GHG emitter in the world, contributes only 1% of the global emissions, which suggests that South Africa's transition efforts alone, although necessary, will not make a huge impact in turning around the world's climate change trajectory. Various countries have been known for not meeting their NDC targets for reducing greenhouse gas emissions, and not submitting the toughened targets every 5 years as per the Paris Agreement requirements, with no consequences. The submission of the NDC targets is not compulsory, and countries can change or re-submit their NDCs, or ignore them, and there are no sanctions. The study recommends that South Africa's transition efforts be supported by cooperation from all countries, including those in the global North, and China. The UNFCCC must design enforcement strategies to hold countries accountable for their climate commitments, as the current mechanism does not have any enforcement provisions.

ii. The study suggested the reskilling of employees occupying coal related jobs to work in the RE Sector. The study recommends multisector reskilling of employees. The reskilling programmes must consider that not all employees in the coal value chain may be interested in or absorbed into the RE sector, some due to age, literacy levels, preferences, and the low full-time equivalent (FTE) of RE jobs versus fossil fuel jobs.

iii. The findings showed that there is limited funding and support for progressive technologies, especially in their research and development phase. The government must fund and support progressive technologies and business models, such as virtual power plants or aggregators, smart grids, prosumers, granular tariff structures, and energy storage.

iv. Institutional quality was a concern, with inefficiencies attributed to cadre deployment and corruption, amongst others. The review of cadre deployment policies is recommended. A mechanism to uproot corruption must be implemented, and offending officials must be held accountable for their actions.

v. The RE funding and incentive mechanisms were found lacking. The study recommends that the South African government adopt other funding and incentive programs that have worked well in other countries, such as FiTs, energy usage quotas, and grants.

vi. The study found various policy challenges which include contradictions, obsolescence, and lack of implementation. The government must ensure that energy policies evolve to match changes in energy systems. Priorities and actions need to be clearly articulated, and the responsibilities of all stakeholders involved in the execution of energy policies need to be clearly defined. Monitoring, evaluation, feedback and enforcement mechanisms need to be designed and implemented.

vii. Stakeholder engagement and community support programmes need to be established and implemented well ahead of the execution of any power plant decommissioning. Stakeholder engagement and community support programmes must start at the early stages of project planning, not only at the Environmental Impact Assessment phase when decommission is about to commence. Often decommissioning projects leave employees and nearby communities with unanswered questions and uncertainty due to lack of, or delayed stakeholder engagement at the planning phases of decommissioning projects. The decommissioning of the Komati Power Station left employees distressed and uncertain about their jobs due to a lack of early stakeholder engagement. Stakeholders must be engaged on issues of legacy, heritage, land management, and livelihood restoration, among others, at the early stages of project planning.

viii. Recently, four South African trade unions joined forces in November 2023 to establish a Just Transition research facility to provide the unions with the technological know-how needed to address the threats that the energy transition presents to workers. This initiative currently has private funders. The government must support and fund such initiatives by trade unions to ensure trade unions contribute positively to the transition.

ix. Political interference was found to be of concern in the transition. The government procurement systems need to be tightened, and offending politicians must be held accountable.

x. The monopoly nature of ESKOM needs to be transformed. The study suggests that the unbundling of ESKOM needs to be followed by privatisation and opening avenues for new entrants in the market.

6.4 Future Research Recommendations

i. This study focussed mainly on the electricity generation sector transition. Further study needs to look at how all sectors with activities that emit greenhouse gases, such as chemical and fuel manufacturing companies, transportation, farming, and housing amongst others, can transition to a green economy.

ii. The study did not dwell much on how energy-intensive industries can transition from coal to renewables. Reference is made to Sasol, the world’s largest coal-based fuel producer, which has been forced to scale down its operations in Secunda due to pressure to reduce emissions. Further research can look at how heavy energy-consuming industries can transition to a green economy while continuing with their economic activities.

iii. The study focussed on national governments' role in the transition. Further research can investigate intergovernmental roles in the transition, referring to initiatives such as the Southern Africa Power Pool, Nordic Power Pool, and the European Power Pool.

iv. The study concentrated on the energy transition perspectives mainly of government and renewable energy organisations. Further research needs to be done on the energy transition perspectives of organisations in the fossil fuels value chain, such as coal mines and synthetic fuel manufacturers.

v. The study focused on energy transition barriers that the national government has control over. Further research can focus on the energy transition barriers arising from external forces, or beyond the national government’s control.

vi. Another possible area of research is to investigate the role of Artificial Intelligence (AI) in the energy transition.

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APPENDICES

Appendix A: Interview Schedule

INTERVIEW SCHEDULE

FOR ENERGY EXPERTS IN GOVERNMENT AND PRIVATE ORGANISATIONS IN SOUTH AFRICA

All answers will be treated as strictly confidential and will be used for academic purposes only.

INTERVIEW QUESTIONS ON PERSPECTIVES ON SOUTH AFRICA'S ENERGY TRANSITION FROM COAL TO RENEWABLE ENERGY

- Thank you for taking the time to take part in this interview.
- The interview will take +/- 90 minutes.
- You are free to withdraw from the interview at any point if you wish to.

Part 1: Background Information

1. Age: ___________
2. Sex: ___________
3. Please can you briefly outline your job role and responsibilities?
4. How long have you been in your current role? ________________________________

Part 2: Experience in the energy transition from coal to renewable energy

1. What is your take on the current energy challenges that South Africa is facing?
2. What is the role of government institutions in the energy transition?
3. In your view, what are the key elements to spearhead the transition?
4. In your view, what strategies can South Africa embark on for a successful transition from coal to renewable energy sources?
5. In your view, what are the challenges, barriers, and opportunities to the transition from coal to renewable energy in South Africa?
6. How can these challenges be overcome?
7. In your opinion, in what ways do existing national energy policies and legislation facilitate or hinder the transition from coal to renewable energy?
8. What do you think of the future of coal-dependent energy?
9. How, if at all, do you think the adoption of renewable energy can be accelerated?
10. Is there anything else you would like to add to your responses?

Thank you for participating in this research.

Appendix B: Research Questionnaire for South African respondents

FOR SOUTH AFRICAN ENERGY EXPERTS
All answers will be treated as strictly confidential and will be used for academic purposes only.
QUESTIONNAIRE ON PERSPECTIVES ON SOUTH AFRICA'S ENERGY

- Thank you for taking time to complete this questionnaire.
- The questionnaire will take +/- 30 minutes.
- Please tick (or cross) the appropriate box.
- Please indicate your own personal views on the space provided.

TRANSITION FROM COAL TO RENEWABLE ENERGY

Part 1: Background Information

1. Age: ___________
2. Sex: ___________
3. Job Title: ____________________________
4. Area of Specialisation (i.e. wind, solar, nuclear etc.): _____________________________

Part 2: Experience in the energy transition from coal to renewable energy

1. Are you familiar with your national energy policies/ legislation?

   Yes ☐ No ☐
2. If yes, provide a list of the policies and legislation your organisation works/ you are familiar with?

   ____

   ____
3. What do you think of their adequacy in addressing your organisation needs? Adequate ☐ Improvement required ☐

4. If improvement is required, what suggested improvements do you think must be incorporated?

   ____

   ____

5. In the absence of coal, do you think the renewable energy sector can be able to meet South Africa's energy demand?

Yes ☐ No ☐

6. What is the role of government institutions in the energy transition? Identify and rank them according to priority.

____

____

7. In your view, what strategies can South Africa embark on for a successful transition from coal to renewable energy sources? Identify and rank them according to priority.

____

____

8. What barriers or challenges do you think exist that hinder the transition from coal to renewable energy in South Africa? Identify and rank them according to priority.

____

____

What are the key elements to spearhead the transition? Identify and rank them according to priority.

____

____

____

THANK YOU FOR YOUR TIME

Appendix C: Research Questionnaire for Global respondents

FOR GLOBAL ENERGY EXPERTS

All answers will be treated as strictly confidential and will be used for academic purposes only.

QUESTIONNAIRE ON PERSPECTIVES ON SOUTH AFRICA'S ENERGY

- Thank you for taking time to complete this questionnaire.
- The questionnaire will take +/- 30 minutes.
- Please tick (or cross) the appropriate box.
- Please indicate your own personal views on the space provided.

TRANSITION FROM COAL TO RENEWABLE ENERGY

Part 1: Background Information

1. Age: ___________
2. Sex: ___________
3. Job Title: ____________________________
4. Area of Specialisation (i.e. wind, solar, nuclear etc.): _____________________________
5. Continent and Country: ____

Part 2: Experience in the energy transition from coal to renewable energy

6. Are you familiar with your country's energy policies/legislation?

   Yes ☐ No ☐

7. If yes, provide a list of the policies and legislation you are familiar with?

   ____

   ____

8. What do you think of their adequacy?

   Adequate ☐ Improvement required ☐

9. If improvement is required, what suggested improvements do you think must be incorporated?

   ____

   ____

10. In the absence of coal, do you think the renewable energy sector can be able to meet your country's energy demand?

Yes ☐ No ☐

11. In your view, what strategies can a country embark on for a successful transition from coal to renewable energy sources? Identify and rank them according to priority.

____

____

12. What barriers or challenges do you think exist that hinder the transition from coal to renewable energy? Identify and rank them according to priority.

____

____

13. If there is anything you are proud of about your country's energy outlook/ policies, what is it?

____

____

14. The renewable energy sector is given an equal opportunity to compete with non-renewable forms of energy in your country. Agree or Disagree.

____

____

____

THANK YOU FOR YOUR TIME

Appendix D: Research Participant Information Sheet 1

Research Participant Information Sheet 1

To energy experts taking part in an interview.

Investigator: Temperance Sebele

Student Number: 1618297

Supervisor: Prof. Mulala Danny Simatele

Research Title: From Coal to Renewable Energy: Perspectives on South Africa's Energy Transition for a Sustainable Future.

Dear Sir/Madam

My name is Temperance Sebele, a Doctor of Philosophy (Ph.D.) student in the School of Geography, Archaeology and Environmental Studies at the University of Witwatersrand, Johannesburg, South Africa. I am conducting a study on South Africa's energy transition perspectives for a sustainable future, moving from coal to renewable energy. I would like to invite you to participate in this study that will be conducted through a telephonic interview and/or Microsoft Teams. The interview will require approximately +/- 90 minutes of your time. The research records will be kept strictly confidential and all electronic information will have all biographical information removed and be securely stored in a password-protected computer. The data collected will be used for academic purposes only and will be destroyed five years after the completion of the thesis, and a copy of the thesis will be provided to you on request. The study is anticipated to provide long-lasting or permanent solutions to South Africa's current energy and climate change challenges. You were selected as a possible participant by your role as an energy expert in the study organization. There are no expected risks associated with the study and participation is voluntary. You may withdraw from the study at any stage when you feel uncomfortable, and the study is anonymous. We will not be collecting or retaining any biographical data and no payment or reimbursement is offered for taking part in the study. You have the right to ask questions at any stage of the interview. If you have any further questions about the study, at any time feel free to contact me on the email address and cell phone number provided below.

Purpose of the Study

The purpose of the study is to investigate strategies that South Africa can embark on for a successful transition from coal to renewable energy, to address climate change and sustainable development challenges. The challenges, barriers, and opportunities to an accelerated transition from coal to renewable energy and how the challenges can be overcome will also be explored. The existing energy policies and legislation will also be reviewed to identify factors that hinder or facilitate the transition from coal to renewable energy in South Africa.

Researcher Contact details

Study Investigator

Temperance Sebele

Phone Number: +27 83 342 8372

Email: 1618297@students.wits.ac.za

Supervisor

Prof. Mulala Danny Simatele

+27 11 717 6602/061 530 7348

mulala.simatele@wits.ac.za

Appendix E: Research Participant Information Sheet 2

Research Participant Information Sheet 2

To energy experts completing questionnaires.
Investigator: Temperance Sebele
Student Number: 1618297
Supervisor: Prof. Mulala Danny Simatele
Research Title: From Coal to Renewable Energy: Perspectives on South Africa's Energy Transition for a Sustainable Future.

Dear Sir/Madam
My name is Temperance Sebele, a Doctor of Philosophy (Ph.D.) student in the School of Geography, Archaeology and Environmental Studies at the University of Witwatersrand, Johannesburg, South Africa. I am conducting a study on South Africa's energy transition perspectives for a sustainable future, moving from coal to renewable energy. I would like to invite you to participate in this study that will be conducted through the completion of self-administered questionnaires. The questionnaires will require approximately +/- 30 minutes of your time. The research records will be kept strictly confidential and all electronic information will have all biographical information removed and be securely stored in a password-protected computer. The data collected will be used for academic purposes only and will be destroyed five years after the completion of the thesis and a copy of the thesis will be provided to you on request. The study is anticipated to provide long-lasting or permanent solutions to South Africa's current energy and climate change challenges. You were selected as a possible participant by your affiliation or professional membership in the study organization. There are no expected risks associated with the study and participation is voluntary. You may withdraw from the study at any stage when you feel uncomfortable and the study is anonymous. We will not be collecting or retaining any biographical data and no payment or reimbursement is offered for taking part in the study. You have the right to ask questions at any stage of the interview. If you have any further questions about the study, at any time feel free to contact me on the email and cell phone number provided below.

Purpose of the Study
The purpose of the study is to investigate systems and/or strategies that South Africa can embark on for a successful transition from coal to renewable energy to address climate change and sustainable development challenges. The challenges, barriers, and opportunities to an accelerated transition from coal to renewable energy and how the challenges can be overcome will also be explored. The existing energy policies and legislation will also be reviewed to identify factors that hinder or facilitate the transition from coal to renewable energy in South Africa.

Researcher Contact details

Study Investigator
Temperance Sebele
Phone Number: +27 83 342 8372
Email: 1618297@students.wits.ac.za

Supervisor
Prof. Mulala Danny Simatele
+27 11 717 6602/061 530 7348
mulala.simatele@wits.ac.za

Appendix F: Consent Form

Consent to Participate in a Research Study
For all research participants

Title of Study: From Coal to Renewable Energy: Perspectives on South Africa's Energy Transition for a Sustainable Future.

Study Investigator: Temperance Sebele

I hereby confirm that the study investigator has explained the purpose, nature, risks, and benefits of the study. I have read and understood the participant information sheet for the above study. I have been allowed to thoroughly go through the information, ask questions, and got answered satisfactorily. I am aware that the results of the study will be anonymously processed and understand that I am free to withdraw from the interview at any time when I feel uncomfortable without giving any reason. I confirm that I am more than 18 years of age and voluntarily agree to take part in the study without expecting any payment or reimbursement in return.

With my signature below, I confirm that I have been fully informed about my role in the study and agree to take part in an unstructured telephonic and/or virtual interview through Microsoft Teams.

____________________	____________________
Signature of Participant	Date

I, Temperance Sebele, hereby confirm that the above participant has been fully informed about the purpose, nature, risks, and benefits of the study.

____________________	____________________	____________________
Study Investigator (Print Name)	Signature	Date

Appendix G: Ethics Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Sebele

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H20/11/56**
PROJECT TITLE	From Coal to Renewable Energy: Perspectives on South Africa's Energy Transition for a Sustainable Future
INVESTIGATOR(S)	Ms T Sebele
SCHOOL/DEPARTMENT	Geography, Archaeology and Environmental Studies/
DATE CONSIDERED	20 November 2020
DECISION OF THE COMMITTEE	Approved Risk Level: Minimal
EXPIRY DATE	23 February 2024

DATE 24 February 2021 **CHAIRPERSON** ____________________ (Professor J Knight)

cc: Supervisor : Professor M Simatele

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to submit an amendment of the protocol to the Committee. **I agree to completion of a regular progress report. For Minimal and Low studies, this is due annually on 31 December. For Medium and High Risk studies, this is due twice annually on 30 June and 31 December.**

Signature ____________________ 24 / 02 / 2021 **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES