

https://dspace.org/

A Prognosis of the Application of Ackoff's Idealised Redesign Framework for Invoking a Just Energy Transition in South Africa

Mkhize, Zwelihle

2025

University of the Witwatersrand, Johannesburg

https://hdl.handle.net/10539/50167

Mkhize, Zwelihle. (2025). A Prognosis of the Application of Ackoff's Idealised Redesign Framework for Invoking a Just Energy Transition in South Africa [Master`s dissertation, University of the Witwatersrand, Johannesburg]. WIReDSpace. https://hdl.handle.net/10539/50167

Downloaded from a DSpace repository. https://dspace.org/

A Prognosis of the Application of Ackoff's Idealised Redesign Framework for Invoking a Just Energy Transition in South Africa

Zwelihle Mkhize

WITS Business School

A thesis presented in partial fulfilment for the degree of Master of Business Administration to the Faculty of Commerce, Law, and Management, University of the Witwatersrand

28 February 2025

Declaration

I, **Zwelihle Mkhize**, declare that this research report entitled 'A Prognosis of the Application of Ackoff's Idealised Redesign Framework for Invoking a Just Energy Transition in South Africa' is my own unaided work. I have acknowledged, attributed, and referenced all ideas sourced elsewhere. I am hereby submitting it in partial fulfilment of the requirements of the degree of Master of Business Administration at the University of the Witwatersrand, Johannesburg. I have not submitted this report before for any other degree or examination to any other institution.

Zwelihle Mkhize

Signed at Johannesburg on 28 February 2025

Name of candidate	Zwelihle Mkhize
Student number	401654
Telephone numbers	0827124622
Email address	zwelihle_mkhize@me.com
Date of report submission	28 February 2025
Name of supervisor	Dr Geoffry Heald

Abstract

This study was completed as a field case study with an immediate impact and practical implications for the production and consumption of energy in South Africa. The researcher undertook a prognosis of the application of Ackoff's Idealised Redesign and Interactive Planning methodology to invoke a Just Energy Transition in South Africa.

Research Question: The study answered the question whether there are any benefits to the planners of the South African energy system if the implementation of the Just Energy Transition were to be pursued with the help of the Idealised Redesign and Interactive Planning process.

Scope of the Study: The study was confined to the "mess formulation" component of Russel Ackoff's Idealised Redesign process.

Methodology: The study comprises (a) a theoretical phase, which addressed the first research question, being an examination of how the South African energy system is configured and operates; and (b) an empirical phase, which addresses remaining research questions. The theoretical phase of the study was completed through a review of internet documents; and the empirical phase was completed through interviews with five expert respondents, where the Delphi method of inquiry was followed.

Findings: South Africa's energy planners face not only technical and financial challenges but also profound social issues central to the Just Energy Transition. These deeper concerns, linked to inclusivity, identity, and development, are often overlooked due to the lack of a suitable problem-solving framework. The study identifies Idealised Redesign as crucial for clarifying the real challenges, forming a shared vision, and preventing solutions that create new problems. It also shows that while technical and financial complexities are acknowledged, the social complexity driven by deep-rooted conflict is underestimated. The transition is therefore part of a broader restructuring of South Africa's social system and its development trajectory. Overall, the study argues for a holistic, participatory, long-term planning approach to ensure a genuinely Just Energy Transition.

Key Words: Just Energy Transition, Interactive Planning, Idealised Redesign, Sociotechnical Systems, Energy Transitions, Delphi Framework, Wicked Problems, Social Complexity

Author: Zwelihle Mkhize **Supervisor** Dr Geoffry Heald

Thesis title: A Prognosis of the Application of Ackoff's Idealised Redesign Framework for Invoking a Just Energy Transition in South Africa

Johannesburg, 28 February 2025

TABLE OF CONTENTS

Declaration 1
Table of contents 4
List of tables 6
List of figures 6
ACKNOWLEDGEMENTS 7
1 INTRODUCTION TO THE RESEARCH 8
1.1 Purpose of the Study 8
1.1.1 Investigating the Application of Interactive Planning to the Just Energy Transition 8
1.2 Study Objectives 9
1.3 Context of the Study 11
1.3.1 The Just Energy Transition and Competing Paradigms 11
1.3.2 Socio-Technical Systems and Complexity 12
1.3.3 Environmental Sustainability 12
1.3.4 Energy, Sources and Transitions 13
1.3.5 The Energy System 13
1.3.6 Energy Transitions 16
1.4 Research Conceptualisation 22
1.4.1 The Research Problem Statement 22
1.4.2 The Research Purpose (Aim and Objectives) Statement 25
1.4.3 Research Questions 26
1.4.4 Delimitations And Assumptions of the Research Study 28
1.5 Significance of the Study 29
1.6 Preface to the Research Report 29
2 LITERATURE REVIEW 30
2.1 Research Problem Analysis: Symptoms, Root Causes, and Consequences 30
2.1.1 Competing Developmental Priorities 30
2.1.2 Weak Government Institutions and State Decline 31
2.1.3 Endemic Corruption 32
2.1.4 Socio-political Conflicts and Schisms 32
2.1.5 Consequences if the Problem is not Addressed 33
2.2 Research knowledge gap analysis 35
2.2.1 Introduction to the Research Gap Analysis 35
2.2.2 Research Gap Analysis Literature 36
2.2.3 Research Gap Analysis Conclusion 44
2.3 Qualitative Attributes Key to the Study 45
2.3.1 Introduction to Systems Thinking Literature Analysis 45
2.3.2 An Overview of Systems Thinking 46
3 RESEARCH STRATEGY, DESIGN, PROCEDURE AND METHODS 65
3.1 Introduction 65
3.2 The Research Strategy of the Study 65

3.2.1 Specific Reasons for the Qualitative Research Paradigm 66
3.3 The Research Design of the Study 68
3.3.1 Research Design: The Theoretical Phase and Internet Document Sources 70
3.3.2 Research Design: The Empirical Phase and Delphi Technique 71
3.4 Research Procedure and Methods 72
3.4.1 Research Data and Information Collection Process 72
3.5 Research Data and Information Collection Instrument(s) 75
3.5.1 Theoretical Phase Data Collection: Internet Documents 75
3.5.2 Empirical Phase Data Collection: Interviews 76
3.6 Research Target Population and Selection of Respondents 78
3.6.1 Selecting Respondents from the Target Population 78
3.6.2 Population of Interest and Target Population 79
3.6.3 Profile of the Respondents 80
3.6.4 Interview Process 82
3.6.5 The Delphi Method 83
3.6.6 Anonymity 84
3.6.7 Study Weaknesses 84
3.7 Ethical Considerations When Collecting Research Data 86
3.7.1 Introduction to Ethical Considerations 86
3.7.2 Approach to Maintenance of Ethical Standards 87
3.8 Research Data and Information Processing and Analysis 89
3.9 General Description of the Research Respondents 89
3.10 Research Strengthens—Reliability and Validity Measures 89
3.10.1 Introduction to Research Strengthens 89
3.10.2 The Importance of Reliability and Validity 90
3.10.3 Rigour and Conventional Measurement Validity 91
3.10.4 Trustworthiness and Measurement Validity in Qualitative Research 95
3.10.5 Generalisability in Qualitative Research 95
3.10.6 Trustworthiness as an alternative to reliability and validity 96
3.10.7 The Development of Alternative Criteria in Qualitative Research 97
3.10.8 Lincoln and Guba (1986)'s Alternative Measurement Validity Criteria for Qualitative Inquiries 97
3.10.9 Measures to Strengthen the Trustworthiness of the Proposed Study 100
3.10.10 Other Approaches to Improve Trustworthiness 101
4 RESULTS 106
4.1 Theoretical Phase Results 106
4.1.1 Theoretical Phase Introduction 106
4.1.2 Theoretical Phase Results 107
4.2 Empirical Phase 116
4.2.1 Empirical Phase Introduction 116
4.2.1 Empirical Phase Results 117
4.2.1 Conclusion of the Empirical Phase 126

5 DISCUSSION 130
5.1 Introduction 130
5.2 Discussion: Mess Formulation 130
5.3 Recommendations 134
5.4 Recommendations Regarding Future Studies 135
6 CONCLUSION 135
REFERENCES 137
APPENDICES 147
APPENDIX 1.1: DATA COLLECTION INSTRUMENT(S) 147
APPENDIX 2.1: SHORT BIO OF THE RESEARCHER 150
APPENDIX 2.2: ETHICS DOCUMENTATION 151
APPENDIX 3.1: FUNDING 151
APPENDIX 4.1: INVITATION PACK 151
APPENDIX 5.1: INFORMED CONSENT 164

List of tables

Table 1: Aim and Objectives of Study, as well as the Proposed Methodology 10
Table 2: Overview of Interactive Planning Process (Russell L Ackoff, 2001) 64
Table 3: First Study Objective, Restated 107
Table 4: First Study Objective, Restated 117
Table 5: Research Instrument for the Theoretical Phase of the Study 147
Table 6: Research Instrument for the Empirical Phase of the Study 150
Table 7: Code of Practice for Ethical Standards Involving Human Participants. Adapted from Oxford Brooks University (2010) in Saunders and Lewis (2012) 151

List of figures

Figure 1: Overview of Focus of Study – Adapted from (Russell L Ackoff, 2001) 11
Figure 2: Primary vs Secondary Energy (Watt Watchers of Texas, 2021) 15
Figure 3: Humanity's Energy Footprint (Loh & Wackernagel, 2004) 18
Figure 4: Predicted Energy Systems Leading up to 2050 (WorldOil, 2019) 21
Figure 5: HDI Index of Selected Sub-Saharan Africa Countries 31
Figure 6: South Africa's Country Dashboard - Fragile States Index (Fund for Peace, 2023) 32
Figure 7: Global and Hemispheric Anomalies from 1850 to 2023 (NOAA National Centers for Environmental Information, 2023a) 33
Figure 8: Global and Hemispheric Anomalies from 1850 to 2023-Africa Land Only (NOAA National Centers for Environmental Information, 2023b) 34
Figure 9: A Depiction of Systems Approaches by da Costa Junior et al. (2019) 51
Figure 10: Delphi Process Example - Extracted from Jones and Hunter (1995) 75
Figure 11: Populations and Samples in Research Studies - Adapted from Casteel & Bridier (2021) in Willie (2022) 79

=

ACKNOWLEDGEMENTS

I wish to express my gratitude to my family, Kabo, Sahlulo and Yenama for being patient with me while I embarked on this journey. You have provided me with much needed inpiration and fortutude. I also would like to aknowledge my colleagues, past and present for providing me with the professional insights and experiences that shape my worldview; and which have found expression in this work. The past and present colleagues at Shepstone & Wylie Attorneys, Sasol, and the Development Bank of Southern Africa have been most impactful. I could not have completed this journey without my extended formal and informal networks who have provided me with support and the opportunity to reflect on my ideas over the years. These include friends, associates and collaborators at organisations such as Transnet, Eskom, the Department of Minerals and Energy, ABSA, Shell, BP and many others. Special acknowledgement goes out to those individuals who made themselves available to help me gain access to study participants and other important resources. Among others, these individuals include my networks at the law firm Pinsent Masons, and the Infrastructure Fund and Kabo of ABSA Group Limited. I am unable to reveal the names of the experts who participated in the study, due to strict confidentiality requirements. However, I owe a debt of gratitude to each and everyone of you for your generousity of spirit and your willingness to step away from your work in order to participate in this research. Your passion and belief in South Africa's future is something that I will always try to emulate. Finally, my research supervisor and lecturer, Dr Geoffry Heald has not only meticulously supervised this study, but he has stretched and tested my thinking on the research topic, and inspired me to always find true meaning in the work. For this, I could not thank you enough.

1 INTRODUCTION TO THE RESEARCH

"Idealised design enables the system to do better in the future than the best it can do today"-Ackoff.

1.1 Purpose of the Study

1.1.1 Investigating the Application of Interactive Planning to the Just Energy Transition

The researcher explored the utility of the Idealised Redesign Framework as a means of navigating the complexities associated with bringing about the Just Energy Transition in South Africa. The study was conceptualised as a field investigation, which yielded practical recommendations with an immediate impact for the delivery and consumption of energy in South Africa.

The study was framed as prognosis of the application of Russel Ackoff's Idealised Redesign and Interactive Planning methodology (Russell L Ackoff, 1979a, 2001) to invoke a Just Energy Transition **(JET)** in South Africa. In the interests of brevity, the Idealised Redesign and Interactive Planning methodology is referred to simply, as **"Idealised Redesign"**.

Idealised Redesign is an interactive planning process, where stakeholders (i.e. the planners) work together, with the assistance of a facilitator, to prepare a vision of what they wish their organisation to be in the future, assuming there were no constraints standing in the way of their plans. After completing the design, the planners proceed to the next step; and focus on bringing their plan to life by closing the gaps between the envisioned future organisation and the present one.

Idealised Redesign is an incredibly powerful process grounded in rich theory. It has been developed and refined through decades of practical application. It is a group effort comprising two parts: idealisation (the designing of an envisioned future) and realisation (of the design)(Russell L Ackoff, 1993; Russell L Ackoff, 2001). The design must meet two conditions, i.e. it must be technologically feasible and operationally viable.
The study was confined to the "mess formulation" step of Idealised Redesign, which is discussed in Section 1.2 below. To complete the first step of the mess formulation process, the researcher initially conducted a theoretical exercise (da Costa Júnior *et al.*, 2020) to understand the nature of

the system, the problems manifesting within it, and the interrelationships between the system's parts (Russell L Ackoff, 1979b). This is the systems analysis aspect of the Idealised Redesign process.

Having completed the system analysis process, the researcher then worked with a small sample of experts and stakeholders to complete the rest of the mess formulation step (i.e. obstruction analysis, reference projections, and reference scenario). To obtain the respondents' views, semi-structured interviews were utilised within the consensus-building Delphi framework(Brady, 2015).

1.2 Study Objectives

The study aim was to complete the mess formulation process of Idealised Redesign as depicted detailed in **Table 1** below. The study strictly followed the Idealised Redesign steps laid out by Russell L Ackoff (2001). The output of the mess formulation process was a framing of the problem in the South African energy system, that hinders the successful invoking of a Just Energy Transition.

Idealised Redesign is a methodical and carefully applied framework, which the researcher followed as recommended by Russell L Ackoff (2001). In support of the study aim, the objectives of the study were broken down according to the steps of the mess formulation process, as follows:

Objectives	Research Methodology
i. **Step 1:** Providing an overview of how the South African energy system presently operates, encompassing the system's political, socio-economic, and technological components (Russell L Ackoff, 2001).	Theoretical exercise (da Costa Jùnior and others *(et al.)*, 2020), comprising an analysis of the South African energy system, utilising the qualitative attributes in Section 2.3 *(Qualitative Attributes Key to the Research)*.
ii. **Step 2:** Completing an obstruction analysis, by providing a description of the characteristics and properties of the South African energy system that	Delphi exercise (Brady, 2015).

	hinder the successful invoking of the JET (Russell L Ackoff, 2001).	
iii.	**Step 3:** Projecting aspects of the expected future of the energy system, assuming existing methods of energy distribution and consumption, as well as the predicted future environment, remain unchanged (Russell L Ackoff, 2001).	Delphi exercise (Brady, 2015).
iv.	**Step 4:** Providing a description of how and why the South African energy system, if the assumptions above were true, would destroy itself (Russell L Ackoff, 2001).	Delphi exercise (Brady, 2015).

Table 1: Aim and Objectives of Study, as well as the Proposed Methodology

The "Mess formulation" process is the first phase of Russell L Ackoff's Idealised Redesign framework. The completions of all the Idealised Redesign phases was not withing the scope of the study. The ommitted phases were "ends planning", "means planning", "resource planning", "implementation design", and "control design" (Russell L Ackoff, 2001). The rest of the Idealised Redesign process has been left for future studies.

Figure 1 below depicts the entirety of the Idealised Redesign process (Russell L Ackoff, 2001) and indicates the limited focus of the study. These are shown alongside the phases that are not in scope.

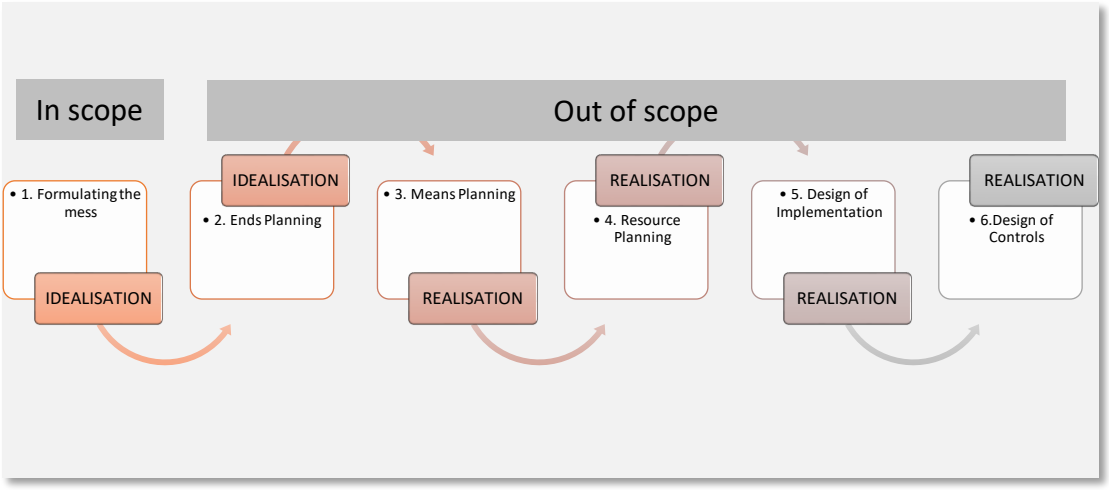


Figure 1: Overview of Focus of Study – Adapted from (Russell L Ackoff, 2001)

Phases 1 ("formulating the mess") and 2 ("ends planning") form part of the idealisation portion of the Interactive Planning process. Phases 3 to 6 are part of the realisation portion (Russell L Ackoff, 2001). The study focused on Phase 1, addressing only the initial part of idealisation.

1.3 Context of the Study

This Section 1.3 provides the context of the study and an overview of the key terminology and ideas used by the researcher in conceptualising the topic.

1.3.1 The Just Energy Transition and Competing Paradigms

The success or failure of the JET in South Africa will ultimately be determined by the balance of competing paradigms, one representing the proponents of the *status quo* (i.e. the "do-nothing" paradigm); and the other representing change (i.e. the "transition paradigm"). This balancing act is driven by the energy system's planners and stakeholders, who are presently engaged in a fierce power struggle that is characterised by conflicting vested interests, views and politically charged competition for influence (Smit, 2023). Stakeholder groups have made a bet on an envisioned energy future, but deep-rooted conflict hinders the charting of a clear path towards agreement and shared solutions.

In exploring the mess formulation process (Russell L Ackoff, 1979a, 2001) the researcher worked with a small group of carefully selected energy stakeholders and experts in the South African energy system. These respondents were invited to assist the researcher to frame the problem preventing the successful invoking of the JET in South Africa. The study ultimately

arrived at a set of conclusions and recommendations based on the consensus view of the respondents. "Framing the problem" is at the core of the mess formulation process (Russell L Ackoff, 1979a, 2001). Problem-framing process invites stakeholders to align on the definition of the problem before attempting to address it.

1.3.2 Socio-Technical Systems and Complexity

Energy transitions have a strong socio-technical aspect to them. The theory highlights the complexity of socio-technical systems (Andrew, 2001; da Costa Junior *et al.*, 2019; Healy & Barry, 2017; Kemp *et al.*, 2007; Kern & Smith, 2008; Markard *et al.*, 2012; Radhakrishnan, 2021). It is understood that problems arising within socio-technical systems are inherently complex (Banathy, 2009).

Complex or "wicked problems" problems are difficult to define. They have multiple potential causes and solutions. Some of the solutions have unintended consequences; and may very well cause other problems (Banathy, 2009; Jackson & Keys, 1984; Kmon, 2016). Among the complexities associated with JET implementation is an inadequately defined problem (as to the cause and effects), lack of alignment on viable solutions, and stakeholders with varying and often conflicting interests. These complexities and accompanying deeprooted conflict make it difficult to resolve JET challenges through simple, normal problem-solving methods such as negotiation, compromise or trade-off (Bloomfield & Ben Reilly, 1998). It therefore follows that the starting point is a carefully managed problem-framing process.
The value of Idealised Redesign in implementing energy transitions does have theoretical support (see, for example, Kemp *et al.* (2007)). This theoretical support provides a solid foundation for exploring the application of Idealised Redesign to South Africa's JET process.

1.3.3 Environmental Sustainability

The sustainability problem is a complex problem.

Environmental sustainability, energy security, and their impact on international and domestic relations are pressing global issues. Many nations are presently grappling with the implications of the sustainability challenge for their own socio-economic and developmental agendas. A unified response to climate change remains painfully elusive, with questions remaining unanswered

regarding responsibility for redress, the apportionment of blame, and the management of the negative impacts of climate change on development, industrialisation, jobs, trade, and industry.

To contribute meaningfully to the global debate, countries must consider their unique circumstances and contribute meaningfully to the Paris Agreement on Climate Change (UNFCC, 2015).

Further complicating matters is that developing countries, who are most in need of industrialisation, are often more susceptible to global warming effects, making it crucial for all of us to ensure a clear understanding of the nature of the problem (Radhakrishnan, 2021).

1.3.4 Energy, Sources and Transitions

Prior to the discovery of fire, humans relied on their own physical bodies for energy. The domestication of fire approximately 300,000 years ago marked the beginning of our relationship with external forms of energy (Harari, 2014). Scientists define energy as the ability to do work (Hicks, 1983). Generally, energy can be divided into various categories, including mechanical, thermal, nuclear, chemical, electromagnetic, sonic, gravitational, kinetic, potential, and ionisation energy (Helmenstine, 2020). However, everyday people often view energy differently. The Chambers Thesaurus and the Collins English Dictionary & Thesaurus define energy as "fuel", a "propellant", "motive power", "vitality" or "vigour". For the purposes of this study, energy means the different types of fuel that serve as sources of energy.

1.3.5 The Energy System

If Systems Thinking is to be the adopted approach for addressing a problem, the system in which the problem manifests itself should exhibit the properties of a system as outlined by systems thinkers (Russell L Ackoff, 1979a; Konkarikoski *et al.*, 2010; Lumbo, 2007; Stichweh, 2011). Systems Thinking is described in greater detail in the Literature Review in Section 2 below *(Literature Review)*, the underpinning theme being that the systems approach views the situation being investigated holistically, as a collection of varied interacting parts within a specific environment, where the behaviour of the system is influenced more by the interaction between the parts than by the nature of the individual parts themselves (Lumbo, 2007; Mingers & White, 2010; Sinn, 1998; Tejeda & Ferreira, 2014).

As part of the study scope, the researcher investigated the manner in which the South African energy system is configured and operates (See above - *Purpose of the Study).* This required an examination, among other things, of the elements of the system and how the elements interact with each other and with the environment in which the system is found (Lumbo, 2007; Mingers & White, 2010; Sinn, 1998; Tejeda & Ferreira, 2014). The researcher undertook this investigation as part of the theoretical phase of the research.

1.3.5.1 An Overview of the Energy System

Radhakrishnan (2021) highlights the complexity of the energy system, which comprises many interconnected parts. Humanity has advanced through various energy sources over millennia, including mechanical, thermal, and chemical energy. These energy sources form part of a system where energy is configured, sourced, and consumed in specific ways, contributing to the overall energy system (Helmenstine, 2020; McCauley *et al.*, 2019; Smil, 2004; Solomon & Krishna, 2011).

An energy system refers to the processes used to generate and consume energy, including extraction, conversion, and delivery to consumers (McCauley *et al.*, 2019). In order to fulfil its primary goal of delivering energy to users, an energy system requires various engineering and economic components working together for production, transformation, transportation, and distribution (Allwood *et al.*, 2014; Hoffman & Wood, 1975; School Energy & Environment, 2021). This interconnectivity aligns with the English definition of a "system" as a set of organs or structures performing a specific function (Collins English Dictionary, 2019).

An energy system consists of integrated technical and economic activities, including imports and domestic production, within a complex societal framework. The elements of the energy system therefore are technical activities, economic activities; and an environment including imports and domestic production (and consumption), as well as a complex societal framework.

Energy systems can be classified as "socio-technical systems" and studied under socio-technical multi-level theory (Anandarajah *et al.*, 2009; Healy & Barry, 2017; Hoffman & Wood, 1975; Kern & Smith, 2008).It is important to recognise the societal aspects of the energy system, because the energy system cannot be viewed separately from the societies it serves. The recognition of the socio-technical nature of energy systems is essential for understanding energy justice across various lifecycles (Anandarajah *et al.*, 2009; Healy & Barry, 2017; Hoffman & Wood, 1975; Kern & Smith, 2008).

A holistic understanding of the energy system requires that we distinguish between primary and secondary energy sources (Øvergaard, 2008; Watt Watchers of Texas, 2021). Primary energy refers to energy sources in their raw or natural form, prior to being transformed artificially, converted or stored into processed forms of energy (i.e. secondary energy) (Watt Watchers of Texas, 2021). The International Recognition for Energy Statistics (IRES) emphasises the importance of an internationally agreed definition of primary and secondary energy. However based on the current understanding, in order to accurately define primary and secondary energy, we consider whether the physical characteristics of the energy source change at capture (Øvergaard, 2008). **Figure 2** below demonstrates, at a high-level, the difference between primary and secondary sources of energy.

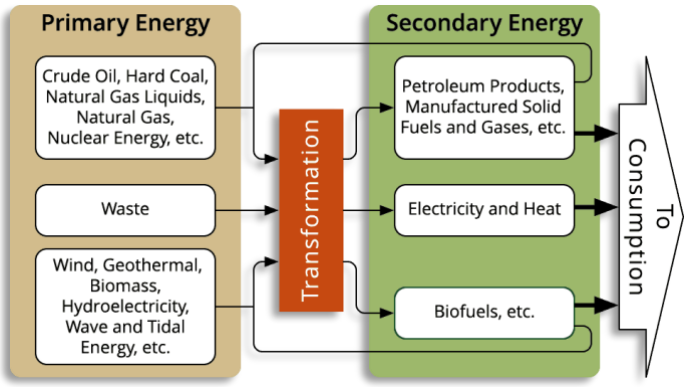


Figure 2: Primary vs Secondary Energy (Watt Watchers of Texas, 2021)

It is not always possible to determine the exact components and behaviours that make up a particular energy system, as this is largely dependent on the prevailing circumstances, the evolutionary path of the energy system over time, the assumptions made by the person undertaking the analysis, as well as trade-offs in respect of the different components within that system (Anandarajah *et al.*, 2009; Häfele & Sassin, 1977). It is partly for this reason that the configuration and operation of the South African energy system was investigated during the theoretical phase of the study.

The most important thing to note from the above discussion is that an energy system brings together various engineering and economic processes (the components of the system), which work together to source and ultimately deliver energy, and to satisfy societal needs (Anandarajah *et al.*, 2009; Hoffman & Wood, 1975; School Energy & Environment, 2021).

As a final but important point, one does need to consider whether the energy system under consideration is local, regional or global as this would influence the configuration and behaviour of its components (Häfele & Sassin, 1977).

1.3.6 Energy Transitions

The World Energy Council defines an energy transition as a significant, long-term, and structural change in energy systems, involving a shift from dominant fuel configurations to new ones (Smil, 2004; World Energy Council, 2021). This transition must be fundamental and system-wide, impacting how energy sources are interconnected and consumed (Smil, 2004); and does not include a mere change from one energy source to a new energy source, because one energy source does not make up the energy system (Anandarajah *et al.*, 2009; Hoffman & Wood, 1975; School Energy & Environment, 2021).

Further, the change should operate on "patterns of energy use in a society, potentially affecting resources, carriers, converters, and services" ('Connor, 2010, p. 2). This point underscores the importance of the societal link discussed in Section 1.3.5.1, where it is stated that energy systems cannot be viewed separately from the society that they serve (Kern & Smith, 2008). Change taking place as part of an energy transition could be understood to be taking place at a local, regional or global level, depending on the energy system and society being studied (Arya, 2021; O'Connor, 2010).

The known history of energy transitions dates back over 300,000 years, starting with the first *homo sapiens* who primarily used muscle power (Smil, 2004). This preceded a series of later, significant energy transitions. Over 250,000 years ago, the domestication of draft animals and the discovery of fire were significant transitions (Smil, 2004). The first settled societies used waterwheels and windmills to convert wind and water energy sources (Smil, 2004). The 18th century then saw a shift to engines and fossil fuels (Smil, 2004), followed by coal (Fouquet (2009) in Fouquet & Pearson (2012)), electricity, oil, natural gas, and nuclear (Smil, 2004). The 2000s saw a transition to renewables and nuclear energy (Fouquet & Pearson, 2012; Smil, 2004).

The paragraph above provides an overview of the main energy transitions that have taken place in the course of human history. The overview is not meant serve as the ultimate representation of all energy transitions because as stated previously, the manner in which a particular energy transition is understood depends on prevailing circumstances and the assumptions made by the

analyst concerned (Anandarajah *et al.*, 2009; Häfele & Sassin, 1977). There is always the possibility of a different representation, by a different analyst.

Presently, we are witnessing an energy transition from an energy system that is dependent on fossil fuels to one that prioritises renewable energy sources (Fouquet & Pearson, 2012). There is more than one prediction as to the form that the transition towards renewable energy sources could take. WorldOil (2019)presents the possible transition scenarios in an insightful chart, starting from transitions of the past and ending with predicted transitions of the future. The chart, which is reproduced in **Figure 4** below, demonstrates that notwithstanding the introduction of renewable energy sources, demand for crude oil is likely to remain until at least 2050.

An energy transition can be "natural" or involuntary, in the sense that it can occur almost spontaneously, as civilisations or societies evolve through time (García-García *et al.*, 2020; Leach, 1992). A transition can also be instigated by governments, so that it is voluntary, policy-based and painstakingly managed (García-García *et al.*, 2020; Leach, 1992). In other words, an energy transition can take place for different reasons. The reasons include a society's move towards better or more desired technology or, as is the case currently, it can be due to a drive to reduce strong reliance on fossil fuels (Friedlingstein *et al.*, 2019).

The current, ongoing transition away from fossil fuels, seeks to simultaneously embrace "greener" energy, by increasing reliance on renewable energy sources (Friedlingstein *et al.*, 2019). Green energy is still very much at its infancy (Larson, 2021) and as depicted in **Figure 4**, fossil fuels will yet remain part of energy systems for some time (Friedlingstein *et al.*, 2019; Smil, 2004; WorldOil, 2019). The shift towards greener energy comes from conscious and concerted efforts to achieve a more environmentally friendly energy system, this being an objective that the world's nations committed to at the 2015 Paris Climate Change Conference: COP21(Rhodes, 2016).

Energy transitions of the past typically fall in the "natural transition" category, while conventional wisdom is that the current transition mainly falls in the "policy-led" category (García-García *et al.*, 2020).This study was concerned with the policy-led energy transition towards green energy.

Transitions in energy systems are not clear-cut lines, and the beginning or end of a transition is a fluid concept. For instance, in some parts of Africa and developing countries, the transition from

animate to engine-powered vehicles and biomass to fossil fuels is still ongoing, despite the simultaneous transition to renewable energy sources (Smil, 2004). This is supported by the chart in **Figure 4** below, which shows that crude oil is likely to remain in use for years, despite the shift towards renewable energy sources.

1.3.6.1 The Just Energy Transition

1.3.6.1.1 JET and Energy Justice

Energy is crucial for national economies and human civilisation (Azam, 2020; Häfele & Sassin, 1977; McCauley *et al.*, 2019). Historically, humankind has utilised fossil fuels to accelerate industrialisation (Azam, 2020; Häfele & Sassin, 1977; McCauley *et al.*, 2019). However, this consumption of fossil fuels has led to environmental damage and long-term environmental sustainability challenges (Ranasinghe *et al.*, 2012).

Humanity's increasing energy footprint has led to high environmental costs due to rising carbon levels in the atmosphere (see Error! Reference source not found.**)**. As the implications of fossil fuel reliance become more evident, climate patterns and other environmental phenomena have prompted nations to consider alternatives for a sustainable energy future (Chapman *et al.*, 2018; Church *et al.*, 2008; Hoel & Kverndokk, 1996; Loh & Wackernagel, 2004; Ranasinghe *et al.*, 2012).

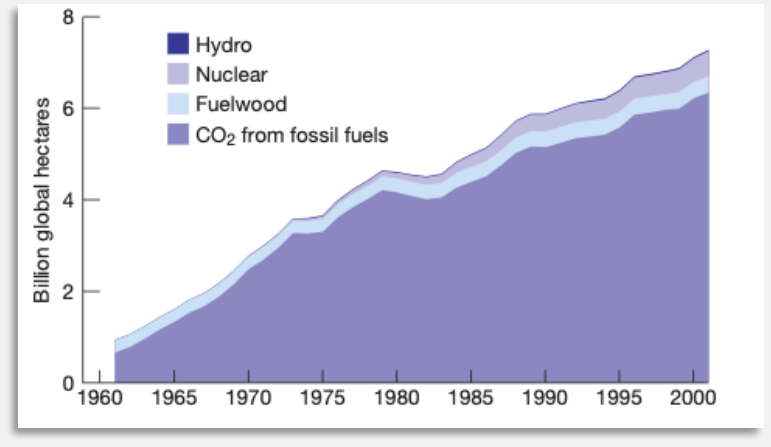


Figure 3: Humanity's Energy Footprint (Loh & Wackernagel, 2004)

The JET is a specific approach to achieving a voluntary energy transition. If we were to use García-García *et al.* (2020)'s categorisation of energy transitions as either natural or policy-led,

JET would fall under the category of "policy-led" transitions. JET is still a developing concept, which is in the process of being fully conceptualised, alongside a continuing search for agreement regarding the definition of the term (García-García *et al.*, 2020). As might be apparent from its name, JET is closely linked to, and has its roots in energy justice, which is recognised as an important perspective in energy decision-making (Healy & Barry, 2017; Pellegrini-Masini *et al.*, 2020).

To help energy planners make better decisions, Pellegrini-Masini *et al.* (2020)developed a comprehensive energy justice framework, which integrates distributive and procedural justice considerations.Pellegrini-Masini *et al.* (2020)'s energy justice framework proposes that an energy decision is socially and politically sound if it considers energy availability, affordability, due process, good governance, sustainability, intragenerational equity, and responsibility. Considerations under each of the components of Pellegrini-Masini *et al.* (2020)'s energy justice framework could include several areas of focus, such as, for example, the avoidance of stranded assets and any adverse impact on workers in legacy or current energy systems (Roberts, 2016).

Alongside technical considerations, the social perspective is important for understanding JET. The social perspective dovetails naturally with the classification of energy systems as socio-technical systems (Kern & Smith, 2008). The Systems Thinking literature reviewed in Section 2 *(Literature Review)* demonstrates that this is one of the main sources of complexity associated with the JET, which would make Systems Thinking appropriate as a problem-solving approach.

1.3.6.1.2 Brief Context Regarding the Origins of Energy Justice

García-García *et al.* (2020) propose that the origins of JET can be traced back to the union movement of 1970s America, where it first started to take shape as part of unionist Tony Mazzocchi's agitation for favourable working conditions for refinery employees. Mazzocchi's agitation focused mainly on working conditions (i.e. occupational safety and health in the workplace)(García-García *et al.*, 2020), but later the concept evolved and was diffused to other unionist branches, whereafter a slight decline of the movement then followed in the United States. Notwithstanding its decline in the United State, the JET concept nonetheless gained momentum in the rest of the globe, featuring prominently in the United Nations and European Union dialogue (García-García *et al.*, 2020).

In 2020, the policy and advocacy team of "Project 90" (Project 90 by 2030, 2020a) attended a roundtable discussion on JET, together with labour unions, civil society organisations and other stakeholders. During this discussion, the energy justice theme of JET was most pronounced, as the participants proposed that the priorities for a transformative JET include energy accessibility and affordability of supply, provision for workers in legacy energy systems, and socially or community based energy "ownership" (Project 90 by 2030, 2020a).

1.3.6.1.3 JET vs Sustainable Energy Production

The JET is to be distinguished from the concept of sustainable energy production , which preceded JET (García-García *et al.*, 2020). Sustainable energy production is only one of the considerations in Pellegrini-Masini *et al.* (2020)'s JET framework. The question of a Just Energy Transition is more comprehensive and cuts across the entire energy system, linking the contestation of energy systems utilised by mankind and the appropriateness of the individual components of the systems (McCauley *et al.*, 2019). JET requires a systemic perspective.

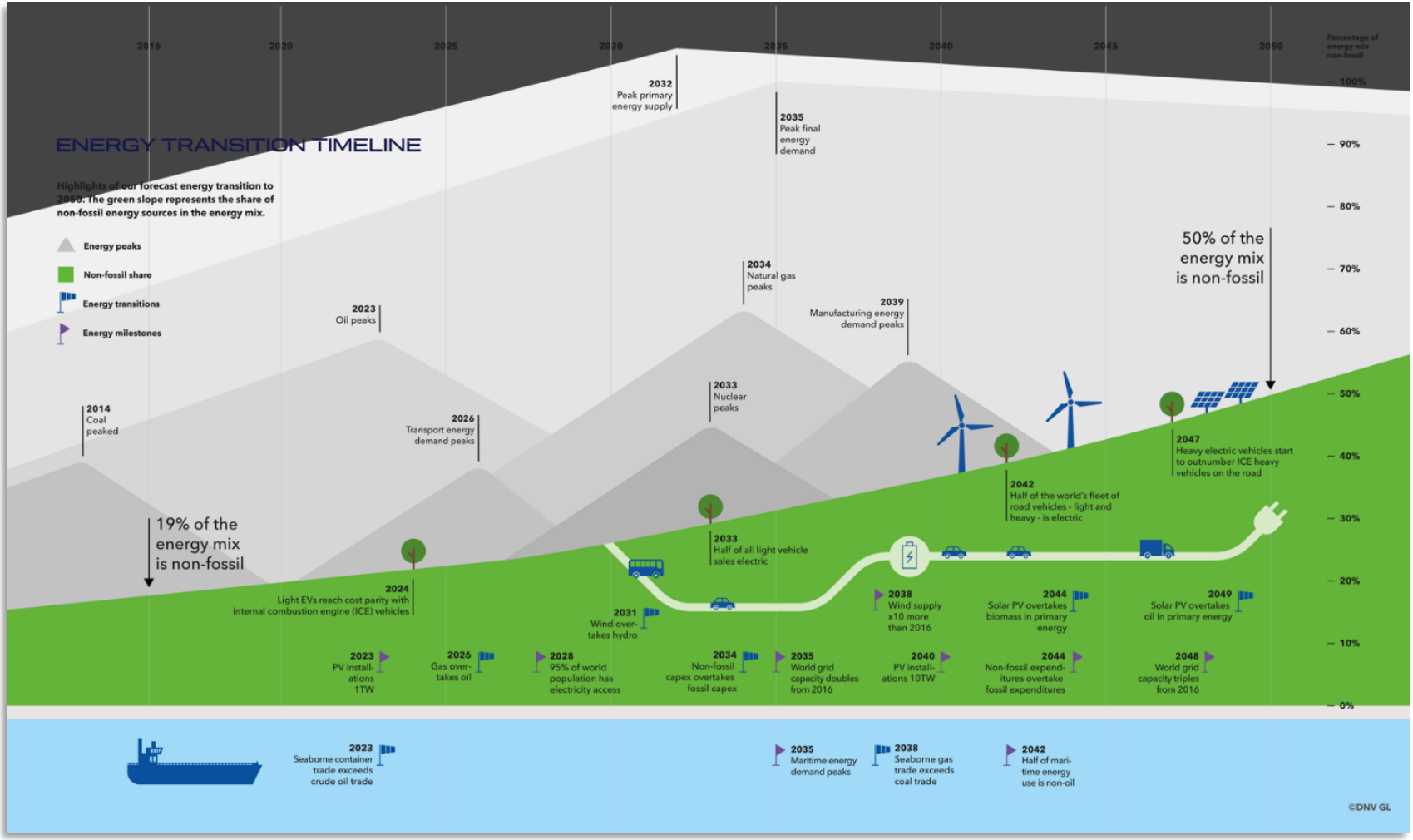


Figure 4: Predicted Energy Systems Leading up to 2050 (WorldOil, 2019)

1.4 Research Conceptualisation

The discussion below begins with a research problem statement (Section 1.4.1), followed by an outline of the research aim and objectives (Section 1.4.2). It then delves into the rationale for choosing the qualitative research paradigm (Section **Error! Reference source not found.**). The research questions are then presented (Section 1.4.3), followed by study delimitations and the study's significance in Section 1.5. A preface to the research report is provided in Section 1.6.

1.4.1 The Research Problem Statement

1.4.1.1 The Lack of a Suitable Framework towards Invoking a Just Energy Transition

There is a lack of a universally-agreed and suitable problem-solving framework towards invoking a just energy transition.

Notwithstanding the importance of the JET, the approach to South Africa's energy transition is seemingly fragmented and disjointed (Anekwe *et al.*, 2025; Mauger & Barnard, 2018). There are significant challenges in the practicalisation of the country's JET plans, most visible in among other things:

- the communities' lived experiences being omitted from the plannign of the transitions (International Institute for Sustainable Development, 2025);
- the slow pace of renewable energy delivery; and
- unsatisfactory measures to secure reliable, affordable energy (Anekwe *et al.*, 2025).

The resistance to the transition from coal remains (Anekwe *et al.*, 2025) despite the clear articulation by the government of the need for change. The primary feature of this lack of cohesiveness is a "top-down" approach by the governmet, which risks achieving the opposite of what is intended, inclusing worsening current inequalities (Makaula, 2025).

The fact of the matter is that while the country has an end-point in mind (i.e. bringing about a Just Energy Transition), there is much misalignment on the activities and priorities that require immediate attention. For example, the involvement of youth, skills development, empowerment, localisation and beneficiation (Makaula, 2025) are some of the areas of interest which are not

finding practical expression in current JET activities. Ramsarup *et al.* (2024) argues that learning pathways into JET-related skills and jobs remain unclear and fragmented (Ramsarup *et al.*, 2024)

This misalignment is despite the South African government having published the "Just Energy Transition Investment Plan: 2023-2027" **("JET-IP")** and put in place enabling instruments, such as the Climate Change Act 22 of 2024. Further, a Just Energy Transition framework was established through multi-stakeholder engagement (Government of South Africa, 2022).

The JET-IP and other related interventions by the government are indeed reasonable steps towards the implementation of the JET, but the lack of cohesiveness remains a problem that is yet to be resolved.

A question then arises as to what framework the stakeholders should rely on in designing and implementing a new energy future; and whether Idealised Redesign could be a viable approach for South Africa to understand energy justice; and successfully invoke the JET (McCauley *et al.*, 2019).

The above problem is characterised and exarcebated by the following sub-problems, which add to the complexity to the situation that has been described:

1.4.1.1.1 Contentions and Schisms

The implementation of South Africa's JET is beset with contentions; and there are growing schisms between energy justice proponents who demand change; and ruling elites who are supported by a powerful corporate power bloc that so far have had the power to determine what is possible, all while stalling the change (Bond, 2023).

South Africa is not the only country facing this difficultly. The propensity of energy transitions to be politicised is well-documented (Betsill & Stevis, 2016). There remains a need for cooperation (Halsey, 2017) and social dialogue (Creamer, 2019) to try and manage the high risk of disagreement between stakeholders (Now Media, 2019), as well as paralysis due to protracted debate and indecision (90 by 2030, 2020).

The schisms among some of the stakeholders in the South African energy system (Now Media, 2019) threaten to fester and defeat efforts to implement a sustainable change.

The coal industry continues to hold on to its desire to protect jobs and the longevity of the industry (Gatticchi, 2020; Project 90 by 2030, 2020b). This interest is pitted against the interests of environmental reformists and other political interest groupings (Project 90 by 2030, 2020b). The debate on fracking in the Karoo has raged on in the midst of significant natural gas findings in the area(Fig, 2012; Mathe, 2019). There is also the the stalling introduction of Euro-grade "clean fuels" specification in the motor industry (Oirere, 2017; Smith, 2017). These are some examples which underscore the importance of a streamlined approach to the energy transition.

It is generally accepted that due to the structural changes that an energy transition demands, it often is difficult to execute from a political point of view (Kern & Smith, 2008). Further, the interests of political elites are often at odds with the real needs of energy systems (Healy & Barry, 2017). This then calls for a different approch in managing and resolving the conflict among the energy system stakeholders.

1.4.1.1.2 Worsening Environmental Challenges and the Closing Window of Opportunity

The need to align on the approach and means to implement JET has become urgent due to the accelerating environmental challenges associated with climate change. South Africa has in recent years experienced worsening adverse weather events, which have become more frequent and intense. These include:

- droughts, such as from 2018 to 2021 and 2023 to 2024 (classified level 2 Red-Class)(SASSCAL, 2020);
- extreme heatwaves such as the one experienced in 2021 with temparatures recorded at up to 45 degrees celcius (Simane & Ngam, 2024);
- average temperature increases, with South Africa having outpaced the global average two-fold (Igamba, 2023); and
- floods, such as those recorded in KwaZulu-Natal 2022 and linked by a formal study to climate change (Evans, 2025).

These extreme weather events often come with adverse social, economic and health impacts, including food insecurity, loss of lives and property (Human Sciences Research Council, 2025).

This places pressure on the country to resolve the energy transition challenge in the shortest time possible while in parallel, putting in place responsive mitigation and adaptation measures. The window of opportunity to find alignment closes with each new event, leaving the country scrambling for solutions. An efficient framework is needed to wrestle control back and ensure that the planning process is not overtaken by events, resulting in suboptimal solutions.

1.4.2 The Research Purpose (Aim and Objectives) Statement

As articulated in Section 1.1 *(Purpose of the Study)*, the aim of the study is to complete a prognosis of the application of the Interactive Planning methodology to invoke a Just Energy Transition in South Africa. This entails the succint framing of the problem hindering the sucessful invoking of the JET by undertaking the "mess formulation" process of Russell L Ackoff (2001)'s Idealised Redesign framework.

The aim and objectives previously listed in **Table 1** are re-stated in summary form below as follows.

Research Aim: "Formulating the Mess" UsingRussell L Ackoff (2001)'s Interactive Planning methodology, the problem will be framed, which hinders the successful invoking of the JET in South Africa towards an idealised, sustainable energy future.	
Objectives	Research Methodology
i. Providing an overview of how the South African energy system presently operates, encompassing the system's political, socio-economic, and technological components (Russell L Ackoff, 2001).	Theoretical exercise (da Costa Júnior *et al.*, 2020) comprising an analysis of the South African energy system, utilising the qualitative attributes in Section 2.3 *(Literature Review on Interactive Planning: Qualitative Attributes Key to the Research).*
ii. Completing an obstruction analysis, by providing a description of the characteristics and	Delphi exercise (Brady, 2015) with a panel of experts respondents.

	properties of the South African energy system that hinder the successful invoking of the JET (Russell L Ackoff, 2001).	**Tool:** Open-ended questionnaire as part of semi-structured interviews (Drever, 1995; Linstone & Turoff, 1975; Skulmoski *et al.*, 2007).
iii.	Projecting aspects of the expected future of the energy system, assuming existing methods of energy distribution and consumption, as well as the predicted future environment, remain unchanged (Russell L Ackoff, 2001).	Delphi exercise (Brady, 2015) with a panel of expert respondents. **Tool:** Open-ended questionnaire as part of semi-structured interviews (Drever, 1995; Linstone & Turoff, 1975; Skulmoski *et al.*, 2007).
iv.	Providing a description of how and why the South African energy system, if the assumptions above were true, would destroy itself (Russell L Ackoff, 2001).	Delphi exercise (Brady, 2015) with a panel of experts from a South African development finance bank . **Tool:** Open-ended questionnaire as part of semi-structured interviews (Drever, 1995; Linstone & Turoff, 1975; Skulmoski *et al.*, 2007).

1.4.3 Research Questions

1.4.3.1 Research Question 1:

Question	Note
Systems Analysis: Please consider the provided description of how the South African energy system currently operates, particularly in respect of its political, socio-economic, and technological components(Russell L Ackoff, 2001)? Also, note the indicated description of the system's stakeholders, as well as their interests.	The expert respondents were provided with the output of the theoretical phase of the study, which was summarised and presented to the respondents for review and comment.

1.4.3.2 Research Question 2:

Question	Note
How would you describe the idealised JET in South Africa and how do you envision the country's idealised energy future? **Obstruction Analysis:** Having considered the above, how would you describe the characteristics and properties of the South African energy system that hinder the successful invoking of the JET?	The expert respondents were guided as appropriate by the researcher, who fulfilled the role of a facilitator.

1.4.3.3 Research Question 3:

Question	Note
Kindly consider the listed methods of energy distribution and consumption in South Africa. Also, please consider the description of the predicted future environment of the energy system. Do you agree with this list of consumption and distribution methods, as well as the description of the predicted future environment? Is there anything that you wish to add, or correct? **Reference Projections:** Assuming the existing methods of energy distribution and consumption, as well as the predicted future environment remain unchanged, what do you think is the likely future of the South African energy system (Russell L Ackoff, 2001)?	The expert respondents were provided with the output of the theoretical phase of the study, which was summarised and presented to the respondents for review and comment.

1.4.3.4 Research Question 4:

Question	Note
Reference scenario: How do you think that the South African energy system would destroy itself if the assumptions above were true (Russell L Ackoff, 2001)? In other words, if no changes are made to the existing methods of energy distribution and consumption, as well as the predicted future environment, how would the energy system destroy itself, or be destroyed?	The expert respondents were guided as appropriate by the researcher, who fulfilled the role of a facilitator through the Delphi process.

1.4.4 Delimitations And Assumptions of the Research Study

1.4.4.1 Scope Delimitations

As indicated above, Systems Thinking is a broad subject, which finds relevance in numerous fields (Cabrera, 2006; Mingers & White, 2010). Given the broadness of the subject, it is necessary that researchers venturing into a Systems Thinking study should give careful thought to the approaches and methodologies that are under consideration.

The study's limitation to Russell L Ackoff (2001)'s Idealised Redesign process had the effect of automatically focusing the study on Soft Systems Methodologies, to the exclusion of others. This was a delimitation flowing from the manner in which the study was conceptualised.

1.4.4.2 Time Delimitations

The study examined South Africa's energy future up to 2050, following the Integrated Resource Plan planning period (Government of the Republic of South Africa, 2019).

1.4.4.3 Geographical Delimitations

The study exclusively focused on the energy system of the Republic of South Africa.

1.4.4.4 Data Delimitations

The theoretical phase of the study utilised data collected from the Internet, to the extent that the data helped to answer the first research question (See Section 1.4.3). The empirical phase relied on data collected from the research interviews.

1.4.4.5 Population Delimitations

In Russell L Ackoff (2001)'s conceptualisation of the Interactive Planning process, "an idealised design is a group product" (page 14) in that it is an outcome of consensus among the stakeholders participating in the system concerned (Russell L Ackoff, 2001). In conceptualising the study, it was not the intention of the researcher that all of the stakeholders in South Africa's energy system should be invited to participate in the Interactive Process.

Assuming that the South African energy incorporates a large amount of varied stakeholders, the process of bringing the stakeholders together would take a significant amount of time and effort. The advantage offered by the Delphi technique is that the experts' views can be used to represent a broader Interactive Planning process. The respondents participating in the Delphi process were chosen from a select group of industry stakeholders.

1.5 Significance of the Study

There are two aspects to the significance of the study. First, the study provides reference considerations in energy and environmental sustainability policymaking. Second, it contributes towards Idealised Redesign and JET practice theory. These points are elaborated on below. In addition to the above, South Africa, is considered a testing ground for the JET, due to its heavy dependence on coal (Boussion, 2022). This would imply that a failure to implement South Africa's JET would potentially not augur well for other JETs elsewhere in the world. It is therefore extremely important, for the global climate change effort, that South Africa's JET succeed.

1.6 Preface to the Research Report

This research report has six chapters.

Following the introductory section in Chapter 1, Chapter 2 provides a literature review, covering the problem, past studies, the explanatory framework and the conceptual framework. Chapter 3 discusses the research strategy, design, procedures, reliability and validity measures as well as limitations. Chapters 4, 5 and 6 respectively present and discuss the findings, interrogate the research questions and finally, summarise and conclude the research.

2 LITERATURE REVIEW

This Chapter 2 has three broad objectives; namely:

- to understand the research problem;
- to identify the knowledge gap, and
- to develop a framework for interpreting the research findings (Rocco & Plakhotnik, 2009).

In Section 2.1, the research problem is analysed. Section 2.2 reviews the published literature to reveal the knowledge gap. Section 2.3 focuses on a review of the literature with the aim of proposing the interpretative framework and the qualitative attributes that are key to the study. The remainder of the section presents a summary of the topics that have been considered.

2.1 Research Problem Analysis: Symptoms, Root Causes, and Consequences

The research problem stated in Section 1.4.1 *(the Research Problem Statement)* has several possible causes, which the researcher initially explored through a mind-mapping exercise. The most prominent of these root causes (in the assessment of the researcher) are discussed in the paragraphs that follow below. After the discussion of the possible root causes of the problem, the researcher then explores the likely consequences if the stated problems are not addressed.

2.1.1 Competing Developmental Priorities

South Africa's current Human Development Index **(HDI)** score of 0.713 places the country in the "high" human development category (United Nations Development Programme, 2023). As may be seen in **Figure 5**, South Africa's HDI scores experienced steady growth from about 2004 to 2012, where the growth started to taper off. While growth is observable during the period between 2012 and 2018, the rate of growth is obviously slower. There is then a sharp decline from 2018.

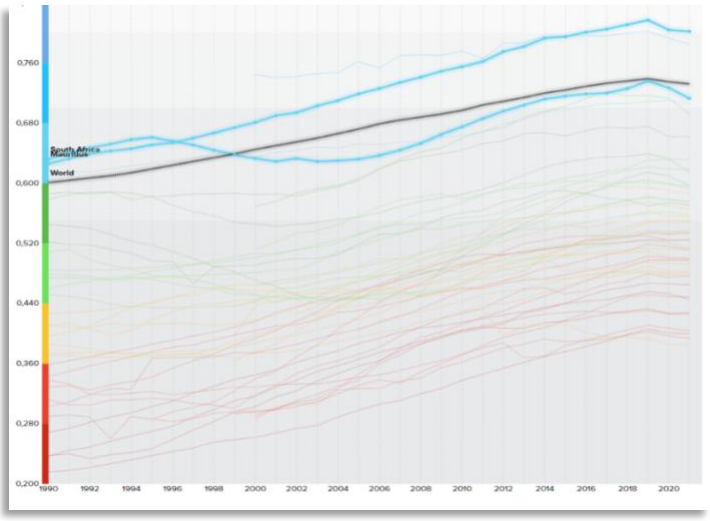


Figure 5: HDI Index of Selected Sub-Saharan Africa Countries

Figure 5 compares South Africa's HDI score to that of Mauritius (the country with the highest HDI in Sub-Saharan Africa), as well as the world average HDI score. South Africa's Human Development Index **(HDI)** score is below the world average and Mauritius's, with a more volatile trajectory. The country faces major developmental challenges, including low economic growth, poverty, inequality, low investment, and unemployment (Government of the Republic of South Africa & United Nations Development Programme, 2022). The Human Development Report of 2022 focuses on youth unemployment and environmental issues like food security (Government of the Republic of South Africa & United Nations Development Programme, 2022).

The country's heavy reliance on coal and oil is also highlighted, which brings forth the question as to how the economy could transition to renewable energy sources without jeopardising the country's path towards development (Government of the Republic of South Africa & United Nations Development Programme, 2022).

2.1.2 Weak Government Institutions and State Decline

The establishment and execution of progressive government policy in South Africa is a challenge, due to weakening state institutions potentially delaying the formation of a stable, mature, and competitively equitable market (Walker, 2023). The country's Fragile States Index scores show similar trends to to the HDI trends in **Figure 5** above, indicating a weakening of the state's ability to meet its obligations to citizens, including reducing corruption, driving economic progress, and ensuring security (Fund for Peace, 2023).

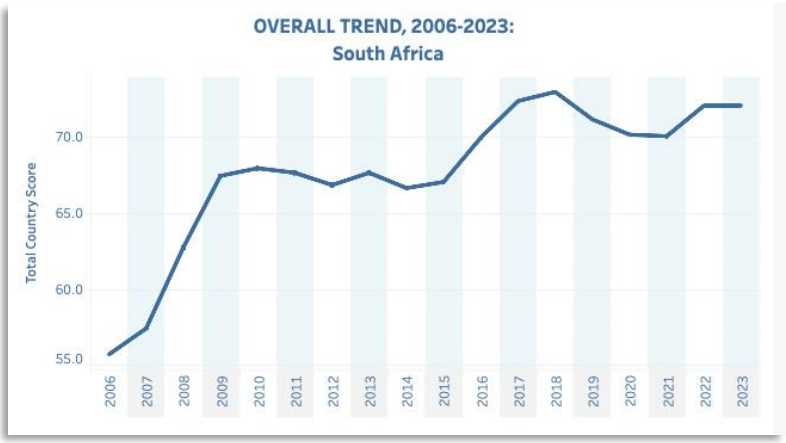


Figure 6: South Africa's Country Dashboard - Fragile States Index (Fund for Peace, 2023)

2.1.3 Endemic Corruption

South Africa's Corruption Perception Index (CPI) score in 2022 was 43 out of 100, similar to the global average (Transparency International, 2023). However, Transparency International reports that global efforts against corruption have stalled, with at least 124 nations failing to make progress. South Africa is one of 31 nations with a CPI score below 50 since 2021, and ranks 72nd out of 180 countries with the greatest perceptions of corruption (Transparency International, 2023). Given the fragile state of South Africa's society and potential social and transition risks, South Africa should be concerned about its anti-corruption performance.

2.1.4 Socio-political Conflicts and Schisms

South Africa is a deeply divided society with a history of racial and ethnic division, resulting in contested positions and claims (Horowitz, 2023). This deep-rooted conflict and divisions makes it difficult to resolve disagreements via normal means (Kelman, 2010). Recently, deep divisions can be seen between political parties and even within political parties themselves. For example, the ruling party's paralysing fictional battles (Cooper, 2015) have played out in the open, with a devastating effect on government's ability to do its work. The Institute for Economics & Peace's global peace index categorises South Africa's state of peace as "low" for 2023, reflecting a general downward trend in global peacefulness since 2008 (Institute for Economics & Peace, 2023).

2.1.5 Consequences if the Problem is not Addressed

Simply stated, South Africa's failure to implement a just energy transition could result in a poorly managed transition or no transition at all. The country has a presidential commission, which is the custodian of the country's JET-IP (Government of South Africa, 2022). The JET-IP was first revealed at COP27 and signed at COP26 by South Africa, France, Germany, the UK, the US, and the European Union (Government of South Africa, 2022).

This implies that South Africa does have a JET plan. The outstanding issue then is whether the JET plan is capable of being managed effectively. A poorly managed transition would not only scupper South Africa's efforts to decarbonise its economy, but it would also adversely affect the country's international commitments under the United Nations Framework Convention on Climate Change (UNFCCC), which it acceded to in 1997, as well as the Kyoto Protocol, which it ratified in 2002 (Government of the Republic of South Africa, 2011).

2.1.5.1 Consequences for the Global Effort Against Climate

Failure by any one country to contribute the reduction of GHGs has disastrous implications for the international effort to respond to climate change. **Figure 7** below puts the consequences of failure in context.

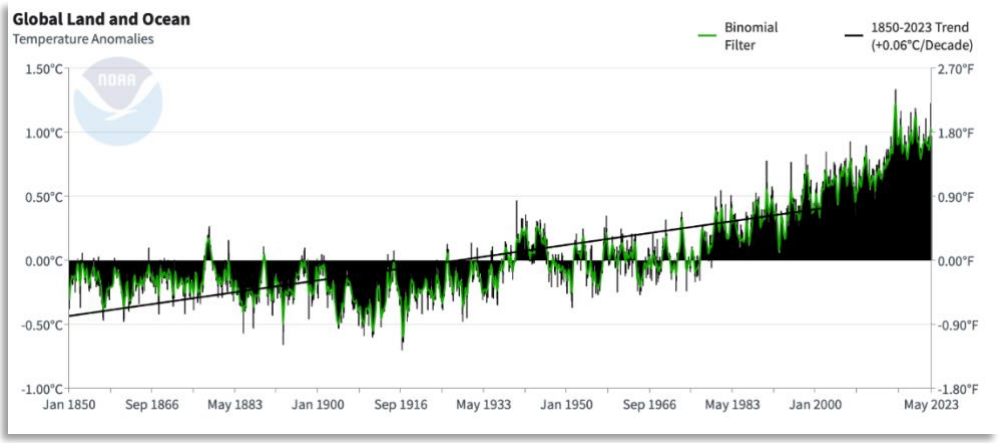


Figure 7: Global and Hemispheric Anomalies from 1850 to 2023 (NOAA National Centers for Environmental Information, 2023a)

The graph in **Figure 7** shows the world's temperature anomalies on our land and oceans, from 1850 to 2023. The trendline shows a quadrupling of average temperatures by May 2023. For example, the curve of the time series for Africa, which is presented **Figure 8** below, looks

remarkably similar to the global graph. It must however be stated that global warming is expected to develop twice as fast on the African continent (Government of South Africa, 2022).

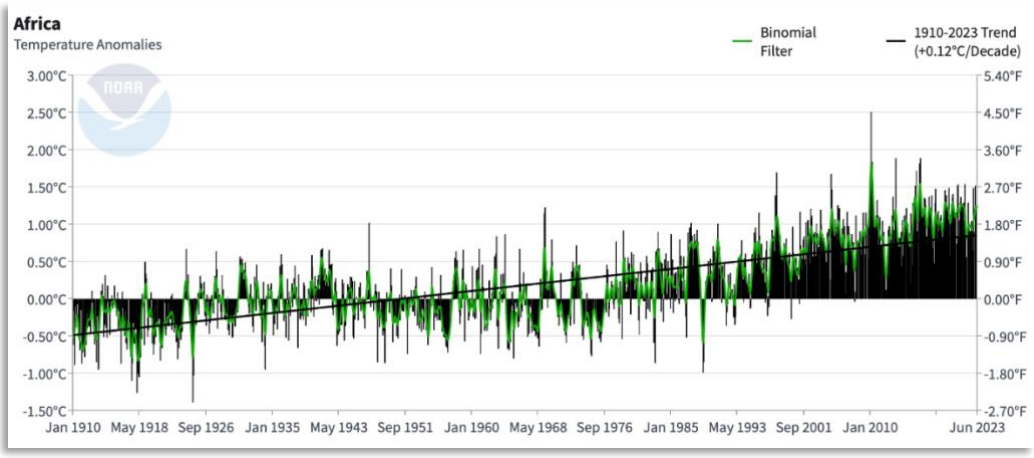


Figure 8: Global and Hemispheric Anomalies from 1850 to 2023-Africa Land Only (NOAA National Centers for Environmental Information, 2023b)

The graphs above show that global temperatures have been steadily rising since the 1940s, with a sharper rise since 2010. This rise is closely linked to the increasing use of fossil fuels as depicted in Error! Reference source not found. above. By 2050, fossil-fuel sources make up 25% of the world's energy systems. However as predicted in **Figure 4,** if global efforts to address climate change succeed, crude oil will peak in the next 5 years, and non-fossil fuel sources will contribute 55% by 2050.

Further as indicated previously, South Africa's high coal dependency makes it a crucial testing ground for the JET, and failure to implement it and failure to implement could hinder learning opportunities. The JET-IP reflects the global community's recognition of South Africa's JET's impact on climate change. It manages an initial $8.5 billion offer from international partners, including the UK, France, Germany, and the European Union (Government of South Africa, 2022), with the objective of supporting South Africa's JET.

2.1.5.2 Consequences for South Africa

2.1.5.2.1 Economic Sustainability and Developmental Targets

South Africa's attempts at creating a sustainable economy would be severely hampered if the country failed at achieving the JET. In his JET-IP opening message (Government of South Africa, 2022), the South African President argues that JET can generate new businesses and jobs, as well as contribute to energy security and climate resilience. These remarks are not mere

promises. Rather, they are a reflection of the country's ambitious developmental targets, which are articulated in South Africa's National Development Plan **(NDP)** 2030(Government of South Africa, 2022; National Planning Commission, 2013).

The NDP which has "its focus on tackling the county's systemic challenges of poverty, inequality, and unemployment" (Government of South Africa, p. 6) is the premise of the JET-IP. South Africa's Failure at implementing just energy transition could lead to the developmental targets being missed. These targets include the elimination of poverty and inequality by 2030. One of the enabling milestones provided for in the plan is to "produce sufficient energy to support industry at competitive prices, ensuring access for poor households, while reducing carbon emissions per unit of power by about one-third" (National Planning Commission, 2013, p. 24). Insofar as the reduction of carbon emissions is concerned, the NDP presents the example of investing and helping to exploit opportunities for low-carbon energy from hydroelectric and other clean energy sources in the Southern Africa region (National Planning Commission, 2013).

2.1.5.2.2 Other Risks or Consequences

The JET-IP reveals other risks associated with a failure to successfully implement the JET in South Africa. These include physical risks, social risks and transition risks (Government of South Africa, 2022). Physical risks include physical impacts of global warming, such as desertification and extreme seaboard storms, which require adaptation. Social risks involve the vulnerability of poor communities to climate change due to economic inequality, unemployment, and poverty. Transition risks involve the impact of other nations' decarbonisation efforts, such as carbon taxes on South African commodities exported to countries like the US, UK, and those in the EU. These risks require careful management of the energy transition.

2.2 Research knowledge gap analysis

2.2.1 Introduction to the Research Gap Analysis

Mingers and White (2010) highlight the complexity of Systems Thinking, requiring researchers to be selective in selecting study areas due to the vastness of the search area. This selectivity is the approach that the gap analysis below follows.

2.2.2 Research Gap Analysis Literature

2.2.2.1 1982 Literature

Mattesich: Mattessich (1982) discusses the literature on systems theory and cybernetics, arguing that the field was initially expected to replace traditional science. However, opinions at the time remained divided on the space occupied by Systems Thinking. Pioneers like von Bertalanffy, Bogdanov, Ackoff, and Herbert A. Simon contributed to the field, with Ackoff focusing on empirical systems, Churchman on system optimisation, and Simon's Science of Design and Artificial Intelligence emphasising the relationship between system purpose, elements, and environment.

2.2.2.2 1988 Literature

Oliga: Oliga (1988) critiques the underdevelopment of systems science methodologies, arguing they had not fully advanced beyond empiricism and natural hermeneutics. He emphasises the need for prudence in selecting methodologies, citing Jackson and Keys' extension of Checkland's complementarist viewpoint and Banathy's contingency-theory perspective, which emphasise considering the problem situation.

2.2.2.3 1993 Literature

Ackoff: In his 1993 paper, Russel L Ackoff (Russel L Ackoff, 1993) discusses the concept of idealised design, which he believes is a method for stakeholders to prepare a vision of their organisation's future. He argues that visions are often vague and unpredictable, and that aspirations are constantly changing. Ackoff discusses the two types of idealised design: constrained and unrestrained. He suggests that when faced with a problem, a group can choose between absolution, resolution, solution, or dissolution. Optimal design enables the system to perform at a higher level in the future.

2.2.2.4 2001 Literature

Andrew: Andrew's 2001 study on South African telecommunications explores rural development (Andrew, 2001), examining whether access is a privilege or a right. It examines

factors such as technological, physical, and sociological factors, and proposes a combination of soft systems methodology, interpretive structural modelling, and critical systems heuristics for effective rural telecommunications planning.

2.2.2.5 2006 Literature

Cabrera: Cabrera's 2006 research explored the challenges of implementing Systems Thinking in public health (Cabrera, 2006). He defines Systems Thinking as a conceptual framework that influences scientific thought and development, influenced by various methodologies. The study identifies two heuristic components: "knowledge about systems" and "Systems Thinking." Cabrera concludes that Systems Thinking lacks precision and is not a science, but rather serves as an orientation or paradigm. His study presents a theory of Systems Thinking, providing insights into how public health practitioners conceptualise and implement it. Although further research is needed, Cabrera's study offers valuable insights into public health practitioners' conceptualisation and implementation difficulties.

Baron: Baron (2006) published a paper arguing that our understanding of addressing global warming may be incorrect and that the mainstream activist position may be mistaken. The paper points to a knowledge gap in the application of Systems Thinking in energy transition contexts. Baron (2006) argues that wealthier countries should consider assisting those most in need, as global warming would primarily affect developing nations. He also argues that biases such as naturalism (where damage brought on by people is deemed to be worse than that brought on by nature), undoing (where it is throught to be preferable to undo the evil one has caused rather thatn do good in another way), and parochialism (where people reject the notion of assisting strangers, such as people from other nations), may influence people's perception of global warming. He concludes that the Kyoto deal cost a lot of money while making little progress in halting global warming, and that there may be affordable options, such as assisting less developed nations in the best way possible.

Pickering: Pickering (2006) conducted a qualitative case study in American public institutions, focusing on idealised design as an alternative to traditional reform strategies and strategic planning. The research examines the influence of participants on the idealised design process and their perceptions of the new design's potential for local school districts. The study recommends employing idealised design, as previous studies lack clear examples. The researcher uses a qualitative methodology due to its contextual nature, selecting instructors, administrators, board

members, and community members as participants. The study finds that idealised design altered respondents' perspectives on education and design, leading to increased commitment and understanding of interrelated problems. The potential of idealised design exists for districts and communities seeking to change educational discourse.

2.2.2.6 2007 Literature

Lumbo: Lumbo (2007) explored Ackoff's Interactive Planning methodology, focusing on idealised design and its complexity. He reviewed systems literature, arguing modern Systems Thinking began around 1970. Lumbo discusses alternative approaches like organisational cybernetics, Soft Systems Thinking, and critical Systems Thinking. He finds that effective facilitators must possess communication, analytical, and people skills, understand group dynamics, and exhibit originality and creativity.

Kemp and Colleagues: Kemp et al. (2007) studied the Dutch energy transition policy in the Netherlands, addressing six steering problems: ambivalence, uncertainty, distributed control power, political myopia, short-term change, and lock-in risk. They find that transition management, a reflexive governance model, combined incremental politics and planning. They suggest continuous deliberation and evaluation for defining future parameters, and suggested interactive governance through Interactive Planning for long-term goals and transition processes. This approach enables actors to coordinate actions for societal benefit.

Sweeney and Sterman: Sweeney and Sterman (2007) conducted a study on middle school students and teachers' aptitude for Systems Thinking in two US middle schools. They find that intuitive system capabilities are limited, and "open-loop" or one-way causal reasoning is prevalent. They used methods like Systems-based inquiry protocol, feedback structures, nonlinearities, time delays, and time horidons. The study highlights the importance of Systems Thinking in managing complex, dynamic systems, such as poverty, environmental degradation, and climate change.

2.2.2.7 2008 Literature

Snyder: Snyder (2008) highlights the importance of Systems Thinking in sustainable energy, focusing on the global depletion of fossil fuels, rising energy demand, and climate change concerns. The transition to renewable energy sources and declining oil and gas production will

require various disciplines, with planning, development, and implementation of a new global energy infrastructure being the most challenging. Snyder argues that a case must be made to convince the public of the necessity of sustainable energy transition, requiring systems engineers to create an easily understood vision.

Kasser and Mackey: Kasser and Mackley (2008) argued in 2008 that systems engineering is an emerging field in problem definition and resolution, and Systems Thinking is an emerging paradigm for problem-solving. They propose nine perspectives for applying Systems Thinking to systems engineering, ranging from operational to scientific. The literature's application of Systems Thinking is generic and not organised consistently. They conclude that the lack of publications on the application of Systems Thinking is a symptom of a paradigm shift and that additional research is needed to address this issue.

Kern and Smith: Kern and Smith's 2008 study on the Netherlands' transition policy, focusing on the Fourt Duch National Environmental Policy Plan, identified four dilemmas that impact energy transition approaches. These include long-term goals vs short-term success, investor certainty vs. level playing field, regime incumbents vs. frontrunners, and nurturing niches vs. control policies. The study finds that the relative strength of regime actors led to inefficiencies, hindered energy system innovations, and made it difficult to combine niche cultivation with control policies. They suggest that the impact could be mitigated by incorporating a broader societal process as opposed to energy regime incumbents.

2.2.2.8 2010 Literature

Mingers and White: Mingers and White (2010) conducted a working paper on Systems Thinking's contributions to operational research and management science. They analysed existing literature, examining systems theories and techniques, and discussed applications in strategy, information systems, organisations, production, ecology, agriculture, and medicine.

In their findings, they emphasise Systems Thinking's position as a discipline in its own right and its generality, but concluded that its applications are not widespread or well-established, leading to a deficiency in systems engineering.

2.2.2.9 2012 Literature

Markard and Colleagues: Markard *et al.* (2012) identified sustainability transitions as a growing field of study, analysing 540 journal articles and presenting six papers. They then identify four frameworks: transition management, strategic niche management, the multi-level perspective on socio-technical transitions, and technological innovation systems. Notable authors in these frameworks include Kern and Smith (2008), Kemp *et al.* (2007) and others.

Markard *et al.* (2012) identify four areas of focus for future research: elucidating conceptual frameworks, building on early adoption of transition-based policy concepts, understanding actor groups' agency, and conceptualising spatial transition processes.

Musango: Musango (2012) conducted a South African renewable sustainability energy technology assessment, incorporating system dynamics as a strategic policy-making tool due to the complexity of energy technology assessment, necessitating a holistic and transdisciplinary approach.

2.2.2.10 2013 Literature

Bouricius and Schecter: Bouricius and Schecter (2013) conducted a study on Idealised Design, focusing on the American legislative branch. They criticised key aspects of modern democracies' legislative branches, such as election of legislators and the same entities carrying out legislative and meta-legislative functions.

They (Bouricius & Schecter, 2013) then propose a new legislative system based on classical Athenian democracy principles, aiming to spark discussion among systems theorists on Idealised Design for legislative and broader governmental functions.

2.2.2.11 2014 Literature

As'mui and Fitriati: In 2014, political science professors Asmu'i and Fitriati (Fitriati, 2014) explored the use of Interactive Planning in Indonesia's public transport system. They used Ackoff's Interactive Planning method and considered leadership articles, public initiatives, and innovative leadership. They conclude that strong, determined leadership is crucial for planning

the system, adhering to participatory, continuity, and holistic principles. They suggest a sustainable transport strategy for the success of the services.

Tejeda and Ferreira: Tejeda and Ferreira (2014) utilised Systems Thinking to analyse the sustainability of wind energy, focusing on its evolution as a substitute for conventional energy sources. They (Tejeda & Ferreira, 2014) create a causal model using Forrester's systems dynamics, which will be used to create a system dynamics simulator, aiding decision-makers in making informed choices about wind energy solutions.

2.2.2.12 2015 Literature

Chowdhurry: Chowdhury (2015) uses Interactive Planning to develop a child protection framework and delivery model for an Indian NGO, UTSAH. The organisation needed a strategy to support its future viability and was chosen for its effectiveness and efficiency. The author discusses the history of Interactive Planning and Ackoff's role in creating the concept, as well as literature on child development. The benefits of Interactive Planning include its realistic, holistic, participatory, empowering, creative, action-oriented, and flexible nature. The study employs a consultant to understand UTSAH's ecological system and engages stakeholders in stakeholder analysis and conversations. Feedback and views from informed readers will help improve the framework and inform future interventions.

2.2.2.13 2016 Literature

Hodgson: Hodgson (2016) explores the intersection of systems and futures thinking in business, governance, and community resilience. He argues that despite their sophistication, these approaches are not suitable for decision complexity. He suggests a paradigm shift is needed to address this complexity. His study uses participation experiments to highlight the need for decision-makers to understand the world and anticipate future conditions. Evidence-based policy and scenario planning have emerged, but future assessment doesn't require evidence construction. Intuition, creativity, and deduction will always play a role. Hodgson believes that attentive anticipatory present moment practice will be a step towards combining evidence-based and foresight-based approaches more effectively than their use in individual disciplines.

Kmon: Kmon (2016) proposes a framework for implementing social-ecological management in the USFS Enterprise Programme (EP), a land management agency. The framework focuses on wicked environmental problems, such as climate change, population growth, resource scarcities, and degraded ecosystems. The study reviews literature on Systems Thinking and compares soft and rigid approaches, highlighting the importance of understanding the various Systems Thinking tools. Kmon (2016) identifies ten characteristics of wicked problems and uses a thematic clustering approach. The framework is based on literature synthesis and three case studies.

Kmon (2016) concludes that Systems Thinking is a transdisciplinary, holistic study of complex phenomena, focusing on computationally complex systems and complex adaptive systems. The Soft Systems approach and hierarchy and cooperation theory are proposed as the most helpful in solving social-ecological problems. The framework offers value to resource managers as environmental narratives worsen and the need for sustainable lifestyles increases.

2.2.2.14 2017 Literature

Healy and Barry: Healy and Barry (2017) advocate for the politicisation of the sustainability energy transition, emphasising the importance of energy justice and a systematic approach. They suggest considering the influence of politics, power dynamics, and political economics on sociotechnical transitions and a more systematic approach to addressing the JET and its effects on employees. They criticise the lack of attention given to the JET in energy justice literature and call for the democratisation of energy system transitions. They believe a common vision and plan are needed to ensure an effective and just transition.

Flacke and de Boer: Flacke and De Boer developed COLLAGE, an interactive planning tool, to improve renewable energy policies in the Netherlands. The tool, which allows users to explore the consequences of different technologies and energy sources, has been effective in increasing community engagement. However, further research is needed to extend the tool to other energy sources.

2.2.2.15 2019 Literature

Da Costa Junior and Colleagues: Da Costa Junior et al. (2019) propose a Systems Thinking-inspired framework for solving complex societal issues, focusing on multifaceted social and

technological processes. They argue that a paradigm shift is necessary due to the negative effects and inability of problem-solvers to cope with complexity. They review literature on sustainability studies, systems science, complex theory, design research, and systems approaches, drawing from pioneers like Checkland, Churchman, Hall, Opter, and Bausch.Da Costa Junior et al. (2019) propose a Systems Thinking-inspired framework for solving complex societal issues, focusing on multifaceted social and technological processes. They argue that a paradigm shift is necessary due to the negative effects and inability of problem-solvers to cope with complexity. They review literature on sustainability studies, systems science, complex theory, design research, and systems approaches, drawing from pioneers like Checkland, Churchman, Hall, Opter, and Bausch.

Ballew and Colleagues: Ballew et al. (2019) study Systems Thinking as a pathway to global warming beliefs and attitudes in the United States. They argue that a general pro-environmental orientation is associated with Systems Thinking, which perceives phenomena as interconnected and dynamic. The study uses an online instrument and a sample of 1058 U.S. adults to examine the relationship between Systems Thinking and beliefs and attitudes about global warming. The results show that Systems Thinking is positively related to global warming beliefs and attitudes, but is largely explained by an ecological worldview.

2.2.2.16 2020 Literature

Da Costa and Colleagues: In 2019, da Costa Junior *et al.* developed a Systems Thinking framework for solving complex societal issues. In 2020, they proposed a systems design approach for sustainable development in low-income energy markets. The research aimed to understand how sustainable thinking systems could contribute to handling the complexity of energy product-service system design. The study focused on understanding the characteristics of complex societal problems in low-income energy markets, the development of Systems Thinking as a method for handling these problems, and the optimal approach for designing solutions.

The framework was presented and applied in the practical part of the study.

2.2.2.17 2021 Literature

Radhakrishnan: Radhakrishnan (2021) uses Systems Thinking methods to evaluate the energy transition, focusing on its socio-technical nature. He uses the Three Horizons Model to describe stakeholder roles and potential negative effects of clean energy futures. The study emphasises the

need for global coordination between companies and stakeholders to ensure a successful and just transition. The global energy transition is crucial for achieving carbon reduction goals, but only changes in technology and infrastructure address one aspect. Successful decarbonisation requires a collaborative response involving global coordination. The study highlights the need to transcend paradigms and recognise that sustainability will always evolve. The developing world is expected to be disproportionately affected by the climate change problem, and global coordinated responses are essential.

2.2.3 Research Gap Analysis Conclusion

Systems Thinking has evolved over time, with pioneers like Mattessich (1982) and Oliga (1988) focusing on systems theory and cybernetics. Ackoff's seminal work in 1993, Idealised Redesign, opened up possibilities for the application of Systems Thinking in various fields. By 2001, there was an increase in publications based on Systems Thinking, with writers applying the paradigm to spefific fields. However, not all scholars immediately found value in Systems Thinking.

Baron (2006) argued that our understanding of global warming was incorrect, but later studies showed that energy systems and the JET can be understood and addressed through the Systems Thinking lens. The common theme across studies relying on Systems Thinking in its different guises is that the systems being considered might be described as complex, with some being clear examples of socio-technical systems. While writers have found increasing application of Systems Thinking, there are still opportunities for further work and discoveries.

What emerges clearly from the literature is the paucity of studies focusing on the application of Interactive Planning to the complexities associated with managing the JET. Globally, there remain opportunities to undertake this work. However, the paucity is even more pronounced in developing nations, such as South Africa. While the JET itself has certainly been commented on in the South African context, there is not a lot of work on the use of frameworks such as Interactive Plannign to try and invoke the JET.

2.3 Qualitative Attributes Key to the Study

2.3.1 Introduction to Systems Thinking Literature Analysis

The difficulty in defining Systems Thinking or the systems approach is well recognised. Notwithstanding several theoretical and conceptual ambiquities, as well as a lack of clarity(Cabrera, 2006), attempts to define Systems Thinking have been made by several authors. The theme that cuts across many of the definitions is that Systems Thinking is a (i) framework, (ii) a cognitive paradigm, (iii) a set of tools, (iv) a set of skills, (v) a discipline, a language, (vi) an art and a science premised on viewing phenomena as systemic wholes(Arnold & Wade, 2015; Ballew *et al.*, 2019; Mingers & White, 2010; Stichweh, 2011).

In the context of Systems Thinking, a system is understood to feature complex, dynamic, circular interconnections between its individual components (Anderson & Johnson, 1997; Ballew *et al.*, 2019; Konkarikoski *et al.*, 2010). The focus on interrelationships between these components that make up the system, is in fact, the very foundation of Systems Thinking (Arnold & Wade, 2015). Systems thinkers therefore, promote a holistic approach to viewing phenomena and as a consequence, are firmly opposed to reductionism (Anderson & Johnson, 1997; Arnold & Wade, 2015; Kmon, 2016).

They hold the view that the structure and behavior of the system are shaped by the interaction between its components (Anderson & Johnson, 1997; Arnold & Wade, 2015; Kmon, 2016), with the primary interest of systems thinkers being to understand how the components within the whole influence one another (Konkarikoski *et al.*, 2010). Systems thinkers understand that things may have properties that when viewed holistically, cannot be found in their individual parts, which then would dissuade attempts at taking the things apart (reductionism), in order to understand them (Brockman, 2012).

The understanding of things as being dynamic, complex and interdepent (Sinn, 1998) encourages systems thinkers to resist the temptation to focus on linear causal relationships (Anderson & Johnson, 1997), but to instead, view the system as a "dynamic whole" (Ballew *et al.*, 2019). Accompanying this holistic view or "big picture thinking", as well as the focus on dynamism, are other principles of Systems Thinking, which include (i) recognising the balance between short-term and long-term perspectives, (ii) considering measurable and non-measurable factors and (iii) that actors in a system also shape and influence it (Anderson & Johnson, 1997).

Attempts have been made to improve on the existing definitions of Systems Thinking. For example, Arnold and Wade (2015)proposed a singular definition of Systems Thinking, after having reviewed and compared different sources of the literature available at the time.

Arnold and Wade (2015)'s singular definition centered on Systems Thinking as a set of analytical skills, which in their view, its usefulness in different disciplines, where critical thinking in required (Arnold & Wade, 2015). They argue that these analytical skills themselves work as a system (Arnold & Wade, 2015).

In 2011, Stichweh (2011), explored systems theory, which was followed by Friedman and Neumann Allen (2014), who also did the same. In essence, systems theory was originated by Ludwig von Bertalanffy as part of his work in social work; and is described as a science, the primary aim of which is the comparative study of different system types (Friedman & Neumann Allen, 2014; Stichweh, 2011). It is valuable in developing intervention strategies pertaining to systems (Friedman & Neumann Allen, 2014).

Ludwig von Bertalanffy's work led to general systems theory, which is based mainly on concepts linked to biology, physiology, information theory and cybernetics (Stichweh, 2011). This initial understanding proposed certain features for systems, including: (i) the extent to which parts are interdependent, (ii) consideration of the environment in which the system is found, (iii) the extent to which the system adapts and readapts to the environment, (iv) the ability of the sytem to self-organise as a response to external interventions, and (v) complexity (Stichweh, 2011). Developing alongside general systems theory was also a paradigm contributed by writers such as Talcott Parsons and Nicklaus Luhmann, and linked primarily to sociological theorising and research (Stichweh, 2011).

2.3.2 An Overview of Systems Thinking

As Cabrera (2006) explains, knowledge about systems has a 2600-year history, but Systems Thinking, the concetual framework, is much more recent. According to Jackson (1991), the history of Systems Thinking begins in the 80s, with Ulrich (1983), Jackson and Keys (1984); Oliga (1988) and Oliga (1988) cited as examples. Jackson further recounts that the concepts matured in the 90s, with examples of publications including Flood (1995), Jackson (1991), as well as Jackson (1991).

While they are all related and traceable to knowledge about systems, Systems Thinking, sytems sciences, systems theory and systems methods are distinguislable from each other (Cabrera, 2006). In its early days, it had been hoped that Systems Thinking would be a replacement for traditional science – which implies that traditional science is the older concept – but, this view was quickly abandoned, to the point that the framework was ultimately seen as a temporary fad (Mattessich, 1982).

There are many systems. Examples include scientific systems, organisations, personal systems and public systems (Cabrera, 2006), to name a few. Systems Thinking would be applicable as a lens through which to view and understand these systems.

Arnold and Wade (2015) argue that complex systems are growing rapidly, propelled by phenomena such as increased globalisation and interconnectedness. As a means of viewing the world, (Cabrera, 2006), Systems Thinking provides the skillset that assist in better understanding this increasing complexity (Arnold & Wade, 2015). This might then explain how Systems Thinking has increasingly come to be assimilated by other disciplines, such as health, production and sustainability (Mingers & White, 2010).

2.3.2.1 Hard Systems Thinking and Soft Systems Thinking

One of the earlier commentaries on Systems Thinking took the form of a proposal of a general systems theory by Von Bertalanffy (1973), who attempted to explain how general systems theory (or GST) differs from traditional sciences. Having responded to objections that had been leveled against GST, Von Bertalanffy (1973)then proposed that GST would satisfy the need for a new discipline focusing on formulating and deriving principles applicable to general systems. Von Bertalanffy (1973)proposed that general systems theory would help to provide models that are portable across different fields, while avoiding vague analogies which have prevailed before GST and have hampered progress. Unlike traditional sciences such as classical physics (which focuses on unorganised complexity), general systems theory would be concerned with concepts of organisation, wholeness, directiveness, teleology and differentiation. These problems still appear in the biological, behavioural and social sciences. One of the notable distinctions between conventional sciences and Systems Thinking is that while conventional sciences deal with closed systems, Systems Thinking has the ability to deal with open systems, such as living organisms (Von Bertalanffy, 1973).

In 1974, Russell L Ackoff (1974)published his seminal paper on organisational strategy. In the paper, Russell L Ackoff (1974)made the argument that the distinction between strategy and tactics did not always been sufficiently defined and that in fact, there was a paucity of defitions of strategy. In what would later be core to idea of the interplay between a sytems and the environment within which it exists, Russell L Ackoff (1974)argued that strategy pertained to the organisation and how it would navigate its environment. He laid out the elements of strategy and strategic decisions, emphasising that (i) strategic decisions affect the entire organisation, (ii) the focus of strategic decisions is long-term growth, as opposed to mere effeciency; (iii) that the focus of strategic decisions is anticipatory , taking into account changes in the environment, which could have a significant impact on the performance of the organisation.

Russell L Ackoff (1974)'s paper did not make an obvious case for Systems Thinking, but laid a strong foundstion on which Ackoff's future thinking was based. Lilienfeld (1975)did pick up the mantle from where Von Bertalanffy (1973) had left off. He (Lilienfeld, 1975) sought to expand systems theory, with his focus being on systems theory as an ideology. His argument was that a systems approch is required to realise humanity's capabilities and find solutions some of the problems plaguing society.

Russell L Ackoff (1979a) returned with another seminal paper on operational research in the context of organisations. He argued that operational research was facing several challenges, including the dispersion of operational research in organisaitons, the displacemen of operational research workers and the dissolution of the interdisciplinarity of operational research. Depicting the early sings of Idealised Redesign, and a Systems Thinking approach, Russell L Ackoff (1979a)proposed that operational research needed to be optimised through: (i) relearning and adaptability, as problem situations continuously change, (ii) understanding the concept of "a means" (to an end), as well as the pertinent cycles and tradeoffs (iii) realising that problems are not independed of each other, but are part of dynamic and complex "messes", (iv) synthesising learning paradigms, to work towards designing a desirable future and inventing ways of bringing about, (v) effectively treating messes through the interaction of a wide range of disciplines, and (vi) understanding that all those who can be affected by the output of decision-making should either be involved in it, or the interest should be well represented. These, in effect were the building blocks of the Interactive Planning methodology, with the shortcomings of the predict-and-prepare paradigm of OR being shown to be deficient and needing to be be replaced with a paradigm focusing on the designing of a desirable future and ways to bring the desirable future

about. The problem-solving approach was also proposed to be replaced with an approach focusing on the planning for and design of systems (Russell L Ackoff, 1979a, 1979b).

As a follow-up to the cautionary note on the threat to operational reaeach, Russell L Ackoff (1979b), amplified upon the proposed paradigm focusing on bringing about a desirable future. He touched on four aspects of operational reseach, *viz*., (i) the paradigm employed by operational research, (ii) the matter in which which the operational research profession was practised, (iii) the professional society's role and (iv) the manner in which professionals were educated. Russell L Ackoff (1979b)then went on to propose the interactive (or proactive) paradigm (in replacement of the predict-and-prepare paradigm of operational research). In addition, the principles underpinning the interactive paradim were advanced. It is important that these principles, which are listed below, are well understood, as they are at the core of Interactive Planning:

- The **participative principle** holds that the "principal benefit of planning comes from engaging in it" and not in consuming the plans. No one can plan effectively for someone else and therefore, people must plan for themselves (Russell L Ackoff, 1979b).

- The **principle of continuity** stands in contracts against cyclical planning - and appreciates that plans rarely work exactly as expected. Therefore, there is a need for plans to be continuously revised (Russell L Ackoff, 1979b).

- The **holistic principle** requires the simultaneous and interdependent planning for all units at the same level of an organisation (Russell L Ackoff, 1979b). In other words, there should be no top-down and bottom-up planning (Russell L Ackoff, 1979b).

Jackson (1982) undertook some work to provide an overview of the work of Ackoff and how this work contributed to and shaped Soft Systems Thinking. Also studied by Jackson (1982), was the work of Churchman, as well as Checkland. These individuals may be viewed as the pioneers of the paradigm. The subjective nature of Soft Systems Thinking is emphasised by the view that the means employed by action researchers to analyse or change social systems will be influenced by the view that the researcher develops about social reality, which in turn will be shaped by theory (Jackson, 1982).Jackson (1982), having demonstrated Soft Systems Thinking's place in the interpretative sociological paradigm, was at great pains to explain the importance of theoretical understanding among researchers, but he cautioned that GST (General Systems Theory) may not necessarily provide the required theoretical support. Therefore, he (Jackson, 1982) proposed that

action researchers may look to social sciences for the support. It must be stated that these viewes are in contrast to those of Naughton, who believed that systems research should be approach as "social technology" and that theory should be abandoned. The views are also in contrast to those of Vickers, who believed that social sciences cannot provide the theoretical support required by researchers.

The main section of Jackson (1982)'s paper highlighted some of the work that had been undertaken to create the link between social theory and Systems Thinking. The main section of the paper also examines each of the metholodogies advanced by Churchman, Ackoff and Checkland, with the observations being summarised as follows:

- Churchman's Singerian systems approach is founded on the understanding that any observation of the world must be underpinned by a theoretical understanding (Churchman was a disciple of philosopher E. A. Singer, hence the term "Singerian"). Churchman understood that different evaluations of social reality are possible and that the analyst therefore needs to respect different points of view. This is then a subjectivist approach (Jackson, 1982).

- Ackoff was also a disciple of E.A. A Singer. His revised Interactive Planning methodology was found to be clearly subjectivist and regulative. It is such that there can be many different versions of what the problem is. The methodology is concerned with bringing about consensus among stakeholders, with interactive planners participating in designing and "idealised future"(Jackson, 1982).

- Checkland's work towards a soft systems methodology was also found to have produced a regulative methology, interpretive and subjective methodology, in that it has to do with people's perceptions of reality (Jackson, 1982). Each of the seven stages of Checkland's methodology were discussed in turn, but in the interests of brevity, they will not be repeated in this summary (Jackson, 1982).

In the early 80s, the International Encyclopedia of the Social Sciences had broken down Systems Thinking into five categories, being (i) general sytems theory, (ii) social systems, (iii) political systems, (iv) international systems, and (v) psychology systems, which categorations Mattessich (1982) thought were unsatisfactory. In an attempt to improve the categorisation of Systems Thinking, Mattessich (1982)then proposed the following categories: (i) systems philosophy, (ii) systems analysis, (iii) empirical systems research and (iv) systems engineering.

In summary, the holistic paradigms of philosopers such as Heraclitus, Leibnis, Vico, Hegel, Marx, Whitehead, Driesch, and others are argued to have been key to Systems Thinking's philosophical leanings. This is notwithstanding the fact that Bogdanov and von Bertalanffy (the pioneers of the systems approach) considered it to be a scientific approach (Mattessich, 1982).

Mattessich (1982) makes the point that Systems Thinking is a point a view, as well as a methodology arising out of the point of view, the important revelation being his argument that the methodology is suitable to applied sciences, due to its input-output feature. The pure scientific approach (i.e. the non-pholosophical approach), as Mattessich (1982) argued, would be unsuitable for applied sciences due to its lack of some features that would respond appropriately to applied sciences' concerns of not only cognitive hypothesis, but also means-end considerations. Mattessich (1982) proposed some views regarding the rest of his categorisations (i.e. systems analysis, empirical systems research and systems engineering) which are not restated, in the interests of brevity.

When systems thinkers speak of systems science, they categorise the different problem methodologies under Hard Systems Methodologies, Soft Systems Methodologies and Critical Systems Methodologies, as depicted in **Figure 9** below.

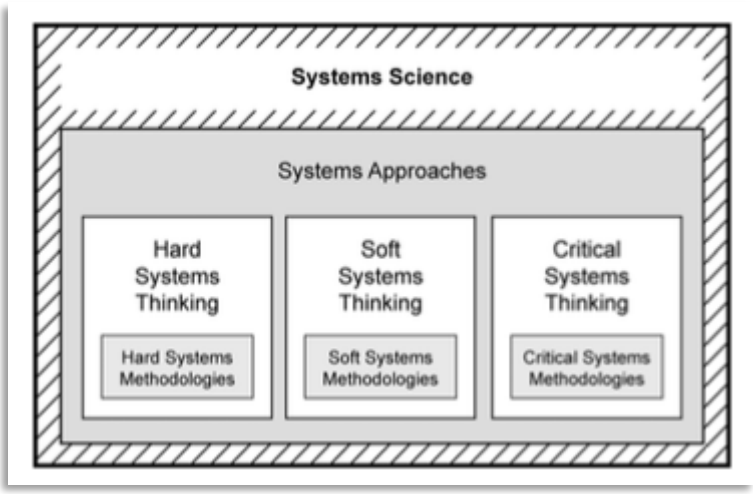


Figure 9: A Depiction of Systems Approaches by da Costa Junior et al. (2019)

Hard Systems Thinking excludes subjectivity in its approach and Soft Systems Thinking pursues the applicable perceptions of reality, while providing the observer of the system with the means to meaningfully engage with these (Lumbo, 2007). Hard Systems Thinking is based on the functionalist paradigm; and is viewed as the problem-solving method most similar to conventional design (Jackson, 1982; Jackson & Keys, 1984). As a problem-solving approach, it

implies that a problem situation is resolved by optimising the system's performance (Jackson, 1982; Jackson & Keys, 1984).

Hard Systems Thinking methodologies are grounded in positivism and consist of quantitative methods and classical or traditional operations research, systems engineering, and systems analysis (da Costa Junior *et al.*, 2019; Sinn, 1998).

Soft Systems Thinking is a response to the limitations of hard systems approaches and is based on the premise that problems can be socially complex (Checkland 1978, 1981; Ackoff 1979). Soft Systems Thinking Methodologies are grounded in interpretive thinking (Sinn, 1998).

Given that real-world problems do not always manifest in systems with explicitly defined goals and objectives, Soft Systems Theory is subjectivist, in the sense that the observer's meaning and purpose affect how problems situations are viewed (da Costa Junior *et al.*, 2019; Oliga, 1988).

Churchman, Ackoff and Checkland developed Soft Systems Methodologies based on the premise that problem situations must be managed, as opposed to being solved (da Costa Junior *et al.*, 2019). The result then is that Soft Systems Methodologies provide the observer with tools for comprehending particular interpretations of the social world, (i) to create a shared understanding and consensus, (ii) so that mutual agreement can emerge regarding action (da Costa Junior *et al.*, 2019). Soft Systems Methodologies, alongside other methodologies like inquiring Systems Design (Churchman, 1971), and Social Systems Design (Gharajedaghi, 2011) prioritise the values and interests of the system's stakeholders (da Costa Junior *et al.*, 2019). Churchman's, Ackoff's and Checkland's contribution to Soft Systems Thinking was analysed in detail byJackson (1982), and discussed by da Costa Junior *et al.* (2019), among other commentators..

Critical Systems Thinking was introduced as an alternative to Hard and Soft Systems Thinking (da Costa Junior *et al.*, 2019; Jackson, 1991). It emerged after Hard Systems Thinking faced criticism from writers such as Checkland (1981), who in their support of Soft Systems Thinking, argued that the "objective" approach of Hard Systems Thinking was removed from real world problems, which hardly manifested in well-defined systems with identiable goals and objectives (da Costa Junior *et al.*, 2019; Jackson, 1991; Sinn, 1998).

Jackson (1991) subsequently argued that Soft Systems Thinking was also open to criticism. Summarising Jackson (1982)'s views, da Costa Junior *et al.* (2019)notes that Soft Systems Methodologies were based on interpretive assumptions, which hindered Soft Systems Thinking's

ability to support robust stakeholder debate stakeholders in problem situations. As an alternative then, Critical Systems Thinking was introduced, in an attempt to exclude the influence of technical and social-political impurities in the design and implementation of systems (da Costa Junior *et al.*, 2019).

Jackson (1991) explained that critical Systems Thinking can be traced to critical management sciences, which were born out of criticism levelled at traditional management sciences by writers such as, among others, Hales (1974), Rosenhead (1982), Tinker and Lowe (1982), who argued that traditional management sciences were too accepting of the then positions of wealth inequality, status, power and authority. These critics held the view that traditional management sciences did not push the envelope enough and if anything, they supported the *status quo (Jackson, 1991)*. This initial criticism then eventually gave way to Critical Systems Thinking, which was more theoretically organised as an approach.

The five commitments that Critical Systems Thinking was founded upon were (i) critical awareness, (ii) social awareness, (iii) complementarism (metholodogically), (iv) complementarism (theoretically) and (v) a dedication to human emancipation (Jackson, 1991).

The above criticisms did not necesssarily aim to do away with Systems Thinking, but merely attempted to arrive at what would be deemed to be an appropriate Systems Thinking approach. Meanwhile, an external threat to Systems Thinking was brewing, as it faced a barrage of attacks from the proponents of other problem-solving approaches (Dando and Bennett in Jackson (1981). As a results of these attacks, Systems Thinking experiences a "Kuhnian crisis", which prompted some systems thinkers to work at salvaging the framework (Lumbo, 2007).

For example, Jackson and Keys (1984) responded to the external criticims, as well as Ackoff's cautionary papers, by pitting operational research against the other problem-solving methologies that had been proposed at the time. The contributions of Ackoff, Dando and Bennett, as well as Rosenhead and Thurnhurst are re-examined, with the aim of adding to the body of operational research literature and developing a systems of identifying problem-solving methodologies that are suitable for specified problem contexts (Jackson & Keys, 1984).

Before considering the problem context classification by Jackson and Keys (1984), it is worthwhile to first note the authors' commentary on the nature and type of systems, as conceptulised by Systems Thinking pioneers, such as Ackoff. One could view systems as closed or open, depending on how they interact with the environment that contains them (Jackson &

Keys, 1984). Closed sytems do not have meaningful interaction with the environment where they are found, while open systems interact frequently with their environment (Jackson & Keys, 1984). This view of open and closed systems was later corroborated by Konkarikoski *et al.* (2010), who argued that closed systems are self-sufficient, while closed systems interact with the environment.

As Jackson and Keys (1984) further explain, one could also seek guidance from Ackoff's machine-age and systems-age references. The machine-age refers to an era where systems were understood to be closed and comprised passive parts (Jackson & Keys, 1984). Such systems were understood to be fully observable and capable of being analysed through reductionism and utilising traditional scientific approaches (Jackson & Keys, 1984). The latter refers to an era where systems are understood to be open and comprising purposeful parts (Jackson & Keys, 1984). Such systems are considered to be partially observable and not suitable for analysis through reductionism (Jackson & Keys, 1984).

With this understanding of systems types, Jackson and Keys (1984)then began the task of looking at classifying problem contexts based on the (i) the nature of the system in which the problem is found, and (ii) the nature of the decision-makers who have the problem.

While they concede that systems can be classified as simple (i.e. with "easy" problems) or complex (i.e. with "difficult" problems) based on the perspective of the analyst, the nature of the problem and the analyst's purpose for observing the system, Jackson and Keys (1984) do put forward Vemuri's suggestions as to what might make a system complex:

- Complex systems present difficult problems due to their tendency to be partially observable, probabilistic, open, to have purposeful parts and to be subject to behavioural influences (Jackson & Keys, 1984). Simple systems would be the opposite of this (Jackson & Keys, 1984).

- Insofar as the decision-makers are concerned, the problem context is shaped primarily by whether the objectives of the decision-makers renders them to be "unitary" or "pluralist". Unitary decision-makers are in agreement regarding a common set of goals, with decisions made in accordance with this agreement, while pluralist decision-makers are either not in agrement or cannot make decisions in accordance with their agreement (Jackson & Keys, 1984).

The above classification produced the following problem contexts: *mechanical-unitary*, *systemic-unitary*, *mechanical-pluralist* and *systemic-pluralist* problem contexts (Jackson & Keys, 1984). Having classified problem contexts, Jackson and Keys (1984)then suggested that:

- Classical operational research, and the related approaches of systems engineering and systems analysis would be appropriate for problems within a *mechanical-unitary* context (Jackson & Keys, 1984). Churchman branded these techniques "hard Systems Thinking" methodologies (Jackson & Keys, 1984);

- If certain conditions are met, cybernatics is proposed for problems within a *systemic-unitary* context (Jackson & Keys, 1984);

- Under specific conditions, Hard Systems Thinking" methodologies are also recommended for problems associated with *mechanical-pluralist* contexts (Jackson & Keys, 1984). In order to arrive at a "synthesis" among the pluralist decision-makers, Churchman's methodology, which is based on Hagel and Singer's views, is recommended. The strategic assumption surfacing and testing (SAST) methodology, which was developed by Mitroff, Mason and colleagues is a refinement of Churchman's methodology (Jackson & Keys, 1984).

- While the SAST methodology referred to above is argued by its advocates to also be suitable for the wicked-problems associated with systemic-pluralist contexts, SAST does not seek to address the systemic aspects of such problems, given its focus on assisting pluralist decision-makers (Jackson & Keys, 1984). Instead, the "Soft Systems Thinking" approaches conceptualised by Ackoff, Checkland and Churchman are deemed suitable for problems withing this context (Jackson & Keys, 1984). Ackoff's focus is on managing "messes", while planning for and designing systems. Ackoff's methodology, as decribed in his 1981 publication on Systems Thinking, is also recommended by Jackson and Keys (1984).

It is reiterated that the proposed study will rely on Ackoff's Interactive Planning methodology, which is described in greater detail in section 2.3.2.2 *(Ackoff's Interactive Pannign and Idealised Design)* below.

In the process of compiling their proposals towards a system of systems of systems methodologies, Jackson and Keys (1984) achieved a very useful secondary result. In their

publication, Jackson and Keys (1984) succeeded in providing a coherent description of Systems Thinking. They also (Jackson & Keys, 1984) were able to describe different types of systems and different types of decision-makers, in a clear, intelligible way (Jackson & Keys, 1984). Further, the authors (Jackson & Keys, 1984) not only made a distinction between hard Systems Thinking and Soft Systems Thinking; but they went on to describe the specific methodologies under these approaches (Jackson & Keys, 1984). For the purposes of this study, this is a useful conceptual map, which shows where Ackoff's Interactive Methodology sits on the list of available Systems Thinking methodologies.

In addition to the above, there were several other authors that are worth mentioning, who contributed to Systems Thinking literature; and whose writings add onto the list of qualitative attributes relevant to the proposed study. Oliga (1988) investigated the methodological foundations of Systems Methodologies; and related contemporary systems work on modes of inquiry and problem-solving approaches linked to their methodological foudations.

Oliga (1988)'s paper contains a detailed chapter explaining the formal distintion between a method and a methodology, which touched on Burrell and Morgan's (1979) philosophy of science and theory of society, as well as considered Habermas' (1972) interest constitution theory. Oliga (1988) then examined empiricism, hermeneutics and provided a critique of the three methodological foundations corresponding to the three forms of human interests (*viz.* technical, practical and emancipatory interests), before concluding that the different modes of inquiry are informed by empiricism, hermeneutics and critique.

He (Oliga, 1988) points out that the underwriting assumptions of the then established systems methodologies did not appear to have developed beyong empiricism and hermeneutics, which implied that historical hermeneutica and critique had hitherto been omitted. In addition to this underdevelopment, as Oliga (1988) noted, the existence of a variety of both "hard" and "soft" systems methodologies presented systems thinkers with the problem of appropriate criteria for methodological choice. This is notwithstanding the work previously undertaken by Jackson and Keys (1984) and Banathy in aid of methodological choice.

Oliga (1988) found the contigency-theory underpinning the works of these authors to be pursuasive and potentially influential, but nonetheless recommended a cautious approach, especially in respect of addressing those structural aspects of social life that cannot be avoided or altered.

Jackson (1990) examined the influence of Ackoff's work as a contribution to the development of community operations research. He (Jackson, 1990) began by examining Ackoff's work in "a black ghetto and community OR" and analysed the methods followed by Ackoff, before concluding that Ackoff showed why operational research was to be considered the opposite to the management sciences, as well as why was deemed relevant to the "systems age" era. Ackoff's Interactive Planning methodology was highlighted as a detailed methodology, through which desirable futures can be planned and pursued (Jackson, 1990). Jackson (1990) however disagreed with Ackoff's support or championing of the "reformist" strand of OR and Systems Thinking because in his view, its implicitly endorsed a *laissez-faire* form of capitalism, which must frustrate the ends to which both reformists and "revolutionaries" aspired.

The point is made above that the criticisms directed at Systems Thinking resulted in Systems Thinking experiencing a "Kuhnian crisis".

After Oliga (1988) had lamented the underdevelopment of criticalism in systems sciences, Jackson (1991) shone the spotlight on critical Systems Thinking, which, while a relatively a new arrival in systems sciences, was experiencing more growth than other parts of Systems Thinking (Jackson, 1991). Jackson (1991) explained that the origins of Critical Management Science, the precursor to Systems Thinking, can be traced back to the 1970s when traditional management sciences began being attacked by management sciences such as Soft Systems Thinking, on the basis of the "status quo" argument referred to above. Critical Systems Thinking became the more organised paradigm birthed out of the Critical Management Science foundation, having been shaped, during the 80s and 90s, by authors such as Ulrich, 1983, Jackson, 1985a, Oliga, 1988 (Jackson, 1991). He (Jackson, 1991) comments on the growth of critical and social awareness, with writers such as Checkland (1978, 1981) leading the charges in criticising hard Systems Thinking for its real-world shortcomings.

He continued and highlighted how Soft Systems Thinking, which was advocated by Ackoff, Checkland and Churchman, also had shortcomings due to the assumptions made by these authors, leading to an inability to use Soft Systems Thinking in many problems situations, as well as a limited domain of application (Jackson, 1991). (Jackson, 1991) further highlights the emergence of complementarism, which aided the classification and complementary use of systems methodologies, which was followed by the pursuit of human emancipation. These developments, which contributed to the development of critical Systems Thinking find expression in the five commmitments of critical Systems Thinking, *viz.* (i) critical awareness, (ii)

social awareness, (iii) complementary use of systems methodologies, (iv) complementarism at a theoretical level, and (v) a dedication to human emancipation (Jackson, 1991).

To build on the work undertaken by previous authors who had set out to explain Systems Thinking approaches as well as the different methodologies thereunder, (Carvajal, 1992) elaborated on Ackoff's contribution towards the development and packaging of operations research and systems science as two paradigms.Carvajal (1992) considered the developmental period between 1946 and 1980, with a focus on Ackoff's work during the '80s. Having reviewed Ackoff's wirtings during the relevant period, Carvajal (1992) observed that operational research advanced through several stages comprising emergence, expansion of frontiers, institutionalisation, controversy, and separations. Carvajal (1992) then concludes that the final stages of operations research and the initial stages of systems science coincided, with the latter comprising initial ideas, accumulation of deviants, expansion withing operations research and the formal launching of systems science.

Flood (1995) also studied operations research, management and systems sciences, albeit through a lens different from Carvajal (1992)'s. Flood (1995) noted the then raging controversies as to which approach provided the best problem-solving methods. Flood (1995) proposed that these controversies might be addressed through "total systems intervention" or TSI, which entailed the use of all the available problem-solving methods as an organised whole,, based on the strenghts and weaknesses of each one. Such ability to choose a method using the understanding of each one is argued by Flood (1995) to be in line with System Thinkings original holistic intent. Examples of cases where TSI had been used were provided, as were the principles and phases of TSI Flood (1995). Flood (1995) provides clear principles and ideas of choice of (i) method type and (ii) actual method based on, among other things:

- whether the organisation being studies is understood in a mechanistic, organic, neuro-cybernetic, socio-cultural or socio-political mannter; and

- whether the analysi is concerned with technical or human activities, with the former being concerned with prediction and control; and the latter being concerned with matters that require conceptual freedom, through open and meaningful debate.

In 1993, Ackoff published his seminal paper on idealised design. The details of this method are provided in paragraph 2.3.2.2 below, due to importance for this study and the researcher's desire to give prominence to the work.

Ackoff's submissions were followed by Anderson and Johnson (1997)'s writings in 1997, which were an addition to the explanatory work on Systems Thinking. Anderson and Johnson (1997) explained that System Thinking discourages the focus on causal loops, but instead, promotes the investigation of interconnected, circular relationships. This is based on the understanding of the interconnectedness of the many problems facing managers [and society] (Anderson & Johnson, 1997). The gravitation away from causal loops can be traced to Ludwig von Bertalanffy views at the time of developing systems theory. He expressed dissatisfaction with linear, cause-and-effect theories and instead, promoted the view the interaction of the parts of an organism is significant (Friedman & Neumann Allen, 2014).

Ackoff speaks of "messes" (Russell L Ackoff, 1979a, 1979b; Jackson & Keys, 1984) and authors such as Kmon (2016) (as well asJackson and Keys (1984)) speak of "wicked problems". According to Anderson and Johnson (1997), Systems Thinking is based on the following principles: (i) "Big picture" thinking, (ii) short-term and long-term perspectives, (iii) consideration of the dynamic, complex and interdependent nature of systems, (iv) consideration of both measureable and non-measureable factors and that actors within a systems influence the systems in which they operate and are also influenced by such systems.

Notwithstanding Flood (1995)'s TSI proposals and Jackson and Keys (1984) "system of systems methodologies" proposals, Sinn (1998) still noted that multiplicity of systems-based methods, examples including the Viable Systems Model (Stafford Beer, 1972, 1979), System Dynamic Modelling (J W. Forrester (1975), Interactive Planning (Russel Ackoff (1981) and Soft Systems Methodology (Peter Checkland, 1981). Sinn (1998) also noted the "Kuhnian crisis" emanating from this multiplicicy of methods and the concern that they were contradictory (i.e. not complementary, as discussed by pluralists such as Jackson (1991), Flood (1995's TSI proposals and Jackson and Keys (1984) and others.

Sinn (1998) believed that despite the work by previous authors, there was still a need for clarity as to the best methods, which could be achieved through grouping the different methods in cells and comparing the methods that are grouped together. Ackoff's Interactive Planning and Checkland's Soft Systems Methodology were grouped in the *complex-pluralistic* cell; and then compared. Sinn (1998) then provided an overview of Interactive Planning (which is laid out in paragraph 2.3.2.2 below), as well as Checkland's soft system's theory, which includes (i) the rejection of reductionism, (ii) understanding the distiction between hard systems and soft systems (i.e. "human activity systems"), and (iv) understanding the aim of the positive interaction of *"wetanschauung"* , as opposed to thriving for goals.

The subjectivism in both methodologies was acknowledged, as was the similarites leading to the *complex-pluralistic* context categorisation for both methodologies (Sinn, 1998). Sinn (1998) notes that while the methodologies encourage the uncovering of assumptions, Soft Systems Methodology compares models with real-world situations, and Interactive Planning compares idealised design with the present reality. This then leads to differences in outcomes regarding the likelihood of the initiation of action post-planning, the detail of planning for change, and the distribution of derived benefits (Sinn, 1998).

Also provided in paragraph 2.3.2.2 below is a summary of the views advanced by various speakers in a conference celebrating Ackoff's work and his contributions to Systems Thinking. These points are accordingly not discussed in this seciton.

Interactive Planning does appear to share some similarities with Frooman (1999)'s stakeholder theory, which can be utilised as a strategy to influence stakeholders. Frooman (1999) explains that the primary objective of stakeholder theory is to assist managers in understanding stakeholders, and to manage them strategically. In arriving at this understanding, the analysist needs to answer the following questions about the stakeholders:

- Who are they?
- What do they want (ends)?
- How are they going to try and get what they want (means)?

In 2000, Ackoff published a paper on creating the corporate future, which was followed by a guide to Interactive Planning, as published in 2001(Russell L Ackoff, 2000, 2001). These papers are also discussed in paragraph 2.3.2.2 below, alongside a discussion of Gharajedaghi (2004)'s contribution to Interactive Planning theory, through his 2004 paper on the systems methodology.

In 2005, Banathy and Jenlink (2005) had highlighted the importance of dialogue as a means of communication that would aid the development of social systems. Banathy (2009) elaborated on the idea of designing social systems in 2009, placing reliance on the idea contained in systems sciences that systems are to be understood as wholes, comprising interacting parts. According to Banathy (2009), the growth of systems sciences enhanced the understanding of how to design systems in a purposeful manner. Banathy (2009) argued that given the inadequacy of social systems that had been designed in the machine age, a design imperative existed, given social

changes taking place in the post-industrial knowledge era. He (Banathy, 2009) proposed social design as a means of collectively empowering society to create an improved future. To explore the concept of social design, Banathy (2009) first examined the process of design, describing it as an action of purposeful creation. Social design then, was seen as the collective human activity of creating the future, the understanding being that social design problems are ill-defined and inherently wicked (Banathy, 2009). As he concluded, design became necessary as a means of managing and shaping change, which could be achieved through systems design methods (Banathy, 2009).

2.3.2.2 Ackoff's Interactive Planning and Idealised Design

As discussed above, Interactive Planning as conceptualised by Russell L Ackoff (2001) is a particular problem-solving methodology alongside others under the Soft Systems Methodologies categorisation (Jackson, 1990; Mingers & White, 2010; Sinn, 1998). In summary, Interactive Planning refers to an approach to discovering or designing an imagined future, as if the planners did not have any constraints to their wishes by technological feasibility and operational viability. It concerns manipulating a present state, so that it brings the entity being designed as close as possible to where it is wished to be (Russell L Ackoff, 2001; Jackson, 1990).

The research knowledge gap analysis in Section 2.2 contains literature which, among other things, comments on the suitability of Interactive Planning for certain complex problem situations, including those in socio-technical systems (See for example, Lumbo (2007), Kemp *et al.* (2007) , Asmu'i and Fitriati (2014), Chowdhury (2015), da Costa Junior *et al.* (2019) andda Costa Júnior *et al.* (2020). Some of this literature contains examples of the practical use of Interactive Planning. It is therefore clear that Interactive Planning has found practical use among present-day systems thinkers.

The place occupied by Interactive Planning in the Sytems Thinking universe is explained in detail in Sections 2.3.1, 2.3.2, and 2.3.2.1 above. Also contained in these sections is the overview of the assumptions informing Interactive Planning, as a Soft Systems Methodology. These considerations are not repeated in this section. Instead, what follows below is an overview of Ackoff's own submissions as to what Interactive Planning is, as well as the phases that form part of the methodology.

In the early stages of the conceptualisation of Interactive Planning; and having noted the criticisms faced by operational research (particularly in the United States, where it was founded), Russell L Ackoff (1979a)suggested the following approaches towards the optimisation of operational research:

- the need for decision-making approaches to learn and adapt quickly in respect to the continuous changes in problem situations (Russell L Ackoff, 1979a);

- taking into account the concepts of "means", "trade" and "cycle", by understanding that a cause of action that is likely to result in a particular end is a "means", while the desired objective is the "end" (Russell L Ackoff, 1979a);

- understanding that problems, rather than being independent of each other, are party of "messes" or situations that are dynamic, and which are made up of problems that are changing and that interact with each other (Russell L Ackoff, 1979a);

- the need for a departure from attempting to solve problems, towards managing messes, by producing systems that are idealised, to the satisfaction of the participants (Russell L Ackoff, 1979a);

- as opposed to the "predict and prepare" approach, adopting learning paradigms such as the design of a desired future and ways to realise it (Russell L Ackoff, 1979a) ;

- using the interaction of a wide range of disciplines in order to effectively manage messes (Russell L Ackoff, 1979a); and

- ensuring that those who are potentially impacted by the results of a decision-making process are involved in the proess or adequately represented, so that their interest can be considered (Russell L Ackoff, 1979a).

Russell L Ackoff (1979b) susequently proposed that the "predict-and-prepare" paradigm, which he had shown to have shortcomings (Russell L Ackoff, 1979a), be replaced with an interactive paradigm focusing on designing a desirable future, and ways to realise the desirable future. He (Russell L Ackoff, 1979a) proposed the following operating principles underpinning the paradigm:

- The benefit of the paradigm derives from engaging in it (participative principle). One needs to plan for oneself, because another cannot plan effectively for someone else (Russell L Ackoff, 1979a).

- Also to be embraced is the principle of continuity, which holds that plans typically do not necessarily work exactly as envisaged, which means that plans must be contrinuously reconsidered (Russell L Ackoff, 1979a).

- There is also the holistic principle, which holds that all the units that are in the same level of an organisation need to be olanned for at the same time and interdependently. Further, any level of a multilevel system needs to be planned for by involving all other levels of that system (Russell L Ackoff, 1979a).

Russell L Ackoff (1979b) then explains the content of operational research. Formulating the mess involves identifying problems and deteming the prospects and relationships between the problems. This is then followed by means-end planning, which involves setting organisational goals and objectives, as well as determining the means to pursue the goals and objectives. After means-end planning, the pursuit of the goals and objectives is organised and managed, which is finally followed by the implementation and control of the pursuit(Russell L Ackoff, 1979a).

Idealised design is introduced as a means of preparing an idealised system that is wished for, with the objective that the system will replace the existing one as thought the designers had the freedom to do so. The contraints that idealised design is subject to are: (i) whether the redesing is technologically feasible; and (ii) whether it is operationally viable (Russell L Ackoff, 1979a).

While the 1979 paper provided glimples of Russell L Ackoff (1979b)'s initial understanding of the Interactive Planning and Idealised Design process, the year 2001 saw Ackoff producing a more detailed and organised explanation of the process (Russell L Ackoff, 2001). The principles and assumptions disccused above (Russell L Ackoff, 1979a) are very much at the core of the Interactive Planning and Idealised Design process. Reactive planning (bottom-up) and proactive planning (top-down) are contrasted with Ackoff's process, which serves to highlight the holistic principle (Russell L Ackoff, 1979a, 2001). The principle is emphasised that Interactive Planning involves designing a desirable present and selective or inventing ways of approximating it as best as possible (Russell L Ackoff, 2001). Russell L Ackoff (2001) reiterates the constraints that the process is subject to (i.e. technological feasibility amd operational viability), and adds a new one – that learning and adaptability has to be included as part of the design.

The process is depicted in **Table 2** below.

<table>
<tr><th colspan="3">IDEALISED DESIGN</th></tr>
<tr><td colspan="3">• The Formulation of a Mission Statement (Russell L Ackoff, 2001).
• Specification of the Properties the Designers want the designed organisation to have (Russell L Ackoff, 2001).
• Design of an organisation that has these properties (Russell L Ackoff, 2001).</td></tr>
<tr><td colspan="3">INTERACTIVE PLANNING</td></tr>
<tr><td rowspan="2">Idealisation Process</td><td>Formulating The Mess (Situational Analysis).</td><td>• Systems analysis: understanding how the system currently operates (Russell L Ackoff, 2001).
• Obstruction analysis: identifying the characteristics and properties of the system that obstruct progress (Russell L Ackoff, 2001).
• Reference projections: undertaking projections of organisation's future, while assuming no change in current plans; and no change in the future environment (Russell L Ackoff, 2001) .
• Reference scenario: Providing a description of how and why the organisation would destroy itself if the assumptions were true (Russell L Ackoff, 2001).</td></tr>
<tr><td>Ends Planning</td><td>• Determining what the organisation would ideally be like to be now (gaps between this ideal and the projected reference scenario) - then moving on to realisation, which is about reducing these gaps, taken collectively and interactively (Russell L Ackoff, 2001).</td></tr>
<tr><td rowspan="4">Realisation Process</td><td>Means Planning</td><td>• Determining what needs to be done to remove or reduce the gaps identified in Ends Planning (Russell L Ackoff, 2001).</td></tr>
<tr><td>Resource Planning</td><td>• Determining how much of each type of resource is needed or will be available (Russell L Ackoff, 2001).</td></tr>
<tr><td>Design Of Implementation</td><td>• Deciding what to do, when and where (Russell L Ackoff, 2001).</td></tr>
<tr><td>Design Of Controls</td><td>• Monitoring (Russell L Ackoff, 2001)</td></tr>
</table>

Table 2: Overview of Interactive Planning Process (Russell L Ackoff, 2001)

3 RESEARCH STRATEGY, DESIGN, PROCEDURE AND METHODS

3.1 Introduction

This Chapter 3 describes the research approach that was followed by the researcher. It discusses the procedure and methods that were employed to collect, process, and analyse the data relied on for responding to the research questions.

The chapter also describes the reliability and validity measures (Section 3.10) that the researcher has applied to undertake the study. Finally, technical and administrative limitations of the strategies chosen are discussed.

3.2 The Research Strategy of the Study

The research strategy or research paradigm refers to the mode of inquiry that is followed to systematically explore the research topic (Marshall & Rossman, 2014). It encompasses plans, procedures, tools and methods that are employed to collect, analyse and interprete research evidence (Creswell & Creswell, 2017; Marshall & Rossman, 2014). There are three main research approaches, namely, qualitative, quantitative and mixed methods (Creswell & Creswell, 2017).

The selection of a mode of inquiry is informed by several factors. Examples of these factors include the nature of the research problem, the researcher's worldview and assumptions, efficiency, researcher's experiences, research designs and methods that have been identified (Creswell & Creswell, 2017; Marshall & Rossman, 2014).

The researcher conceptualised the study such that it has a theoretical phase and an empirical phase. The researcher relied on document data from Internet sources during the theoretical phase; and relied on expert semi-structured interviews during the empirical phase. The Delphi methodology was used to structure and manage the interview process (see Section 3.3.1 and 3.3.2).

The exploratory nature of the study, the two-pronged research design and the data collection methods selected (i.e. Internet documents data and the Delphi's semi-structured interviews), lended themselves to the qualitative research paradigm (Creswell & Creswell, 2017; Marshall & Rossman, 2014).

3.2.1 Specific Reasons for the Qualitative Research Paradigm

The choice of the qualitative research paradigm was also informed by the researcher's specific reasons, perspectives and attitudes discussed immediately below.

3.2.1.1 The JET as a Developing and Complex Field of Study

The JET or rather, the energy transition to renewable sources of energy is a developing field of study, given that the energy transition is at its infancy (Larson, 2021). It is also a complex topic. Qualitative methods, including the Delphi method, have been shown to be beneficial to researchers seeking to deeply understand complex phenomena (Brady, 2015; Denzin & Lincoln, 2011; Yin, 2009). Further, such methods have been argued to be useful in generating empirical data where little exists (Maclaran and Catterall 2002, Buchanan and Jones 2010).

3.2.1.2 The Researcher's Philosophical Orientation and Assumptions

Research philosophy is crucial in understanding the development of knowledge (Saunders & Lewis, 2012). A researcher's philosophical orientation, or "world view," influences the choice of study, research strategy, and data collection method (Creswell & Creswell, 2017; Malterud, 2001; Saunders & Lewis, 2012). This orientation affects the quality and trustworthiness of research, shaping methods, investigation posture, findings, and presentation (Creswell & Creswell, 2017; Malterud, 2001). The researcher has a natural orientation towards the detailed, decriptive nature of qualitative research.

The researcher is trained in legal reasoning. Although legal reasoning is traditionally deductive, the field increasingly recognises that inductive reasoning may also be appropriate, depending on the context and particulars of the case (Walton, 2010).

3.2.1.3 Inductive Reasoning and the Researcher's Desire for Pragmatism and a Context-based Study

Inductive reasoning is a research approach that focuses on developing deep meaning and understanding (Saunders & Lewis, 2012). This approach is not focused on conclusiveness, but rather on generating deep meaning from patterns or repeated observations (Walton, 2010). Qualitative methods are suitable for studies of the form undertaken by the researcher, as they allow for a deeper understanding of phenomena unfolding naturally in a context-specific, "real-world" setting (Patton, 2001, p. 39 in Golafshani (2003)).

Since qualitative research is less conclusive than deductive methods (Walton, 2010), a qualitative researcher's final manuscript may be defeasible in the face of future evolving theories, as explained by Cronbach and Meehl (1955). However, this risk was not fatal to the study, as the subject being investigated is still developing. The defeasibility of a qualitative researcher's argument comes not from its being fallacious, but rather, from the time context in which the argument is studied and used (Walton, 2010).

Walton (2010) submits that the conclusiveness of deductive logic can be a weakness if one considers that this form of logic is context-free. In the case where the context in which an argument is used is vital, the context-free nature of deductive logic is not desirable (See Hage et al., 1994 in Walton (2010)).

In Section 1.3.5.1 *(An Overview of the Energy System)*, the point is made that the energy transition could take place in a local, regional or global context, and that the identification of such a change, including the nature of the energy system being studied, depends on the applicable circumstances and the assumptions being made by the analyst (Anandarajah *et al.*, 2009; Arya, 2021; Häfele & Sassin, 1977).

It therefore follows that context and the qualitative views of the person making such an inquiry are an intrinsic part of the assessment. In a doctoral study seeking to redesign American public school systems, Pickering (2006) explained that due to the contextual nature of idealised design, the qualitative research paradigm was chosen for the study. The researcher relied on these views to further conclude on the appropriateness of the qualitative research paradigm.

3.2.1.4 Flexibility

The researcher sought to benefit from the flexibility of the inductive approach (Saunders & Lewis, 2012) and the Delphi process (Skulmoski *et al.*, 2007), as the study developed (Saunders & Lewis, 2012). Flexibility was desired so that the researcher could "be dynamic, intuitive and creative, to be able to think, reason and theorise" (Buchanan and Jones, 2010: p.3).

3.2.1.5 The Researcher's View on Generalisability

The researcher was more concerned with the deep understanding to be derived from the contextual input of expert respondents than the ability to generalise. The Delphi method has therefore been deemed suitable in that a generalisable sample is not its focus , but instead, it prioritises expert input on the topic being studied (Brady, 2015). This is not to say that transferrability is not possible (see Section 3.2.1.3 above).

3.3 The Research Design of the Study

Research design refers to the systems and procedures of inquiry adopted by a researcher to collect and interpret the research evidence or data (Creswell & Creswell, 2017). Bryman (2016) lists five generic research designs, namely, (i) experimental design, (ii) cross-sectional design, (iii) longitudinal design(s), (iv) case study design and (v) comparative design.

Given the researcher's worldview, research aim, research questions and literature reviewed, it was determined that the study would benefit from a consensus-seeking method. The aim was to assess the extent of agreement among a small sample of subject-matter experts (Brady, 2015; Jones & Hunter, 1995) in respect of the questions posed. The consensus view informs the conclusions made by the researcher.

It was also determined that there was a need for a theoretical inquiry. The theoretical inquiry needed to be completed prior to the empirical phase, with the aim of answering the first research question. The researcher therefore adopted a two-pronged design, comprising a theoretical inquiry and an empirical inquiry. Both these approaches fall under the case study research design (Bryman, 2016; Yin, 2017).

The theoretical phase primarily addressed the research question pertaining to the current operation of South Africa's energy system (see Section 1.2 above on the research objectives). The empirical investigation addressed the research questions dealing with the steps of the Idealised Redesign process (also, refer to Section 1.2).

This two-pronged approach is not without precedent. In 2020, da Costa Júnior *et al.* (2020) conducted a study with the objective of proposing a systems design approach to sustainable development. Their (da Costa Júnior *et al.*, 2020) study was undertaken in the context of complex energy challenges in low-income markets, with Brazil being the specific geographical context.

Using the two-pronged approach (i.e. a theoretical inquiry combined with an empirical inquiry), da Costa Júnior *et al.* (2020) put forward six research questions, which together would answer the study's main question as to how Systems Thinking **(Systems Thinking)** can contribute to addressing the complexity of sustainable system design for low-income energy markets. In the interests of succinctness, the six questions will not be restated.

To answer research questions 1 to 3, da Costa Júnior *et al.* (2020) completed a theoretical inquiry to understand certain aspects of prevailing societal problems. The theoretical inquiry also aimed to discover the contribution of Systems Thinking to resolving complex societal problems. To answer research questions 4 to 6, da Costa Júnior *et al.* (2020) then completed the empirical phase of their research, by undertaking observations of existing practice in the Brazilian low-income energy market. In addition, da Costa Júnior *et al.* (2020) completed exploratory exercises. The findings helped the authors answer the main research question and ultimately achieve the objective of the research.

In conceiving this study, the researcher began by pondering how Systems Thinking may contribute towards the realisation of the JET in South Africa. While the focus and context are clearly different to da Costa Júnior *et al.* (2020)'s, the initial question posed by the researcher at study conception is, to a certain degree, to the primary question posed by da Costa (da Costa Junior *et al.*, 2019), regarding the contribution of Systems Thinking towards addressing the complexity of sustainable system design for low-income energy markets. However, due to time and space constraints, the researcher was unable to conduct a comprehensive System Thinking investigation. da Costa Júnior *et al.* (2020) had the benefit of relying on their own prior research to finish the theoretical portion of their study.

In the final study concept as presented for approval, the proposed researcher abandoned the initial question posed at conceptions, insofar as it related to the contribution of Systems Thinking to the realisation of the JET in South Africa. This is because the study was ultimately conceived to focus on only one phase of the Interactive Planning and Idealised Design process, which is not adequate to fully address the issue of how Systems Thinking might contribute to the successful implementation of the JET in South Africa. Nonetheless, undertaking the first phase of the Interactive Planning process does produce knowledge that may be utilised as a foundation for future study, which may ultimately allow for the primary question to be fully answered.

While the this study does not pose a primary question similar to da Costa Júnior *et al.* (2020)'s, it does follow a two-pronged approach because the first study objective (see Section 1.2 above) is capable of being adequately addressed through a theoretical inquiry, while the next study objectives may be successfully addressed through expert interviews and where possible, a combination of a theoretical inquiry and expert interviews. The expert interviews follow the Delphi described in Section 3 *(Research Strategy, Design, Procedure and Methods).* The reasoning behind this method is contained in the aforementioned Section 3.3.2 and will therefore not be repeated, in the interests of brevity. It however is important to demontrate visually, the manner in which the Delphi process will unfold. This is attempted in ***Figure 10*** below, where an example of the Delphi approach used by Jones and Hunter (1995) is inserted.

3.3.1 Research Design: The Theoretical Phase and Internet Document Sources

As indicated above, the study followed a two-pronged research strategy. In the theoretical phase of the study, the first objective was pursued (i.e., completing a systems analysis of South Africa's energy system). The systems analysis entails, among other things, an investigation of the manner in which the South African energy system currently operates (Russell L Ackoff, 2001).

Russell L Ackoff (2001)'s description of the Idealised Redesign process envisages that all the phases of the process are undertaken interactively by the stakeholders themselves, with the assistance of a facilitator. However, for the objectives of this study, the systems analysis activity relies on the collecting of data about the South African energy system from Internet sources, and the analysis of the data by comparing it to existing theory. The theory is analysed in Section 2 *(Literature Review)*. Conclusions are then drawn by the researcher, as appropriate.

The collection of data in this way was appropriate; and is one of the data collection methods that a qualitative researcher may utilise (Creswell & Creswell, 2017; Vogt *et al.*, 2012). As stated in Section 1.3.5.1 above *(An Overview of the Energy System)*, it is not always possible to determine the exact components and behaviours that make up a particular energy system;

- as this is largely dependent on the prevailing circumstances, the evolutionary path of the energy system over time; and
- the assumptions made by the person doing the analysis, as well as trade-offs in respect of the different components within that system (Anandarajah *et al.*, 2009; Häfele & Sassin, 1977).

The researcher therefore made his own assumptions with the guidance of published theory, as opposed to analysing the potentially widely varying assumptions made by the stakeholder panellists. The making of findings during the theoretical phase of the study was not an end in and of itself, but rather a first step in a continuum ending with the final research question forming part of the empirical phase. The theoretical phase findings informed the conduct of the empirical phase, in a similar way da Costa Júnior *et al.* (2020)'s study was designed, such that the empirical phase was shaped and informed by the theoretical phase. From that point of view then, the two phases of the study were interlinked.

3.3.2 Research Design: The Empirical Phase and Delphi Technique

The empirical phase of the study addressed objectives 2, 3 and 4 and adopted the Delphi Technique (**"the Delphi"**). To address the above study objectives, a consensus view was obtained from the expert witnesses, who participated in an Idealised Redesign process facilitated by the researcher. The manner in which the South African energy system operates (objective 1) informed the rest of the study objectives.

There are apt examples where the Delphi has successfully been used by researchers in different fields, some of whom pursued Interactive Planning. Almaiah and Almulhem (2018) used the Delphi to identify critical factors that will contribute to successful e-learning implementation at Saudi Arabian universities. In South Africa, Fokkens (2011)relied on the Delphi technique to forecast an ideal South African Military Academy by the year 2030. The Delphi offers significant advantages to the proposed study due to its pragmatism and its serving as a bridge between theory and real-world understanding (Brady, 2015). The Delphi is further characterised by

affordability, lack of complexity, and its prioritisation of expert input over generalisability (Brady, 2015).

The nature of the research problem required a deep understanding of the meaning ascribed by individuals (in this case, expert respondents), to the problem (Creswell & Creswell, 2017; Malterud, 2001; Rocco & Plakhotnik, 2009). This gravitated towards an inductive qualitative approach (Creswell & Creswell, 2017; Malterud, 2001; Rocco & Plakhotnik, 2009). This deep understanding is important in qualitative research, given that this form of research focuses on an interpretive, naturalistic approach (Pandey & Patnaik, 2014), with a particular interest in phenomena as they occur in their natural setting, or alternatively, the meaning brought by others onto them (Malterud, 2001; Pandey & Patnaik, 2014). This study therefore fell within the interpretivism research approach, where the social actors and the meanings they attribute to the phenomena being studied take centre stage (Saunders & Lewis, 2012). The actors are the expert witnesses who participate as stakeholders in the South African energy system.

3.4 Research Procedure and Methods

This section documents the actual procedure, and the methods employed in this research to collect, collate, process, and analyse empirical evidence. Broadly, the section addresses the research data and information collection process (Section 3.4.1), the research data and information collection instruments (Section 3.5), the research target population and selection of respondents (Section **Error! Reference source not found.**), ethical considerations when collecting research data (Section 3.7), research data and information processing and analysis (Section 3.8), and provides a description of the research respondents (Section 3.9).

3.4.1 Research Data and Information Collection Process

The data collection process entails systematically and honestly gathering, analysing or measuring information on the qualitative attributes or variables of interest, so as to be in a position to answer the study's research question(s) (Stellenbosch University Library Guides, 2023); Yin (2017) lists documentation (which can also be sourced from the Internet), archival records, interviews, direct observation, participation-observation, and physical artifacts as the main sources of research data. Yin's list is compiled from the perspective of a qualitative researcher or more specifically, the case study researcher. Qualitative research is recognised as offering

significantly diverse sources of data (Hugh-Jones & Gibson, 2012). Generically, researchers list four research modes, namely participant observation or ethnography, interviews (face-to-face, telephone, or internet-based), focus group discussion, and documents)(Lopez & Whitehead, 2013).

The procedure of inquiry or research design was informed by the research problem (See Section 1.4.1), the research questions arising from the research problem (See Section 1.4.3; and the theories flowing from the research objectives (Creswell & Creswell, 2017; Vogt *et al.*, 2012).

The researcher had available to him several evidence collection methods, including (i) documentation, (ii) archival records, (iii) interviews, (iv) direct observation, (v) participation-observation, and (vi) physical artifacts, or (vii) a combination of any of these methods (Creswell & Creswell, 2017; Vogt *et al.*, 2012; Yin, 2009).

The researcher ultimately utilised a combination of documentation (theoretical phase of the study) and interviews (empirical phase of the study).

3.4.1.1 Theoretical Phase Data Collection Process

The theoretical phase of the study relied on documentation sourced from the Internet. This represents a form of indirect evidence with benefits such as stability, unobtrusiveness, specificity, efficiency and broadness (Marshall & Rossman, 2014; Yin, 2017).

3.4.1.2 Empirical Phase Data Collection Process

Expert opinions were considered very important for research objectives 2, 3, and 4. Due to expert opinions being an integral part of the research problem, interviews were undertaken as a data collection method for the empirical phase of the study (Vogt *et al.*, 2012). The Delphi interviewing technique was utilised in this study as a means of extracting and refining the participant's opinions towards a consensus view. This pragmatic method was built upon the philosophies of Locke, Kant and Hegel, which recognise the importance of the opinions and perceptions of individuals and groups, alongside other empirical data (see Turoff, 1970 in Brady (2015)).

The Delphi is particularly beneficial in studies (i) where there is a need to forecast in the face of inadequate data, (ii) where traditional quantitative forecasting approaches would not be suitable (Fokkens, 2011); and (iii) where there may not be a way to immediately verify initial and divergent opinion (hence, the need for refinement of the opinions through the Delphi technique) (Dalkey, 1967). Further, given the research problem, the Delphi was considered appropriate as a method to facilitate "the formation of a group judgment" unaydin, 2006, p. 1.), which would work well with the Interactive Planning process.

Figure 10 below provides a visual overview of the Delphi process from an example provided by Jones and Hunter (1995). However there are some notable differences between the Delphi process in the example and the process that is followed by the researcher. Unlike Jones and Hunter (1995) who relied on 20 experts, the researcher proposed a sample of up to **five experts (three is ideal)**. The reasons behind this sampling approach are stated in Section 3.3.2, read with Section **Error! Reference source not found.**.

Further, there was no testing of the results against a real situation. In the preceding sections, it is explained that the Delphi was deemed to be a proxy for the "observations" that accompany a case study research design; and that the experts are deemed to be a proxy for the South African energy system stakeholders. The intention was not to generalise the research findings to the broader population of stakeholders, but to rather introduce sound and credible considerations for the "mess formulation" process when undertaking Interactive Planning towards an idealised JET and of the South African energy system.

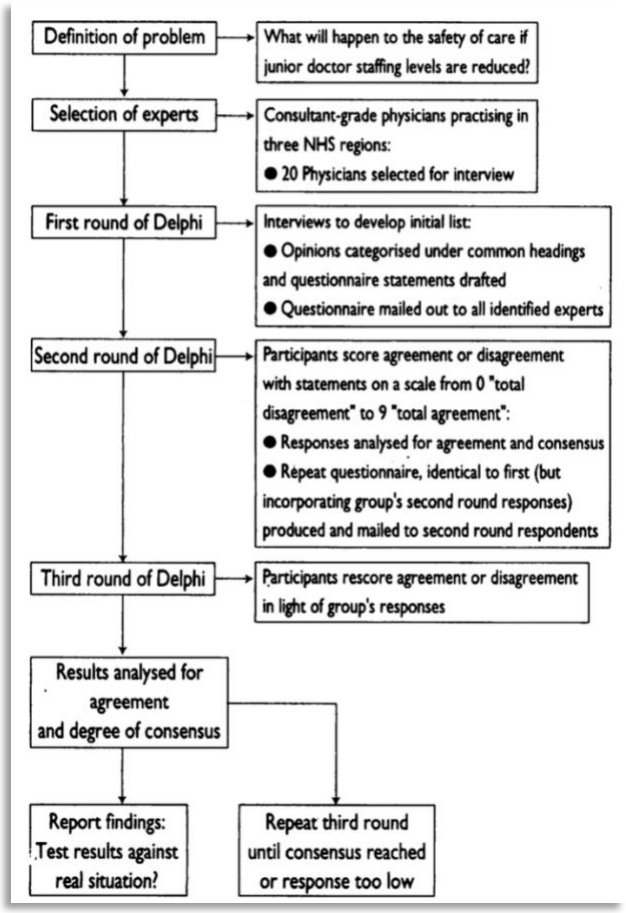


Figure 10: Delphi Process Example - Extracted from Jones and Hunter (1995)

3.5 Research Data and Information Collection Instrument(s)

A research data collection instrument is the tool that a researcher uses for the purpose of collecting research data (Ngulube, 2019). Types include the observation schedule, the in-depth interview schedule (Marshall & Rossman, 2014). The research instrument may be unstructured, semi-structures or fully-structured (Creswell & Creswell, 2017; Marshall & Rossman, 2014; Yin, 2017). The research questions lead to an explorative study, where new insights were targeted to bring new understanding (Saunders & Lewis, 2012).

3.5.1 Theoretical Phase Data Collection: Internet Documents

The theoretical phase of the study relied on document data collection methods, primarily from the internet. This approach offered efficiency benefits, allows for freedom in making assumptions about the South African energy system, and ensured stability, unobtrusiveness, specificity, and broadness (Anandarajah *et al.*, 2009; Häfele & Sassin, 1977; Yin, 2017). The applicable data collection instrument is included in **Appendix 1.1** *(Data Collection Instruments)*.

3.5.2 Empirical Phase Data Collection: Interviews

Insofar as the empirical phase of the study is concerned, the researcher relied on expert interviews. This is in light of the desire to seek deep understanding, where participant's views were an integral part of the research question (Saunders & Lewis, 2012; Vogt *et al.*, 2012). As opposed to surveys, interviews "resemble guided conversations rather than structured queries" (Yin, 2009, p. 110). This however does not mean that interviews cannot at least be semi-structured.

Given the time constrains and the need to contain the volume of data that might be produced, it was beneficial to the study that semi-structured interviews were used as a data-collection method. Drever (1995) argues that in a study where a small group of people is to be interviewed, a semi-structured interview may be more appropriate, since it allows for the predetermination of a high-level structure and the most important questions, while being flexible enough not to encroach on the manner in which respondents express themselves, as well as what they say.

Further, the study had similarities with the circumstances described by Fokkens (2011), in that the research problem required that the researcher engage in a process of forecasting, in circumstances where sufficient data does not exist to support traditional statistical methods.

Relying on the writings of Adler and Ziglio (1996), and Delbecq *et al.* (1975), Skulmoski *et al.* (2007) propose that the Delphi is especially attractive where forecasting is required in the face of limited or incomplete information about a phenomenon. In such a case, the qualitative Delphi interviewing technique was undertaken to facilitate the human forecasting intervention required (Fokkens, 2011; Skulmoski *et al.*, 2007). Dalkey (1967) describes the Delphi technique as "a set of procedures for eliciting and refining the opinions of a group of people. In practice, the Delphi was would be used with a group of experts or especially knowledgeable individuals" (p.1). The key features of the Delphi process include anonymity, communication, controlled feedback, and pseudo-statistical group responses by expert respondents (Dalkey, 1967; Skulmoski *et al.*, 2007; Yousuf, 2007). The primary advantage of the Delphi is that it is aimed at arriving at a consensus view among a group of expert respondents (Almaiah & Almulhem, 2018). This works well with the consensus seeking Interactive Planning process.

The classic Delphi exercise was utilised, whereby the researcher relied on a semi-structured, but open-ended questionnaire (Linstone & Turoff, 1975; Skulmoski *et al.*, 2007). As part of the noise-

reducing, controlled feedback process described by Dalkey (1967), the researcher summarised the responses received and fed them back, together with counterarguments, to the respondents. More responses were then solicited, with the respondents afforded the opportunity to reconsider their initial responses, with the benefit of the fed-back summaries and group response (Almaiah & Almulhem, 2018; Dalkey, 1967; Linstone & Turoff, 1975). One iteration of the Delphi was undertaken, with one feed-back exercise completed (See Dalkey (1967), Linstone and Turoff (1975) andFokkens (2011).

Given the small size of the group of experts interviewed, Drever (1995)'s suggestion of semi-structured interviews was followed, which is in keeping with the Delphi technique's reliance on small sample sizes.

Collection methods such as documentation, surveys, archival records, experiments, direct observations, participant-observation, or physical artifacts (See Creswell and Creswell (2017); Yin (2009) and Vogt *et al.* (2012) on data collection methods) were not considered appropriate for the empirical phase of the study, given that they would not provide the required deep insight into the participant's views, which was necessary to address objectives 2, 3 and 4 (See Section 1.4.2). In contrast, interviews have the advantage of being focused on case study topics and delivering deep insight, which includes the personal views of the respondents (Yin, 2009).

Disadvantages of the proposed data collection method (interviews) include (i) possible bias on the part of the researcher, (ii) if questions are not presented appropriately, possible response bias, (iii) inaccuracies resulting from the researcher's skill in recalling responses, (iv) as well as interviewees being reflexive by giving what they believe is the desired response (Yin, 2009). The researcher attempted to minimise the impact of these disadvantages by adopting the reliability and validity measures discussed in Section 3.10 of this proposal *(Research Strengthens – Reliability and Validity Measures).*

The data collection Instrument for the empirical phase of the study is included in **Appendix 1.1** *(Data Collection Instruments).*

3.6 Research Target Population and Selection of Respondents

3.6.1 Selecting Respondents from the Target Population

In conceptualising the study, the researcher was more concerned with the deep understanding to be derived from the contextual input of expert respondents than the ability to generalise. In Sections 3.2.1.5 *(Researcher's view on Generalisability)* and 3.3.2 *(Research Design: The Empirical Phase and Delphi Technique)*, the point is made that a generalisable sample is not the focus of the Delphi, which prioritises expert input on the topic instead (Brady, 2015). The role of generalisability in qualitative research is discussed in detail in Section 3.10.4 *(Trustworthiness and Measurement Validity in Qualitative Research)*. The gist of the argument is that in qualitative research, the focus is on the event, and the objective is to understand the event deeply (Creswell & Creswell, 2017; Malterud, 2001; Rocco & Plakhotnik, 2009). If generalisability is to be considered, this would only be in respect of whether the to the extent that the theory produced is theory could be used to understand a similar event elsewhere (Maxwell, 1992) (i.e. this is not generalising to the target population).

From that point of view then, sampling, though important, is approached differently in qualitative research in that rather than being randomised, it is in purposeful or theoretical, with reference being had to the research questions and the phenomena being studied (See Patton (1990) and Strauss (1987) in Maxwell (1992)).

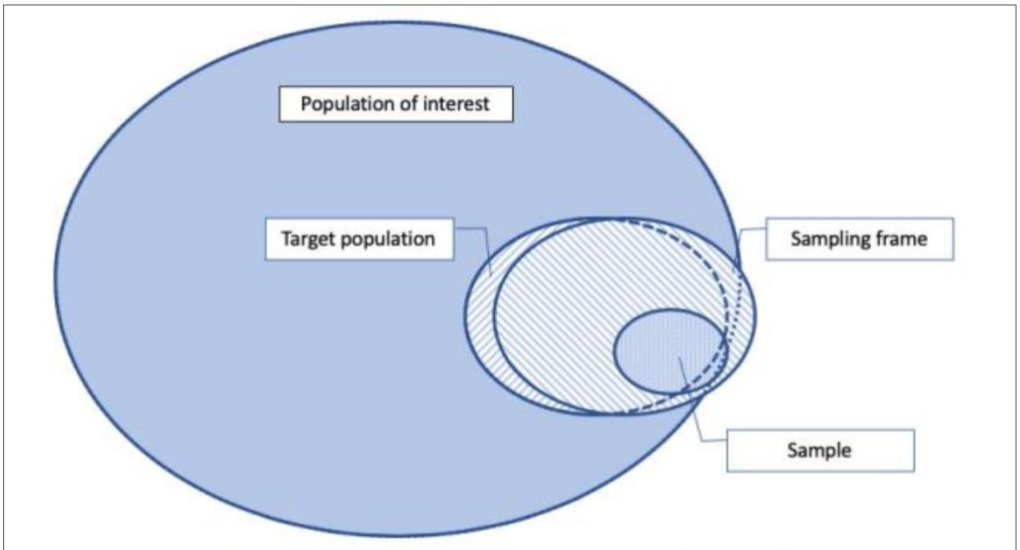
Ordinarily, a researcher is faced with a choice between two sampling techniques: probality or randomised sampling and non-probality sampling (Brady, 2015; Creswell & Creswell, 2017; Marshall & Rossman, 2014; Maxwell, 1992; Yin, 2017). In light of the objectives discussed above, the applicable theory, the research strategy and the research design, non-randomised sampling was chosen (Brady, 2015; Creswell & Creswell, 2017; Marshall & Rossman, 2014; Maxwell, 1992; Yin, 2017). Qualitative research samples need not be large (Brady, 2015; Creswell & Creswell, 2017; Marshall & Rossman, 2014; Maxwell, 1992; Yin, 2017), given the purposefulness of the samples. The Delphi, particularly, relies on small samples. The researcher accordingly draw a sample of between three and five experts. It is submitted that two experts, if this becomes an option, will not be fatal to the study objectives.

In Section 3.5.2 *(Empirical Phase Data Collection: Interviews)*, examples are provided of studies that relied on the Delphi, including (i)Almaiah and Almulhem (2018), who used the Delphi to identify critical factors that will contribute to successful e-learning implementation at Saudi Arabian

universities; (ii) Fokkens (2011), who relied on the Delphi technique to forecast an ideal South African Military Academy by the year 2030; and finally, (iii) Brady (2015). This studies relied on focused, purposefully drawn samples. While there are examples of Delphi studied that drew relatively large samples, such as Jones and Hunter (1995), who had a sample of 20, there are are unique circumstances supporting such relatively large sampling.

3.6.2 Population of Interest and Target Population

The population of interest is a group of people or individuals in a specific geographical area, who can be shown to have at least on characteristic in common, while a target population is a group of people or individuals within the target population, who meet all the criteria set by the researcher as part of the study (Willie, 2022). In other words, the target population is the group of people or individuals that the reasearcher wishes to investigate (Willie, 2022). **Error! Reference source not found.** below depicts the important distinction between a population of interest and a target population.



Note. In the two center ellipses, the target population is depicted by right to left diagonal lines and the sampling frame is depicted by left to right diagonal lines. The sampling frame intersects the target population. The sample and sampling frame described extends outside of the target population and population of interest as occasionally the sampling frame may include individuals not qualified for the study.

Figure 11: Populations and Samples in Research Studies - Adapted from Casteel & Bridier (2021) in Willie (2022)

For the purposes of this study, the population of interest was the entire population of the Republic of South Africa. The target population was that portion of the population of interest that represents the stakeholders to the South African energy system.

In determining the target population for the purposes of the study, the researcher gave thought to who would ideally participate in an Idealised Redesign process to bring about a just energy transition - if the reseacher had the freedom to invite each and every "qualifying" person. The participative principle of Interactive Planning (see Section 2.3.2.1) holds that one needs to plan for oneself, because another cannot plan effectively for someone else (Russell L Ackoff, 1979a). Therefore, all that are affected by a plan need to either participate in the planning process, or they need to have their interests well represented (Russell L Ackoff, 1979a).

A plan going into the very roots of the South African energy system would impact all the stakeholders of the energy system, who are the entire South Africa population. From that point of view then, the population of interest and the target population are the same. However, the story does not end there. Russell L Ackoff (1979b) speaks of "the planners" of a system. Energy planning in South Africa is a complex process, with socio-economic implications. Due to the complexity of the process, it is not every individual stakeholder that participates. Instead, we have groupings of stakeholder representatives, such as lawmakers, various business groups, user representatives etc. These "planners" were therefore considered the target population for the purposes of the study.

3.6.3 Profile of the Respondents

As indicated in Section **Error! Reference source not found.** *(Selecting Respondents from the Target Population)*, the respondents were carefully selected in a purposeful, non-randomised manner, based on their ability to provide the researcher with deep understanding of the research topic (Brady, 2015; Creswell & Creswell, 2017; Marshall & Rossman, 2014; Maxwell, 1992; Yin, 2017). In the interests of anonymity, the full CVs of the respondents are not shared. However, their profiles are summarised below, in order to allow the reader to appreciate the unique perspectives of each respondent. It is submitted that the respondents collectively provided a balanced view, given their varied backgrounds and expertise.

- **Respondent #1** is a senior executive at the South African state energy utility, who is responsible for the introduction of new technologies to support. He is a qualified engineer. Due to his current responsibilities and experience, he is well-positioned to express a view on the Just Energy Transition, including (i) the political and technical aspects of the Just Energy Transition, (i) Eskom's place in the energy system, (ii) the

current trajectory of the energy system, as well as (iii) the role of private entities in the energy transition.

- **Respondent #2** is also a qualified engineer. He is a senior business development specialist at a major multinational energy and petro-chemical company, which has operations in multiple countries across the world. He is a qualified engineer and is well-versed in the technical and commercial matters pertaining to energy generation, transmission, storage and distribution. Respondent #2 has worked on expat assignments establishing power plants in several countries. From that perspective, he was able to provide deeply considered views on (i) the role of the private sector in the energy transition, (ii) the power of efficient regulatory mechanism and political will, and (iii) placing the energy system in its global context.

- **Respondent #3** is a qualified finance professional. He is a senior executive in a major commercial bank that is responsible for financing renewable energy projects, utilising project finance. In order to be in a position to finance a project, the bank needs to satisfy itself with the bankability of the project concerned. The bankability dimensions include primarily legal, commercial, financial and social dimensions. Due to his exposure to multiple renewable energy and assessing them for bankability, Respondent #3 gained a deep understanding of the interconnections that shape the energy system. In addition to being in a position to express a view on these interconnections, Respondent #3 was able to explain these interconnections in a holistic manner. He also provided insights into the financing of renewable energy projects.

- **Respondent #4** has a Bachelor of Science degree in urban design and town planning. He is experienced, consulting urban planner. He has a deep understanding of how the planning of the urban environment impacts the energy systems of societies. Respondent #4 has worked with, among others, development finance institutions to plan solutions for "smart" cities and energy-saving solutions for the urban environment. He brought into the discussion, an empathetic view in respect of the social aspects of the energy system. As an urban planner, Respondent #4 naturally leans towards Systems Thinking.

- **Respondent #5** is an engineer, currently working as a senior executive in the climate finance division of a developmental finance institution. The developmental finance institution concerned funds and manages social infrastructure projects across the

continent, including energy projects by private and governmental entities. It is also championing the Just Energy Transition on the continent, together with the World Bank, the Global Climate Fund. Respondent #5 manages the Global Climate Fund's and the Global Environmental Facility on behalf of international donors, to ensure that qualifying projects receive the required support. Respondent #5 was well-positioned to comment on South Africa's NEC targets, given the links between the developmental finance institution that employs him and the Presidential Commission on Climate Change. He was also in a position to discuss issues of energy justice, in light of his work on developmental finance.

3.6.4 Interview Process

By design, the Delphi process relies on a small sample.

At study inception, the researcher had set a target of **three to five** expert respondents, to be interviewed. Ultimately, **five respondents** were interviewed. The researcher invited each respondent to take part in the research well in advance; through an "invitation pack" sent electronically. The invitation pack contained:

- a letter inviting the respondent to participate in the study;
- an overview of the study and its purpose;
- a short profile of the researcher and the research supervisor;
- framing questions, to allow the respondent to prepare before the interview; and
- an informed consent form.

A copy of the invitation pack is attached as **Appendix 4.1**.

The interviews were conducted physically or via Microsoft Teams®, depending on the preferences and availability of each respondent. Each interview lasted approximately 1 hour, with the researcher assisting the respondents by initially explaining the concept of Idealised Redesign. The interviewees were requested to pretend that they were together with other energy stakeholders in a room, during a session facilitated by the researcher. The researcher expressed to each respondent that the Idealised Redesign process would provide an opportunity to co-create an envisioned future for the South African energy system, by initially addressing one of the

biggest barriers to the resolution of wicked problems: formulating the mess and defining the Just Energy Transition problem through a holistic approach.

This explanation encouraged the respondents to think systematically and to find connections between various phenomena. The respondents were encouraged to think freely and to not feel compelled to always adhere to the framing questions. However, it was incumbent upon the researcher to ensure that all the framing questions received attention.

3.6.5 The Delphi Method

Marshall and Rossman (2014) list the main genres of qualitative research as ethnography, phenomenology, sociolinguistic approaches, grounded theory, case studies and art-informed and multimodal approaches. Brady (2015) views the Delphi as standing apart from the "more well-known approaches to qualitative inquiry" (p.1), which as he mentions, include grounded theory, phenomenology, constructivist inquiry, and narrative inquiry. The Delphi is distinguished by its pragmatism and usefulness in informing practice, policy or decision making (Brady (2015), citing Aldler & Ziglio (1996) and Dietz (1997)).

While Brady (2015) clearly distinguishes the Delphi from grounded theory inquiries, Päivärinta *et al.* (2011) explain how, with appropriate analysis techniques, the Delphi method could be used to ground theory. While this is noted, it was the intention of the researcher to contribute to theory in the emerging fields of Interactive Planning and JET (in the South African context), which was achieved not through grounded theory, but through induction (Saunders & Lewis, 2012). Grounded theory on the other hand, embraces deduction to a degree, in that from research data arises theory (Saunders & Lewis, 2012). From this perspective then, the Delphi process, served as a proxy for the "repeated observations" although in reality, the Delphi is simply, a special type of interview process The Delphi is recommended for research in emerging fields, where the line of enquiry is exploratory (Päivärinta *et al.*, 2011).

Figure 10 contains an example of the Delphi process (Jones & Hunter, 1995). The researcher implemented the Delphi process as follows:

- Experts were selected as discussed in the preceding sections (Brady, 2015; Jones & Hunter, 1995).
- Interviews were conducted physically or via physically or via Microsoft Teams®.

- The interviews that were held on Microsoft Teams® were recorded using the built-in recording tool. Face-to-face interviews were recorded on an Olympus® Dictaphone. Both Microsoft Teams® and the Olympus® Dictaphone are password-controlled. This was shared with the interviewees to instill trust in the process.
- The researcher then generated a transcript for each interview; and analysed the transcript thematically, with the assistance of the NVIVO® suite.
- The themes and views were compared across all the interviews, with similar views grouped together (Brady, 2015; Jones & Hunter, 1995).
- Where there were divergent views, these were noted and recorded separately (Brady, 2015; Jones & Hunter, 1995).
- A second round was used to provide an opportunity to reach consensus on the divergent views (Brady, 2015; Jones & Hunter, 1995).
- When consensus was reached, the views were once again compared through the NVIVO® suite, to finally confirm the consensus view through detailed analysis (Brady, 2015; Jones & Hunter, 1995). The results, being the consensus view, were then presented (Brady, 2015; Jones & Hunter, 1995).

The Delphi process does anticipate that the results would be tested against a real situation(Jones & Hunter, 1995). This is one of the recommendations of this study.

3.6.6 Anonymity

The respondents had been informed of their right to anonymity beforehand; and had been provided with a copy of the informed-consent form. While all the respondents were indifferent regarding their anonymity, the ethics approval received when the study was approved by the research committee was on the basis that the research participants' anonymity would be guaranteed. Therefore, their names and any identifying data are not revealed.

3.6.7 Study Weaknesses

The measures adopted by the researcher to improve the credibility of the study are discussed in Section 3.10 below *(Research Strengthens – Reliability and Validity Measures)*. While it is submitted that these measures have significantly improved the credibility of the study, the reader should be aware of the following study weaknesses:

- **Limited Delphi rounds:** The Delphi process as a consensus-seeking approach may provide more insights if the Delphi rounds are increased to at least three (Brady, 2015; Jones & Hunter, 1995). The researcher only had one Delphi round due to the limited time within which to complete the study; and difficulties in securing the availability of the respondents. However, it is submitted that this is not fatal to the study, given that the consensus view was secured. The main disadvantage of the limited Delphi rounds is that there could potentially have been more new views shared by the respondents in subsequent Delphi rounds, which would have added to the richness of the study.

- **Time Constraints and Voluminous Data:** As stated above, the researcher had a limited amount of time within which to complete the study and submit it in partial fulfilment for the Masters degree that he is enrolled for. The Delphi, even though it had been shortened to one round, was a time-consuming exercise. Not only was it time-consuming in the sense that it requires feedback processes and iterations (Brady, 2015; Dalkey, 1967; Skulmoski *et al.*, 2007; Yousuf, 2007), but it is also time-consuming from the fact that the interviews return vast amounts of data , the organisation and interpretation of which was challenging (Buchanan and Jones 2010). Saunders and Lewis (2012) provides the example of a research student who audio-recorded semi-structured interviews, and later transcribed them. The process of transcribing and properly presenting each 30-minute interview took between three and four hours (Saunders & Lewis, 2012). The researcher's interviews lasted about an hour each, with the transcribing process taking up to a full 8-hour day. The researcher relied on the NVIVO® suite, which proved to be an invaluable CAQDAS tool. The researcher also relied on the Nuance® Dragon® Individual suite as the dictation, annotation and transcription tool of choice. While it worked well, it did lend itself to producing vast amounts of data. The reader should therefore note that a decision needed to be made to stop the analysis when it became too time-consuming.

- **Limited Access to Respondents:** The Delphi requires more than one interaction with each Respondent (Brady, 2015; Dalkey, 1967; Skulmoski *et al.*, 2007; Yousuf, 2007). From that point of view, the researcher was at the mercy of the respondents. For this reason, the researcher kept the iterations of the Delphi to a minimum, as stated above. This limited opportunities for feedback and further detailed reflection on the part of the respondents. Further, save for one interview which lasted approximately two hours, all the interviews were limited to approximately an hour. Limited access to respondents in

interviews can lead to inferences drawn from unexplored aspects of the study, potentially affecting internal validity. This can result in false interpretations. To address this weakness, the Delphi iterative and feedback process was supported by a meticulous thematic analysis process by the researcher(Brady, 2015; Maxwell, 1992).

- **Imperfect Judgment on the Part of the Researcher:** As indicated above, the researcher had to make a decision to halt the analysis process when it became too tme consuming. The study therefore may be negatively impacted by the researcher's imperfect judgment in data selection (See Buchanan and Jones 2010 on sampling). While peer reviews may be beneficial (J. Buchanan & M. L. Jones, 2010), the researcher cannot access this option. However, the research supervisor's guidance was relied upon to the extent necessary, alongside the validation strategies discussed in Section 3.10.9 *(Peer Debriefing and Member Checks)*, which entail relying on the mechanisms provided by the University.

3.7 Ethical Considerations When Collecting Research Data

3.7.1 Introduction to Ethical Considerations

Ethics in research refers to moral principles influencing conduct (Collins English Dictionary, 2019). The Concise Oxford Thesaurus lists the following alternative meanings: "morals, morality, values, rights and wrongs, principles, ideals, standards (of behaviour), virtues". Research ethics refer to the appropriateness of a researcher's behavior in relation to the rights of those involved or affected by a research project (Saunders & Lewis, 2012). This study required the participation of human respondents; and the protection of human rights is crucial in research involving human participants (Marshall & Rossman, 2014; Orb *et al.*, 2001). A clear plan for ethical conduct, including access to respondents, protection from harm, and preservation of privacy, is essential for a study's trustworthiness (Marshall & Rossman, 2014; Orb *et al.*, 2001). Access to respondents should be negotiated based on an honest articulation of the study's purpose and introduction of the researcher (Marshall & Rossman, 2014). In qualitative research, the ultimate goal is to build a relationship with respondents, ensuring privacy and confidentiality. These considerations are particularly important in qualitative research (Creswell & Creswell, 2017; Marshall & Rossman, 2014; Yin, 2017).

3.7.2 Approach to Maintenance of Ethical Standards

As an additional consideration, the values that a researcher subscribes to could have an impact on whether or not such researcher adheres to ethical standards (Marshall & Rossman, 2014). At the time of undertaking this study, the researcher was an attorney employed as in-house legal counsel in a development finance institution owned by South African government (See **Appendix 2.1** for a short bio of the researcher). The research is not sponsored by his employer.

The researcher's interest in the research topic arises out of the many years spent in the development, implementation, and operation of energy projects in South Africa and internationally. There was no incentive the part of the researcher to deceive the respondents regarding the objective of the proposed study and the manner in which their responses will be used. Further, the researcher is motivated to ensure that the thoughts of the respondents should be correctly captured and documented, so that the research topic is deeply understood.

Ultimately, the Delphi method is premised on relationship-building, mutual learning and reciprocity in the research community (Brady, 2015; Saunders & Lewis, 2012), which requires that trust be cultivated. From that perspective, ethical conduct is important (Brady, 2015; Saunders & Lewis, 2012).To ensure an ethical approach to the research, the researcher adhered to the standards contained in the code of practice included in **Table 7**, alongside the University's guidelines (Saunders & Lewis, 2012).

3.7.2.1 No Coercion

The researcher ensured that respondents participated freely in the research without undue pressure or duress (Marshall & Rossman, 2014). This approach was considered appropriate and not a threat to the trustworthiness of the study. The respondents were all experts in their field, and the researcher's choice of research topic without coercion is crucial for the quality of the study (Saunders & Lewis, 2012). The respondents are experts in their field and did not required any monetary incentivisation to participate in the study (Marshall & Rossman, 2014). Their voluntary preserved the trustworthiness of the study.

3.7.2.2 Informed Consent

Informed consent was sought (Reynolds *et al.*, 2013; Saunders & Lewis, 2012) from each respondent before interviews and any further iterations of the Delphi, to preserve the transparency of the study (Orb *et al.*, 2001; Reynolds *et al.*, 2013). As experts in their fields (Brady, 2015), the respondents were not vulnerable in sense described by Saunders and Lewis (2012). A consent form was offered to the intended expert panellists. The form will be in a format approved by the University. As part of the consent-seeking process, the panellists will be informed that participation in the study is voluntary; and that they are not obligated to sign the form, or to give their consent (Creswell & Creswell, 2017).

3.7.2.3 Anonymity

The research supervisor highlighted the importance of changing the names of the respondents, when transcribing, in order to preserve anonymity. The confidentiality of respondents, and their anonymity, was maintained during the collection, interpretation and reporting of data (Saunders & Lewis, 2012). As proposed by Saunders and Lewis (2012), the names of the respondents were changed when transcribing their responses. Further, the some of the reiterations of the Delphi require that respondents be made aware of the responses of the other participants, to afford them the opportunity to reconsider their initial views. As stated in section 3.5.2, anonymity is one of the key features of the Delphi process, alongside controlled feedback, and pseudo-statistical group responses by expert respondents (Dalkey, 1967; Skulmoski *et al.*, 2007; Yousuf, 2007). All applicable laws were. In particular, personal data protection legislation (Saunders & Lewis, 2012) applicable in South Africa were observed.

An invitation to participate in the study was sent to all respondents as may be seen in **Appendix 6**.

The Protection of Personal Information Act 4 of 2013 ("POPIA) became fully operational on 1 July 2021. The researcher relied on the wording inserted in the informed consent form in Appendix 2.2, to ensure that consent to collect and process personal information, as required by POPIA, was secured. Consent to record the respondents was obtained, and an Olympus® recorder with a PIN lock was used record the interviews.

Further, the respondents were fully advised of the reasons for the collection of their personal information. The manner in which the personal information would, stored and ultimately, disposed of was also be disclosed. There were no attempts to collect or process personal information or special personal information (such as political preferences), which was not required for the purposes of the study. In particular, the raw data, which was in the form of electronic documents and voice recordings, was stored in a computer hard drive. The transcripts were then transferred to NVIVO®, which is discussed in section 3.10.10.7. After the final manuscript had been produced, the raw data and manuscripts were disposed of.

3.7.2.4 "Do no Harm"

Further, there was no attempt to harm or stress the respondents, or to in anyway place them in a situation where they lose their self-esteem or feel humiliated (Saunders & Lewis, 2012). Questions were answered freely without any pressing (Saunders & Lewis, 2012). Signs of discomfort were keenly observed, and courteous behaviour on the part of the researcher, such as adherence to times allotted, were pursued (Saunders & Lewis, 2012).

3.8 Research Data and Information Processing and Analysis

Data was analysed through thematic content analysis, with NVIVO® utilised as the applicable Computer Assisted Qualitative Data Analysis Software (CAQDAS).

3.9 General Description of the Research Respondents

Research respondents included persons involved in the energy industry, all of whom were within the age range from 18-68 years. Profiles of the respondents are included in Section The 3.6.3 *(Profile of the Respondents)*.

3.10 Research Strengthens—Reliability and Validity Measures

3.10.1Introduction to Research Strengthens

This study followed the qualitative research paradigm. Consequently, the section contains a discussion of research measurement validation approaches that apply to this particular research paradigm. In the sections below, the researcher discusses the importance of validating research

measures, distinguishing between qualitative and quantitative validation criteria, and distinguishing between rigor and trustworthiness. It also discusses reliability and validity in conventional sense, alternatives for qualitative studies, and research validation approaches.

3.10.2 The Importance of Reliability and Validity

3.10.2.1 Reliability and Validity of Research Measures or Tests

A study's credibility and trustworthiness are based on its sound design quality, which is assessed through reliability and validity of measures used by the researcher. This includes accurately measuring what the study sets out to measure and using data collection and analysis methods that support consistent findings. Generally, studies based on traditions of inquiry or systematic approaches are likely to be credible (Golafshani, 2003; Marshall & Rossman, 2014; Saunders & Lewis, 2012). Researchers evaluate reliability and validity through evidence, usefulness, and compatibility of methodologies and empirical data, ensuring a sound study (Marshall & Rossman, 2014).

3.10.2.2 Measurement Errors and Variances

At the core of the matter, a study will lack credibility if the measures or tests used are subject to errors or variances, be it methodical or random ones (Bagozzi *et al.*, 1991). Lincoln and Guba (1986) list the specific problems resulting from such errors and variances. The authors highlight "confounding, atypicality, instability, and bias" (Lincoln and Guba, 1986: p. 74) as the notable problems resulting from research measures that are subject to errors or variances. Unless the errors and variances are minimised or eliminated, they invariably lead to inaccurate research conclusions (Bagozzi *et al.*, 1991). It is therefore one of the researcher's primary tasks to, as best as possible, reduce or eliminate these measurement errors and variances (Bagozzi *et al.*, 1991) and therefore, the problems associated with them.

Measurement errors can be categorised into errors pertaining to the theoretical concept or construct of a study (e.g. criterion-oriented errors) (Bagozzi *et al.*, 1991). Reliability and validity enhancements are, in essence, strategies employed by researchers to minimise study errors and variances (Bagozzi *et al.*, 1991) that might detrimentally affect the effectiveness of measures used to arrive at study conclusions.

3.10.3 Rigour and Conventional Measurement Validity

Traditionally, reliability and validity have been explored by researchers seeking to maintain rigour in logical positivism, to test the design quality and measurement capabilities of studies (J. Buchanan & M. L. Jones, 2010; Golafshani, 2003; Lincoln & Guba, 1986; Marshall & Rossman, 2014; Pandey & Patnaik, 2014; Yin, 2009).

Logical positivism is a research paradigm, typically applicable in scientific inquiries, where replication, control and generalisations are a primary focus (Guba & Lincoln, 1994; Saunders & Lewis, 2012). In other words, after having observed measurable variables in a controlled setting, the positivist researcher seeks to predict research outcomes, so that they may be capable of being controlled in the future (Guba & Lincoln, 1994; Saunders & Lewis, 2012). For this reason, studies following logical positivism emphasise causal relationships between variables, predictability and generalisability (J. Buchanan & M. L. Jones, 2010; Golafshani, 2003; Marshall & Rossman, 2014; Pandey & Patnaik, 2014; Yin, 2009). Given their scientific nature, therefore, it is necessary that positivist inquiries should follow highly structured research methods (Saunders & Lewis, 2012), which are often experimental in approach (J. Buchanan & M. L. Jones, 2010).

More so than is the case with constructivist enquiries, the measurement validation of positivist inquiries is achieved by paying careful attention to design quality (Saunders & Lewis, 2012; Yin, 2009). Lincoln and Guba (1986) use "rigour" as an umbrella term to encapsulate the design quality considerations that come to bear in positivist or postpositivist studies. Falling under this umbrella term, the authors (Lincoln & Guba, 1986) go on to identify internal validity, external validity, reliability and objectivity as the primary criteria for assessing study "goodness" (p.112).

Stated differently,Lincoln and Guba (1986)'s submission is that the rigour levels of a quantitative study can be assessed by "exploring the truth value of the inquiry or evaluation (internal validity), its applicability (external validity or generalisability), its consistency (reliability or replicability), and its neutrality" (p. 74).

3.10.3.1 Reliability

Reliability addresses the problem of instability or consistency through techniques that explore a study's consistency (Lincoln & Guba, 1986). The reliability test considers the appropriateness of the study methods and instrument employed by the researcher, and further assesses whether the

results produced by the study could be reproduced elsewhere using similar methods or instruments (Golafshani, 2003; Marshall & Rossman, 2014). Quite simply, reliability means repeatability (Lincoln & Guba, 1986; Yin, 2009).

3.10.3.2 Objectivity

While reliability is concerned with stability or consistency, objectivity addresses the problem of the lack of neutrality (Lincoln & Guba, 1986). To realise study neutrality, the objectivity test requires that the researcher employs techniques addressing bias (Lincoln & Guba, 1986).

3.10.3.3 Validity

A study measure or test is valid if it measures what it is supposed to measure; and does so fully (Cronbach & Meehl, 1955; Yaghmaei, 2003). The four main categories of validity are construct validity, predictive validity, concurrent validity and content validity (Cronbach & Meehl, 1955).

Predictive validity and concurrent validity are criterion-oriented forms of validity, in that they assess the study's tests relative relationship to the theoretical construct (the criterion), while construct validity and content validity may be studied independently, in their own right (Cronbach & Meehl, 1955).

As stated above, other notable forms of validity include internal validity and external validity (Lincoln & Guba, 1986).

3.10.3.4 A Brief Description of Criterion-Oriented Validity

As briefly highlighted above, criterion-oriented forms of validity (namely, predictive validity and concurrent validity) are concerned with a study's tests relative relationship to the theoretical construct (Cronbach & Meehl, 1955). This means that criterion-oriented validity assesses the extent to which specific operations of the study concept adequately define the concept being measured (See Bechtoldt, 1951 in Cronbach and Meehl, 1955). This type of validity is demonstrated when the operations of a study concept correlate with other theoretical representations or measurements of the very same concept (Cronbach & Meehl, 1955).

Content validity is concerned with the extent to which test items accurately represent the universe of interest (Cronbach & Meehl, 1955). Content validity is demonstrated when the researcher has identified each item describing the concept being measured; and when the identified items contain all aspects of the concept (Cronbach & Meehl, 1955; Yaghmaei, 2003).

3.10.3.5 Construct Validity

Bagozzi *et al.* (1991) explain that the construct validity test assesses whether a study "measures the concept it is supposed to measure" (p.421).Pandey and Patnaik (2014), who offer a similar description, understand construct validity as the extent to which the correct operational measures are identified in respect of the concepts under consideration.

The construct is the foundational concept of a study, which informs the type of data to be collected and the method of collecting data (Golafshani, 2003). Consequently, the construct is the primary attribute of interest to the researcher, and it serves as a navigational aid which guides the statements that are made when interpreting findings (Cronbach & Meehl, 1955). A construct may be qualitative or quantitative (Cronbach & Meehl, 1955).

Cronbach and Meehl (1955) were among the first writers to describe construct validity and approaches aimed at assessing it. Numerous writers subsequently built onto the foundation laid by Cronbach and Meehl (1955). Notwithstanding the accumulation of writings on the topic, the understanding of what construct validity is has broadly remained the same.

Validating a construct refers to the choice of appropriate measures or tests for the applicable construct (Yin, 2009), so that the test chosen accurately and completely reflects the construct being measured (Cronbach & Meehl, 1955).

Clearly then, construct validity is evident when a measure correlates with other measures of the same concept, since it can be concluded that due to such correlation, the measure or test is likely valid and complete, relative to the concept being assessed (Mickalide, 1997).

Construct validity is important because if the wrong measure, or an incomplete measure, is chosen to operationalise a particular study concept, the research findings will be misleading and consequently, the claims advanced by the study will not be useful relative to the research problem (Bagozzi *et al.*, 1991; Marshall & Rossman, 2014).

3.10.3.6 Internal Validity

Internal validity addresses the problem of confounding through techniques that explore the "truth value" (p.74) of a study (Lincoln & Guba, 1986). The internal validity test considers whether the correct causal relationships have been identified between variable conditions or phenomena being observed (Yin, 2009). Therefore, internal validity is an appropriate consideration for researchers interested in explanatory or causal relationships (Lincoln & Guba, 1986; Malterud, 2001; Yin, 2009).

Traditionally, the internal validity test is not a strong consideration for qualitative descriptive or exploratory studies (Yin, 2009), such as the one adopted by the researcher. In section 3.10.6, the point is made that causal relationships are typically the purview of quantitative methods (see Hoepfl, 1997 in Golafshani (2003)) and (Saunders & Lewis, 2012)).

3.10.3.7 External Validity

External validity addresses the problem of atypicality (Lincoln & Guba, 1986). This is done through techniques that explore a study's applicability or generalisability (Lincoln & Guba, 1986). The external validity test assesses whether the appropriate environment upon which the findings of the study can be generalised has been identified (Yin, 2009).

3.10.3.8 Ecological Validity

Ecological validity also assesses the generalisability of a study (Schmuckler, 2001). However, rather than investigate whether appropriate environment upon which the findings of the study can be generalised has been identified (Yin, 2009), the ecological validity test assesses whether a study's findings can be generalised from observed behaviour and into natural behaviour in the outside world (Schmuckler, 2001).

As articulated in section 3.2.1.5 *(Reseacher's view on Generalisability)* above, generalisability is not an objective of the proposed study; hence the researcher's comfort with the choice of qualitative research methods.

3.10.4 Trustworthiness and Measurement Validity in Qualitative Research

In the past, questions have arisen as to whether naturalistic inquiries are too subjective to be trusted (Lincoln & Guba, 1986). While some have viewed qualitative research as lacking in objectivity and facts, it nonetheless is possible to introduce scientific quality to such studies (Malterud, 2001). However, the traditional rigour standards typically used in quantitative inquiries (as discussed in section 3.10.3 above) may not be directly portable to qualitative research; and may need to either be adapted or replaced by alternative validation standards (Brady, 2015; Golafshani, 2003). As an umbrella concept, rigour itself cannot, without qualification, always be readily applied in qualitative studies (See Hamberg et al, 1994 in Malterud, 2001). It is therefore important to appreciate the distinction between the measurement validation criteria of a qualitative study and those of a quantitative study.

Unlike their quantitative counterparts, qualitative researchers are not always be in a position to rely on built-in design features for the purpose of measurement validation (Brady, 2015; Maxwell, 1992; Yin, 2009). To strengthen the credibility of a study, a qualitative researcher might look primarily towards the research process itself, as well as the presentation of the final product or manuscript (Brady, 2015).

In his analysis of how qualitative research can help to improve understanding of medicine, Malterud (2001) recalls the work of Hamberg et al (1994), who advance the hitherto widely accepted view that traditional approaches to scientific rigour cannot be neatly applied to qualitative research (Malterud, 2001). Citing Hamberg et al (1994), Malterud (2001) highlights the difficulties presented by applying traditional rigour approaches to qualitative research (Malterud, 2001). Given, these difficulties, Hamberg et al (1994) express support for Lincoln and Guba (1985)'s proposed alternative criteria for qualitative inquiries (Malterud, 2001). Hamberg et al (1994) do nonetheless recognise that Lincoln and Guba (1985)'s alternative criteria are, in some respects, comparable to traditional ones (Malterud, 2001).

3.10.5 Generalisability in Qualitative Research

According to Maxwell (1992), generalisability fulfils a different function in qualitative studies than it does in quantitative research. Qualitative research does not seek to generalise (Maxwell, 1992), but there is a modified way that qualitative researchers understand generalisability.

Drawing from the writings of Becker (1990) and Yin (1984), Maxwell (1992) explains that one way of understanding generalisability in qualitative research is to consider the extent to which a theory could be used to understand a similar event elsewhere. In qualitative research, focus is on the event, and the objective is to understand the event deeply (Creswell & Creswell, 2017; Malterud, 2001; Rocco & Plakhotnik, 2009).

From that point of view then, sampling, though important, is approached differently in qualitative research in that rather than being randomised, it purposeful, with reference being had to the research questions and the phenomena being studied (See Patton (1990) and Strauss (1987) in Maxwell (1992)). In other words, qualitative researchers do not approach sampling with a view to generalise in the same way that quantitative researchers do.

3.10.6 Trustworthiness as an alternative to reliability and validity

That alternative criteria are proposed for qualitative studies is by no means a suggestion that reliability and validity tests are to be removed completely from constructivist inquiries. On the contrary, rather than discard reliability and validity altogether, qualitative researchers adapt these tests for use in constructivist paradigms (Brady, 2015; Golafshani, 2003). Qualitative research has been adapted to include alternative criteria for reliability and validity tests, which are not completely removed from constructivist inquiries (Brady, 2015; Golafshani, 2003). Constructivist researchers do not emphasise the distinction between reliability and validity but instead present them as trustworthiness and authenticity (Golafshani, 2003). This adaptation is a result of a long-running debate about the relevance of these tests in qualitative research. Some argue that these criteria are incompatible with qualitative research, while others recognise that they can be appropriately applied to qualitative inquiries under new criteria, as long as they emphasise plausibility, credibility, and defensibility (Creswell & Creswell, 2017; Lincoln & Guba, 1985; Marshall & Rossman, 2014; Miles *et al.*, 2018).

There are several views on staff reliability and validity in validity research, but the prevailing theme is that an alternative approach is required. Some argue that emphasising the researcher's

credibility is more important than reliability (Kapoulas & Mitic, 2012; Marshall & Rossman, 2014; Patton, 1999; Xu & Storr, 2012), while others suggest that the significance, relevance, impact, and utility of completed research are important measures of reliability and validity in qualitative research (Morse *et al.*, 2008). The understanding of these terms is different from how a quantitative researcher may understand them. The current understanding is that the "goodness or quality criteria" (Lincoln and Guba, 1986, p.112) of inquiries following constructivism are based on trustworthiness, credibility, and authenticity.

3.10.7 The Development of Alternative Criteria in Qualitative Research

In their analysis of competing paradigms in qualitative research, Guba and Lincoln's (1994) thinking on measurement validation appears to have developed sufficiently to show a clear distinction between rigour in the conventional, scientific sense and rigour in the naturalistic sense. This thinking, where the two forms of rigour became distinguished from each other, had started to evolve years prior, shortly after the authors' (Lincoln & Guba, 1986) presentation of the alternative qualitative criteria for constructivism. In their 1986 paper, they (Lincoln & Guba, 1986) explained that in their view, reliability, internal validity, external validity and objectivity criteria are part of hitherto accepted standards for rigour, in the conventional, scientific sense.

Having reminded the reader of previously highlighted methodical differences between the conventional and naturalistic paradigms, Lincoln and Guba (1986) then present a strong view that the criteria for judging an inquiry will be determined by the applicable paradigm and the assumptions thereunder, such that a specific criterion may not be appropriate or relevant to a different paradigm (Lincoln & Guba, 1986). The authors the present alternative measurement criteria for qualitative research.

3.10.8 Lincoln and Guba (1986)'s Alternative Measurement Validity Criteria for Qualitative Inquiries

Researchers are duty-bound to give thought to "the truth value, applicability, consistency, and neutrality (Lincoln and Guba, 1986, p.76)" of inquiries. Lincoln and Guba (1986) refer to these validation considerations as the "goodness or qualitative criteria" (p. 112, Lincoln and Guba,

1984) of a study. For qualitative inquiries, goodness requirements are met through alternative criteria, which depart from the conventional rigour criteria.

Credibility is proposed in the place of internal validity (Lincoln & Guba, 1986). Transferability is proposed as an alternative to external validity (Lincoln & Guba, 1986). Dependability is proposed as an alternative to reliability; and confirmability to objectivity (Lincoln & Guba, 1986). Rigour, being the overarching or umbrella term, encapsulating the goodness criteria of positivist research (i.e. the umbrella term for reliability or replicability, internal validity, external validity or generalisability and objectivity) is replaced by trustworthiness and authenticity, in the case of qualitative studies (Lincoln & Guba, 1986).

The concept of trustworthiness and authenticity, together with the qualitative criteria of credibility, transferability, dependability and confirmability effectively provides researchers following naturalistic methods with an adapted measurement validation approach and accompanying assessment criteria (Lincoln & Guba, 1986).

Lincoln and Guba (1986)'s alternative validity criteria for qualitative inquiries are summarised below.

3.10.8.1 Dependability

Dependability assesses the extent to which a study's findings are consistent and capable of being repeated (Lincoln & Guba, 1985). Being analogous to reliability, dependability means repeatability (Lincoln & Guba, 1986; Yin, 2009).

3.10.8.2 Credibility

Credibility is analogous to internal validity and would therefore be concerned with the identification of the correct causal relationships between variables (Lincoln & Guba, 1986; Malterud, 2001).

3.10.8.3 Transferability

The transferability test evaluates the applicability of study findings to other contexts, similar to external validity. It evaluates a study's applicability beyond its initial context, assessing its applicability beyond the study's intended context (Lincoln & Guba, 1985, 1986; Malterud, 2001).

3.10.8.4 Conformability

The conformability test assesses the neutrality of a study by determining whether the findings made by the researcher arise out of the respondents' submissions, and not from the researcher's biases and personal agenda (Lincoln & Guba, 1985). This might be viewed as analogous to the objectivity test highlighted in section 3.10.3.2 above.

3.10.8.5 Maxwell (1992)'s Five Types of Validity Approaches for Qualitative Research

Maxwell (1992), who is part of the school of thought that believes that the validity concept is of less direct use in qualitative studies, proposes that qualitative researchers could understand validity in five ways, and that his proposal represents a realist approach to validity for qualitative studies. These five alternative dimensions of validity for qualitative studies are discussed in turn below.

Descriptive Validity: Descriptive validity assesses the factual accuracy of the qualitative researcher's account (Maxwell, 1992).

Interpretive Validity: Interpretive validity is crucial in qualitative research, as it ensures the researcher accurately understands participants' meanings of observed events, especially in an interpretive, naturalistic approach, where the researcher serves as the primary interpretive instrument (Kapoulas & Mitic, 2012; Maxwell, 1992; Pandey & Patnaik, 2014; Patton, 1999; Xu & Storr, 2012).

Theoretical Validity: Theoretical validity evaluates if an account accurately represents a theory about a phenomenon, focusing on adhering to a specific theoretical construct. It consists of two elements: an element comparable to construct validity and an element comparable to internal validity, as discussed in more detail in section 3.10.3.5 and 3.10.3.6 above(Maxwell, 1992).

Evaluative Validity: Evaluative Validity involves considerations as to whether the appropriate evaluative framework has been implemented by the qualitative researcher (Maxwell, 1992).

3.10.9 Measures to Strengthen the Trustworthiness of the Proposed Study

3.10.9.1 Introduction to Measures to Strengthen Trustworthiness

The validation strategies that the researcher describes in this section become relevant in different ways, as the study progresses through these phases. It is not possible to apply all the measurement validation strategies that are available. Accordingly, the most relevant or practicable validation strategies will be adopted.

3.10.9.2 The Need to Validate Qualitative Research with Reference to the Researcher's Account

Quantitative researchers address validity threats through design features, while qualitative researchers use unique approaches specific to their account , by introducing evidence that threats to validity pertaining to the research at hand, have been eliminated or significantly reduced (Maxwell, 1992). Therefore, threats to validity are addressed by qualitative researchers after developing a tentative account (Maxwell, 1992). Validation in qualitative research is nuanced and dependent on the researcher's skill and integrity, such as managing crucial activities (Maxwell, 1992; Yin, 2009). To ensure trustworthiness, qualitative researchers emphasise controls focusing on the researcher's actions in producing the work (Golafshani, 2003; Kuzmanić, 2009; Morse *et al.*, 2008). Onwuegbuzie and Johnson (2006) and Yin (2009) suggest that a qualitative researcher should employ validation strategies, even during the course of the study, so that threats to validity and reliability can be addressed as they are discovered. Bagozzi *et al.* (1991) advises that the appropriate time to validate research measures, and to address measurement errors, is prior to testing theory.

3.10.9.3 Brady's Proposed Measurement Validation Strategies

As stated in Section 3.3, the Delphi method was employed. In his article on adapting the Delphi method for use in qualitative research, Brady (2015) shares some lessons learned on how the measurement validation of qualitative studies may be improved. The bulk of the lessons shared by Brady (2015) were learned from a research study approved by the Virginia Commonwealth

University, with the objective of building beginning-level practice theory in the field of community organising.

As Brady (2015) explains, the Delphi method was chosen over other possible alternatives, such as the traditional grounded theory and constructivist approaches. The choice was motivated by several considerations, including the location of the participants, their busy schedules, the risk of some participants being unwilling to yield to undue demands on their time, as well as the richness of the Delphi method as a tool for deep learning and understanding (Brady, 2015). The considerations influencing the choice of the Delphi for the Virginia Commonwealth University's study are relatively similar to the considerations that motivate the researcher's own proposal to rely on the Delphi. These considerations are discussed in more detail in section 3.4 above.

Brady (2015) observes that despite the Delphi's pragmatic usefulness in social science studies, fewer qualitative studies, in comparison to mixed method studies, have utilised it. As a consequence, there is insufficient guidance available to qualitative researchers on using this method in theory building (Brady, 2015). As an attempt at bridging this gap, Brady (2015) suggests strategies that a qualitative researcher utilising the Delphi may rely on to improve study trustworthiness.

Brady (2015) proposes that for the qualitative researcher, the Delphi feedback mechanism presents an opportunity to improve the trustworthiness of research. Brady (2015) goes on to suggest more useful measurement validation approaches that take advantage of the Delphi as a research method. The techniques proposed by Brady (2015) are discussed in more detail below. In summary, Brady (2015) suggests that the qualitative researcher may follow a thematic analysis process. Secondly, reliance may be placed on the control feedback mechanism, validation and final-member check steps of the Delphi (Brady, 2015). Thirdly, the keeping of a methods journal is suggested (Brady, 2015).

3.10.10 Other Approaches to Improve Trustworthiness

Brady (2015) suggests that qualitative researchers utilising the Delphi method may improve study trustworthiness by taking advantage of the Delphi's built-in validation mechanisms, including the reiterative controlled feedback and validation process and final-member checks. Outside of the Delphi mechanisms, Brady (2015) proposes that researchers should keep a methods journal, which augments the validations mechanisms of the Delphi.

Over and above the approaches suggested by Brady (2015), there are other validation strategies that the researcher has implemented. These are discussed below. Each validity measure is discussed under a heading stating the aspect of trustworthiness sought to be addressed.

3.10.10.1 Strategies for Improving Reflexivity

This section discusses strategies to improve reflexivity in qualitative research, recommending the inclusion of the reflexivity criterion in validation standards (Malterud, 2001). Reflexivity requires a systematic approach to knowledge creation, applied throughout all stages of the research (Malterud, 2001). Researchers must share their preconceptions, motivations, qualifications, education, interests, perspectives, and theoretical assumptions, which are shaping their worldview (Creswell & Creswell, 2017; Malterud, 2001).

3.10.10.2 Improving the Credibility of the Researcher

To maintain the trustworthiness of a study, steps need to be taken to establish the credibility of the researcher (Morse *et al.*, 2002; Patton, 1999). In qualitative research, the researcher researcher is the primary instrument through which data is generated, collected, processed and interpreted (Kapoulas & Mitic, 2012; Patton, 1999; Xu & Storr, 2012), and plays a critical role in shaping the trustworthiness of a study throught data collection and interpretation (Marshall & Rossman, 2014). Unlike his quantitative counterparts, the qualitative researcher is the main instrument for the generation, collection, processing and interpretation of data in qualitative research (Kapoulas & Mitic, 2012; Patton, 1999; Xu & Storr, 2012). The skill and integrity of the researcher is of utmost importance in maintaining sudy credibility (Maxwell, 1992; Yin, 2009). The following credibility-enhancing strategies have been utilised:

3.10.10.2.1 Communication of Assumptions

Bagozzi *et al.* (1991) suggest that when opting for a particular construct validation approach, a researcher should consider the assumptions underlying each of the models and validation approaches and upon selecting a specific measurement validation approach, the researcher should clearly communicate the assumptions informing the choice. The researcher followed this guidance.

3.10.10.2.2 Demonstrating and Relying on the Appropriate Attributes of the Researcher

A researcher's skill, experience, philosophical orientation and background (Malterud, 2001; Maxwell, 1992; Saunders & Lewis, 2012; Yin, 2009) can influence the trustworthiness of qualitative research. Key attributes include asking good questions, being a good listener, being adaptive, and understanding the issues under study (Yin, 2009). To be credible and trustworthy, a researcher must balance their assumptions with the study's goals, research questions, methods, writing style, role, vocabularies, and data interpretation criteria (Ellingson, 2009 in Marshall and Rossman (2014)). As a new entrant in qualitative research, the researcher maximised his prior exposure to inductive, naturalistic inquiries. Where skills were inadequate, guidance was sought from a university research supervisor (see Patton 1999).

3.10.10.2.3 Triangulation

Lincoln and Guba (1986) suggest that triangulation can enhance the reliability of qualitative studies by using multiple data sources or methods. Golafshani (2003)and Yin (2009) also highlight the credibility-improving advantages of triangulation. The Delphi technique, which relies on a multi-expert sample, intrinsically triangulates the process through reiterations, feedback, and data cross-checking (Adler & Ziglio, 1996; Dalkey, 1967; Delbecq *et al.*, 1975; Lincoln & Guba, 1986; Skulmoski *et al.*, 2007; Yousuf, 2007).

3.10.10.2.4 Reducing the Likelihood of Irrelevant Observations

The research focused on the energy transition in South Africa, analysing the context and expert responses. The Delphi method directed responses to the study's topics, reducing irrelevant observations. This approach ensured reliability and validity in qualitative research, allowing the researcher to think theoretically while maintaining focus (J. Buchanan & M. Jones, 2010; Morse *et al.*, 2008; Yin, 2009). This approach ensured that the study remained relevant.

3.10.10.2.5 Establishing an Audit Trail

Morse *et al.* (2002) suggest that when performing tasks such as the coding and categorisation of data, the qualitative researcher has to adopt methodical strategies that assist in establishing an audit trail. Yin (2009) advises qualitative researchers to strengthen construct validity by

establishing a chain of evidence during the data collection phase of the study. The "audit trail" validation strategy has been adopted, and given effect to through approaches such as the keeping of a methods journal as proposed by Brady (2015) and discussed in above, as well as taking advantage of the digital record-keeping functionality of NVIVO®, as discussed in section 3.10.10.7.

3.10.10.2.6 Maximising Transparency

Given that qualitative research is not as transparent or methodological as quantitative research (See Gummerson, 2005 in Kapoulas and Mitic (2012), it was important for the researcher to find ways to maximise transparency and therefore, trustworthiness (Golafshani, 2003; Onwuegbuzie & Johnson, 2006). The notable approaches include writing in a transparency-enhancing language as described in section 3.10.10.5 and using CAQDAS as further discussed in section 3.10.10.7.

There was the importance of convention. The researcher conducted audio-recorded interviews for transcription. Saunders and Lewis (2012) propose that in such instances, researchers should present their transcripts in a conventional way, including meeting certain minimum standards as regards the details to be included in the transcripts.

3.10.10.2.7 Persistent Observation and Prolonged Engagement

To improve credibility, Lincoln and Guba (1986) propose prolonged engagement with respondents, as well as persistent, in-depth observation of the salient elements of a study. The Delphi method, through its reiterative approach and feedback mechanism(Brady, 2015), compels the researcher to observe this validation suggestion.

3.10.10.2.8 Peer Debriefing and Member Checks

Lincoln and Guba (1986) propose that qualitative researchers may improve study credibility by checking their reconstruction of responses as they make them. For the purpose of the proposed study, this was achieved as part of the Delphi's reiterative and feedback process described in Section 3. Lincoln and Guba (1986) also recommend that a researcher subjects his work to the review of an arms-length professional peer, to improve study credibility (Lincoln & Guba, 1986). While the study was not be submitted for peer review as envisaged by Lincoln and Guba (1986), reliance was placed on the study review mechanisms established by the University.

3.10.10.3 Improving Transferability

To improve the transferability of research findings, a researcher may develop a rich narrative about the context of the study, to enable the application of the finding elsewhere, by others (Lincoln & Guba, 1986). The context of the study is detailed in Section 1.

3.10.10.4 Improving Dependability and Confirmability

Discussed below are strategies that are adopted to improve the dependability and confirmability of the study.

3.10.10.5 Addressing Confirmability by Reducing Bias

Objectivity in research is crucial, avoiding biased interpretations and personal agendas (Johnson, 1997; Kapoulas & Mitic, 2012; Kuzmanić, 2009; Morse *et al.*, 2008). Researchers should employ techniques to address bias and enhance study objectivity. Objectivity doesn't mean the researcher's voice or standpoint isn't present, as they are an active participant in the research process. Reporting findings using simple language and a personal writing style can promote objectivity. The use of CAQDAS can reduce the risk of commingling evidentiary data with the researcher's interpretation (Yin, 2017). Respondents should be asked questions that aren't personal or intrusive, reducing the risk of response bias due to sensitivity (Mickalide, 1997).

3.10.10.6 Ethics

While the risk of response bias is significantly reduced, there was still a need for the researcher to tread carefully as regards the ethical treatment of respondents, as failure to do so would threaten the trustworthiness of the study (Marshall & Rossman, 2014). The steps that were taken to ensure that the study adheres to ethical principles are discussed in section 3.7 above.

3.10.10.7 Computer Assisted Qualitative Data Analysis Software

As a final measurement validation strategy, trustworthiness was maximised through the use of Computer Assisted Qualitative Data Analysis Software (CAQDAS), in the form of the NVIVO® suite. The NVIVO® suite is a Computer Assisted Qualitative Data Analysis Software

(CAQDAS) that maximi ses trustworthiness in qualitative research (Morse *et al.*, 2002). It simplifies tasks such as auditing, data management, and filing, making the task of coding easier and enhancing quality, transparency, and auditing accuracy (J. Buchanan & M. L. Jones, 2010; Welsh, 2002). NVIVO® also helps in developing conceptual models, allowing researchers to examine multiple alternative answers to the research question (J. Buchanan & M. L. Jones, 2010; Goulding, 1998). It also places the qualitative researcher in the middle of the iterative interaction between data and analysis, making it a valuable analysis tool for the purposes of the proposed study(Morse *et al.*, 2008). The suite's primary features include auditing, data management, and filing, making it an essential tool for qualitative researchers (Morse *et al.*, 2008).

In order to improve the delivery of the researcher's argument through clear and coherent language, Quillbot®, a form of artificial intelligence tool, was utilised to summarise and simplify the researcher's own, original arguments where they appeared to be overly complex and too long.

4 RESULTS

4.1 Theoretical Phase Results

4.1.1 Theoretical Phase Introduction

This section comprises the theoretical phase of the study. As indicated in Section 3.3.1 *(Research Design: The Theoretical Phase and Internet Document Sources)*, the theoretical phase pursues the first study objective (i.e., completing a systems analysis of South Africa's energy system), which for ease of reference is restated as follows:

Research Aim: "Formulating the Mess" – UsingRussell L Ackoff (2001)'s Interactive Planning methodology, the problem will be framed, which hinders the successful invoking of the JET in South Africa, towards an in idealised, sustainable energy future.	
Objectives	Research Methodology
Providing an overview of how the South African energy system presently operates, encompassing the system's political, socio-	Theoretical exercise (da Costa Júnior *et al.*, 2020) comprising an analysis of the South African energy system, utilising the qualitative attributes

economic, and technological components(Russell L Ackoff, 2001).	in Section 2.3 *(Literature Review on Interactive Planning: Qualitative Attributes Key to the Research).*

Table 3: First Study Objective, Restated

The systems analysis entails an investigation of the way the South African energy system is currently configured and operates (Russell L Ackoff, 2001). In Section 3.4.1.1 *(Theoretical Phase Data Collection Process)*, it is stated that the theoretical phase of the study relies on documentation sourced from the Internet, which represents a form of indirect evidence, and which has benefits such as stability, unobtrusiveness, specificity, efficiency and broadness (Marshall & Rossman, 2014; Yin, 2017).

4.1.2 Theoretical Phase Results

4.1.2.1 Introduction

South Africa's energy system stands at a critical crossroads, characterised by a complex interplay of historical, political, economic, and technical challenges. Despite formal commitments to decarbonisation and the adoption of Nationally Determined Contribution (NDC) targets under the Paris Agreement, the country's transition away from coal faces significant obstacles. This section provides a comprehensive analysis of the crisis, the role of Eskom, policy and planning failures, the socio-technical nature of the energy system, and the imperative for a paradigm shift grounded in systems thinking.

4.1.2.2 The Coal Dependency Dilemma and NDC Commitments

South Africa's persistent reliance on coal is a central theme in the energy transition discourse. Despite international and domestic recognition of the need to reduce greenhouse gas (GHG) emissions, the country has struggled to wean itself off coal (Climate Action Tracker, 2023). The December 2024 announcement of a pilot project to procure electricity transmission infrastructure from the private sector was framed as a contribution to the National Development Plan, rather than as a direct step towards decarbonisation (South African Government, 2024). This reflects a broader pattern in which policy actions are often decoupled from the urgent need for a just energy transition.

South Africa's NDC targets, first submitted in 2016 and updated in 2021, set GHG emissions ranges for 2025 (398–510 Mt CO2-eq) and 2030 (350–420 Mt CO2-eq) (NDC Partnership, 2024;

UNFCC, 2021). However, these targets are acknowledged as conservative, constrained by uncertainties in emissions calculation and policy implementation (Presidential Climate Commission, 2021). Independent assessments rate South Africa's NDCs as "almost insufficient" and its policies as "insufficient" (Climate Action Tracker, 2023), highlighting a significant gap between ambition and action.

4.1.2.3 Policy Paralysis and the Disconnect Between Plans and Reality

A recurring motif in the analysis is the disconnect between South Africa's transition plans and the realities of its energy system. Despite the existence of targets, policies, and initiatives, the country remains unable to implement an effective transition, largely due to a raging energy crisis and paralysis in policy execution. This disconnect is symptomatic of what Ackoff (Russell L Ackoff, 1979a) terms a failure to adequately formulate the "mess"—the complex, interrelated problems that characterise the energy system. As a result, the means (plans, policies, actions) do not adequately address the underlying problems.

4.1.2.4 Eskom: The Lens for Understanding Systemic Crisis

Eskom, South Africa's state-owned electricity utility, is both a symbol and a cause of the country's energy woes. Supplying a significant portion of the country's domestic electricity consumption, Eskom's fortunes are inextricably linked to the national energy system (Jaglin & Dubresson, 2016). Historically, Eskom was established as an autonomous entity to support state capitalism and the minerals-energy complex. However, post-apartheid reforms eroded its autonomy, rendering it increasingly subject to political interference and the shifting priorities of those in power (Jaglin & Dubresson, 2016).

The technopolitical environment in which Eskom operates is characterised by power struggles, contestations, and the influence of "myths and ideologies" held by political elites. This environment has fostered resistance to change and has perpetuated the status quo, with vested interests either actively or inadvertently blocking the socio-technical transformation required for sustainability (Ting & Byrne, 2020).

The importance of Eskom in advancing the country's developmental targets is well understood. However there is no clear agreement as to how to address the paralysis introduced by

mismanagement, maladministration and allegations of corruption (Mashilo & Kgobe, 2023). Further, there is the strong likelihood that the unbundling of Eskom and the creation of a new distribution entity may have an adverse impact on efforts to alleviate energy poverty (and by extension, the JET) – due to an unsustainable tariff structure (Mohlakoana *et al.*, 2023).It is nonetheless argued that Eskom's restructuring is an important aspect of bringing about a JET, which requires a holistic approach including technical, economic, planning and governance considerations (Anekwe *et al.*, 2025). This strengthens the case for a problem-solving methodology such as Idealised Redesign.

4.1.2.5 The Socio-Technical Nature of the Energy System

4.1.2.5.1 Defining the Socio-Technical System

A socio-technical system is one in which social and technical elements are deeply intertwined, each shaping and being shaped by the other (Ting & Byrne, 2020). In the context of South Africa's energy sector, this means that technological infrastructure—such as power plants, transmission lines, and renewable energy installations—cannot be understood in isolation from the political, economic, and social forces that govern their development, operation, and transformation.

4.1.2.5.2 Historical Evolution and Political Economy

Eskom's historical trajectory exemplifies the socio-technical nature of the energy system. Initially established as an autonomous commission to support the state's industrial and economic ambitions, Eskom's operations were guided by the prevailing political ideologies and economic strategies of the time (Jaglin & Dubresson, 2016). The post-apartheid era saw Eskom's autonomy eroded, as it became increasingly subject to political interference and the shifting priorities of those in power. This shift transformed Eskom from a relatively technocratic entity into a battleground for competing interests, where technical decisions are often subordinated to political considerations.

4.1.2.6 Power Struggles and Resistance to Change

The South African energy system is marked by persistent power struggles among stakeholders, including government ministries, Eskom management, labour unions, the mining sector, independent power producers, and civil society (Mirzania *et al.*, 2023; Ting & Byrne, 2020). These struggles manifest in both overt and covert forms of resistance to change. For example, vested

interests within the coal sector and certain political factions have actively resisted the transition to renewable energy, fearing job losses, diminished influence, or threats to established revenue streams.

This resistance is not merely a matter of policy preference but is embedded in the very structure of the socio-technical regime. The "lock-in" effect—where existing technologies, infrastructures, and institutional arrangements reinforce one another—makes it difficult to shift towards alternative energy pathways (Jaglin & Dubresson, 2016). As a result, even well-intentioned policies and plans often fail to gain traction or are implemented in ways that reinforce *the status quo*.

4.1.2.7 Unintended Consequences and Systemic Feedback

Socio-technical systems are characterised by complex feedback loops and unintended consequences. The rapid, uncoordinated adoption of rooftop solar photovoltaics by wealthier households and businesses, for instance, has provided some relief to Eskom's strained supply but has also undermined its revenue base and the financial stability of municipalities reliant on electricity sales (Jaglin & Dubresson, 2016). This, in turn, exacerbates inequalities, as poorer households—unable to afford alternative energy sources—are left to bear the brunt of rising tariffs and unreliable supply (International Bank for the construction and Development, 2023) Such dynamics illustrate the concept of "wicked problems," where attempts to solve one aspect of the crisis inadvertently generate new challenges elsewhere in the system (Banathy, 2009; Jackson & Keys, 1984). The South African case demonstrates that technical solutions alone are insufficient; they must be accompanied by social, institutional, and governance reforms that address the root causes of systemic dysfunction.

4.1.2.8 The Role of Myths, Ideologies, and Social Narratives

Socio-technical transitions are also shaped by the myths, ideologies, and narratives that circulate within society and among decision-makers (Jaglin & Dubresson, 2016). In South Africa, the legacy of the minerals-energy complex, the ideology of state-led development, and the narrative of energy security have all influenced the trajectory of the energy system. These narratives can serve to justify resistance to change, legitimise certain policy choices, or obscure the need for deeper structural reform.

For example, the framing of coal as essential to economic development and national sovereignty has been used to justify continued investment in coal-fired power, even in the face of mounting evidence of its environmental and economic unsustainability(Climate Action Tracker, 2023).Conversely, the emerging narrative of a "just transition" seeks to reframe the debate around issues of equity, inclusion, and long-term sustainability.

4.1.2.9 Participatory Governance and Stakeholder Engagement

A key insight from socio-technical systems theory is the importance of participatory governance and stakeholder engagement. Effective energy transitions require the involvement of all affected parties, including government, industry, labour, communities, and civil society (Russell L Ackoff, 1979a; Presidential Climate Commission, 2023). However, as highlighted in the analysis of the Just Energy Transition Investment Plan (JET-IP), South Africa's planning processes have often been top-down, with limited opportunities for meaningful stakeholder input or co-creation. This lack of participation undermines the legitimacy and effectiveness of transition policies, as stakeholders may feel excluded or fail to take ownership of the outcomes. The principle of "planning for oneself," as articulated by Russell L Ackoff (1979b), is thus critical: only by involving those who are directly affected by decisions can policies be designed that are both effective and just.

4.1.2.10 The Need for Systems Thinking

The complexity of South Africa's energy transition underscores the need for systems thinking—a holistic approach that recognises the interdependence of technical, social, economic, and political factors(Russell L Ackoff, 2001; Kemp *et al.*, 2007).Systems thinking enables policymakers and stakeholders to identify leverage points, anticipate unintended consequences, and design interventions that address root causes rather than symptoms.

Idealised redesign, as advocated by Russell L Ackoff (2001), offers a practical methodology for envisioning and implementing transformative change. Rather than tinkering at the margins, this approach calls for a fundamental reimagining of the energy system, grounded in the principles of inclusivity, adaptability, and long-term sustainability.

4.1.2.11 Unintended Consequences and Social Justice Concerns

The rise of distributed solar generation has had significant unintended consequences. Municipalities, which rely on electricity sales for revenue, have seen their income eroded, while

poor households—unable to afford alternative energy sources—bear the brunt of rising tariffs (International Bank for the construction and Development, 2023). This dynamic has entrenched climate resilience as a privilege of the wealthy, exacerbating social and economic inequalities. The situation exemplifies the challenges of addressing "wicked problems" within complex socio-technical systems, where each solution can give rise to new problems (Banathy, 2009; Jackson & Keys, 1984; Kmon, 2016). The need for systems thinking and idealised redesign is thus paramount, particularly in the context of energy transitions (Kemp *et al.*, 2007).

4.1.2.12 Policy Responses: Restructuring and Its Limits

Recognising the unsustainability of the status quo, the government has initiated the restructuring of Eskom, separating it into generation, transmission, and distribution divisions. However, this restructuring is largely superficial, addressing symptoms rather than the underlying technopolitical regime (Moolman, 2024).By the end of 2024, key regulatory processes remained incomplete, underscoring the slow pace of reform (NTCSA, 2024).

The origins of the crisis can be traced to missed opportunities for proactive planning. As early as 1998, the Department of Minerals and Energy warned that Eskom's generation surplus would be exhausted by 2007 (Daily Investor, 2023). The government's failure to heed these warnings, coupled with a focus on short-term survival over long-term transformation, has perpetuated the crisis. Successive administrations have relied on interventions such as tariff increases, demand reduction, and emergency generation, rather than systemic reform.

4.1.2.13 The Imperative for Systems Thinking and Idealised Redesign

The analysis strongly advocates for a paradigm shift grounded in systems thinking and idealised redesign (Russell L Ackoff, 2001). South Africa's reactive, crisis-driven approach to change has resulted in a cycle of short-term interventions that fail to address root causes. Idealised redesign offers a framework for reimagining the energy system, moving beyond incremental fixes to envision and implement a fundamentally new paradigm (da Costa Junior *et al.*, 2019).

4.1.2.14 Recent Policy Initiatives: JET-IP and SAREM

Despite the challenges, there are signs of progress. The Cabinet-approved JET-IP seeks to support decarbonisation in line with NDC targets (Presidential Commission, 2023). However, the plan's efficacy is limited by its top-down formulation, with stakeholders invited to comment

on a pre-approved plan rather than being meaningfully involved in its development (Russell L Ackoff, 1979a). For lasting buy-in, participatory planning and idealised redesign are essential. Similarly, the South African Renewable Energy Master Plan (SAREM) was developed through a social compact involving government, industry, and civil society. SAREM aims to support local industry development and build renewable energy value chains (Institute for Economic Justice, 2021; Preuss, 2024). However, its implementation has been delayed by fiscal constraints, conflicts over gas procurement, and trade-offs between local manufacturing and cost (Greencape, 2022; Institute for Economic Justice, 2021). These delays reflect persistent gaps in alignment and stakeholder buy-in.

4.1.2.15 Voluntary vs. Involuntary Transitions

The text distinguishes between voluntary, policy-led energy transitions—characteristic of the global response to climate change—and the involuntary, crisis-driven transition unfolding in South Africa (García-García *et al.*, 2020; Leach, 1992). While the global transition is motivated by the desire to avert future catastrophe, South Africa's transition is reactive, shaped by immediate crises and the need to escape dependence on Eskom.

Although South Africa has ratified the Paris Agreement and submitted NDCs, its planning, policies, and actions remain insufficient to contribute meaningfully to the global transition effort (Climate Action Tracker, 2023). The Integrated Resource Plan has been criticised for its modelling and cost assumptions, with doubts being raised about the country's ability to meet its NDC targets (Department of Minerals and Energy, 2023; Engineering News, 2024).

4.1.2.16 The Energy Mix and the IRP Debate

A comparison of the various iterations of the Integrated Resource Plan (as from 2019 onwards) reveals a troubling trend: the proposed energy mix for 2030 envisages an even greater reliance on coal, with reduced contributions from hydropower, solar, and wind(Energy Group, 2024). While there is some growth in grid-stabilising capacity, including battery energy storage systems (Kgaditsi, 2024), the overall shift towards renewables is insufficient. This underscores the government's fierce urgency to stabilise the grid, but also its inability to break free from coal dependency.

The Integrated Resource Plan is conceptualised with reference to the National Development Plan 2030, which seeks to reduce inequality, unemployment, and poverty. However, the energy crisis poses a significant risk to these developmental objectives, highlighting the centrality of energy availability to South Africa's socio-economic contrast (Business Tech Africa, 2024).

4.1.2.17 Urban Planning, Social Justice, and the Just Urban Transition

The reimagining of the energy system is tantamount to the redesign of society itself, with profound implications for urban planning and social justice. The concept of the Just Urban Transition (JUT) emphasises the need for integrated approaches that address spatial, economic, and environmental inequalities (International Bank for the construction and Development, 2023). Opportunities for climate action and resilience include renewable energy, low-carbon mobility, universal access to services, and ecological infrastructure.

The pursuit of social justice in the energy transition requires the collaboration of diverse stakeholders, including Eskom, government departments, regulators, municipalities, independent power producers, consumers, civil society, financial institutions, and international partners. The primary source of conflict is the speed of transition away from coal, with barriers including techno-economic constraints, power struggles, distributive and recognition injustices, social hierarchy, and the trans-nationalisation of renewable energy projects (Mirzania *et al.*, 2023; Todd & McCauley, 2021).

4.1.2.18 Barriers to Transition: Stakeholder Conflicts and Institutional Weaknesses

The analysis identifies a range of barriers to South Africa's energy transition. These include:

- the weakness of Eskom, given its central role in the energy strategy;
- policy and practical deficiencies within government;
- lack of strategic direction for major municipalities;
- the political power of the mining industry and unions;
- conflicting interests among stakeholders regarding the pace and nature of the transition (Mirzania *et al.*, 2023; Todd & McCauley, 2021).

These barriers are shaped by governmental, national, municipal, industrial, institutional, and labour dynamics, all of which are influenced by the conflicting interests of stakeholders.

4.1.2.19 Urgent Need for a Fair, Just and Equitable Transition

South Africa's envisioned, greener energy future requires an urgent and deep systematic change (Stephens, 2014), to transition from current, carbon-emitting sources of energy towards renewable and "cleaner" sources (McCauley *et al.*, 2019; Myhrvold & Caldeira, 2012). This transformation has significant socio-economic repercussions, some of which are in the form of undesirable consequences (Piggot *et al.*, 2019). For this reason, the transition, although required urgently (Solomon & Krishna, 2011), needs careful thought, planning and balancing of its short and long-term consequences (Markard *et al.*, 2012). The transition needs to be fair, just and equitable (McCauley *et al.*, 2019; Piggot *et al.*, 2019), while at the same time confronting the sustainability challenges presented by fossil fuels (Markard *et al.*, 2012). This is an extremely delicate balance that requires the coordination of various group interests and objectives, some of which may be at odds with one another (Gründinger, 2017; Kern & Smith, 2008).

Being in the top 20 of the highest GHG emitters in the world, South Africa has embraced the concept of sustainable economic development. One of the ways that the country plans to advance towards a greener future is to bring to life the vision first articulated in the Integrated Resource Plan. The Integrated Resource Plan is conceptualised with reference to the country's National Development Plan 2030 **("NDP")**, which lays out the country's long-term development plan towards the reduction of inequality, unemployment, and poverty, as well as the improvement of the standard of living. Energy access is recognised as one of the important inputs towards these long-term developmental targets.

The Integrated Resource Plan seeks to redesign the country's energy mix, with a gradual increase of renewable energy sources, and a gradual decrease of fossil fuels. A scanning of the South African energy landscape reveals that various businesses, stakeholders and industry participants are, separately and collaboratively, investigating and deliberating on the role that they can play in South Africa's energy future. The contemplated transition towards "renewables" or "green energy" (Martin & Ward, 2020) will have implications for the future of industry and society (García-García *et al.*, 2020). It needs to be balanced against considerations founded in fairness and equitability, with a focus on issues such as continued job security, constant electricity provision, economic growth and the country's ability to compete globally, among others (McCauley & Heffron, 2018). From that point of view, the resultant energy mix needs to be sustainable (García-García *et al.*, 2020).

4.1.2.20 Conclusion

South Africa's energy transition is a clear case of a "messy" socio-technical problem, characterised by historical legacies, institutional weaknesses, policy paralysis, and stakeholder conflicts. The country's continued reliance on coal, the crisis at Eskom, and the inadequacy of current policies and plans underscore the need for a fundamental paradigm shift. Systems thinking and idealised redesign offer a pathway for reimagining the energy system, moving beyond reactive, short-term interventions to a holistic, participatory, and just transition. The challenges are formidable, but the stakes are equally high. The future of South Africa's developmental project, social justice, and contribution to the global climate effort depend on the ability to transcend the *status quo* and embrace a new, integrated approach to energy planning and governance.

4.2 Empirical Phase

4.2.1 Empirical Phase Introduction

The theoretical phase of the study (Section 4.1 above) pursues the first study objective. The empirical phase below addresses the remaining study objectives, which are restated for ease of reference as follows:

Objectives	Research Methodology
Completing an obstruction analysis, by providing a description of the characteristics and properties of the South African energy system that hinder the successful invoking of the JET (Russell L Ackoff, 2001).	Delphi exercise (Brady, 2015) with a panel of experts from a South African development finance bank. **Tool:** Open-ended questionnaire as part of semi-structured interviews(Drever, 1995; Linstone & Turoff, 1975; Skulmoski *et al.*, 2007).
Projecting aspects of the expected future of the energy system, assuming existing methods of energy distribution and consumption, as well as the predicted future environment, remain unchanged (Russell L Ackoff, 2001).	Delphi exercise (Brady, 2015) with a panel of experts from a South African development finance bank.

	Tool: Open-ended questionnaire as part of semi-structured interviews (Drever, 1995; Linstone & Turoff, 1975; Skulmoski *et al.*, 2007).
Providing a description of how and why the South African energy system, if the assumptions above were true, would destroy itself (Russell L Ackoff, 2001).	Delphi exercise (Brady, 2015) with a panel of experts from a South African development finance bank . **Tool:** Open-ended questionnaire as part of semi-structured interviews (Drever, 1995; Linstone & Turoff, 1975; Skulmoski *et al.*, 2007).

Table 4: First Study Objective, Restated

The empirical phase process entailed collecting views from the expert respondents individually through interviews facilitated by the researcher. The interviews, which were recorded, were then transcribed and analysed thematically with the assistance of NVIVO®. Thereafter, the output was interpreted, with the views consolidated; and transferred onto a document. The document was used to facilitate a follow-up interview with each respondent, to determine if there was consensus among the respondents under each theme. There was one iteration of the Delphi process, after which the researcher settled on a consensus view. Presented below is the consensus view of the respondents, in respect of each research question.

4.2.1 Empirical Phase Results

4.2.1.1 Question 1: System Analysis

The first research question under the empirical phase of the study sought to confirm the findings of the system analysis initially made by the researcher in the theoretical phase. To that end, the expert respondents were requested to confirm whether they agreed with the theoretical analysis of the South African energy system. This process pursues the "system analysis" step of Russell L Ackoff (2001)'s Idealised Redesign. In addition to confirming their agreement, the respondents were provided with an opportunity to correct any perceived errors; and to provide any additional points, covering the political, socio-economic, and technological components of the energy system. The system analysis also covers the way the components of the system interact with each other, which in turn shapes the character of the energy system. Finally, the analysis seeks to explain

the nature of the environment within which the system is contained, including the way the system interacts within the containing environment.

The first research question under the empirical phase is as follows:

Please consider the provided description of how the South African energy system currently operates (Annexure A), particularly in respect of its political, socio-economic, and technological components, as well as the environment within which the system is contained (Russell L Ackoff, 2001).
Please also note the indicated description of the system's stakeholders, as well as their interests.
Do you agree with the statements in Annexure A? Is there anything that you with to add, or correct?

Overall, the respondents agreed with the analysis of the South African energy system undertaken in the theoretical phase of the research. Taking into account the points clarified, added and corrected by each of the during the Delphi process, the researcher presents the following consensus view regarding the nature of the South African energy system and how it is configured, as expressed by the expert respondents. The respondents' views, which have been interpreted and consolidated, are presented as follows:

- The South African energy system is a complex system, with social, technical and economic elements.
- The technical elements of the system include physical structures and installations such as power plants, distribution and transmission lines, boilers, wind turbines, solar panels, vehicles; (e.g. coal trucks), pipelines for the transportation of various products including gas and crude oil, etc. These physical structures and installations belong to, or are operated by, different private and public sector stakeholders, including different stakeholders. Stakeholders such as Eskom, private households and companies, municipalities, commercial operators, etc.
- The respondents also agreed that raw materials, natural and otherwise, also form part of the technical elements of the systems. Examples include coal, natural gas, shale gas, wind, water resources, etc.
- The social elements of the South African energy system, according to the expert respondents, include, simply put, people that are involved in the generation, transmission and distribution of energy. These people form part of the South African energy system in various ways, including among other things, (i) participating as managers of energy companies, such as Eskom, liquid fuel produces (e.g. Engen, Sasol, Shell, BP and others), (ii) forming part of various spheres of government, where laws and policies are formulated and/or enforced in respect of energy (e.g. NERSA, the Department of Minerals and

Energy, various municipality councils etc), (iii) participating in various activist groupings and commentator associations, such as NGOs (e.g. Treasure the Karoo Action Group), economists and consultants, activist shareholders socio-political analysts, and (iv) direct consumers, such as companies and households, who require energy for their day-to-day activities.

- The theme that cuts across the views expressed by expert respondents is that it is particularly challenging to produce a uniform, comprehensive and exhaustive list of the elements and parts that comprise an energy system due to the contextual nature of the analysis, as well as the proposition that each person analysing the system has to decide on the perspective from which they are seeking to understand the system. In order to attempt to address this challenge, the expert respondents accepted that there is a strong possibility that the energy system could be understood in the narrow sense; as well as the broad, expanded sense. The narrow view of the energy system focuses on the on those elements of the energy system that are directly involved in the generation, transmission, distribution and consumption of energy. The expanded view of the energy system embraces the logic that energy impacts all facets of society, directly and indirectly. For example, it is accepted in South Africa that energy access has an impact on the country's developmental targets, including, for example, education levels, access to health services, industrialisation, business activity, business sentiment, etc.
- While some of the respondents were not able to list examples in this regard, there were expert respondents argued that systems and structures which seemingly are not connected to the energy system. At first glance could, in terms of the expanded view of the energy system be considered to be part of the system. An example is the road network, which has taken on a higher number of GHG emitting trucks since the country's rail network started deteriorating. The same view is applicable to the social elements of the system, where one could consider how the structure of South African society has an impact on energy access. The example that was put forward in this regard is that there are parts of South African who, due to the structural inequality that characterises South African society, are not yet in a position to transcend existential challenges, such that they can confront the question of clean energy. A blue-collar worker who lives in Soweto and who works in scenting spans a large amount of their monthly income on transportation; and for such a worker, the energy issue is also a geographical, special issue, which is a whole lot more to do with historical legacies than preferences.

- Regarding the environment within which the respondent primarily adopted the expanded view of the energy system .
- The global context features strongly in shaping the understanding of the South African energy environment, particularly in relation to two important considerations:
    - First, South Africa has made commitments to contribute to the reduction of its GHG emissions under the Paris Convention. These commitments have a significant impact on what South Africa aspires to achieve from an energy transition point of view.
    - Second, South Africa is a globally integration economy. Some of South Africa's trading partners (e.g. the European Union) are beginning to take certain climate-based actions, which require that products and services adhere to GHG footprint targets, failing which, the EU will not trade in those products and services. This has the effect of forcing South Africa to accelerate its transition, for the benefit of its economy.
- There is also the local context. According to the expert respondents, the port of departure is an understanding of the history of the South African energy system. The consensus view is that South Africa's mineral discoveries, alongside the discovery of affordable coal set South Africa on a course, where cheap, low-quality coal became the very foundation of the South African economy. This resulted in increased mineral output, the emergence of supporting industries and secured South Africa's place as the most industrialised economy on the continent.
- However, there was a cost. The manner in which the South African sociopolitical economy proceeded along its developmental path meant that there was lock-in, which could be described in two main ways.
    - First, South Africa's industrialisation came with high GHG emissions, given the historical importance of the availability of affordable coal. The country's energy generation infrastructure remains largely configured for coal energy production. From that point of view, it is proven difficult to engineer a move away from coal, without a high cost to South Africa's fragile economy.
    - Second, South Africa's energy-mineral complex has historically been buttressed by a social design that is characterised by cheap labour, inequality and a specific spatial arrangement (i.e. in terms of where and how people live and commute). For many years, this social design seemed to work as intended, in that it supported a highly industrialised economy. Nonetheless, the underlying social order was never

sustainable. For example, many workers lived far from where they worked, and they commuted to work by train or minibus taxi. This worked only to the extent that costs remained low enough. Another example of the unsustainability of the underlying social order is that the inequality that for many defined the South African economy needed to be confronted and addressed. It could not remain in the long term.

However, notwithstanding attempts at social redress, South Africa still grapples with inequality, geographical exclusion and other forms of "inefficiencies" in the social design. There is lock-in in the sense that these issues remain at the core of South African society and have not been easy to change.

South Africa's social design has a direct impact on how energy is produced and consumed. While in the past, there may have been an explanation (not necessarily a justification) for the manner in which society was designed, the design no longer has any tangible economic benefits.

The expert respondents argue that in order to bring about a just energy transition, South Africa needs to accept that the transition is not about energy *per se*, but the transition is in fact about changing the very fabric of South African society and moving away from a social order which no longer serves its purpose. The conflicts and contestations that come from the transition are deep-rooted because they have to do with this fundamental issue.

Coal reliance worked in the past for as long as the price of energy produced was low. And for as long as the other contributing factors remained in place (i.e. low labour rates, visible industrialisation, low costs of living, low costs of commuting etc). Now, most of these factors are no longer in place, which means that the only reasons justifying the country's continued reliance in coal are that (i) the cost of the transition is high; and (ii) the deep-rooted conflict associated with the transition is difficult to resolve.

- The deep-rooted conflict manifests in socio-political contestations among the energy system stakeholders, who have differing views about the process to be followed to implement the energy transition as well as ensuring the justness of the transition.

4.2.1.2 Question 2: System Analysis

The second research question assesses whether the respondents could idealise a Just Energy Transition in South Africa. It is stated as follows:

Taking into account, your views on how the South African energy system currently operates, particularly in respect of its political, socio-economic, and technological components, as well as the environment in which the energy system is contained, how would you describe the ideal Just Energy Transition in South Africa? How should such an energy transition be designed; and implemented?
What, in your view, is the idealised energy future system, that South Africa needs to strive for, in replacement of the current one?
Please note that this is not necessarily the energy future system that is most likely to transpire, based on current predictions and efforts. Instead, this is the future energy system that you would ideally wish to see created if you were free to do so.
This idealised future system needs to be:

- ***technologically feasible; and***
- ***operationally viable.***

The expert respondents provided the following consensus view:

- The idealised energy future system that South Africa needs to strive for, in replacement of the current one needs to be based on the expanded view of the energy system (see Section 4.2.1 – *Empirical Phase Introduction*).
- To achieve justness in the energy transition, South Africa needs a paradigm shift in how the energy transition is understood. The character of South Africa's energy system was initially shaped by the country's social construct, which no longer serves its purpose (see *Question 1* above). Accordingly, the achievement of a just energy transition will not be possible if stakeholders focus solely on the energy question. The primary question is a social design one. It is about how South Africa redesigns itself and moves away from the social order of the past. The question is about equality, national development, where and how people live and commute etc. Focusing solely on the energy question is discouraged because it only exacerbates the schisms between energy industry players and promotes self-interest. Adopting the expanded view diffuses the context by emphasising the developmental project.
- The expert respondents than proposed that if the above the approach is adopted, then it should be possible for stakeholders to idealise a future system that is technologically feasible and operationally viable. However, it is argued by the expert respondents that the current attempts by South Africa to invoke a just energy transition are proving to be difficult to operationalise technologically, financially and even politically, given the current inability of the country to wean itself off coal. They propose that Idealised Redesign could help to resolve this difficulty.

4.2.1.3 Question 3: Obstruction Analysis

The first research question is meant to facilitate an obstruction analysis; and is restated as follows:

Having considered the above, how would you describe the characteristics and properties of the South African energy system that hinder the successful invoking of the JET, as well as the system's progress towards its idealised future?

According to the expert respondents, the effective implementation of the JET in South Africa is hindered by the following characteristics and properties of the energy system:

- **Competing national priorities:** The implementation of a just energy transition in South Africa is currently in competition and sometimes, conflict with other national priorities (e.g. expenditure on health care, social welfare and education takes financial resources away from the energy transition).
- **Conflicting interests:** The South African energy system's stakeholders may agree that a Just Energy Transition is an ideal worth pursuing, however the practical mechanisms for achieving a Just Energy Transitions are not fully aligned on and are fiercely contested. Areas of divergence include among other things, the financing mechanisms, sequencing of projects and programmes and the prioritisation of technologies.
- **Corruption and malfeasance:** Corruption and malfeasance have the effect of removing objectivity in decision-making processes and they drain the county's limited resources.
- **Eskom weaknesses:** As a state utility, Eskom provides the lion's share of South Africa's energy requirements. However, Eskom is currently unable to fulfil its role efficiently, due to its operational weaknesses.
- **Relative power of the proponents of the *status quo*:** The proponents of the *status quo*, including labour unions, some sections of government and private players (e.g. mining companies), are in a stronger political and economic position, relative to the proponents of change.
- **An inefficient regulatory regime:** While South Africa aspires to achieve a Just Energy Transition, the regulatory regime is not adequate to support the transition; and is disjointed in places (e.g. the financing mechanism of the JET-IP are not yet in place).
- **Political Indecision and Infighting:** South Africa is experiencing a period of infighting, policy uncertainty and decision which has lasted for over a decade. The African National Congress (ANC), which has been the majority party for many years after the advent of

democracy has until recently, been plagues by factionalism, which has spilled over onto its management of the economy and parastatals. Presently, the government of national unity or the "grand coalition" comprising the ANC, the Democratic Alliance and other parties is not always aligned on some of the major issues. The misalignment within the grand coalition has resulted in the postponement of the 2025 national budget speech due to the inability to find common ground, a first in democratic South Africa. A compromise budget means that all government interventions which rely on budget allocations, including the energy transitions, are exposed to uncertainty.

- **Financial constraints:** South Africa's fiscus is constrained and is experiencing a shrinking of the tax base. The funding of the energy transition therefore requires the participation of the private sector, donors and international partners. The required financing regime is not yet fully in place.
- **Lack of technological integration:** Some of the technologies required to support the JET are not optimally integrated into the energy system, underscoring a lack of control in this regard. For example, South Africa is still at loggerheads about whether private homeowners who have implemented a rooftop solar solution should pay a fee to Eskom. Another example is an outstanding decision on whether such private homeowners will be allowed or required to install two-way meters so that they can sell excess power to the grid and participate in "wheeling" arrangements.

4.2.1.4 Question 4: Reference Projections and Question 5 (Reference Scenario)

Due to the way the expert respondents answered questions 4 (Reference Projections) and 5 (Reference Scenario), the two questions have been combined. The questions are restated below as follows:

Question 4 (Reference Projections): Please consider the methods of energy distribution and consumption in South Africa, examples of which are listed in Annexure A.
Also, please consider the description of the predicted future environment of the energy system if no changes are made to current plans and efforts.
Do you agree with this list of energy consumption and distribution methods, as well as the description of the predicted future environment?
Is there anything that you wish to add or correct, particularly, given your views in Sections 1 and 2 above?
Now, assuming the existing methods of energy distribution and consumption, as well as the predicted future environment remain unchanged, what do you think is the likely (less than ideal) future of the South African energy system(Russell L Ackoff, 2001)?

Question 5: Reference Scenario

Question 5 (Reference Scenario): How do you think that the South African energy system would destroy itself if the assumptions above were true(Russell L Ackoff, 2001)? In other words, if no changes are made to the existing methods of energy distribution and consumption, as well as the predicted future environment, how would the energy system destroy itself, or be destroyed?

Should there be no changes in the current energy system and its projected trajectory, the expert respondents' consensus view delivers the following reference projections and reference scenario:

- **An imploded Eskom:** Eskom is that it will find itself in a vicious cycle where tariffs have to be increased for the company's survival, which will prompt customers to find alternative energy sources. This will continue until the tariff increases are no longer sustainable, in the face of a decimated customer base. Eskom would then lose its monopoly position in the market. This would be a disastrous outcome for the national government, given that Eskom is expected to continue to feature prominently in the Just Energy Transition plans (e.g. Eskom's subsidiary, National Transmission Company of South Africa SOC Limited is currently implementing plans to expand the country's electricity transmission network, while Eskom itself has expressed a desire to pivot to renewable energy in the future).
- **A chaotic, uncontrolled energy transition that is lacking in justice:** As the costs of energy continue to rise, households and businesses will continue to invest in alternative energy sources. These private investments will largely be uncontrolled, meaning that the transition itself will also be uncontrolled. The effect of an uncontrolled and chaotic transition is a lack of justice, given that the ability to afford alternative energy will determine whether or not consumers are susceptible to Eskom's predicted collapse.
- **Missed developmental targets:** The expanded view of the energy system recognises the importance of a Just Energy Transition for the country's developmental targets and in particular, the NDP 2030. Should the energy system continue in its present trajectory, with the current distribution and consumption methods unchanged, the country would fall short of its developmental targets, as access to affordable energy would not have been secured.
- **An economy that is globally uncompetitive:** The expert respondents predict a transition that is forced, as opposed to one that is voluntary. The transition would be forced in the sense that (i) South Africa needs to respond to climate science requirements

by its partners; and (ii) local households and businesses need to respond to the challenge presented by unreliable electricity and rising energy costs. Due to the forced nature of the transition, there is likely to be a disconnect between what the country has identified as the underpinnings of a voluntary and Just Energy Transition (e.g. financing mechanisms) and the means and ends actually adopted. In other words, the planning would be inadequate, resulting in a costly transition. Economies that would have given themselves adequate time to plan and implement a voluntary and Just energy transition would be more competitive globally when South Africa.

- **Weakened climate change adaptation response:** The energy transition is two-pronged; in that it is a climate change mitigation intervention and an adaptation intervention. As the urgency of the adaptation intervention increases (due to occurrences such as droughts and floods), the mitigation intervention becomes important. An inefficient energy transition is expected to result in South Africa being unable to meet its NDCs, which in turn means that the global climate change effort would be undermined. Given Africa's exposure to the effects of climate change and given South Africa's position as one of the highest GHG emitters on the continent, it would stretch the country's climate change adaptation resources and weaken the country's response.
- **Breakdown in social relations:** In the South African context, the Just Energy Transition should be understood as being more than a mere transition from one energy system to another. The South African energy transition represents a shift from an old social construct to a new one. A protracted planning phase followed by an inefficient implementation process allows for the effects of deep-rooted conflict fester. Contestations are likely to be more pronounced under the stress of a deteriorating energy environment.

4.2.1 Conclusion of the Empirical Phase

In the empirical phase of the study, the researcher follows the Delphi process to complete the phase first of Russel Ackoff's Idealised Redesign process. Through the facilitation of the researcher, expert respondents reach consensus in respect of five research questions and in that way complete the following steps of the Idealised Redesign process:

- system analysis;
- obstruction analysis;
- reference projections; and
- reference scenario.

Regarding the system analysis process, the expert respondents proposed a broad approach that should be adopted to idealise a future energy system that is technologically feasible and operationally viable, insisting that more work would need to be undertaken in this regard. The findings of the empirical phase, which represent the consensus view of the respondents, are summarised below.

System Analysis: The South African energy system is a complex system with social, technical, and economic elements. Technical elements include physical structures and installations, such as power plants and pipelines, operated by various stakeholders. Raw materials, such as coal, natural gas, shale gas, wind, and water resources, also form part of the system.
Social elements include people involved in the generation, transmission, and distribution of energy, such as managers of energy companies, government spheres, activist groups, and direct consumers.

The challenge of producing a uniform, comprehensive list of energy system elements is due to the contextual nature of the analysis. Expert respondents accepted that the energy system could be understood in both a narrow and broad sense. The narrow view focuses on the elements directly involved in energy generation, transmission, distribution, and consumption, while the expanded view considers the impact of energy on all facets of society, including education levels, health services, industrialization, and business activity.

Examples of systems and structures not connected to the energy system include the road network and the social elements, such as structural inequality and geographical issues. The environment within which the respondent primarily adopted the expanded view of the energy system is also considered.

The South African energy environment is shaped by the global context, including its commitments to reduce greenhouse gas (GHG) emissions under the Paris Convention and its global integration with trading partners like the European Union. The country's history of mineral discoveries and affordable coal has led to increased mineral output and the establishment of supporting industries. However, this has come with high GHG emissions due to the country's historical dependence on coal.
The country's energy generation infrastructure remains largely configured for coal energy production, making it difficult to engineer a move away from coal without a high cost to its fragile economy. Additionally, South Africa's energy-mineral complex is characterised by cheap labour,

inequality and a specific spatial arrangement, which has not been easy to change.

Expert respondents argue that a just energy transition requires South Africa to accept that the transition is about changing the fabric of society and moving away from a social order that no longer serves its purpose. The deep-rooted conflict and contestations surrounding the transition are manifesting in socio-political contestations among energy system stakeholders, who have differing views on the process to implement the transition and ensure its justness.

Idealised Future System: The expert respondents agree that South Africa needs an idealised energy future system based on an expanded view of the energy system. They emphasise the need for a paradigm shift in understanding the energy transition, focusing on social design, equality, and national development. They then propose that adopting this approach could enable stakeholders to idealise a technologically feasible and operationally viable future system. However, they argue that the current attempts to achieve a Just Energy Transition are challenging due to the country's inability to transition from coal.

Obstruction Analysis: The implementation of the Just Energy Transition (JET) in South Africa faces several challenges, including competing national priorities, conflicting interests, corruption, and inefficient regulatory regime. Eskom, the state utility responsible for South Africa's energy needs, is struggling to fulfil its role efficiently due to operational weaknesses. The relative power of the status quo, including labour unions, government, and private players, also hinders the transition. The regulatory regime is insufficient to support the transition, and political infighting and infighting have caused policy uncertainty. The government's grand coalition, including the ANC, is not always aligned on major issues, resulting in the postponement of the 2025 national budget speech. Financial constraints and lack of technological integration also hinder the transition. The country's fiscus is constrained, and the financing regime for the energy transition requires private sector participation, donors, and international partners. Technological integration is also lacking, with disagreements over fees for rooftop solar solutions and the installation of two-way meters for private homeowners.

Reference Projections and Reference Scenario: The expert respondents predict that if the current energy system remains unchanged, South Africa could face several negative consequences. First, Eskom could face a vicious cycle of increasing tariffs for survival, leading to customers seeking alternative energy sources. Second, a chaotic, uncontrolled energy transition could lead to

a lack of justice, as consumers' ability to afford alternative energy could determine their susceptibility to Eskom's collapse. Third, the country would miss its developmental targets, as access to affordable energy would not have been secured. Fourth, the transition would be forced, causing a disconnect between the country's underpinnings of a voluntary and Just Energy Transition and the actual means and ends adopted. Fifth, the transition could weaken South Africa's climate change adaptation response, as it would be unable to meet its National Development Goals (NDCs) and undermine the global climate change effort. Finally, the Just Energy Transition could lead to a breakdown in social relations, as the transition represents a shift from an old social construct to a new one.

5 DISCUSSION

5.1 Introduction

This section comprises a discussion of the topic of the study with reference to the study findings in Section 4 *(Results)* and the Literature Review in Section 2 *(Literature Review)*.

5.2 Discussion: Mess Formulation

The study findings reveal that the planners of South Africa's energy transition are faced with many complex questions. The questions are not only in respect of abvious considerations, such as how to finance the energy transition, how to schedule and sequence it; and what technologies to use. The questions are in fact, profound and deep. The Just Energy Transition has to do with the fundamental question of how South Africa makes the transition from economic and social exclusivity to inclusivity. It has to do with how South Africa defines and pursues its development ideals. To a certain degree, these profound questions often fall fall to the background and under the shadow of the obvious enquiries, due the lack of a problem-solving framework that would allow the planners to clearly and firmly appreciate the main interconnections that shape the problem before them. In order to address these problems, Idealised Redesign is a *sine qua non*.

Not only does Idealised Redesign ensure that the challenge before the planners is identified and articulated correctly, but it also serves as a vessel that contains the planners' shared vision of what the idealised future needs to be. It also provides the mechanism for chosing the appropriate tools, processes and pathways to bring the envisioned future about. Because the planners are an intrinsic part of the planning process, they commit to the plan. And because the plan is holistic, it avoids one of the main pitfalls of a simplistic approach to resolving complex problems: implementing solutions that bring about more problems.

The study results indicate that South Africa is not oblivious to the technical and financial complexity of the Just Energy Transition. However, it would appear that the social complexity is not fully appreciated. The schisms and contenstations between the energy stakeholders are often recognised and highlighted as part of the general commentary on the Just Energy Transition. However, what the Delphi process brought to the fore is that one of the main underlying causes to the contenstations: deep-rooted conflict.

Burton (1987) introduces the topic of deep-rooted conflict as follows:

"Deep-rooted conflict of the kind that is our concern occur, however, at all social levels. Tney occur in the social relationships of the family and of the work place. Furthermore, most modern societies are multi-cultural or multi -ethnic. Most have problems of poverty and plenty. Most have problems of inequality of opportunity. Most have problems of frustration and lack of participation and identity. Most, as a consequence, have high levels of alienation, leading to conflict situations of many kinds that affect the whole of a society and, indirectly, the world society." (p.3)

Such conflicts are driven by deep feelings, values and other needs and as a result, they cannot be resolved through simple means (Burton, 1987). The Just Energy Transision that is contemplated in South Africa is unique and incomparable to transition processes elsewhere, which may be viewed as a simple shift from one energy system to another. South Africa's Just Energy Transition coincides with the country's developmental aspirations, and which in turn coincide with the democratic vision of emerging from a painful, exclusionary past, to a more equal-opportunity society. The deep feelings, values, needs and issues of identity highlighted by Burton (1987) shape the energy transition and national development discourse in South Africa. When rich households are able to afford solar power, while poor ones are at the mercy of Eskom and dysfunctional municipalities, the issue ceases to be a simple energy transition one. It becomes a deep-seated problem going to the core of the needs and identities of societies.

The Integrated Resource Plan is pegged to South Africa's National Development Plan. This begs the question as to what development exactly is. Gharajedaghi and Ackoff (1986) cautions that national development is not analogous to growth; and proposes that development should be defined as *"the process in which people increase their abilities and desires to satisfy their own needs and legitimate desires and those of others" [basic concepts]*. What this implies is that if the Just Energy Transition is to be successful and if it is to result in national development, then its effect shold be a society where people have increases their ability and desires to satisfy their own need and the legitimate desires and those of others. As indicated above, needs and desires are a deep-seated issue (Burton, 1987).

The expanded view of the South African energy system, as proposed by the respondents, considers the importance of the social and developmental aspects of the energy system, as opposed to focusing solely on the technological and financial aspects. This implies that the energy system could be conceived as a social system, in that it can restructure itself with no restraints (Gharajedaghi & Ackoff, 1986). The attempt at the Just Energy Transition in South Africa is in fact an attempt by the social system to restructure itself.

As demostrated by the study results, the regulations, actions and interventions that have to date been put in place to support the Just Energy Transition (e.g the JET-IP) indicate that the energy system is viewed as mechanical one at worst; and an organismic one at best. A mechanical system has no ability to restructure itself (Gharajedaghi & Ackoff, 1986). An organismic one has a limited ability to restructure itself, with some of the parts taking on the functions of other parts (Gharajedaghi & Ackoff, 1986). The focus of the interventions is on the system's individual parts, or a collection of selected parts (e.g. technologies). However, the fact that some aspects of South Africa's energy transition are uncontrolled (e.g. the uncontrolled emergence of rooftop solar power solutions) points to a social system that is busy restructuring itself. The question then is: how do we plan for an energy system that has the ability to restructure itself towards development? In other words, how do we help energy planners make better decisions, taking into account distributive and procedural justice considerations (Pellegrini-Masini *et al.*, 2020)? Such considerations include not just energy availability, but affordability, due process, good governance, sustainability, intergenerational equity, intragenerational equity, and responsibility (Pellegrini-Masini *et al.*, 2020). These are serious questions of development; and which go go far beyond the narrow issue of the survival of Eskom, which appears to have taken centre stage.

Viewed in the context of national development, Eskom presents an ideal lens through which we may begin to understand the interlinkages between South Africa's energy system and the complex questions of a desired social construct. The expert respondents argue that Eskom, which has been a behemoth looming large over the energy system for many decades, started its life as a reflection of the social construct that the then government had envisioned. It was designed to further the interests of the pre-1994 state (i.e. providing low-cost electricity, supporting the mineral-energy economy, achieving industrial diversification and supporting Afrikaner economic and political power)(Jaglin & Dubresson, 2016). There a complex sociopolitical, legal and economic system accompanying this vision: apartheid. It could be argued that this was a social system as contemplated by Gharajedaghi and Ackoff (1986). Hower, this social system had not reached a developed state in that the people in it were not capable of increasing their abilities and desires to satisfy their own needs and legitimate desires and those of others (Gharajedaghi & Ackoff, 1986).

Attempting to address the South African energy system, and Eskom's place in it without recognising the above is a failure in designing social systems. In the Literature Review, it is stated that Banathy (2009) understands the idea of designing social systems as based on the view that systems are to be be understood as wholes, comprising interacting parts. The above paragraph

provides insights as to how Eskom interacted with the parts of the social system that is now no more. The mess formulation process under Idealised Redesign would bring clarity on how Eskom presently interacts with the parts of the present social system; and would further assist in determining how the parts of the envisioned social system should interact (Russell L Ackoff, 2001; Banathy, 2009).

It should follow then that the Just Energy Transition in South Africa should be understood in its context. To appreciate the context of the Just Energy Transition in South Africa, we may begin by accepting that South Africa is presently attempting to device a social construct, in replacement of an old one. The problem context within which the Just Energy Transition emerges as a "problem" to be resolved is a *social-pluralist* one, in the sense that we are dealing with a social system where there are many stakeholders, with varying interests (Jackson & Keys, 1984). This is described in more detail in the theoretical and empirical phases of the study. From this perspective then, the Just Energy Transition is part of a bigger "mess", which needs to be managed, while planning for and designing an envisioned social construct (Russell L Ackoff, 2001). The contextual nature of Idealised Redesigned has been explained by authors such as Pickering (2006).

This "mess" management process is Idealised Redesign (Russell L Ackoff, 2001). The participative principle (Russell L Ackoff, 1979b) of Idealised Redesign would imply that instead of having specific groupings and organisations devise a Just Energy Transition to be implemented by others, all those who would be affected by the plan should participate, so that they plan for themselves and take ownership of the process of bringing the plan to life.

The continuity principle (Russell L Ackoff, 1979b) can be viewed alongside Hofstede (2011) *short-term vs long-term orientation* dimension of culture. The current energy in South Africa crisis can be attributable to the short-term orientation of the planners, in that the looming crisis had been foretold, but plans were not made to avert it (Daily Investor, 2023). Currently, the planners of the South African energy system are facing a planning dilemma in the form of "long-term goals and commitment vs. short-term success", due to the country's inability to wean itself off coal. The continuity principle (Russell L Ackoff, 1979b), if applied alongside a long-term orientation would have the planners accept that (Russell L Ackoff, 1979b) putting in place a new social construct is a long-term exercise. They would further accept that the implementation plan requires continous revision (Russell L Ackoff, 1979b) since plans do not always work as expected. This would have the effect of introducing a shared patience and reducing the level of contenstations in respect of the Just Energy Transition.

The holistic principle (Russell L Ackoff, 1979b) is of utmost importance. Interventions such as as the JET-IP, the Integrated Resource Plan, SAREM and others are seemingly top-down, which is the opposite of what the holistic principle proposes (i.e. a bottom-up approach). The proponents of the *status quo* and the proponents of change are in a power struggle, where the winner is determined by who holds the levers of power. Those who find themselves on the wrong side of decisions have no option but to express their displeasure (e.g. the critiques of the IRP2023), which takes away from the collective effort required to successfully bring about a Just Energy Transition in South Africa. The question of justice, distributive and procedural, is fundamental to the Just Energy Transition and would also receive due consideration under the holistic principle.

5.3 Recommendations

Given the discussion above, and the results of the study (Section 4) and in particular, the mess formulation output, the following recommendations are made:

- Idealised Redesign should be adopted as means to achieve a holistic planning process. Plans such as the JET-IP anticipate that stakeholders will need to be engaged with. Planners do need to be open to the idea that the involvement of stakeholders under an Idealised Redesign process will mean a redefinition of the envisioned future system.

- The South African energy system should be viewed in its proper context as part of a continuum beginning with the country's transition into democracy. Therefore, South Africa will need to design a desired social construct, with the energy question featuring in support of that.

- Inasmuch as South Africa should commit to the global climate change effort, South Africa needs to recognise that in its context, the energy question is intrinsically linked to the developmental aspirations of the country, and that the conflicts that arise in this regard are deep-rooted; and cannot be resolved through simple means.

- Instead of planning solely for the Just Energy Transition, South Africa should plan for its national development, with the Just Energy Transition being recognised as one of the mechanisms to achieve development and justice.

- The planning of the Just Energy Transition needs to be bottom-up and not top-down. To the extent that plans have already been produced, steps will need to be taken refine the plans with the involvement of as many stakeholders as possible.

5.4 Recommendations Regarding Future Studies

- While the researcher completed part of the Idealised Redesign process (i.e. the "mess formulation" process) utilising the Delphi technique, it should be noted that the Delphi technique is limited to a small sample. The Delphi process does anticipate that the study that is the subject matter of the Delphi would, after being concluded successfully, be applied in a real life setting. The researcher has demonstrated the usefulness of Idealised Redesign in formulating the mess. It is now recommended that this be applied in a real life setting, as part of the country's Just Energy Transition plannig process.

- The study only address the mess formulation aspect of the Idealised Redesign process. It is recommended that future studies address the remaining Idealised Redesign steps. Alternatively, these steps can be completed in a real life setting.

6 CONCLUSION

The researcher set out on a study of the Idealised Redesign process as a mechanism to enable the transisio from a predominanly fossil fuel energy economy to a sustainable energy economy. The researcher undertook a literature review on *inter alia* systems thinking, complex problems and Idealised Redesign. The Delphi process was then employed to complete interviews with carefully selected expert respondents, who offered insights as part of the "mess formulation" step of the Idealised Redesign process. The scope of the research was restricted to only "mess formulation", with the research comprising a theoretical and empirical phase. The theoretical phase address the first part of mess formulation (i.e. system analysis), while the empirical phase addressed the rest of the process.

The output of the mess formulation process was analysed against the theory, confirming the utility of Idealised Redesign in invoking a Just Energy Transition. However, given the limited focus of the study, it is recommended that future studies be undertaken to analyse the rest of the

Idealised Redesign process. Further, it is recommended that the outcome of this study be applied to a real life setting, as part of the planning of the Just Energy Transition in South Africa.

REFERENCES

90 by 2030. (2020). Remaking Our Energy Future: Towards A Just Energy Transition (JET) in South Africa. Retrieved from https://90by2030.org.za/wp-content/uploads/2020/03/Remaking-our-Energy-Future.pdf

Ackoff, R. L. (1974). Redesigning the future. *New York, 29*.

Ackoff, R. L. (1979a). The future of operational research is past. *Journal of the operational research society, 30*(2), 93-104.

Ackoff, R. L. (1979b). Resurrecting the future of operational research. *Journal of the operational research society, 30*(3), 189-199.

Ackoff, R. L. (1993). Idealized design: Creative corporate visioning. *Omega, 21*(4), 401-410.

Ackoff, R. L. (2000). Creating the corporate future. *Understanding business environments*, 217-227.

Ackoff, R. L. (2001). A brief guide to interactive planning and idealized design. *Retrieved on March, 19*, 2006.

Adler, M., & Ziglio, E. (1996). *Gazing into the oracle: The Delphi method and its application to social policy and public health*: Jessica Kingsley Publishers.

Allwood, J., Bosetti, V., Dubash, N., Gómez-Echeverri, L., Stechow, C. v., D'Agosto, M., . . . Brunner, S. (2014). Glossary, Acronyms and Chemical Symbols [Annex I]. In *Climate Change 2014: Mitigation of Climate Change* (pp. 1247-1279): Cambridge University Press.

Almaiah, M. A., & Almulhem, A. (2018). A conceptual framework for determining the success factors of e-learning system implementation using Delphi technique. *Journal of Theoretical and Applied Information Technology, 96*(17), 5962-5976.

Anandarajah, G., Strachan, N., Ekins, P., Kannan, R., & Hughes, N. (2009). Pathways to a low carbon economy: energy systems modelling. *UK Energy Research Centre*.

Anderson, V., & Johnson, L. (1997). Systems Thinking Basics: From Concepts to Casual Loops, Waltham, Massachusetts: Pegasus Communications. In: Inc.

Andrew, T. N. (2001). *A systems thinking approach to the planning of rural telecommunications infrastructure*.

Anekwe, I. M. S., Ashiegbu, D., Isa, Y. M., & Potgieter, H. (2025). Circular economy and energy transition: a review of South Africa's 5-year just energy transition investment plan (JET-IP). *Mitigation and Adaptation Strategies for Global Change, 30*(6), 48.

Arnold, R. D., & Wade, J. P. (2015). A definition of systems thinking: A systems approach. *Procedia Computer Science, 44*, 669-678.

Arya, A. (2021). ENERGY TRANSITION: EVOLUTION OR REVOLUTION? Retrieved from https://partners.wsj.com/ceraweek/connection/energy-transition-evolution-revolution/

Asmu'i, & Fitriati, R. (2014). Applying interactive planning on leadership in the organization: the case of transforming public transport services in Banjarmasin. *Procedia-social and behavioral sciences, 115*, 283-295.

Azam, M. (2020). Energy and economic growth in developing Asian economies. *Journal of the Asia Pacific Economy, 25*(3), 447-471.

Bagozzi, R. P., Yi, Y., & Phillips, L. W. (1991). Assessing construct validity in organizational research. *Administrative science quarterly*, 421-458.

Ballew, M. T., Goldberg, M. H., Rosenthal, S. A., Gustafson, A., & Leiserowitz, A. (2019). Systems thinking as a pathway to global warming beliefs and attitudes through an ecological worldview. *Proceedings of the National Academy of Sciences, 116*(17), 8214-8219.

Banathy, B. H. (2009). Designing Social Systems. *Systems Science and Cybernetics-Volume II*, 105.

Banathy, B. H., & Jenlink, P. M. (2005). *Dialogue as a means of collective communication*: Springer.

Betsill, M., & Stevis, D. (2016). Colorado's move to the New Energy Economy offers lessons on the challenges facing the US transition away from coal towards renewables. *Impact of American Politics & Policy Blog*.

Bloomfield, D., & Ben Reilly, B. (1998). Characteristics of Deep-rooted Conflict. In *Analysing Deep-rooted Conflict* (pp. 9-28): International IDEA.
Bond, P. (2023). Growing Divides between Establishment and Climate Justice Proponents: A View from the Extremes of South Africa. *Perspectives on Global Development and Technology, 21*(5-6), 360-381.
Bouricius, T., & Schecter, D. (2013). An idealized design for the legislative branch of government. *Systems Thinking World Journal: Reflection in Action, 2*(1).
Brady, S. R. (2015). Utilizing and adapting the Delphi method for use in qualitative research. *International journal of qualitative methods, 14*(5), 1609406915621381.
Brockman, J. (2012). *This will make you smarter*: Random House.
Bryman, A. (2016). *Social research methods*: Oxford university press.
Buchanan, J., & Jones, M. (2010). The Efficacy of utilising NVivo for interview data from the electronic gaming industry in two jurisdictions| Macquarie University ResearchOnline.
Buchanan, J., & Jones, M. L. (2010). The efficacy of utilising Nvivo for interview data from the electronic gaming industry in two jurisdictions.
Burton, J. W. (1987). Resolving deep-rooted conflict: A handbook. *(No Title)*.
Business Tech Africa. (2024). Preliminary View of the Draft Integrated Resource Plan (IRP) 2023. Retrieved from https://www.businesstechafrica.co.za/energy/2024/01/30/preliminary-view-of-the-draft-integrated-resource-plan-irp-2023/
Cabrera, D. (2006). Systems Thinking, Cornell University. In: Doctoral Dissertation.
Carvajal, R. (1992). Operations research (OR), management science (MS), systems science, and Russell Ackoff: The development of two paradigms. *Systems practice, 5*(3), 291-318.
Chapman, A. J., McLellan, B. C., & Tezuka, T. (2018). Prioritizing mitigation efforts considering co-benefits, equity and energy justice: Fossil fuel to renewable energy transition pathways. *Applied Energy, 219*, 187-198.
Chowdhury, R. (2015). Using interactive planning to create a child protection framework in an NGO setting. *Systemic Practice and Action Research, 28*(6), 547-574.
Church, J. A., White, N. J., Aarup, T., Wilson, W. S., Woodworth, P. L., Domingues, C. M., . . . Lambeck, K. (2008). Understanding global sea levels: past, present and future. *Sustainability Science, 3*(1), 9-22.
Climate Action Tracker. (2023). South Africa: Country Summary. Retrieved from https://greencape.co.za/assets/SAREM-Draft-March-2022.pdf
Collins English Dictionary. (2019). Collins English dictionary and thesaurus. In: Harper Collins, Glasgow.
Cooper, I. (2015). Zuma, Malema and the provinces: factional conflict within the African National Congress. *Transformation: Critical Perspectives on Southern Africa, 87*(1), 151-174.
Creamer, T. (2019). South Africa's energy transition won't be 'just' in absence of inclusive social dialogue. *Latest News*. Retrieved from https://www.miningweekly.com/article/south-africas-energy-transition-wont-be-just-in-absence-of-inclusive-social-dialogue-2019-05-07
Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.
Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological bulletin, 52*(4), 281.
da Costa Junior, J., Diehl, J. C., & Snelders, D. (2019). A framework for a systems design approach to complex societal problems. *Design Science, 5*.
da Costa Júnior, J., Diehl, J. C., Snelders, D., & Secomandi, F. (2020). RESUMO TESE: A SYSTEMS DESIGN APPROACH TO SUSTAINABLE DEVELOPMENT: EMBRACING THE COMPLEXITY OF ENERGY CHALLENGES IN LOW-INCOME MARKETS. *Mix Sustentavel, 6*(1), 175-180.

Daily Investor. (2023). Government Was Warned About Energy Crisis. Retrieved from https://dailyinvestor.com/energy/28956/government-was-warned-about-energy-crisis/
Dalkey, N. C. (1967). *Delphi*. Retrieved from
Delbecq, A. L., Van de Ven, A. H., & Gustafson, D. H. (1975). *Group techniques for program planning: A guide to nominal group and Delphi processes*: Scott, Foresman.
Denzin, N. K., & Lincoln, Y. S. (2011). *The Sage handbook of qualitative research*: sage.
Department of Minerals and Energy. (2023). Integrated Resource Plan – December 2023. Retrieved from https://www.dmre.gov.za/Portals/0/Energy_Website/IRP/2023/IRP-2023-for-Public-Comments-User-friendly.pdf
Drever, E. (1995). *Using Semi-Structured Interviews in Small-Scale Research. A Teacher's Guide*: ERIC.
Energy Group. (2024). An Overview of South Africa's IRP 2023. Retrieved from https://engp.co.za/an-overview-of-south-africas-irp-2023/#:~:text=This%20article%20analysed%20the%20differences%20between%20the%20IRP,between%20the%20two%20versions%20and%20the%20implications%20thereof.
Engineering News. (2024). Conclusions in Opaque IRP 2023 are 'Incorrect and Economically Damaging'. Retrieved from https://www.engineeringnews.co.za/article/conclusions-in-opaque-irp-2023-are-incorrect-and-economically-damaging-2024-03-19
Evans, J. (2025). 'Watershed moment' – advanced attribution study confirms climate change intensified Durban's deadly 2022 floods. Retrieved from https://www.dailymaverick.co.za/article/2025-07-29-watershed-moment-advanced-attribution-study-confirms-climate-change-intensified-durbans-deadly-2022-floods/. from Daily Maverick https://www.dailymaverick.co.za/article/2025-07-29-watershed-moment-advanced-attribution-study-confirms-climate-change-intensified-durbans-deadly-2022-floods/
Fig, D. (2012). Fracking and the democratic deficit in South Africa. *Transnational Institute*.
Fitriati, R. (2014). Applying interactive planning on leadership in the organization: the case of transforming public transport services in Banjarmasin. *Procedia-social and behavioral sciences, 115*, 283-295.
Flood, R. L. (1995). Total systems intervention (TSI): A reconstitution. *Journal of the operational research society, 46*(2), 174-191.
Fokkens, A. M. (2011). Idealised redesign: the South African Military Academy by the year 2030. *Unpublished M MPil Thesis, Stellenbosch University*.
Fouquet, R., & Pearson, P. J. (2012). Past and prospective energy transitions: Insights from history. In: Elsevier.
Friedlingstein, P., Jones, M. W., O'sullivan, M., Andrew, R. M., Hauck, J., Peters, G. P., . . . Quéré, C. L. (2019). Global carbon budget 2019. *Earth System Science Data, 11*(4), 1783-1838.
Friedman, B. D., & Neumann Allen, K. (2014). Systems Theory. In J. R. Brandell (Ed.), *Essentials of Clinial Social Work* (pp. 3-20). California: Sage Publishing.
Frooman, J. (1999). Stakeholder influence strategies. *Academy of Management review, 24*(2), 191-205.
Fund for Peace. (2023). Country Dashboard - South Africa: Fragile States Index. Retrieved from https://fragilestatesindex.org/country-data/. https://fragilestatesindex.org/country-data/
García-García, P., Carpintero, Ó., & Buendía, L. (2020). Just energy transitions to low carbon economies: A review of the concept and its effects on labour and income. *Energy Research & Social Science, 70*, 101664. doi:10.1016/j.erss.2020.101664
Gatticchi, G. (2020). Energy Transition Threatens 120,000 South African Coal Jobs. Retrieved from https://www.bloomberg.com/news/articles/2020-11-04/renewable-energy-drive-threatens-120-000-south-african-jobs

Gharajedaghi, J. (2004). Systems Methodology A Holistic Language of Interaction And Design Seeing Through Chaos and Understanding Complexities 1.
Gharajedaghi, J., & Ackoff, R. L. (1986). *Prologue to national development planning*: Greenwood Press.
Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The qualitative report, 8*(4), 597-607.
Goulding, C. (1998). Grounded theory: the missing methodology on the interpretivist agenda. *Qualitative Market Research: An International Journal*.
Government of South Africa. (2022). *Africa' is Just EnergyTtransition Investment Plan (JET IP) – for the initial period 2023 to 2027*. Pretoria, South Africa: Government of South Africa Retrieved from https://www.thepresidency.gov.za/content/south-africa%27s-just-energy-transition-investment-plan-jet-ip-2023-2027
Government of the Republic of South Africa. (2011). COP Background. Retrieved from https://www.energy.gov.za/cop%2017/default.html#:~:text=South%20Africa%20is%20a%20party%20to%20both%20the,discussions%20of%20the%20UNFCCC%20and%20its%20Kyoto%20Protocol.
Government of the Republic of South Africa. (2019). Integrated Resource Plan (2019). Retrieved from http://www.energy.gov.za/files/docs/IRP%202019.pdf
Government of the Republic of South Africa, & United Nations Development Programme. (2022). *South Africa National Human Development Report 2022: Harnessing the Employability of South Africa's Youth*. Retrieved from Pretoria, South Africa: https://www.undp.org/south-africa/publications/south-africa-national-human-development-report-2022
Greencape. (2022). South African Renewable Energy Masterplan. Retrieved from https://greencape.co.za/assets/SAREM-Draft-March-2022.pdf
Gründinger, W. (2017). *Drivers of Energy Transition*: Springer.
Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research, 2*(163-194), 105.
Gunaydin, H. M. (2006). The Delphi method. *Optimization Group, accessed at http://www. iyte. edu. tr/~ muratgunaydin/delphi. htm, 16*.
Häfele, W., & Sassin, W. (1977). The global energy system. *Annual Review of Energy, 2*(1), 1-30.
Halsey, R. (2017). To build an equitable energy future we need to put differences aside. Retrieved from https://www.dailymaverick.co.za/opinionista/2017-10-20-to-build-an-equitable-energy-future-we-need-to-put-differences-aside/
Harari, Y. N. (2014). *Sapiens: A brief history of humankind*: Random House.
Healy, N., & Barry, J. (2017). Politicizing energy justice and energy system transitions: Fossil fuel divestment and a "just transition". *Energy policy, 108*, 451-459.
Helmenstine, A. M., Ph.D. (2020). 10 Types of Energy and Examples. Retrieved from https://www.thoughtco.com/main-energy-forms-and-examples-609254
Hicks, N. (1983). Energy Is the Capacity to Do Work--Or Is It? *Physics teacher, 21*(8), 529-530.
Hoel, M., & Kverndokk, S. (1996). Depletion of fossil fuels and the impacts of global warming. *Resource and energy economics, 18*(2), 115-136.
Hoffman, K. C., & Wood, D. O. (1975). Energy system modeling and forecasting.
Hofstede, G. (2011). Dimensionalizing cultures: The Hofstede model in context. *Online readings in psychology and culture, 2*(1), 8.
Horowitz, D. L. (2023). *A democratic South Africa?: Constitutional engineering in a divided society* (Vol. 46): Univ of California Press.
Hugh-Jones, S., & Gibson, S. (2012). Collecting your data. *Doing your qualitative psychology project*, 101-126.
Human Sciences Research Council. (2025). A fair way to go: What do South Africans think of climate change and the transition to clean energy? *Human Sciences Research Council,*. Retrieved from https://hsrc.ac.za/news/climate-change-environment-and-

sustainability/a-fair-way-to-go-what-do-south-africans-think-of-climate-change-and-the-transition-to-clean-energy/#:~:text=In%20South%20Africa%2C%20concerns%20about,banner%20of%20a%20Just%20Transition.
Igamba, J. (2023). Climate Change In South Africa: 21 Stunning Facts About South Africa's Climate Breakdown. Retrieved from https://www.greenpeace.org/africa/en/blog/54171/climate-change-in-south-africa-21-stunning-facts-about-south-africas-climate-breakdown/#:~:text=The%20effects%20of%20climate%20change,to%20be%20a%20critical%20challenge.
Institute for Economic Justice. (2021). Sarem: Challenging Privatisation, Centring Public Ownership and Decent Work. *Institute for Economic Justice,*. Retrieved from https://iej.org.za/sarem-challenging-privatisation-centring-public-ownership-and-decent-work/
Institute for Economics & Peace. (2023). Global Peace Index 2023. *Global Peace Index*. Retrieved from https://www.economicsandpeace.org/wp-content/uploads/2023/06/GPI-2023-Web.pdf
International Bank for the construction and Development. (2023). *Pathways for a Just Urban Transition in South Africa*. Retrieved from https://csp.treasury.gov.za/DocumentsELP/Pathways%20for%20a%20Just%20Urban%20Transition%20in%20South%20Africa.pdf
International Institute for Sustainable Development. (2025). South Africa's Just Energy Transition Plans Miss the Mark Without Communities at the Centre, New Study Finds. Retrieved from https://www.iisd.org/articles/press-release/south-africa-just-energy-transition-miss-mark-without-communities#:~:text=New%20research%20finds%20South%20Africa%E2%80%99s%20plans%20for%20a,local%20realities%20and%20built%20on%20long-term%2C%20trust-based%20engagement.
Jackson, M. C. (1982). The nature of soft systems thinking: The work of Churchman, Ackoff and Checkland. *Journal of applied systems analysis, 9*(1), 17-29.
Jackson, M. C. (1990). Russell Ackoff's Jerusalem. *Systems practice, 3*(2), 177-182.
Jackson, M. C. (1991). The origins and nature of critical systems thinking. *Systems practice, 4*(2), 131-149.
Jackson, M. C., & Keys, P. (1984). Towards a system of systems methodologies. *Journal of the operational research society, 35*(6), 473-486.
Jaglin, S., & Dubresson, A. (2016). *ESKOM: electricity and technopolitics in South Africa*: Juta and Company (Pty) Ltd.
Johnson, R. B. (1997). Examining the validity structure of qualitative research. *Education, 118*(2), 282.
Jones, J., & Hunter, D. (1995). Qualitative Research: Consensus methods for medical and health services research. *BMJ, 311*(7001), 376-380. doi:10.1136/bmj.311.7001.376
Kapoulas, A., & Mitic, M. (2012). Understanding challenges of qualitative research: Rhetorical issues and reality traps. *Qualitative Market Research: An International Journal*.
Kelman, H. C. (2010). Conflict resolution and reconciliation: A social-psychological perspective on ending violent conflict between identity groups. *Landscapes of Violence, 1*(1), 5.
Kemp, R., Rotmans, J., & Loorbach, D. (2007). Assessing the Dutch energy transition policy: how does it deal with dilemmas of managing transitions? *Journal of Environmental Policy & Planning, 9*(3-4), 315-331.
Kern, F., & Smith, A. (2008). Restructuring energy systems for sustainability? Energy transition policy in the Netherlands. *Energy policy, 36*(11), 4093-4103. doi:10.1016/j.enpol.2008.06.018

Kgaditsi, T. (2024). Media Statement: An Additional Two Grid-scale IPP Battery Energy Storage Projects in South Africa Reach Commercial Close [Press release]. Retrieved from https://www.dmre.gov.za/news-room/post/2744/media-statement-an-additional-two-grid-scale-ipp-battery-energy-storage-projects-in-south-africa-reach-commercial-close
Kmon, M. K. (2016). *Systems Thinking in the Forest Service: A Framework to Guide Practical Application for Social-Ecological Management in the Enterprise Program.* Portland State University,
Konkarikoski, K., Ritala, R., & Ihalainen, H. (2010). *Practical systems thinking.* Paper presented at the Journal of Physics: Conference Series.
Kuzmanić, M. (2009). Validity in qualitative research: Interview and the appearance of the truth through dialogue. *Horizons of Psychology, 18*(2), 39-50.
Larson, K. (2021). Energy transition: new maps needed: How quickly can we really move a $100-trillion economy to a sustainable energy mix? Retrieved from https://www.controlglobal.com/articles/2021/energy-transition-new-maps-needed/
Leach, G. (1992). The energy transition. *Energy policy, 20*(2), 116-123.
Lilienfeld, R. (1975). Systems theory as an ideology. *Social Research*, 637-660.
Lincoln, Y. S., & Guba, E. G. (1985). Naturalistic inquiry (vol. 75). In: Sage Thousand Oaks, CA.
Lincoln, Y. S., & Guba, E. G. (1986). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New directions for program evaluation, 1986*(30), 73-84.
Linstone, H. A., & Turoff, M. (1975). *The delphi method*: Addison-Wesley Reading, MA.
Loh, J., & Wackernagel, M. (2004). Living planet report 2004. In: Gland, Switzerland: WWF.
Lopez, V., & Whitehead, D. (2013). Sampling data and data collection in qualitative research. *Nursing & midwifery research: Methods and appraisal for evidence-based practice, 123*, 140.
Lumbo, D. A. (2007). Applications of interactive planning methodology.
Makaula, L. (2025). The current trajectory of the just energy transition risks deepening inequalities. *Opinion.* Retrieved from https://mg.co.za/thought-leader/opinion/2025-07-02-the-current-trajectory-of-the-just-energy-transition-risks-deepening-inequalities/
Malterud, K. (2001). Qualitative research: standards, challenges, and guidelines. *The lancet, 358*(9280), 483-488.
Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research policy, 41*(6), 955-967.
Marshall, C., & Rossman, G. B. (2014). *Designing qualitative research*: Sage publications.
Martin, B., & Ward, M. (2020). Supporting Just Energy Transitions in South Africa. Retrieved from https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledge-documents/supporting_just_transitions_south_africa_mindmap.pdf
Mashilo, M. T., & Kgobe, F. K. L. (2023). Examination of the Performance of the Selected State-Owned Entity in South Africa: Issues and Challenges surrounding Eskom. *Social Sciences and Education Research Review, 10*(2), 101-110.
Mathe, T. (2019). Gwede keeps options open despite anti-fracking ruling. Retrieved from https://mg.co.za/article/2019-07-12-00-gwede-keeps-options-open-despite-anti-fracking-ruling/
Mattessich, R. (1982). The systems approach: Its variety of aspects. *Journal of the American Society for Information Science, 33*(6), 383-394.
Mauger, R., & Barnard, M. (2018). Addressing fragmentation in the South African renewable energy governance effort-lessons to be learnt from France. *Journal of Energy in Southern Africa, 29*(1), 1-10.
Maxwell, J. (1992). Understanding and Validity in Qualitative Research. *Harvard Educational Review, 62*(3), 279-301. doi:10.17763/haer.62.3.8323320856251826
McCauley, D., & Heffron, R. (2018). Just transition: Integrating climate, energy and environmental justice. *Energy policy, 119*, 1-7.

McCauley, D., Ramasar, V., Heffron, R. J., Sovacool, B. K., Mebratu, D., & Mundaca, L. (2019). Energy justice in the transition to low carbon energy systems: Exploring key themes in interdisciplinary research. In: Elsevier.
Mickalide, A. (1997). Threats to measurement validity in self reported data can be overcome. *Injury Prevention, 3*(1), 7.
Miles, M. B., Huberman, A. M., & Saldaña, J. (2018). *Qualitative data analysis: A methods sourcebook*: Sage publications.
Mingers, J., & White, L. (2010). A review of the recent contribution of systems thinking to operational research and management science. *European journal of operational research, 207*(3), 1147-1161.
Mirzania, P., Gordon, J. A., Balta-Ozkan, N., Sayan, R. C., & Marais, L. (2023). Barriers to powering past coal: Implications for a just energy transition in South Africa. *Energy Research & Social Science, 101*, 103122.
Mohlakoana, N., Wolpe, P., & David, A. (2023). Unbundling Eskom: How would a new distribution system impact on energy poverty. *AFD Research Papers*(269), 1-46.
Moolman, S. (2024). 2022 update: Eskom tariff increases vs inflation since 1988 (with projections to 2024). Retrieved from https://poweroptimal.com/2021-update-eskom-tariff-increases-vs-inflation-since-1988/
Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International journal of qualitative methods, 1*(2), 13-22.
Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2008). Verification strategies for establishing reliability and validity in qualitative research. *International journal of qualitative methods, 1*(2), 13-22.
Myhrvold, N. P., & Caldeira, K. (2012). Greenhouse gases, climate change and the transition from coal to low-carbon electricity. *Environmental Research Letters, 7*(1), 014019.
National Planning Commission. (2013). National development plan vision 2030.
Ngulube, P. (2019). *Handbook of research on connecting research methods for information science research*: IGI Global.
NOAA National Centers for Environmental Information. (2023a). Climate at a Glance: Global Time Series. Retrieved from https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series. Retrieved June 2023 https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series
NOAA National Centers for Environmental Information. (2023b, July 2023). Global and Hemispheric Anomalies from 1850 to 2023 – Africa Land Only. *Global Time Series*. Retrieved from https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series/africa/land/all/6/1850-2023?trend=true&trend_base=10&begtrendyear=1850&endtrendyear=2023&filter=true&filterType=binomial
Now Media. (2019). Ensuring a just energy transition for South Africa. Retrieved from https://www.energize.co.za/ensuring-a-just-energy-transition-for-south-africa/
NTCSA. (2024). NERSA Formally Publishes Licences For New Grid Company. Retrieved from https://www.ntcsa.co.za/nersa-formally-publishes-licences-for-new-grid-company/
O'Connor, P. (2010). Energy transitions.
Oirere, S. (2017). Refining: Uncertainty grips South Africa's Clean Fuels Program. Retrieved from https://www.hydrocarbonprocessing.com/magazine/2017/april-2017/columns/refining-uncertainty-grips-south-africa-s-clean-fuels-program
Oliga, J. C. (1988). Methodological foundations of systems methodologies. *Systems practice, 1*(1), 87-112.
Onwuegbuzie, A. J., & Johnson, R. B. (2006). The validity issue in mixed research. *Research in the Schools, 13*(1), 48-63.

Orb, A., Eisenhauer, L., & Wynaden, D. (2001). Ethics in qualitative research. *Journal of nursing scholarship, 33*(1), 93-96.
Øvergaard, S. (2008). Issue paper: Definition of primary and secondary energy. *Statistics Norway, Oslo.*
Päivärinta, T., Pekkola, S., & Moe, C. (2011). *Grounding Theory from Delphi Studies* (Vol. 3).
Pandey, S. C., & Patnaik, S. (2014). Establishing reliability and validity in qualitative inquiry: A critical examination. *Jharkhand journal of development and management studies, 12*(1), 5743-5753.
Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health services research, 34*(5 Pt 2), 1189.
Pellegrini-Masini, G., Pirni, A., Maran, S., & Klöckner, C. A. (2020). Delivering a timely and Just Energy Transition : Which policy research priorities? *Environmental Policy and Governance, 30*(6), 293-305. doi:10.1002/eet.1892
Pickering, T. D. (2006). *Redesigning Public School Systems: A Qualitative Study Into The Potential For Utilizing Idealized Design To Create The" Next Generation" Of American Public Schools.* Drake University,
Piggot, G., Boyland, M., Down, A., & Torre, A. R. (2019). Realizing a just and equitable transition away from fossil fuels. *Development, 2016*, 202033.
Presidential Climate Commission. (2023). Media Alert: PCC Welcomes the South African Renewable Energy Master Plan. Retrieved from https://www.climatecommission.org.za/news-and-insights/media-alert-sarem
Preuss, H. (Producer). (2024). SA must implement Renewable Energy Masterplan urgently, says Gaylor Montmasson-Clair. *Business Report, Economy*. Retrieved from https://www.iol.co.za/business-report/economy/sa-must-implement-renewable-energy-masterplan-urgently-says-gaylor-montmasson-clair-07ca2cca-aa97-47ba-a263-c7b81fad86a6#google_vignette
Project 90 by 2030. (2020a). Just Energy Transition Roundtable Discussion. Retrieved from https://90by2030.org.za/2018/08/16/just-energy-transition-roundtable-discussion/
Project 90 by 2030. (2020b). Just Energy Transition: SA's need for more renewable energy. Retrieved from https://90by2030.org.za/2020/02/25/just-energy-transition-sas-need-for-more-renewable-energy/
Radhakrishnan, S. (2021). The Smart Energy Transition A Systems Thinking Perspective.
Ramsarup, P., Hepplethwaite, V., Poulton, W. I., & Jenkin, N. (2024). Skills for the just energy transition: Is skills research 'on track'? *South African Journal of Science, 120*(9/10).
Ranasinghe, R., Callaghan, D., & Stive, M. J. (2012). Estimating coastal recession due to sea level rise: beyond the Bruun rule. *Climatic Change, 110*(3-4), 561-574.
Reynolds, J., Naiga, S., Taaka, L., & Chandler, C. I. (2013). Quality Assessment & Strengthening of Qualitative Research.
Rhodes, C. J. (2016). The 2015 Paris climate change conference: COP21. *Science progress, 99*(1), 97-104.
Roberts, D. (2016). A global roadmap for climate change action: From COP17 in Durban to COP21 in Paris. *South African Journal of Science, 112*(5-6), 1-3.
Rocco, T. S., & Plakhotnik, M. S. (2009). Literature reviews, conceptual frameworks, and theoretical frameworks: Terms, functions, and distinctions. *Human Resource Development Review, 8*(1), 120-130.
SASSCAL. (2020). Open Data and Information on Climate Change and Adapted Land Management in Southern Africa. Retrieved from http://data.sasscal.org/metadata/view.php?view=doc_documents&id=6729
Saunders, M. N., & Lewis, P. (2012). *Doing research in business & management: An essential guide to planning your project*: Pearson.

Schmuckler, M. A. (2001). What is ecological validity? A dimensional analysis. *Infancy, 2*(4), 419-436.
School Energy & Environment. (2021). The Energy System. *The Man and Energy*. Retrieved from http://www.eniscuola.net/wp-content/uploads/2011/02/pdf_energy_system_1.pdf
Simane, C., & Ngam, R. (2024). The Killer Heatwaves at South Africa's Doorstep. Retrieved from https://www.rosalux.de/en/news/id/52311/the-killer-heatwaves-at-south-africas-doorstep
Sinn, J. S. (1998). A comparison of interactive planning and soft systems methodology: enhancing the complementarist position. *Systemic Practice and Action Research, 11*(4), 435-453.
Skulmoski, G. J., Hartman, F. T., & Krahn, J. (2007). The Delphi method for graduate research. *Journal of Information Technology Education: Research, 6*(1), 1-21.
Smil, V. (2004). World history and energy. *Encyclopedia of energy, 6*, 549-561.
Smit, S. (2023). Power Struggle Threatens Just Energy Transition. *Opinion*. Retrieved from https://mg.co.za/thoughtleader/2023-11-21-power-struggle-threatens-just-energy-transition/
Smith, C. (2017). Dirt in the tank – new fuel regulations unworkable and highly suspect. Retrieved from https://www.biznews.com/sustainable-business/2017/01/12/new-fuel-regulations-unworkable
Solomon, B. D., & Krishna, K. (2011). The coming sustainable energy transition: History, strategies, and outlook. *Energy policy, 39*(11), 7422-7431.
South African Government. (2024). Launch of the Independent Transmission Projects (ITP) Market Sounding Exercise. Retrieved from https://www.gov.za/news/media-statements/treasury-launch-independent-transmission-projects-11-dec-2024
Stellenbosch University Library Guides. (2023). Data Collection/Generation. Retrieved from https://libguides.sun.ac.za/c.php?g=1171905&p=9014105
Stephens, J. C. (2014). Time to stop investing in carbon capture and storage and reduce government subsidies of fossil-fuels. *Wiley Interdisciplinary Reviews: Climate Change, 5*(2), 169-173. doi:10.1002/wcc.266
Stichweh, R. (2011). Systems theory. *International Encyclopedia of Political Science. New York: Sage*.
Tejeda, J., & Ferreira, S. (2014). Applying systems thinking to analyze wind energy sustainability. *Procedia Computer Science, 28*, 213-220.
Ting, M. B., & Byrne, R. (2020). Eskom and the rise of renewables: Regime-resistance, crisis and the strategy of incumbency in South Africa's electricity system. *Energy Research & Social Science, 60*, 101333.
Todd, I., & McCauley, D. (2021). Assessing policy barriers to the energy transition in South Africa. *Energy policy, 158*, 112529.
Transparency International. (2023). CPI 2022: Highlights and Insights. *Corruption Perception Index*. Retrieved from https://www.transparency.org/en/news/cpi-2022-highlights-insights-corruption-conflict
Ulrich, W. (1983). Critical heuristics of social planning: A new approach to practical philosophy.
UNFCC. (2015). Paris Agreement. Retrieved from https://unfccc.int/sites/default/files/english_paris_agreement.pdf
United Nations Development Programme. (2023). Human Development Reports: South Africa. Retrieved from https://hdr.undp.org/data-center/human-development-index#/indicies/HDI. Retrieved July 2023, from United Nations https://hdr.undp.org/data-center/human-development-index#/indicies/HDI
Vogt, W. P., Gardner, D. C., & Haeffele, L. M. (2012). *When to use what research design*: Guilford Press.
Von Bertalanffy, L. (1973). The meaning of general system theory. *General system theory: Foundations, development, applications, 30*, 53.

Walker, C. (2023). Regulatory transfer in transitioning economies: responses to corruption and weak state institutions. *Policy Studies, 44*(1), 26-45.
Walton, D. (2010). *Legal argumentation and evidence*: Penn State Press.
Watt Watchers of Texas. (2021). Activity: Energy Resources: Primary vs. Secondary. Retrieved from https://www.watt-watchers.com/activity/energy-resources-primary-vs-secondary/
Welsh, E. (2002). *Dealing with data: Using NVivo in the qualitative data analysis process.* Paper presented at the Forum qualitative sozialforschung/Forum: qualitative social research.
Willie, M. M. (2022). Differentiating Between Population and Target Population in Research Studies. *International Journal Of Medical Science And Clinical Research Studies, 2*(6), 521-523.
World Energy Council. (2021). What is Energy Transision? Retrieved from https://www.worldenergy.org/about-us/why-our-work-is-important
WorldOil. (2019). Energy Transition Outlook reveals crude oil demand through 2050. Retrieved from https://www.worldoil.com/news/2019/3/20/energy-transition-outlook-reveals-crude-oil-demand-through-2050
Xu, M. A., & Storr, G. B. (2012). Learning the concept of researcher as instrument in qualitative research. *Qualitative Report, 17*, 42.
Yaghmaei, F. (2003). Content validity and its estimation.
Yin, R. K. (2009). *Case study research: Design and methods* (Vol. 5): Sage.
Yin, R. K. (2017). *Case study research and applications: Design and methods*: Sage publications.
Yousuf, M. I. (2007). Using expertsopinions through Delphi technique. *Practical assessment, research, and evaluation, 12*(1), 4.

APPENDICES

APPENDIX 1.1: DATA COLLECTION INSTRUMENT(S)

Theoretical Inquiry:

During the theoretical phase of the research, the researcher sourced evidence from the Internet, with the primary objective of conduction a system analysis (i.e., determining how the South African energy system is currently configured and operates). This information will then be utilised to complete the empirical phase of the research, utilising the Delphi. The findings of this inquiry will be summarised and inserted into a document labelled **"Annexure A"**, which will be shared with the expert panellists, as part of the Delphi process.

The following framing questions will guide this part of the inquiry:

- Who are the stakeholders of the South African energy system?
- What are the various technologies that form part of the South African energy system?
- What are the political and socioeconomic features of the system?
- What is the containing environment of the system?
- How do the various parts and components of the system interact with each other; and the containing environment?

Table 5: Research Instrument for the Theoretical Phase of the Study

Empirical Phase:

QUESTION	GUIDING NOTES	RESPONDENT'S EXPERT COMMENTS
QUESTION 1		
1. System Analysis: Please consider the provided description of how the South African energy system currently operates **(Annexure A)**, particularly in respect of its political, socio-economic, and technological components, as well as the environment within which the system is contained(Russell L Ackoff, 2001). Please also note the indicated description of the system's stakeholders, as well as their interests. **Do you agree with the statements in Annexure A? Is**	The description of how the south African energy system currently operates and is configured is laid out in the attached **Annexure A**. The description identifies the political, socio-economic, and technological components of the energy system. It also contains an explanation of the way the components of the system interact with each other, which in turn shapes the character of the energy system. Finally, the description explains the nature of the	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your computer email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a video-conference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be

there anything that you with to add, or correct?	environment within which the system is contained, including the way the system interacts within the containing environment. .	reached at zwelihle_mkhize@me.com
QUESTION 2		
2. Taking into account, your views on how the South African energy system currently operates, particularly in respect of its political, socio-economic, and technological components, as well as the environment in which the energy system is contained, **how would you describe the ideal Just Energy Transition in South Africa? How should such an energy transition be designed; and implemented?** **What, in your view, is the idealised energy future system, that South Africa needs to strive for, in replacement of the current one?** Please note that this is not necessarily the energy future system that is most likely to transpire, based on current predictions and efforts. Instead, this is the future energy system that you would ideally wish to see created if you were free to do so. **This idealised future system needs to be:** • **technologically feasible; and** • **operationally viable.**	Please answer freely. However, your answer may consider the main considerations under the Just Energy Transition, including but not limited to the following: • An energy transition needs to be fundamental and system-wide, operating on an entire configuration of the system(Smil, 2004). It has an impact on the way sources of energy are interconnected and consumed(Smil, 2004). • It is not just a change from one energy system to another, but instead, it should Further, the change should operate on "patterns of energy use in a society, potentially affecting resources, carriers, converters, and services'" (Connor, 2010, p. 2). • To help energy planners make better decisions, Pellegrini-Masini *et al.* (2020) developed a comprehensive energy justice framework, which integrates distributive and procedural justice considerations. Pellegrini-Masini *et al.* (2020)'s energy justice framework proposes that an energy decision is socially and politically sound if it considers energy availability, affordability, due process, good governance, sustainability, intergenerational equity, intragenerational equity, and responsibility. Considerations under each of the components Pellegrini-Masini *et al.* (2020)'s	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your computer email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a video-conference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com

	energy justice framework could include several areas of focus, such as the avoidance of stranded assets and any adverse impact on workers in legacy or current energy systems(Roberts, 2016).	
3. **Obstruction Analysis:** Having considered the above, how would you describe the characteristics and properties of the South African energy system that hinder the successful invoking of the JET, as well as the system's progress towards its idealised future?	Please answer freely. However, reference will need to please be had to the components, interactions and the containing environment contained above. Reference should also be had to the stakeholders described, as well as their interests. How do these factors obstruct the effective implementation of the just energy transition; and the energy system's progress to the idealised future that you have described?	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a video-conference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com
4. **Reference Projections:** Please consider the methods of energy distribution and consumption in South Africa, examples of which are listed in **Annexure A**. Also, please consider the description of the predicted future environment of the energy system if no changes are made to current plans and efforts. Do you agree with this list of energy consumption and distribution methods, as well as the description of the predicted future environment? Is there anything that you wish to add or correct, particularly, given your views in Sections 1 and 2 above? **Now, assuming the existing methods of energy distribution and consumption, as well as the predicted future environment remain**	Please give consideration to not only the methods of energy distribution and consumption in South Africa, but also, the system's stakeholders and their interests, the political, socio-economic, and technological components of the energy system, as well as the containing environment (You may revisit the points above to refresh the views expressed in this regard).	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a video-conference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com

unchanged, what do you think is the likely (less than ideal) future of the South African energy system(Russell L Ackoff, 2001)?		
5. **Reference scenario:** How do you think that the South African energy system would destroy itself if the assumptions above were true(Russell L Ackoff, 2001)? In other words, if no changes are made to the existing methods of energy distribution and consumption, as well as the predicted future environment, how would the energy system destroy itself, or be destroyed?	The assumptions referred to are as they pertain to the list of energy consumption and distribution methods (Please refer to section 4 above).	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a video-conference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com

Table 6: Research Instrument for the Empirical Phase of the Study

APPENDIX 2.1: SHORT BIO OF THE RESEARCHER

The researcher is an attorney in the commercial, energy and infrastructure fields. Having commenced his career in legal practice, the researcher joined an international petrochemical company, as an in-house legal advisor. Thereafter, he moved to a commercial management role and project development role, before going on an international assignment to complete a large energy complex build.

In all these roles, the researcher became familiar with various reasoning approaches, given the nature of legal work. The qualitative, inductive approach became a natural preference of the researcher, although this is not to suggest that deductive reasoning is not within his understanding.

The researcher is now employed in the project development division of a developmental finance institution, the Development Bank of Southern Africa, Limited (the DBSA). While the DBSA is government-owned, it has operational independence in pursuance of its statutory mandate (i.e., public infrastructure finance in support of the SADC region's developmental targets). Energy infrastructure finance is one of DBSA's areas of focus. In line with this focus, the DBSA has become a thought leader in the just energy transition field. The bank is enjoined by its statutory mandate to work in furtherance of government's obligations under the Paris Agreement, including the obligations pertaining to South Africa's Nationally Determined Contribution (NDC); and Sustainable Development Goal (SDGs). To this end, the DBSA has a climate and environmental finance unit, which works with a wide range of local and international stakeholders in energy, including UNICEF, ICLEI (Local Governments for Sustainability), and DFC (International Development Finance Club). Most importantly, the DBSA is a regional

partner for GCF and most importantly, is a regional partner for the GEF (Global Environmental Facility) and manages Green Climate Fund distributions flowing through the region.
The researcher also relied on the above professional experience and network.

APPENDIX 2.2: ETHICS DOCUMENTATION

The researcher subscribes to the following code of practice for ethical standards, as proposed by Oxford Brooks University (2010) in Saunders and Lewis (2012):

- No research should cause harm, and preferably, it should benefit participants.
- Potential participants normally have the right to receive clearly communicated information from the researcher in advance.
- Participants should be free from coercion of any kind and should not be pressured to participate in a study.
- Participants in a research study have the right to give their informed consent before participating.
- Where third parties are affected by the research, informal consent should be obtained.
- The consent of vulnerable participants (e.g., children) or their representatives' assent should be actively sought by researchers.
- Honesty should be central to the relationship between researcher, participant, and institutional representatives.
- Participants' confidentiality and anonymity should be maintained.
- The collection and storage of research data by researchers must comply with the Protection of Information Act 4 of 2013.
- Researchers have a duty to disseminate their research findings to all appropriate parties.

Table 7: Code of Practice for Ethical Standards Involving Human Participants. Adapted from Oxford Brooks University (2010) in Saunders and Lewis (2012)

APPENDIX 3.1: FUNDING

The proposed study is self-funded by the researcher, in partial completion partial fulfilment for the degree of Master of Business Administration to the Faculty of Commerce, Law, and Management, University of the Witwatersrand.
The researcher's employers and intended panellists have no financial interest in the proposed study; and have not expressed a desire to influence the study in any way.
The researcher undertakes the study freely and without any form of duress. The study is entirely conceptualised by the researcher, based on his own experiences and areas of professional interest.

APPENDIX 4.1: INVITATION PACK

WITS UNIVERSITY | Wits Business School *Sculpting global leaders*

To: [▪]

By Email:

[▪]

Dear [▪],

INVITATION TO PARTICIPATE IN QUALITATIVE RESEARCH ON (i) THE JUST ENERGY TRANSITION AND (ii) THE INTERACTIVE PLANNING OF AN IDEALISED ENERGY FUTURE

1. I hereby request your participation in qualitative research on the topic of **the Just Energy Transition in South Africa (JET)**. The objective of the research is to facilitate the interactive planning of an idealised energy future and the implementation of the JET. I am the prospective researcher.

2. For the purposes of the interactive planning process described below, I will be fulfilling a facilitative role.

3. With the help of the Wits Business School (WBS), I have designed a compelling research topic, which will provide a foundation for your structured collaboration with other experts in the energy field. The study will solicit your expert input in the co-creation of an idealised energy future for South Africa. Although co-creation and cross-learning are at the core of this proposed work, the WBS ethics committee has approved the study on the condition that your anonymity must be guaranteed. You will therefore neither be compelled to interact directly with the other research participants, nor reveal your identity.

4. This is a groundbreaking study. I intend to rely on a problem-solving framework that has been proven to offer immense value in the management of complex problems and in the reshaping of socio-technical systems. This is achieved through collaboration and the interactive planning of those most impacted by the outcome of the planning process.

5. "Wicked problems" are incredibly difficult to define. They often involve multiple stakeholders, who typically have competing interests. Adding to the complexity of "wicked problems" is their tendency to have several seemingly viable solutions, each of

which has unintended consequences and resultant sub-problems. Identifying the most optimal path towards the implementation of the JET might be defined as one such problem – a wicked problem. The JET is as much a socio-political undertaking as it is a technical one.

6. Russel Ackoff's **"Idealised Redesign and Interactive Planning"** framework has been successfully utilised in the pursuance of reform in many complex contexts. Effective and versatile, "Idealised Redesign and Interactive Planning" is grounded in academic theory; and has earned a place in "Systems Thinking" methodologies. Despite the potency of "Idealised Redesign and Interactive Planning" as a problem-solving methodology, its use in managing energy transitions is still at its infancy, particularly in developing societies. These societies are generally viewed as being more susceptible to the effects global warming, despite their relatively smaller contribution to global carbon emissions.

7. The proposed study has real, immediate, and practical implications for South Africa, which is currently looking to meet its obligations under the Paris Agreement on Climate Change.

8. As you undoubtedly will appreciate, implementing the JET is a massive undertaking for South Africa – as it is for many other nations across the world. Energy transitions by their nature are incredibly challenging. Implementing the JET will require a trade-off between more than one alternative, and also between the unintended consequences accompanying each choice.

9. In simple terms, the success or failure of the JET will be determined by the balance of competing paradigms; one representing the proponents of the *status quo* (i.e. the "do-nothing" paradigm); and the other representing change (i.e. the "transition paradigm"). This balancing act will be driven by the energy system's stakeholders, who are the main actors in the sustainable transitions stage. The battle for influence in the transition discourse manifests in a fierce power struggle, which at times, is emotionally and politically charged. Each stakeholder group has made a bet on an envisioned energy future, with seemingly deep-rooted conflict standing in the way of a clear path towards solutions.

10. The success or failure of the JET will also be determined by the extent to which we allow factors and perspectives from outside of our immediate environment to unduly impinge

on the direction that we take, such that the energy future of the country does not reflect the shared vision of those who are most affected by our energy system (i.e. the stakeholders). We should therefore actively and interactively contribute to the planning of what we deem to be our desired energy future.

11. As **[▪]** at [▪], you are not only an incredibly accomplished expert in the field; but you are also a valuable stakeholder in South Africa's energy system. Your voice provides an important perspective in our management of the JET discourse and our efforts to understand how we might achieve a truly "just" energy transition.

12. Should you agree to participate in the study, this process would be exceedingly enriched. The study is designed to be as unintrusive as possible. A minimum of one interview is requested, preferably face-to-face or by teleconference. After the extraction of your initial views (with my assistance in a semi-structured approach), you will be afforded the opportunity to further reflect on your initial views, with the benefit of the work that I would have done to compare the views with those of others (anonymously, of course). You may then choose to augment on, or modify, your initial views. This iterative process will present cross-learning opportunities for all participants and will culminate in as near a "consensus" view as possible.

13. I do hope that the high-level description of the context and objectives of the study has managed to spark your interest, in which case I would be most pleased. Should you wish to delve deeper into what I aim to achieve, please refer to the summary attached to this letter as **"Annexure A"**. The summary contains (i) an overview of the study and methodology, (ii) details about me, the prospective researcher; (iii) details about the research supervisor, and (iv) the academic qualification to which this study will contribute.

14. **"Annexure B"** contains a set of framing questions that will guide our initial discussion. You may please familiarise yourself with these framing questions, should this be your preference. Otherwise, the questions will be revisited during our initial discussion.

15. I kindly request that you advise by email at zwelihle_mkhize@me.com , cc. 401654@students.wits.ac.za as to whether you would be willing to form a part of this exciting exercise. **Please may you then complete and return the consent form attached accompanying this letter**.

16. Should you wish to contact me by telephone, my cell phone number is 082 712 4622 (text, WhatsApp™ or iMessage™ may be the best way to contact me, although you may call if this is your preference).

I look forward to hearing from you and possibly, to work with you on this important exercise.

Yours sincerely,

Mr Zweli Mkhize

Student, Wits Business School

(Prospective Degree: MBA)

ANNEXURE A: STUDY OVERVIEW AND SUMMARY

—

RESEARCH TITLE: A Prognosis of the Application of Ackoff's Idealised Redesign and Interactive Framework for Invoking a Just Energy Transition in South Africa.

WITS BUSINESS SCHOOL FACULTY AND QUALIFICATION: Faculty of Commerce, Law and Management, Master of Business Administration (MBA).

RESEARCH GOALS AND OBJECTIVES: The study is in the form of a practical exercise, to be facilitated by the researcher. The study will produce a prognosis of the application of Russel Ackoff's Idealised Redesign and Interactive Planning Framework for invoking a Just Energy Transition in South Africa. Through this exercise, Idealised Redesign and Interactive Planning will be used to assess the architecture of the current failing energy system in South Africa **and to redesign a sustainable energy mode**, with the intent of adaptation, improvement and implementation.

A sample of carefully selected expert participants and stakeholders will be requested to offer a considered view on how the Just Energy Transition should be enacted. The process will be facilitated by the researcher, under the supervision of Dr Geoffrey Heald of the Wits Business School (WBS) and Gordon Institute of Business Science (GIBS).

ANONIMITY: The anonymity of the participants is guaranteed. However, participants may choose (but not compelled) to have their identity revealed. The study is designed to produce a collective view despite the fact that participants need not interact directly with each other.

ABOUT THE RESEARCHER:



Zwelihle (Zweli) is a commercial lawyer and business development specialist in energy, petrochemicals (upstream, midstream and downstream), infrastructure and manufacturing. Zweli was admitted as an attorney of the High Court of South Africa (RSA) in 2005, after

serving articles at a KZN top law firm. He has approximately 16 years' local and international post-qualification experience (US and SADC), spread across (i) legal practice, (ii) in-house legal advisory, (iii) commercial specialist work in among other things, energy and petrochemicals; and (iv) business development. Zweli may be reached at zwelihle_mkhize@me.com , cc 401654@students.wits.ac.za

Zweli is currently employed at the Development Bank of Southern Africa Limited (DBSA) as a legal specialist. As a development finance institution, the purpose of the DBSA is to accelerate energy access for the people of Africa and to ensure a just transition to low carbon economies. The DBSA prioritises projects with significant impact on the development of energy infrastructure. The work of the DBSA also includes the implementation and management of energy programmes, as their evaluation and monitoring. These energy infrastructure programmes include the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP), Climate Finance Facility (CFF) and the Embedded Generation Investment Programme (EGIP).

In collaboration with the World Economic Forum (WEF), supported by Accenture, on the 13 June 2024, the DBSA co-hosted the roundtable on "Mobilising investment for clean energy in South Africa." The event convened over 80 public and private sector stakeholders to drive forward South Africa's clean and Just Energy Transition. The event marked the launch of the report, "Mobilising Investment for Clean Energy in South Africa". A comprehensive analysis of the current landscape and future opportunities for clean energy investments in South Africa is offered. The report notably outlines recommendations to enhance the investment environment in the country, in the form of four key regulatory and policy actions that could help make the country a more enticing environment for clean energy capital. It goes on to propose five non-policy solutions that will be implemented by local players in the months ahead: from setting up first of a kind credit guarantee and credit facilities for Small Scale Embedded Generation (SSEG), to programmes that can improve awareness of sustainability- and transition finance instruments. **A special emphasis is also put on mutualised efforts between industry players**, with for instance the announcement of a new Clean Hydrogen Innovation Consortium as well as discussions around the power of industrial clusters in formalising transition commitments and catalysing finance.

IMPACT OF STUDY: The study has immediate practical implications for energy in South Africa. It is not intended that the study should be a mere academic (or theoretical) analysis of the subject matter, but rather that implementation should be at the core of the exercise. The very

outcome of the study will be a practical output in that participants will be requested to contribute towards an idealised redesign process, towards the implementation of the JET, as well as the co-creation of an envisioned energy system.

The research is intended to be of benefit to a broad range of stakeholders in the South African energy industry, including private sector, financiers, policymakers, influencers and lobbyists (e.g. government agencies, NGOs and Developmental Finance Institutions). Industries impacted by the energy transition would particularly benefit from a better understanding of South Africa's energy system, as they scan the competitive landscape for the strategic opportunities and imperatives that this brings. The research is also intended to give organisations a system-wide line of sight on matters to focus and report on, from an Environmental, Social and Governance (ESG) perspective. The research also has immense reference value for those seeking to extract lessons from the South African experience.

CONTEXT: Energy security in South Africa is one of the primary concerns of society. It has implications for South Africa's attempts to reach its socio-economic targets and Sustainable Development Goals (SDGs). The pursuance of energy security needs to accommodate the country's commitments to the global climate change mitigation and adaptation efforts, which find expression through the Just Energy Transition (JET). The question then arises as how the JET could be implemented in a way that best serves the South African energy system; and minimises conflict among stakeholders. The energy system cuts across many activities, including sourcing, distribution, delivery and consumption. It also includes many stakeholders, some of whom have conflicting priorities. Such a system embodies social and technical components, which constantly interact with each other, as well as with the environment containing the system. The South African energy system may therefore be understood to be a "socio-technical" system.

COMPLEXITY IN SOCIO-TECHNICAL SYSTEMS: Problems arising in the context of socio-technical systems are complex. They are often difficult to define and cannot be resolved through simple approaches ("wicked problems" and deep-rooted conflict). Systems Thinking is ideal for understanding such systems and addressing associated problems. Idealised Redesign is a specific system thinking framework, which is proposed for addressing problems arising in the context of socio-technical systems. It is premised on Interactive Planning; and involves a methodical process of co-creation, where the participants work together to redesign the relevant system to the idealised standard. In doing so, the designers of the system have to pay attention to the components of the system and ensure that the manner in which the components interact drives the system to achieve the state that is considered to be the ideal. For this reason, Idealised

Redesign and Interactive Planning require the participation of all those who would be affected by the design output.

RESEARCH METHOD: The research will take the form of one-on-one interviews between each participant and the researcher. The researcher will facilitate the process, ask guiding questions and collect responses from each participant. The responses will then be compared to, and contrasted with one another, so that the researcher can arrive at a consensus view. The participants, who will not be required to interact directly with one another, may be afforded the opportunity to reconsider their views, in the context of the consensus view. They will also be afforded the opportunity to confirm their agreement with the consensus view. The participants' identities will not, without consent, as the primary focus will be the views expressed. It may be necessary however to describe the component of the system that each participant represents (e.g. financier of renewable energy projects).

ABOUT THE RESEARCH SUPERVISOR:



As a leading academic and recognised expert in negotiation, deal making and conflict resolution, Dr Geoff Heald has over 30 years' experience, acquired through his work with universities, business schools, diverse companies, government and special interest groups. Geoff works on the interface between business, universities and society to design and present excellent research based and tailor-made negotiation skills programmes that enable clients to acquire the critical skills and knowledge necessary to achieve negotiation mastery, create value and become self-sufficient dealmakers. He offers negotiation skills programmes for business clients and society at large. He also offers consulting services to organisations and private clients. Geoff is an expert in interactive and idealised redesign and is frequently requested to offer practical assistance in facilitating solutions between stakeholders in organisations that are in crisis. Geoff's LinkedIn profile page is as follows: https://www.linkedin.com/in/dr-geoff-heald-41326027/

ANNEXURE B: FRAMING QUESTIONS

QUESTION	GUIDING NOTES	RESPONDENT'S EXPERT COMMENTS
QUESTION 1		
1. System Analysis: Please consider how the South African energy system currently operates, particularly in respect of its political, socio-economic, and technological components, as well as the environment within which the system is contained(Russell L Ackoff, 2001). Please also, note the indicated description of the system's stakeholders, as well as their interests. **Do you agree with the descriptions provided? is there anything that you with to add, or correct?** **NB: This initial description will be provided by the researcher following confirmation of your participation**	**Guiding Notes:** None.	Please use the space provided in this third column to answer or reflect on the questions posed in the first column. If the space is not sufficient, please utilise your computer email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a videoconference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com **Participant's Answer/Reflection on the Question:**
QUESTION 2		
2. Taking into account, your views on how the South African energy system currently operates, particularly in respect of its political, socio-economic, and	**Guiding Notes:** Please answer freely. However, your answer may consider the main considerations under the Just Energy Transition,	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your computer email

technological components, as well as the environment in which the energy system is contained, **Question: how would you describe the ideal Just Energy Transition in South Africa? How should such an energy transition be designed; and implemented?** **Question: What, in your view, is the idealised energy future system, that South Africa needs to strive for, in replacement of the current one?** **Please note that this is not necessarily the energy future system that is most likely to transpire, based on current predictions and efforts. Instead, this is the future energy system that you would ideally wish to see created if you were free to do so.** **This idealised future system needs to be:** • **technologically feasible;** • **operationally viable; and** • **capable of re-learning, unlearning, adaptation and improvement.**	including but not limited to the following: • An energy transition needs to be fundamental and system-wide, operating on an entire configuration of the system(Smil, 2004). It has an impact on the manner in which sources of energy are interconnected and consumed(Smil, 2004). • It is not just a change from one energy system to another, but instead, the change should operate on "patterns of energy use in a society, potentially affecting resources, carriers, converters, and services"' (Connor, 2010, p. 2). • To help energy planners make better decisions, Pellegrini-Masini *et al.* (2020)developed a comprehensive energy justice framework, which integrates distributive and procedural justice considerations. Pellegrini-Masini *et al.* (2020)'s energy justice framework proposes that an energy decision is socially and politically sound if it considers energy availability, affordability, due process, good governance, sustainability, intergenerational equity, intragenerational equity, and responsibility. Considerations under each of the components Pellegrini-Masini *et al.* (2020)'s energy justice framework could include several areas of focus, such as the avoidance of stranded	programme to complete your response. **ALTERNATIVELY**, a face-to-face or a videoconference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com **Participant's Answer/Reflection on the Question:**

	assets and any adverse impact on workers in legacy or current energy systems(Roberts, 2016).	
3. **Obstruction Analysis:** Having considered the above, **Question:** how would you describe the characteristics and properties of the South African energy system that hinder the successful invoking of the JET, as well as the system's progress towards its idealised future?	**Guiding Notes:** Please answer freely. However, reference will need to please be had to the components, interactions and the containing environment described above. Reference should also be had to the stakeholders described, as well as their interests. How do these factors obstruct the effective implementation of the just energy transition; and the energy system's progress to the idealised future that you have described?	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a videoconference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com **Participant's Answer/Reflection on the Question:**
4. **Reference Projections:** Please consider the methods of energy distribution and consumption in South Africa, examples of which are listed in **Annexure A (NB: To be furnished by the researcher following**	**Guiding Notes:** Please give consideration to not only the methods of energy distribution and consumption in South Africa, but also, the system's stakeholders and their interests, the political, socio-economic, and technological components of the energy system,	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a videoconference interview

confirmation of your participation) Also, please consider the description of the predicted future environment of the energy system if no changes are made to current plans and efforts. **Question**: Do you agree with this list of energy consumption and distribution methods, as well as the description of the predicted future environment? **Question:** Is there anything that you wish to add or correct, particularly, given your views in Sections 1 and 2 above? **Question: Now, assuming the existing methods of energy distribution and consumption, as well as the predicted future environment remain unchanged, what do you think is the likely (less than ideal) future of the South African energy system(Russell L Ackoff, 2001)?**	as well as the containing environment (You may revisit the points above to refresh the views expressed in this regard).	can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com **Participant's Answer/Reflection on the Question:**
5. **Reference scenario: Question:** How do you think that the South African energy system would destroy itself if the assumptions above were true(Russell L Ackoff, 2001)? In other words, if no changes are made to the existing methods of energy distribution and consumption, as well as the predicted future environment, how would the energy system destroy itself, or be destroyed?	The assumptions referred to are as they pertain to the list of energy consumption and distribution methods (Please refer to section 4 above).	Please use the space provided in this third column to answer the questions posed in the first column. If the space is not sufficient, please utilise your email programme to complete your response. **ALTERNATIVELY**, a face-to-face or a videoconference interview can be arranged to record your responses orally. Please indicate by email if an interview is preferred. The researcher may be reached at zwelihle_mkhize@me.com **Participant's Answer/Reflection on the Question:**

The standard informed consent notice approved by the University will be shared with the intended panellist when they are invited to participate in the study.

APPENDIX 5.1: INFORMED CONSENT

CONSENT FORM

Title of project: A Prognosis of the Application of Ackoff's Idealised Redesign and Interactive Planning Framework for Invoking a Just Energy Transition in South Africa.

Name of researcher: Zwelihle Mkhize

I, **[▪]**, agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please select the relevant options below).

I agree that my participation will remain anonymous	YES ☐ NO ☐
I agree that the researcher may use anonymous quotes in his / her research report	YES ☐ NO ☐

I agree that the interview may be audio recorded	YES ☐	NO ☐
I agree that the researcher may produce a thematic representation of my views for the purpose of comparison with the views of other participants, as part of the process of arriving at a consensus view	YES ☐	NO ☐

…… (signature) **[▪]** (name of participant)

…… (date)