Gordon Institute of Business Science
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The scaling up of renewable energy consumption in South Africa; challenges and opportunities

by

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A research proposal submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

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ABSTRACT

South Africa has experienced the worst-case scenario of load-shedding over the past few months. Energy security and sustainability are paramount to increasing economic growth and prosperity. This study explains how and why the scale-up of renewable energy can significantly help ease the problem of load-shedding while simultaneously supporting growth prospects. The divergences in extant literature are indicated in studies debating the potential of renewable energy as an alternative energy source to ease pressure on the national grid and close the divergence between electricity demand and supply. The literature demonstrates that applying a circular economic model in South Africa and explicating the scale-up of renewable energy processes and energy transition must be explored. The study employed a qualitative method to examine the phenomenon. The field dataset was collected from 13 participants through Microsoft teams. The participants were purposively selected because of their experience in the energy sector. The dataset generated from the interview of the study participants was transcribed and uploaded into Atlas ti software, where a thematic analysis was performed. The results confirm a viable potential for using renewable energy to alleviate the pressure of energy demand in South Africa; however, the study uncovered vital challenges, such as skills shortages, investment capabilities and models, infrastructure, incoherent government policies, resistance to change, and a lack of stakeholder engagement. This research contributes significantly to the existing research. It provides key stakeholders, government, and private sectors with empirical evidence on the challenges and opportunities to scale-up renewable energy. The recommendations include evaluating the developed model to validate the constructs by future scholars. This study had implications for the scholarly community and managerial implications.

KEYWORDS

Renewable energy, circular economy, South Africa, circular economy scale up, challenges and potential.

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other university. I further declare that I have obtained the necessary authorisation and consent to conduct this research.

Sizwe Ntumba **01 November 2022**

LIST OF ABBREVIATIONS AND ACRONYMS

BBBEEE: Broad Based Black Economic Empowerment

BRICS: Brazil, Russia, India, China & South Africa

Co2: Carbon Dioxide

DME: Department of Mineral & Energy

EU: European Union

GT: Green Technology

KZN: KwaZulu Natal

MW: Mega Watts

RE: Renewable Energy

RSA: Republic of South Africa

SSA: Sub Sharan Africa

TACT: Transferability, Audit, Credibility & Trust

USA: United States of America

UK: United Kingdom

USD: United States Dollars

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CHAPTER 1: INTRODUCTION TO RESEARCH PROBLEM

1.1 Introduction

The energy shortage in South Africa has been persistent for most of a decade. There seems to be no solution, as stakeholders debate the best approach to mitigate the problem; however, there is consensus that a need exists for South Africa to transition to renewable energy to avoid overreliance on fossil fuels (Uhunamure & Shale, 2021). The South African local municipalities depend on Eskom for energy supply. Eskom, therefore, embarked upon massive power cuts to these municipalities, influencing economic activities (Fouché & Brent, 2019). Several attempts have been made to alleviate the problems of power cuts. Some municipalities install solar panels or use biogas and other renewable energy sources to reduce over-dependence on fossil fuels in South Africa (Rasimphi & Tinarwo, 2022).

A main challenge in scaling up renewable energy is financing; several approaches can be used, including grants from multilateral agencies, such as the World Bank and the International Monetary Fund, development assistance, loans from commercial banks, and other development finance banks. Other avenues include co-financing private and public sector organisations, equity finance, and development assistance finance (Le, Nguyen, & Park, 2020). Adopting the circular economy approach is imperative in discussing the energy crisis in South Africa. The circular economy is primed on three key concepts: "reduce, reuse and recycle" (Kirchherr, Reike, & Hekkert, 2017, p.1). Using these principles will significantly affect energy consumption in South Africa.

South Africa can benefit enormously by scaling up renewable energy, such as reducing air population, building internal capacities to enable the country to become energy self-reliant, conversing the rampant cases of power cuts or load-shedding, and significantly reducing the consumption of fossil fuel owing to the increase in prices and inflation (Mutezo, & Mulopo, 2021); however, renewable energy is safe and clean compared to fossil fuel, South Africa is heavily reliant on fossil fuel, and much should be conducted to transition to renewable energy (Rennkamp, Haunss, Wongsa, Ortega, & Casamadrid, 2017).

Businesses must lead to championing energy reforms in South Africa. By applying the circular economy concept, the business could partner with other stakeholders to discuss society's energy problems and challenges (Korhonen, Honkasalo, & Seppälä, 2018). The circular economic concept can cause economic and social wins for society; however, challenges exist in implementing circular economic principles, such as rebound effects, technology, intra-organisational cooperation, and partnerships. This study explored the opportunities and challenges of scaling up renewable energy in South Africa using the circular economy principle, focusing on reuse, reduction, and recycling as the core activities.

1.2 Research problem

Developing a common pathway to a sustainable energy mix in South Africa is paramount. The South African energy crisis reached a high-risk level with energy generation and distribution infrastructure (Folly, 2021) and stakeholders are unsure of the solution to the energy problem and the way forward because multiple solutions have been advanced, including the unbundling of Eskom and licensing more independent power producers (Kumar, 2019; Masondo, 2020). A need exists to develop a sustainable energy plan to secure economic growth in South Africa (Qazi, Hussain, Rahim, Hardaker, Alghazzawi, Shaban, & Haruna, 2019).

Investment in renewable energy infrastructure seems to be strategy policymakers, and stakeholders can pursue to mitigate the energy problem (Khan, Chenggang, Hussain, & Kui, 2021). Coal has traditionally been a source of energy in South Africa. Still, provided the initial energy crisis of 2012, a further problem that arose in 2015, and the ongoing load-shedding since 2018, a need exists to develop a portfolio of energy strategies to consider coal and renewable sources. Climate change owing to global warming is fundamental; its influences continue globally, causing numerous problems to the population (Yalew, van Vliet, Gernaat, Ludwig, Miara, Park, & Van Vuuren, 2020); however, the energy sources known as 'renewables', for example, wind and solar are viable options, but they have inherent problems. Eskom failed to supply copious quantities to power industries and households. It is sometimes unreliable because it depends on other factors, such as its intermittent delivery because of a

lack of basic infrastructure (Brook, Alonso, Meneley, Misak, Blees, & van Erp 2014).

1.3 Purpose statement

This research aimed to extend knowledge and insights into the energy crisis in South Africa and determine how this challenge can be improved through the accelerated scale-up of renewable energy and by applying economic principles.

1.4 Rationale for the study/problem

There is the problem of high energy demand and less supply in South Africa, with heavy reliance on Eskom to supply. This mismatch in demand and supply has resulted in numerous load-shedding daily to allow Eskom to protect the national grid from collapse. Many prior studies debate the value of scaling up renewable energy sources in South Africa. This research aimed to extend scholarship and elucidate the challenges and opportunities of scaling up renewable energy. The study generates knowledge scholars can apply to make informed decisions about importing sustainable renewable energy transition in South Africa.

1.5 Research objectives and questions

1.5.1 Research question

The overarching research objective is to determine how the energy problem in South Africa can be resolved using alternative policy considerations from circular economic principles that advocate for reuse, recycling, and reduction activities. The study discusses two core research questions emphasised below.

- How can renewable energy be scaled up in South Africa?
- How can circular economic principles contribute to scaling up renewable energy?

1.6 Significance and contribution of the study

A need exists to choose a theoretical lens to ensure the research makes an academic and practical contribution to the body of knowledge, which will extend knowledge on the circular

economy when applied to renewables. Scholars and researchers will benefit from this study because of the new knowledge added to the research field, through the circular economy lens. The business rationale for this study is that the circular economic model benefits business stakeholders because the core principles of reuse, recycling, and reduction can significantly allow firms to achieve profitability while simultaneously promoting growth and transparency. This study contributes to theory and practice.

1.7 Conclusion

These sections proffered background to the problem, problem statement, research questions, objectives, rationale for the study, and conclusions. The subsequent section discusses the theory and literature review used to ground and design the study for efficacy.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The literature review supporting the research concern is described in this chapter. The road map for the literature review is based on a seven theoretical framework developed by (Onwuegbuzie & Frels, 2015). It includes the exploratory and interpretive phases, including the analysis and synthesis of information and communication or write-up of the literature. Key search words or terms and research questions were the starting point for appraising relevant literature. The chapter explains the frameworks used and concludes by integrating the literature.

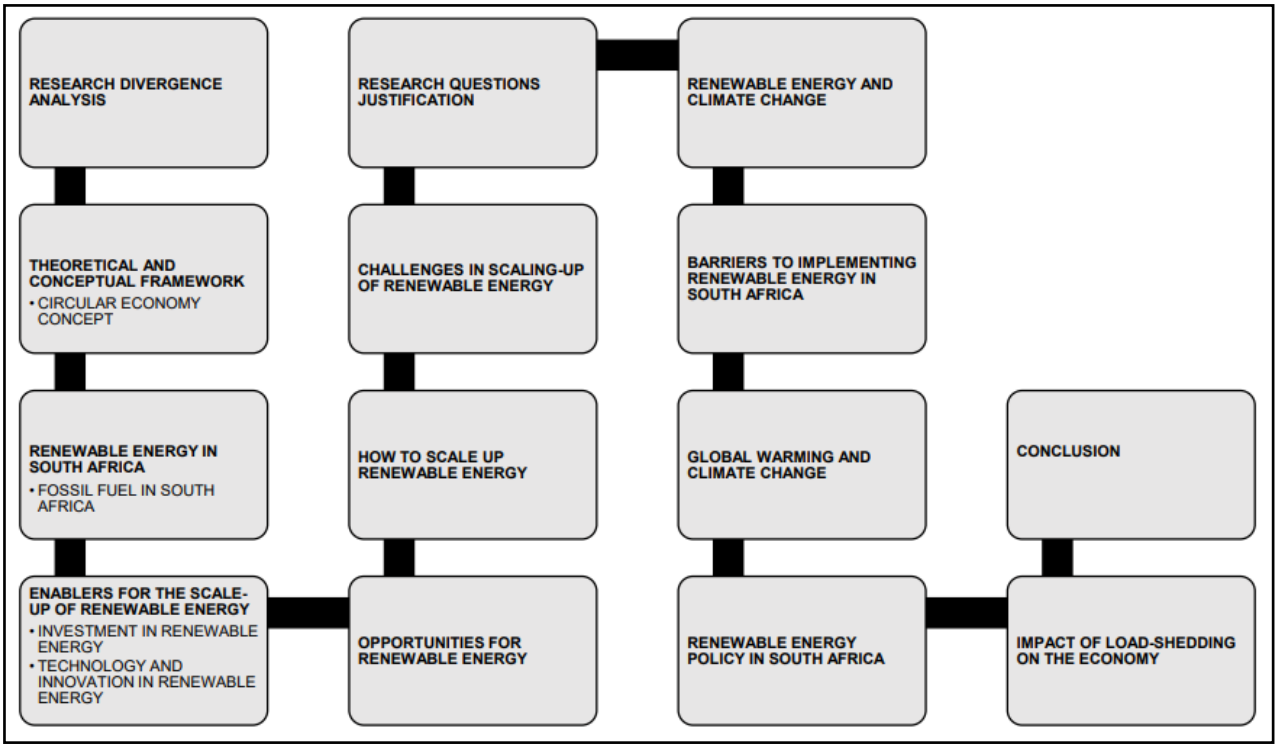
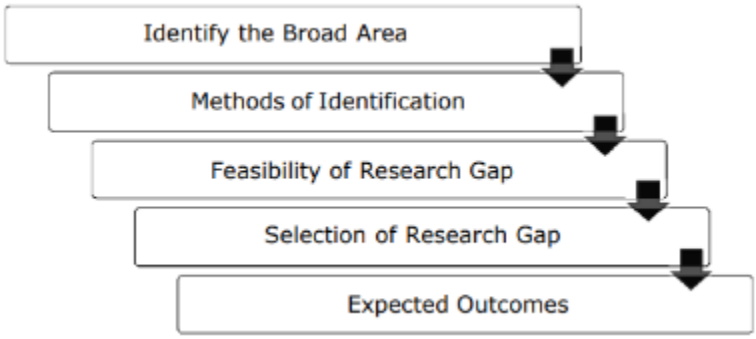


Figure 1: Roadmap *(Researchers compilation)*

2.2 Research divergence analysis and literature review

According to the Paris agreement (Gielen et al., 2019), the need for global energy transformation to support economic growth and sustainable development is imperative;

however, in developing countries or emerging markets, disparate literature discusses the two most important research questions—why and how to scale-up renewable emerging in these markets or countries (Babatunde et al., 2019). The primary reason for the scale of renewable energy in South Africa in the short term is to discuss the energy problem that threatens to damage the economy severely. The long-term strategy relates to sustainable development, global warming, and climate change reduction. The manufacturing transport sector in South Africa has been affected by constant power outages since 2008, and the debate about ageing power supply infrastructure and alternative policy implementation has become more of a song than an action plan.



Farooq Framework (Farooq, 2017)

This study employed the framework developed by Farooq (2017) to identify the research divergence. Several processes are followed, such as identifying the broader areas of scholarship; reviewing methodological divergences in the studies selected; the viability and contribution of the divergences selected; selecting a research divergence; and determining the expected outcome. The research employed the critical research divergence criteria (Miles, 2017). The literature review constructs the research divergences and generates the two critical research questions that require urgent attention, such as (1) how can circular economy principles contribute to scaling up renewable energy? (2) how and what is the strategy to scale-up renewable energy in South Africa to improve the energy challenges? The two key themes discussed are the why theme, which postulates the opportunities in scaling up renewable energy solutions and technology; the how theme discusses the challenges of

scaling up these technologies. The ‘why?’ and ‘how?’ questions provide avenues for scholars to make a meaningful and effective contribution to literature and theory on renewable energy in South Africa.

The literature demonstrates numerous research divergences in the critical areas of theory, methodology, and population. For example, Abbas et al. (2020), which examined the scale-up of renewable energy in South Africa, used an econometric approach (quantitative), whereas Gumbo (2014) applied no theory and leaned on what methodology or approaches are employed. Hadebe, Hansa, Ndlhovu, and Libido (2018) conducted a literature review of the topic, and the study is short on theory, methodology, and population. Although Naicker and Thopil (2019) use qualitative methods to emphasise a framework to scale-up renewable energy in South Africa, the study lacked a theoretical base. This study used divergence spotting and problematisation (Sandberg, & Alvesson, 2011; Chatterjee & Davison, 2021; Kock et al., 2020).

Based on the generic research divergence approach Miles (2017) developed, this study discusses three core research divergences identified in the literature: methodological, population, and theoretical. To supplement the divergence identification, "the theory context and methods" approach, Paul et al. (2017) adopted the framework developed by Farooq (2019). Provided in the context of this study, the circular economic theory provides an excellent theoretical lens for evaluating the whys and hows of scaling up renewable energy.

Naicker and Thopil (2019) identified that research divergences in policy formation, knowledge transfer, and maintenance skills are critical barriers to scaling up renewable energy in South Africa, especially in hydro and biomass renewable technology. Kruger and Eberhard (2018) and Kruger, Nygaard, and Kitzing (2021) compared renewable energy development in three countries—South Africa, Uganda, and Zambia displaying that renewable energy procurement in South Africa is still relatively underdeveloped and requires a strategy to scale-up procurement, such as energy auctions.

Matsuo and Schmidt (2019) support the findings of Kruger and Eberhard (2018) and indicate that a barrier to renewable energy development is a lack of energy policy, especially in the

procurement and auction areas. Abbas et al. (2020) and Akintande et al. (2020) applied a modelling approach to study the scale-up of renewable energy in South Africa. These quantitative studies are sometimes not practical when studying a new phenomenon, and the dataset does not tell the story behind the problem.

Banday and Aneja (2019) used panel data to study renewable and non-renewable energy consumption and carbon emission in the BRICS countries (Brazil, Russia, India, China and South Africa). The study mentions no theories applied in the investigation and, therefore, directs towards a theoretical divergence. Akinbambi et al's. (2021) empirical study on the scale-up of renewable energy in South Africa demonstrates theoretical and methodological divergences, while Adebayo et al. (2021) use econometric models to examine the correlation between coal and renewable energy consumption in South Africa. Khobar et al. (2021) examine renewable energy consumption and employment in South Africa. Again, this study uses World Bank data and lacks any theoretical framework to study the issues; Jain and Jain (2017) wrote a conference study on the rise of renewable energy in South Africa without and theoretical and methodological basis. The above evidence lends credence to the assumption that the literature in this domain of study is still in its nascent stages of development.

A review of the literature demonstrates divergences in the body of knowledge, lacking a synthesised coherency; there are disparate streams of literature; besides a lack of contextual debate among the themes identified; there is a divergence in the shared theoretical perspective and methodology to understand the phenomenon leading to an incomplete and coherent body of knowledge This research attempted to close these divergences in two significant ways—first through applying a robust theoretical framework to connect and explain the phenomenon and second by using the qualitative inductive research methodology to generate testable propositions for future research.

2.3 Theoretical and conceptual framework

2.3.1 Circular economy concept

Unlike traditional recycling, practical policy and business-orientated circular economic

approach emphasise product, component and material reuse, re-manufacturing, refurbishment, repair, cascading and upgrading, and solar, wind, biomass, and waste-derived energy use throughout the product value chain and "cradle-to-cradle life cycle." (Olabi, 2019). Economic wins emanating from adopting the circular economy include the reduction of leaks and consumption of energy, reduction in waste management, emissions controls, environmental legislation, environmental taxes and insurance, development of new markets, innovations, and energy sustainability (Agrawal et al., 2022).

Social gains result in the deployment of circular economic concepts and scale-up of renewable energy sources, including creating new opportunities, especially green jobs in the energy sector, and income for the government. New technology, clean energy, and the environment will significantly contribute to better life quality, increased sense of sharing and uBuntu in the community, and new skills development, which also leads to productivity and job satisfaction and, above all, reduction in global warming (Korhonen et al., 2018); however, the circular economy concept has inherent limitations—some limitations must be discussed to harness the benefits of the circular economy.

The limitations are divided into six key themes: (1) thermodynamic limits dealing with the inherent nature of how cyclical systems consume and generate waste and emissions, (2) system-bound limits concerning spatial and temporal infrastructural problems, (3) the physical scale of the economic activities, (4) path dependence and lock-in theories (5) governance and management challenges in the energy sector in South Africa and (6) social and cultural definition of terms deployed in the circular economy (Korhonen et al., 2017). Kirchherr et al. (2017) define the circular concept with a collection of 114 definitions of the term's sources from various scholars in the field and coded in 17 dimensions.

The key message is "smarter product use and manufacture, extended lifespan of products and parts and useful applications of materials", which correlates with energy and energy usage. The principle of reducing, reusing, recycling, and recovery has a lot to do with the reduction of energy consumption, and these principles can make significant contributions towards lowering the demand for energy in South Africa and ensure that the economy is more

adaptive to renewable sources of energy as opposed to conventional sources of energy.

Corvellec et al. (2022) provide a well-grounded critique of the circular economic concept and its relationship with renewable energy. These critiques posit that the circular economy has diffused limits with unclear theoretical grounds, and its implementation faces structural difficulties. It claims that the circular economy is based on an ideological agenda subjugated by technical and economic accounts, which brings uncertain contributions to sustainability and depoliticises sustainable growth.

These critiques cover definitional problems, neglect of the grounded scholarship in the field, unclear implementation of pathways, a lack of clarity of social and environmental gains, the original model itself, and that it is a corporate model that leads and ignores other stakeholders. Policy considerations, despite these pitfalls, the scale-up of renewable energy and implementation of the circular economy model in South Africa can negate the present energy crisis in the country. It is better than having no solution.

2.4 Overview of renewable energy in South Africa

The literature on renewable energy in South Africa primarily focused on wind and solar because of the abundance of sunlight (Akinbami, Oke, & Bodunrin, 2021). South Africa is a significant CO2 emission produced on the continent from its ailing power plants, primarily coal-driven. The emission accounts for over 20% of all the African continent's emissions. South Africa accounts for one of the largest CO2 producers globally (Salahuddin, Gow, Ali, Hossain, Al-Azami, Akbar, & Gedikli, 2019). Because of the environmental influence of the conventional means of electricity generation in South Africa, efforts were made to diversify the energy sources in the country. South Africa's Department of Energy released the country's latest state of renewable energy data. The data from the document revealed the solar PV, wind, biomass, and concentrated solar power (CSP) renewable energy (RE) technologies present in all the South African provinces.

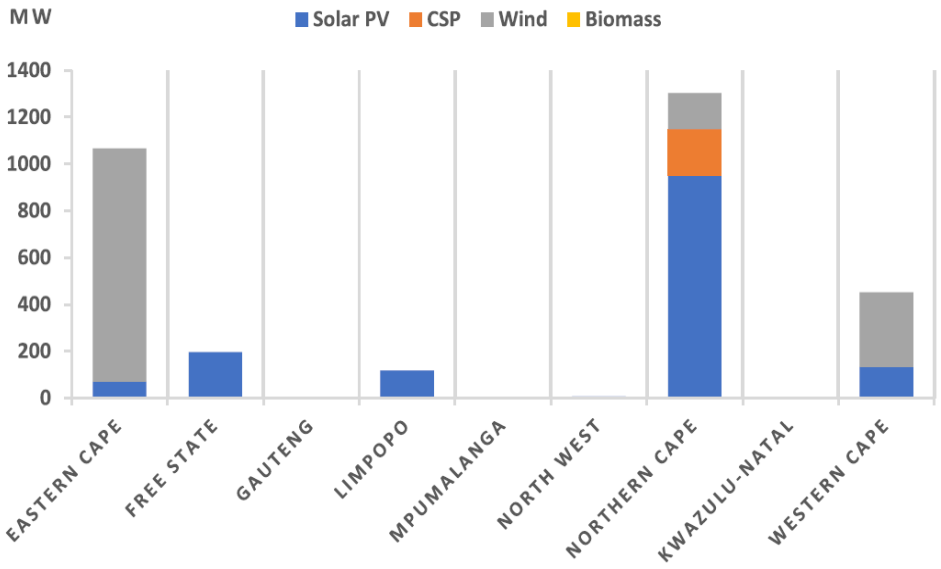


Figure 2: Histogram of renewable consumption in South Africa

The histogram demonstrates that the Northern Cape region ranked highest among all the provinces regarding RE (solar PV, CSP, wind and biomass) deployment in South Africa, closely followed by the Eastern Cape province, then Western Cape. Like most other countries, South Africa understands the need for RE sources to complement or serve as an alternative to its fossil fuel-based energy sector. The efforts to diversify and promote energy transition; therefore, some actions have been taken to diversify the country's energy mix. To migrate towards RE sources, South Africa released a White Paper in 2003 detailing how the country will generate 10 TWh of electricity from RE sources (biomass, wind, solar and small-scale hydro). This policy document serves as the basis for RE technology development in South Africa. The policy document and the resource-integrated plan developed in 2011 have divergences that must be discussed. The goal to add 17 800 MW of RE energy by 2030 is behind schedule because only 6 328 MW has so far been achieved (Eberhard & Naude, 2011).

South Africa needs an ambitious plan to increase the output of RE to support the two key areas of capacity constraints—economic growth and carbon emission reduction, which influences climate change. A need exists for the successful diversification of energy sources.

Part of the power problem debate in South Africa concerns the constraints in Eskom's generating capacity. The additional capacity would be achieved by increasing RE sources, such as solar and wind power.

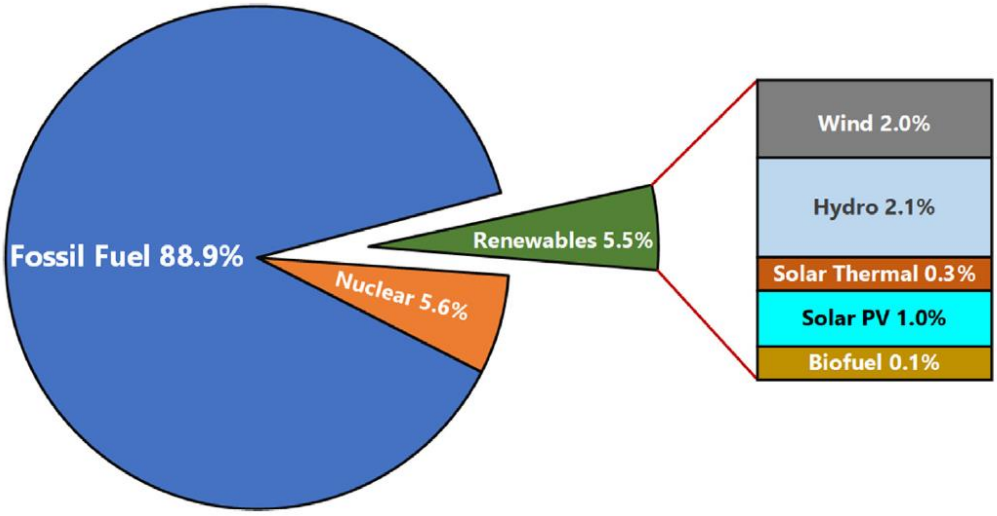


Figure 3: South Africa energy mix (adapted from International Energy Agency Database)

Figure 3 above demonstrates that fossil fuel accounts for 88.9% of South African energy needs, followed by nuclear energy at 5.6% and RE at 5.5%. The dataset demonstrates opportunities to increase the percentage of RE sources obtained from RE. This increment will reduce the dependence on fossil fuels (Wang, Fan, & Zhou, 2022).

2.4.1 Biomass energy

Biomass energy is a crucial RE source, especially in rural areas. It comes from solid, liquid and gas, where such energy is derived from organic substances (Sanderson, Adler, Martin; 2020). Biomass energy is the energy source used by two billion people globally. South Africa has a comparative advantage, particularly in rural areas with high-generation biomass that can connect to the national grid, especially in municipalities and other rural settings (Johnson, Gerber, & Muhoza, 2019); however, as much as there is abundant biomass in rural areas, most of it has not been commercialised. It continues using wood and animal waste as a

source of energy. There need to be regulations to avoid the adverse effect of tree cutting as a source of energy, especially in rural areas (Maji, Sulaiman, & Abdul-Rahim, 2019).

The South African RE Data and Information Service indicated that over 100 GWh of energy was generated by biomass power in 2016, while no values have been recorded since then (Akinbami, Oke, & Bodunrin, 2021). The available data demonstrates that South Africa generated over 100 GWh of energy through biomass power in 2016, but one statistic has been reported. An early attempt to examine the potential of biomass was reported in KwaZulu-Natal in 2006. The pioneer attempted to establish a 5MW biomass electric plant to supply Eskom, but this plan did not materialise. Because of the availability of large chunks of woodland in KZN, there is an opportunity to invest in biomass production to complement coal energy productions currently under-used (DME, 2011).

The conversion of biomass to usable energy (electricity) and heat can occur through several processes, with combustion, gasification, and pyrolysis being the most common of such processes. Biomass combustion is a thermal conversion involving burning biomass in an oxygenated environment to generate heat and electricity. One of the classic applications of biomass combustion is the domestic heating of households, and this can reduce the pressure on the national grid during peak times.

2.5 Fossil fuel in South Africa

According to Salahuddin, Gow, Ali, Hossain, Al-Azami, Akbar, and Gedikli (2019), the evidence from South Africa demonstrates fossil fuel-dependent countries must diversify their energy portfolio to include RE to enhance environmental quality and promote sustainable development; therefore, reducing the influence of global climate change from fossil fuel sources.

Tyler (2020) asserts that South Africa lacks a coherent RE policy, a critical bottleneck in increasing RE use. The Department of Energy and mineral resources (DME) attempted to develop an energy policy, including RE, in 1998. The policy listed RE sources, such as wind, solar, biomass, hydroelectricity, ocean currents, and wave energy. The plan sets an ambitious

target of scaling up RE of 10 000 GWh by 2013 and would translate to a replacement of 1320 units of Eskom combined coal-fired power stations; however, this plan was never fully operationalised (DME, 1998). The plan stated that:

> "10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro The renewable energy is to be used for power generation and non-electric technologies such as solar water heating and bio-fuels This is approximately 4% (1667 MW) of the estimated electricity demand (41539 MW) 2013".

2.6 Enablers for the scale-up of renewable energy

2.6.1 Investment in renewable energy as an enabler

RE investment can positively contribute to the country and the population (Banks & Schäffler, 2005). Investments in RE will significantly increase access to energy (Baruah & Enweremadu, 2019). South Africa has a significant carbon dioxide emission problem because of over-dependence on coal, and therefore, investment in RE is necessary to tackle this problem (Ekwueme et al., 2021). Skills development and innovation will ensue with a scale-up of RE, potentially increasing the share of green jobs in the country (Matsuo & Schmidt, 2019; An & Mikhaylov, 2020; Khobai, 2020; Gumbo, 2014).

There is empirical evidence to suggest that scaling up RE can lead to growth in GDP in the BRICS countries while lowering carbon emissions and greenhouse gases (Banday & Aneja, 2019). Emissions are becoming a severe problem in South Africa, and scaling up RE sources may ease the problem, eventually.

2.6.2 Technology and innovations in renewable energy as an enabler

The availability of innovative technologies to harness developing renewable and non-renewable sources continues to be scaled up globally. Some of these technologies are now available in sub-Saharan Africa, including South Africa, such as solar power. There is

considerable potential for renewables and opportunities for hybrid technologies that exclude traditional fuels (Ayamolowo et al., 2022 & Gawusu et al., 2022).

2.7 Opportunities for renewable energy

A need exists for green primary energy to substitute the consumption of coal is an essential enabler for the scale-up of RE in South Africa. The manufacturing sectors all over the country are constrained because of the constant blackouts, resulting in lower productivity and high-cost of production The influence of COVID-19 on the economy has been disastrous, such as all other countries because of the above, a competitive cost advantage from low carbon energy would increase productivity and lower the cost of production (Kock & Govender, 2021).

The overreliance on energy imports is a critical enabler. South African energy imports display that the European Union (EU) is a critical player. Reducing pollution and using hydrogen in transportation is an essential factor for decarbonisation. The need to bolster crucial export and tax revenues is moving towards a broader transition to a sustainable industry, and these factors point to the potential of renewables as an alternative energy source for South Africa, (Knodt et al., 2022).

According to Kruger and Eberhard (2018), the opportunities for scaling up RE in South Africa would increase job creation, local content development; local ownership; management control; preferential procurement, including BEEE, enterprise development, social-economic development, and small and medium enterprise participation. As of 2018, there are over 102 RE projects. Lorber et al. (2021) established a correlation between RE use, human capital development and trade, and the environment in South Africa.

Several opportunities exist for RE in South Africa, from solar to wind turbines and waste recycling; however, there are also barriers to scaling up RE and integration with the power grid, including poor infrastructure, financial pressures, and poor legislative framework (Fouché & Brent, 2019; Alemzero, Acheampong, & Huaping, 2021). In South Africa, sunshine is abundant, and solar energy has the potential to produce hydrogen that can refuel electric

cars and reduce dependence on gasoline (Ayodele et al., 2021).

Gauteng will be a key in the RE space as it is South Africa's economic hub, however, unlike the Northern and Western Cape, Gauteng is not blessed with RE infrastructures, such as windmills, turbines, and solar energy, but some opportunities can be pursued (Mulaudzi, Bull, & Makhado, 2022) The two primary sources of RE for Gauteng residents would be solar and recycling of waste to generate landfill gas as sources of energy Gauteng has a population that generates thousands of tonnes of waste, and municipalities can recycle this waste to generate electricity (Adeleke et al., 2021; Andreoni, Creamer, Mazzucato, & Steyn, 2022) The circular economy principles have a perfect application.

A need exists to create awareness regarding the recycling and reuse of waste by the population in South Africa, which can affect electricity usage and reduce pressure on the power grid. There are also opportunities to conserve resources, such as water, because constant use of these resources requires energy to either transport the waste to the landfills. These conservation practices, therefore, provide an opportunity for the RE scale (Mbazima et al., 2022). The municipalities must, therefore, embark on an awareness campaign for their residents to promote sustainable use of resources, including energy storage (Longe et al., 2019).

The government needs to urgently license more independent power producers, especially those in the clean energy sector, to increase generation capacity in the national grid (Nel, 2018; Funder et al., 2021). The generation capacity of RE in South Africa is 44000 MW (Kruger et al., 2021); this is lower compared to other BRICS countries, and it demonstrates opportunities to increase capacity in this sector (Gu, Renwick, Xue, 2018). The persistent problem for Eskom has been a lack of capacity; therefore, the increase in generation capacity is the first option for Eskom to solve this problem. The scaling of RE can close the divergence between the demand and the supply of electricity.

The increased capacity of RE would directly affect decreasing load-shedding. The RE would power households rather than electricity, which could then be reserved for the industrial and transportation sectors. The RE scale creates employment and reduces unemployment

divergence in Gauteng (Vivek et al., 2021).

2.8 How to scale-up renewable energy

The funding for scaling up RE in South Africa has been primarily through the South Africa RE Independent Power Producers Procurement Programme (Kruger & Eberhard, 2018). The starting point in the scale-up of the RE in South Africa must develop a robust energy policy (Pathak & Shah, 2019; Bhat, 2018). The government White Paper on energy was developed in 1998, and since then, much has been conducted to operationalise this policy (DME, 1998).

Manufacturing firms in South Africa have increased the output of carbon emissions, affecting global warming and climate change (Kwakwa & Adusah-Poku, 2020). A need exists for effective policies to support and ensure the manufacturing industry's transition to RE (Schmidt et al., 2017). Larsen and Hansen (2020) reiterate the need for a governance and policy framework to scale-up RE. The independent power projects and energy actioning in South Africa have delivered 6328 MW of power for $20.5 billion (Leigland & Eberhard, 2018; Müller & Claar, 2021).

Collaboration and partnerships are quick ways to scale RE in South Africa (Olatunji et al., 2022). Several governments, businesses, and labour stakeholders must develop a plan to scale RE (Funder et al., 2021; Marais et al., 2018). Through waste recycling and reuse, RE can close the divergence in energy demand, and the circular economy principle finds its application in this (Adeleke et al., 2021).

The financing component of the RE transition proved to be one of the key challenges from an emerging market perspective. Financial mobilisation is essential in energy transition and scaling up RE in emerging markets (Zhang, 2020). Innovation is key to scaling up RE in South Africa (Elia et al., 2021).

The global economic climate does not provide immediate scalable solutions because of high inflation, driving the cost of capital high. Therefore, funding RE infrastructure projects can be a challenge (Sachs et al., 2019).

The need to scale-up and develop alternative energy for domestic consumption in rural areas to reduce the demand on the power grid, and this evidence is supported by research in other African countries, such as Rwanda, Kenya, Tanzania, and Uganda. These countries have successfully scaled up clean cooking energy in rural areas primarily through biogas and biomass production (Quinn et al., 2018) renewable for agriculture waste supported by the circular economy principle of reducing, reuse and recycling.

2.9 Challenges in the scale-up of renewable energy

The critical challenges in the scale-up of renewables include but are not limited to the affordability of electricity for most of the low-income populations, enhancement of inefficiency, development of sustainable cities, enhancement of the RE systems, power of market design, governance issues, and the influence of electrification on the economy (Amir, & Khan, 2021).

The power value chain entails several critical factors: deregulating the power system, increment of traffic, commodity prices, personalised metres, implementation of the prepaid metres, and sharing of connection costs. The power value chain could pose a problem in RE scale-up because the contracts and legislation favour Eskom as a monopoly producer. Some challenges to developing RE in South Africa include a lack of energy policy that stifles skills transfer and human capital development (Naicker & Topic, 2021).

Other challenges in developing RE in South Africa include a lack of energy policy that stifles skills transfer and human capital development (Naicker & Topic, 2021). The population density in South Africa, mainly in Gauteng, presents constraints to land to build solar panels, offering quick scale-up opportunities compared to other RE sources, such as windmills and turbines. The scaling up of the RE in South Africa will be affected by resource constraints owing to the COVID-19 pandemic, stagflation, and the war in Ukraine, which has tremendously influenced the global economy (Liadze et al., 2022).

Integrating RE sources into the national power grid remains a challenge because of infrastructure issues and the monopoly from Eskom (Constantinides, & Slavova, 2020; Ting & Byrne, 2020). Independent power procedures require licensing and other special permits

to venture into the RE space, and some permits can take a long time to process (Ayamolowo et al., 2022).) The transmission of RE to private dwellings is impossible without a dedicated transmission infrastructure for the RE source (Andreoni et al., 2022). For example, Gauteng's buildings and transportation infrastructure must be reconfigured to use RE sources, such as solar and windmills. This approach could optimise energy delivery to required users (Chhipa et al., 2022).

The human capital to invest in RE is also a severe barrier to scaling up RE. The skills divergence in the country inhibits the scale-up in two significant ways (1) there is a lack of workforce with the experience and competence in the industry to support the scale-up of RE, and (2) there is a lack of finance to recruit and training technicians and maintenance specialist and planners in the RE sector (Sun et al., 2022) A need exists for skilled human resources to install and service RE infrastructure, in short supply developing skilled human resources also takes a while and, therefore, requires planning, Therefore, the primary power deficit encountered by the residents of Gauteng must be managed through another mechanism.

Contrary to popular belief, RE is expensive to finance. Countries in emerging markets successfully transitioned into RE, such as India and China, spent considerable money building the infrastructure (Li & Ho, 2022). In South Africa, a need exists for a clear financing plan and model of funding and a robust strategy, including all the stakeholders in the business sector, government and private sector. The RE power auction has succeeded, and there are opportunities to build on these success stories; however, no studies have been conducted to determine the cost per unit of RE compared to electricity pricing (Dalala et al., 2022; Mungai et al., 2022).

The legal and regulatory framework is necessary to enable the transition into RE (Trollip et al., 2022; Drago & Gatto, 2022). The Department of Mineral and Energy developed an energy White Paper (Department of Energy, 1998); however, there are divergences, especially around tariffs and the function of key stakeholders, such as municipalities and local authorities. The present situation is that Eskom is the majority electricity supplier to municipalities in the country; however, a transition to RE will affect its revenue from Eskom.

There is resistance by Eskom; therefore, a need for a robust regulatory framework to allow consumers to source alternative energy from independent power producers around the province (Fouché, & Brent, 2019; Davies et al., 2018).

Challenges around procuring RE products and services because of the capacity to manufacture them locally. A need exists to import OEMs (original equipment manufacturers). Some are located outside South Africa in places such as China. The disruption in the supply chain owing to COVID-19 may become a barrier to the scale of RE in the short-run (Sun et al., 2022). The global supply chain has gone through severe shocks and interruptions, which have affected the global value chain, including RE, such as PV solar products and others. This has also observed the pricing of commodities and inflationary pressure globally, and, therefore, renewable remedies may not be the short-run solution to the power problem in South Africa.

2.10 Justification of research questions in the literature

The overarching research question is to identify why and how the scaling up of RE is imperative in discussing the energy problem in South Africa and providing a transition from fossil fuel to RE. The literature review demonstrates that several scholars have emphasised the research questions that can be investigated, such as the barriers to scaling up RE (Manninen et al., 2018). The social and business aspect of RE (De Pascale et al., 2021; Bag et al., 2021), the RE indicators and core principles (de Sousa Jabbour et al., 2019; Miles & Gold, 2021; Mhatre et al., 2021), the opportunities and benefits of the circular economy model and these are captured in the research questions in Appendix 2.

In the scale-up of RE in South Africa, a need exists to eliminate institutional voids; develop robust national policies; remove the financial obstacles encountered by private developers; technology innovation; training and development; create public awareness about the importance of RE; investor promotion; integration of transmission infrastructure to the national grid; and market deregulation. The potential for scale-up RE includes employment creation; economic growth; increased private participation; local content; local ownership; conservation; decarbonisation; a significant reduction in CO2 emissions and greenhouse

gases; levelling up and easing of pressure on demand and supply of electricity. The literature, therefore, leads to the questions:

- How can renewable energy be scaled up in South Africa?
- How can circular economic principles contribute to scaling up renewable energy?

Responses regarding the South African context.

2.11 Renewable energy and climate change

Climate change is an important variable and the subject of renewable energy; climate change, optimisation and economics continue to be debated. There is to develop a global strategy to ease the problem of global warming. Fossil fuels harm the environment; therefore, a cleaner energy source, such as renewable, is an alternative; however, there continue to be policy constraints, especially in emerging markets and countries in sub-Sharan Africa. These constraints involve investing in renewable energy to reduce greenhouse gas from the industrial operation. This is a growing concern, and South Africa cannot be exempt from these challenges (Seymore, Inglesi-Lotz, & Blignaut, 2014).

Using electric cars will positively contribute towards negating the influence of carbon emissions and, therefore, protect the environment from the harmful effects of fossil fuels in South Africa. According to Olabi and Abdelkareem (2022), renewable energy has the potential to alleviate climate change problems and promote sustainable development. In South Africa, the transportation system heavily relies on fossil fuels, and there is an incredible amount of pollution and carbon emissions. Eventually, introducing electric cars has the potential to undo some of the harmful effects of fossil fuels.

2.12 Barriers to implementing renewable energy in South Africa

There are several barriers to the uptake of renewable energy in South Africa. The literature classifies these barriers: economic and financial, technological, technical, institutional, social, political, and regulatory pressure and geographical (Asante, D., Ampah, Afrane, Adjei-Darko, Asante, Fosu, & Amoh, 2022). All the above barriers are present in South Africa, except for

geographical ones. Asante et al. (2022) asserted that the need for direct enabling and integrating policies, renewable energy targets, education, and training are valuable strategies that can overcome barriers.

The economic barriers can be subdivided into capital, project and finance economics, energy cost, market competition, and failure. Technical barriers are categorised into renewable energy, technology, infrastructure, and skilled labour. Social and environmental barriers include cultural behaviour, public acceptance, end-user and other environmental factors. The political and regulatory policies include enabling policies and regulators policies, energy incentives in the energy sectors, foreign direct investment, and government subsidies; and local municipalities are also taking advantage of scale-up renewable energy to improve service delivery within their municipalities (Fouché & Brent, 2019).

The argument can be made to display that South Africa requires new energy regulations and policies to scale-up renewable energy consumption in South Africa. The technological advancement has the potential to improve energy efficiency in generation and distribution to reduce the influence of load-shedding in South Africa. The development of renewable energy is necessary to control climate change in South Africa and to promote sustainable development and create well-paying jobs. The technology used to produce and distribute renewable energy must be innovative; therefore, the cost of energy is managed. Eskom's constantly escalating power tariff is also a problem (Kelly, & Geyer, 2018).

Wang, Dong, and Wang (2022) examined the relationship between emerging renewable consumption and economic growth and established a significant relationship. In South Africa, the constant energy problems have resulted in consumer frustration and have affected economic growth. The energy problems in South Africa have resulted in political and economic risks for the country; scalable solutions must be established soon because of the risk emphasised (Jagarnath, 2022).

Technology has been identified as one of the critical barriers to implementing renewable energy in South Africa. The economics of renewable energy demonstrates a high sunk cost of technology development, and the implementation risks are also inherent. The government

is not willing to invest in renewable energy. Eskom created a monopoly, with resistance from unions and labour and other stakeholders to implement renewable energy because of the direct competition it possesses (Pagels, 2010; Mutombo, 2016; Naicker & Thopil, 2019). Su, Pang, Tao, R., Shao, and Umar (2022) contend that the Fourth Industrial Revolution has changed the development process of renewable energy and technological innovations, significantly reducing C02 emissions. Therefore, deploying innovations in the renewable energy sector in South Africa is paramount; however, this requires the participation of all stakeholders, especially the government and industrialists.

2.13 Global warming and climate change

Global warming is increasingly accepted as valid, and countries in sub-Sharan Africa are at risk. The dataset demonstrates that hydroelectricity and nuclear energy consumptions contribute to lower CO2 emissions, eventually; the scale effect increases CO2 emissions, whereas the technique effect improves it, validating an environmental Kuznets curve (EKC) hypothesis; and oil, coal, and natural gas consumption deteriorate environmental quality (Aliyu, Modu, & Tan, 2018) All these factors are present in South Africa. Government policies regarding the development and investment in the renewal of infrastructure, development of new power stations, develop independent power providers with the capacity to generate additional power to be supplied to the grid to support Eskom. Eskom must kerb ineptitudes in the power generation and distribution systems.

2.14 Renewable energy policy in South Africa

A study by Adeleke, Inzoli, and Colombo (2022) indicated rapid uptake of renewable energy in sub-Saharan Africa, especially in South Africa and Nigeria; however, the fundamental challenges are policy constraints and institutional problems. Government policies are not supportive of renewable energy policy entrepreneurs and investors, and the policies favour those already participants in the markets.

2.15 The Impact of load-shedding on the economy

Load-shedding has affected several businesses in South Africa, including most small and medium enterprises, such as restaurants, beds, and breakfasts. The effect has been a loss of jobs and livelihoods in a country already struggling with high unemployment (Tembe & Hlengwa, 2022). The practical strategies implemented by small and medium enterprises have been to buy power battery banks that can provide lighting and charge small electric equipment used to run the day-to-day business operation of the business.

Gehringer, Rode, and Schomaker (2018) demonstrate that loading shedding influences the South African healthcare sector. Patient admission, care, and treatment shedding have resulted in power healthcare delivery, especially in government hospitals. Because of load-shedding, medication that requires cold storage is at risk of expiration, provided the relentless power outage. Vital medical operations require advanced preparation, and power supply is essential for keeping patients alive during operations (Ndaguba, 2018).

According to Mabugu and Inglesi-Lotz (2022), South Africa has a mismatch between energy demand and supply. A need exists to close the divergence and improve energy security, especially efficiencies. The Eskom coal plants are old, on average, 37 years, and, therefore, there is a high number of unplanned maintenance and shutdowns at a prohibitive cost to Eskom and the public. Policy considerations continue to protect existing participants and bar new entrants to the market.

Ajith and Bavanish (2022) biomass-based energy systems are an alternative, cost-effective and sustainable development and support rural electricity needs. The abundance of biomass in rural areas allows for the scale of renewable energy supply in South Africa. The author remarks that crucial sources of global energy can be divided into; hydroelectricity, which generates electric power; biomass heat, responsible for power generation and transports fuels, additionally geothermal power, used in thermal systems; solar energy, primarily generated through photovoltaic and wind energy generated through windmills, forming part of the renewable energy sources globally.

2.16 Conclusion

The chapter proffers the literature review and theoretical frame, and the circular economy model is the theoretical lens adopted for the study. The literature demonstrates opportunities to scale-up renewable energy in South Africa. These opportunities include mitigating climate change, the creation of green jobs to reduce unemployment, improvement of service delivery, and technological innovations, But the literature also remarks that several factors, such as skill divergences, investment and financing of the renewable energy plan, policy considerations, lack of infrastructure pose a severe threat in the scale-up of renewable energy. The next chapter discusses the methods used to collect and analyse data from participants.

CHAPTER 3: RESEARCH QUESTIONS

3.1 Introduction

This chapter articulates the research questions. The chapter discusses the formation of the research question on renewable energy implementation in South Africa. The research questions were formulated after identifying the research divergence and literature review focused on renewable energy applications in the South African context. The research question formulation is essential for scholars to understand the antecedents and scope of the work in the literature. The key search terms for the literature review was "renewable energy", "climate change", sustainable development, solar, wind, biomass, South Africa, the influence of renewable energy, the potential of renewable energy, and the challenges of renewable energy."

3.2 Research question

Primarily, this research answered two key research questions stated below

- How can renewable energy be scaled up in South Africa?
- How can circular economic principles contribute to scaling up renewable energy?

3.2.1 The scale-up of renewable energy in South Africa

Extant literature demonstrates that the potential of renewable energy in South Africa has not been exploited despite the abundance of renewable energy resources (İnal, Addi, Çakmak, Torusdağ, & Çalışkan, 2022; Nyiwul, 2017; Adefarati, & Obikoya, 2019; Afrane, Ampah, & Aboagye, 2022); however, the challenges around energy security in South Africa have precipitated the need to exploit the abundant renewable energy to ameliorate the problem (Okoroigwe, & Madhlopa, 2015; Kougias, Bódis, Jäger-Waldau, Monforte-Ferrario, & Szabó, 2016; Mzamo, & Manditereza, 2022).

The literature demonstrates that policy barriers and constraints inhibit the implementation of

renewable energy in South Africa (Mungai, Ndiritu, & Da Silva, 2022). Overcoming the abovementioned barriers will put South Africa on the path of energy dependence and alleviate the challenges (Leal Filho, Balogun, Surroop, Salvia, Narula, & Azadi, 2022).

Renewable energy implementation in South Africa will require skill sets to develop and manage the plans, operate the grid, train the workforce to discuss the skills divergences, increase the investment opportunities in the energy sector, technology innovations, develop a robust energy policy with support from all key stakeholders in the private and public sectors; develop new infrastructure (Lombard, & Ferreira, 2015; Jain, & Jain, 2017; Baker, 2015; De Jongh, Ghoorah, & Makina, 2014).

The focal point for renewable energy consumption in South Africa is wind, solar, biomass, geothermal, and recycled waste materials from municipalities (Mohammed, Mustafa, & Bashir, 2013; Adeleke, Akinlabi, Jen, & Dun made, 2021; Hung, 2022; Majeed, Luni, & Tahir, 2022). The essential advantage of renewable energy, such as solar, biomass and recyclables, is that this energy source is associated with low carbon emission and, therefore, promotes environmental and economic sustainability (Said, Bhatti, & Hunjra, 2022; Kiehbadroudinezhad, Merabet, Abo-Khalil, Salameh, & Chennai, 2022).

According to Ayamolowo, Manditereza, and Kusakana (2022), the South African path to energy dependency is through renewable energy. This study demonstrates a need for performance evaluation of renewable programmes. Key performance metrics include but accessibility, diversification of energy sources, augmentation of capacity constraints, good governance, environmental, and economic influence.

3.2.2 Circular economy and renewable energy in South Africa

The circular economy is a crucial ingredient for economic growth and sustainable development. The seven critical circular economy principles are regeneration, absorption, closing the system; resource value chains; reduction, design, and education (Suárez-Eiroa, Fernández, Méndez-Martínez, & Soto-Oñate, 2019). Velenturf and Purnell (2021) assert that the circular economy has become the blueprint for how resources can be used globally to

promote sustainability and ensure people, profit, and the planet are considered. Banaitė (2016) demonstrates that a circular economy operates at micro and meso levels in the economy. Ogunmakinde, Sher, and Egbelakin (2021) identified critical concepts in the circular economy models, including cradle-to-cradle, regenerative design, biomimicry, performance economy, industrial ecology, and reverse logistics are the pillars of the circular economy "p.1".

Research in circular economic models identified key emerging themes linked to renewable energy applications, such as business models, the circular economy, circular business models, value, supply chain, transition, resource, waste, and reuse, and their most prevalent relationships. The link between circular economic models and renewable energy demonstrates a need for managerial, supply-side, demand-side, networking, performance, and contextual considerations of circular business models to collaborate to implement renewable energy in emerging markets (Ogunmakinde, Sher, & Egbelakin, 2021; Ferasso, Beliaeva, Kraus, Clauss, & Ribeiro-Soriano, 2020; Centobelli, Cerchione, Chiaroni, Del Vecchio, & Urbinati, 2020; Lüdeke-Freund, Gold, & Bocken, 2019).

The literature demonstrates a nexus between circular economic models and renewable energy (Fogarassy & Finger, 2020; Mutezo & Mulopo, 2021). The circular economic principles use renewable energy to achieve key goals, such as sustainable development, effective resource use, and reduction in carbon emission. A circular economy envisages scenarios where the entire economy is interconnected, and resource use and sharing are common. More importantly, the circular economy promotes the principle of recycling, reduction and reuse (3R).

3.3 Conclusion

This chapter discusses the research question, literature, and theories used to construct the research questions. The critical theory used was the circular economy model used by the public and private sectors. The literature also indicates a link between circular economic principles and renewable energy. The fundamental principles used in the literature were important in the research's design question and the coding process of the interview with key

participants to understand how South Africa scale-up renewable energy, using circular economic principles.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

This chapter describes the research methodology and design. Research methods and design are the roadmap for research and represent how the research was accomplished or conducted. The sections emphasise the choice of design, philosophy, approach, population, unit of analysis, data analysis, validity, and trustworthiness of the research.

4.2 Purpose of research design

The primary aim of this description-explanatory research is to explain why and how the scaling up of renewable energy can solve the energy problem in South Africa. Data were collected from key industry stakeholders familiar with the phenomenon.

4.3 Choice of research design

4.3.1 Philosophy

The philosophical approach adopted in this study is the interpretivism approach. The justification is that the phenomenon is a real-life problem that warrants attention from scholars, businesses, and policymakers. The scaling up of renewable energy in South Africa should be considered in its natural context. Therefore, the philosophical approach adopted by the researcher fits into the context and nature of the problem.

4.3.2 Approach selected

There are three primary approaches to theoretical development: deductive, inductive, and abductive (Melnikovas, 2018). The present research was inductive because the goal is to explain why scaling up renewable energy can improve the energy problem in South Africa. In this study, an inductive approach to investigate the problem was adopted, provided that inductive research presents scholars with the opportunity to generate new knowledge and dataset to answer the present challenge. The inductive approach allows the researcher to observe the phenomena, collect data, describe the phenomenon under study, and analyse

that data to generate a theory (Woiceshyn & Daellenbach, 2018). The justification is the inductive approach. The bottom-up data-driven approach allowed the dataset to be condensed and provided a rich descriptive meaning to explain the phenomena better than other approaches used in qualitative research paradigms (Azungah, 2018; Babbie, 2007; O'Sullivan et al., 2007).

4.4 Methodological choices

The choice of methods depends on several factors, such as the research question, research purpose, data sources, analysis techniques, population, context, and others (Strijker, Bosworth, & Bouter, 2020). Because of the factors emphasised above, a qualitative research method was preferred for this study to ensure that relevant population and data are collected to discuss the research problem.

The methodological choice of this research was qualitative (Saunders, Lewis, & Thornhill, 2019). The motivation for the choice of methodological because qualitative research can offer a more rich and deep investigation of the problem because researchers can observe and interact with the participants in the renewable energy space, and these interactions can produce meaningful textual datasets capable of describing and explicating phenomena as opposed to quantitative research (Melnikovas, 2018; Saunders et al., 2012).

The reasoning behind qualitative research methodology is that this research is primarily suitable for understanding complex problems, such as scaling up renewable energy where there are a plethora of participants and stakeholders and producing datasets that can answer the how, why and contextual problems of the problem (Creswell, 2014). Qualitative methodology is buttressed by paucity and uncertainty about the ideas, such as circular economy and renewables and other issues considered in this study.

Interpreting the phenomena, the complexity and nature of the problem, and the need to provide new insights and descriptions of the problems lend themselves to a qualitative inquiry rather than a quantitative approach (Park, & Park, 2016; Creswell, 2008 & 2014). In this study, the problem relates to renewable energy, and qualitative research methodology is the most

appropriate theoretical lens to understand the problem and provide actionable solutions.

4.5 Research strategy

The research onion explicates the strategies scholars can adopt, such as "narrative inquiry, grounded theory, action research, case studies, ethnography, archival, survey and experimental research" (Melnikovas, 2018, p.33). The selection of the research strategy was based on aims, objectives, theoretical support, and research methods. Several research strategies can be selected, including experimental research, action research, case studies, and ethnographical and archival research (Saunders et al., 2019). Provided the energy problem in South Africa, it is significant to know how the country arrived and what must solve the problem. The strategy used was to collect data through qualitative in-depth interviews.

The research strategy also refers to the inquiry approach to collect data and understand the problem. The phenomenological approach was chosen because the research can conduct open-ended interviews to collect data, and this dataset can then construct knowledge about the phenomenon. The phenomenological analytical study permitted for exploration of complex issues, such as renewable energy, through the interaction of stakeholders embedded in real-life settings (Creswell, 2014; Saunders et al., 2019).

Through phenomenological investigation of the problem, there is a potential to elucidate, perspective and context about the phenomena compared to other techniques for this study (Mahajan, 2018; Creswell, 2014). The strategy to collect data was semi-structured open-ended qualitative interviews. The justification for using semi-structured interviews is the flexibility in which the dataset was coded, and research themes were generated (Deterding & Waters, 2021).

4.6 Time horizon

Time is essential in research, and scholars must determine how much time was spent designing, collecting, analysing, and reporting data. The time horizon is classified under longitudinal and cross-sectional studies (Saunders, Lewis, & Thornhill, 2019; Hayden &

Steenkamp, 2020). This study used a cross-sectional approach to collect data about fundamental phenomena of interest, and this was also owing to time constraints. The cross-sectional approach is the most suitable technique for examining the problem because of the context and type of data required in this study (Iovino & Tsitsianis, 2020). The dataset was collected over three months, analysed, and reported. Last, time constraints and resources are the primary motivation for choosing a cross-sectional rather than a longitudinal approach.

4.7 Study population

The group and context to which the results are attached are essential in research, also known as the population. The selection of the people of study is necessary because the information collected depends on the quality of the population studies (Haydam & Steenkamp, 2020; Creswell, 2014). The population of interest in this study was employees working with independent power producers in South Africa, as well as Eskom employees. The choice of this population is essential because of the knowledge base and information that can elucidate why and how to scale-up renewable energy in South Africa. The population has industry experience and is aware of the sector's challenges and opportunities.

4.8 Sampling method and size

The population of 13 participants for this study was purposively sampled from the population. The motivation for using the purposive sampling approach is that the phenomena under study require the population to have some specialised knowledge in the sector; therefore, using purposive sampling to draw participants is the most appropriate. The selection criteria were limited to participants with at least three years of relevant experience, being in a managerial role in the industry and well-versed in the challenges and opportunities in the renewable energy area. In qualitative research, data saturation is critical; therefore, the study was saturated with 13 participants. The data collected was of probative value to enable the research to generate critical themes to answer the research questions. The research also used secondary data to fill in the divergences from the primary data set collected. Newspapers and news material debating renewable energy in South Africa were used to enrich the data collected (Creswell, 2014; Babbie, 2007).

The sample size is less for qualitative research than for quantitative research, and data saturation gives an indication of the validity of the sample size (Saunders et al., 2017). The sample size for this study was set at 13, which was decided before the research began (Sim et al., 2018); however, the size can vary from 12 to less or more depending on when data saturation is reached during the investigation (Guest & Bunce, 2006). Data saturation is very important. Data collecting will carry on until the saturation point is achieved (Braun & Clarke, 2021).

The data saturation principle and practical considerations are the justifications for using a small sample size. Qualitative research is defined by the notion of data saturation, which permits the use of a small sample size and extended data saturation. The second defense is grounded in practicality. The population's tiredness makes it difficult for researchers to conduct research during a pandemic and to achieve a high response rate. Therefore, it is recommended to use a small, manageable sample size (Vasileiou, Barnett, Thorpe, & Young, 2018).

4.9 Unit of analysis

The unit of analysis for this research is perceptions of individuals working with independent power producers in South Africa, as well as Eskom employees. These individuals possess a wealth of information about renewable energy. Therefore, it is essential to tap into this knowledge to answer the research questions related to the challenges and opportunities of scaling up renewable energy in South Africa; therefore, this individual chosen as the unit of analysis can produce critical information about the phenomenon.

4.10 Measurement instrument

The research instruments are devices used to collect data in a qualitative research study. The instrument used to collect data in qualitative research is essential is an interview guide (Creswell, 2014). Digital platforms, such as Microsoft teams, have become critical during the pandemic (Majid & Vanstone, 2018). The current study collected non-numeric information and textual data by recording the interview. They were transcribed and interpreted to inform

an understanding of the challenges and opportunities of scaling up renewable energy in South Africa. The instrument used in the study was an interview guide developed from core elements of the literature and revealed in Appendix 2 that the researcher used to collect qualitative data. The information is coded through Atlas ti software and presented thematically according to the core themes generated during the analysis (Braun & Clarke, 2021). The research questions supported data analysis and theme generation.

4.11 Data collection process collection

The data collection technique employed in this study was qualitative through semi-structured open-ended interviews conducted through a Microsoft team conferencing tool. Interview invites are administered through email before the scheduled interview. A copy of the informed consent form is attached to the email sent out to explain the purpose of the interview and the information sought. All participants were informed about the research ethics principles, such as no harm, dignity to participants, privacy, and confidentiality. First, ethical approval was sought for the study from the research ethics committee at GIBS before the research instruments are deployed to determine its suitability. The research collected information for completing this research project. The details are kept confidential and not shared with third parties outside of the research project.

The semi-structured interview with a participant through Microsoft teams was conducted and recorded with the participants' knowledge and consent. They were informed about the purpose of the interview and how the recordings would be used in the research (Santhosh, Rojas, & Lyons, 2021). Data transcription of semi-structured interview recording transcripts was accomplished using Office 365 (Olapane, 2021).

4.12 Pilot study

It is impossible to overstate the value of a pilot study in research. The goal of the pilot study is to determine whether the study's instrument is practical, and the research needs to be clear about its goals (Ismail, Kinchin, & Edwards, 2018). The researcher can validate the methodologies and assess the viability of the chosen methods and the kind of data collecting

during the pilot project. Six participants made up the sample size for the pilot study, which was modest enough to allow the researcher to tie up all the loose ends in the study's theory, framing, data analysis, and presentation (Saunders et al., 2017).

The framework of the pilot study plan determined the participants, sample, context, location, and methods for data collection. The second stage involved evaluating the research tools and procedures. Following the pilot study, the researcher modified and improved the tool and made dynamic additions, deletions, and word replacements in the questions. The final stage of the pilot research was to consider the tool and make deployment plans for it (Janghorban, Latifnejad Roudsari, & Taghipour, 2014).

4.13 The quality control measures

Quality is essential in research, and scholars must ensure that studies meet specified qualitative parameters. This qualitative research used personal reflectivity, end-user involvement, transferability, and triangulation of data sources to ensure the quality of the final output or research report. Other strategies, such as member checking; audit trails, and memos, are used to enhance the credibility, transferability, dependability, and authenticity of the report (Golafshani, 2003; Graneheim, Lindgren, & Lundman, 2017; Levitt, Morrill, Collins, & Rizo, 2021). Rigorous ethical standards are adopted to ensure that quality is provided priority.

In qualitative research, reliability is ensured by the use of credibility and trustworthiness. The strategies of ecliptic self-bracketing, self-transparency, self-exclusion, and reflexivity are used to increase trustworthiness and believability (Shufutinsky, 2020). The ability to be credible also refers to whether study findings are deemed to be credible. The researcher used additional strategies, such as the TACT model (which stands for trust, audit ability, credibility, and transferability), which was made clear by this. By using this model, the research ensured that the data's source and quality are trustworthy, that the results are trustworthy, that the data have a proper audit trail, that the data are collected, verified, and analyzed transparently, that the research is transferable, and that it acknowledges multiple realities to strengthen the analysis (Daniel, 2019).

4.13.1 Research credibility

A crucial component of qualitative research's quality is its trustworthiness. Because of the certainty and confidence associated with the study findings, the results of this study passed the believability test (Creswell, 2014). Researchers typically judge the credibility of qualitative research based on how plausible and believable the findings are (Anney, 2014). The fieldwork-gathered raw data set, which was analyzed, provided an illustration of the distinct perspectives and opinions of the research participants. The analysis of the data was accurate and unaffected by the researcher's personal beliefs or observations of the phenomenon (Saunders et al., 2017). In this study, lengthy involvement, member checking, triangulation, and observation procedures all contributed to the qualitative research's increased credibility (Elo, Kääriäinen, Kante, Pölkki, Utriainen, & Kyngäs, 2014).

4.13.2 Research transferability

Transferability, which measures how well the findings may be applied to different study contexts or settings, is crucial and the second sign of quality in inductive research. The lengthy description was employed in this study to contextualize and place my findings. The results of this study can be applied to settings with populations that are similar. The extensive description in this study provided insight into the behavior and experiences of the population in a caring environment. It provides considerably more information about the context and setting of the study to enhance the behavior and experience of the population under study with regard to diversity (Pratt & Yezierski, 2018).

4.13.3 Research confirmability

Additional conformability was another marker quality applied in this inductive qualitative research, and it explicates how much the research findings are verifiable and confirmed by other researchers, peers, and academics (Singh, Benmamoun, Meyr, & Arikan, 2021). The research applied to know confirmability approaches to verify the dataset and the research's authenticity and interpret the findings. Interpreting the dataset was narrow to focus on the critical issues of discourse, and it was derived from the data and only that data and not any

other inferences (McGinley, Wei, Zhang, & Zheng, 2021).

Dependability in this study was achieved through the qualitative data collected from the participants, and because of the knowledge and level of experience in the group, the findings from the study can be held stable over a long period (Boucerredj & Debbie, 2018). The theoretical framework developed can be tested by other scholars in the field and build new antecedents and propositions.

4.14 Data analysis approach

Qualitative data analysis is frequently difficult, labor-intensive, manual, and subject to theoretical framing restrictions (Azungah, 2018). Thematic analysis and content analysis were two methods used in this qualitative study to analyze the data. In order to construct codes and organize the data to provide meaning, the thematic analysis used first- and second-cycle coding. The themes depict subtleties for academics to interpret meaning and make a story about facts (Saunders et al., 2017).

Six crucial steps in Atlas ti were used to complete the data analysis: (1) initial data organization; (2) open and axial coding; (3) development of an initial codebook; (4) piloting of the codebook; (5) completion of the coding process; and (6) review of codebooks and determination of the analysis's key themes (Richards, & Hemphill, 2018). The seven essential steps listed by Lester, Cho, and Lochmiller (2020) for conducting a thematic analysis of data are data preparation, data transcription, researcher familiarization with the data, memorization of the data using Atlas ti software, coding, generation of codes, moving themes from categories to themes, and transparency of the analytical process.

The qualitative data analysis approach provided meaning for the information collected through in-depth interviews. The thematic analysis process was adopted to present meaning to the data collected from participants. The data was collected, cleaned, and uploaded to Atlas. ti and the six-step approach developed by (Braun & Clarke, 2006) was implemented. These steps include familiarity with the dataset, generation of initial codes and development of codebook, searching critical themes from the data, review of themes, definition and tagging

of themes, and research report write-ups (Saunders et al., 2016).

The complementary approach described by Lester et al. (2021), where the first phase of the data analysis, preparation and organisation of the dataset performed in the second phase, the interviews and field notes were transcribed with the aid of Atlas ti to generate a usable dataset; in the third phase; the researcher developed familiarity with the data; in the fourth phase, memos developed to provide additional meaning to the dataset; in the fifth phase; coding and recoding of the dataset; in the sixth phase; the codes translated into categories, and later the categories be converted into critical themes emerging from the dataset; lastly robust quality check and transparency in reporting the findings and to generate theoretical concepts to explain the phenomenon and challenge the assumptions of existing theories about renewable energy (Lester, Cho & Lockmiller, 2020; Braun et al., 2019; Clarke & Braun, 2013; Richards, & Hemphill, 2018; Braun & Clarke, 2006).

4.15 Limitations

Research studies have inherent limitations, and some key themes include theoretical application, methodology, data analysis, sample population, time, and self-reported data. This qualitative research has limitations in that renewable energy is still a relatively new avenue of research. Therefore, there are divergences, in theory, methodology, and methods, and the understanding of the meaning of the phenomenon and context might lack. The convenient sampling approach has shortcomings and biases, and the sample might not represent the population. Also, this research finding lacks generalizability because of the small sample population used (Sebele-Mpofu, 2020); however, the research mitigated these limitations through increased rigour and objectivity to ensure that the information collected could explain the phenomenon. Also, informant/participant reviews, verification of data sources, and alternative explanations of the phenomenon were conducted.

4.16 Research ethical considerations

According to Hesse, Glenna, Hinrichs, Chiles, and Sachs (2019), there are a number of ethical guidelines that research in the big data era needs to go by. These guidelines include

(a) appreciating methodological diversity; (b) encouraging studies that take into account and maintain context, specificity, and marginalized and frequently ignored populations; (c) pushing past legal constraints and fears to discuss frequently chaotic ethical dilemmas; (d) paying adequate attention to the differences in under-researched populations; and (e) taking into account the entire research lifecycle, including data management and storage after research.

Any time an interview is done without causing any harm, consent must be obtained. It's crucial to have participants' permission before doing an in-depth interview through Microsoft teams. Throughout the interviews and data management, the participants were informed of their rights. Because Microsoft Teams can record audio and video, the respondents' privacy worries will be allayed by using encryption and making sure that the material is not shared with third parties (Greeff, 2020). It was taken into account for the respondents' security during the Microsoft teams meeting to make sure the messages were encrypted and inaccessible to outsiders (Wagenseil, 2020).

The researcher followed the GIBS institutional protocol designed by the university, and permission was sought from all relevant stakeholders before the commencement of the research. The research was submitted for approval to the institutional ethics review board, where the research was conducted. The search instrument was attached to clarify and adapt the questions directed to participants (Navalta, Stone, & Lyons, 2019).

4.17 Conclusion

This is qualitative inductive research, and the data was collected using semi-structured interviews. Convenient sampling drew participants working with independent power producers in South Africa. The interviews were recorded, transcribed, and organised before a thematic data analysis technique was embarked upon to extract rich meaning and draw conclusions from the data. The dataset was reported in text and visual displays, such as tables, graphs, and mind maps.

CHAPTER 5: RESULTS OF THE STUDY

5.1 Introduction

The study aimed to determine why and how the scaling up of renewable energy can solve the energy problem in South Africa. The empirical data of this study was obtained from 13 semi-structured interviews with Eskom employees and employees of independent power producers in South Africa. The findings of the empirical data interview transcripts are analysed and presented in a particular order, starting with the profile of the respondents, the relevance of empirical data, discussing of the themes of the study, and finally, answering the research questions.

5.2 Overview of study participants

The purpose of the study sample was obtained from the profile and the relevance of the empirical data. The data was collected from the`13 participants available for the interview.

5.2.1 Overview of the study sample

For this study, data were collected through semi-structured interviews using an online platform, Zoom, with Eskom employees and independent power producer employees. The overview of the study sample was obtained from the profile and the relevance of the empirical data.

5.2.2 Profile of the participants

The participants provided their job descriptions and or background in the energy industry, which aided their relevance in participating in the study (Table 1). The participants comprised individuals working in various parts of the value chain system in the energy industry. This included engineers, business owners and executives in various energy sections, such as gas, oil and petrochemical energy.

Table 1: Participant demographics

Participant	Job description	Industry experience	Gender
P1	Senior engineer	9 Years	Male
P2	Senior engineer	17 Years	Male
P3	Senior business engineer	10 Years	Male
P4	Senior manager	16 Years	Male
P5	Investment adviser energy	21 Years	Male
P6	Managing director	3 Years	Male
P7	Senior project manager – renewable energy	20 Years	Male
P8	Energy specialist	14 Years	Male
P9	Executive head - energy	14 Years	Male
P10	Energy lead	12 Years	Female
P11	Energy and oil manager	11 Years	Female
P12	Senior manager	10 Years	Male
P13	Energy manager	12 Years	Female

5.2.3 Relevance of empirical data

The word list from Atlas ti 22 was used to determine the relevance of the empirical data and the alignment of data across all interviews with the purpose of the study (Figure 4). The dominant words were energy, renewable, power, solar, country, Africa, government, industry, infrastructure, and technology. These words were prevalent across all interviews and were, according to the study. The relevance of empirical data and interviews is essential for the credibility and rigour of the findings (Guetterman, 2015)

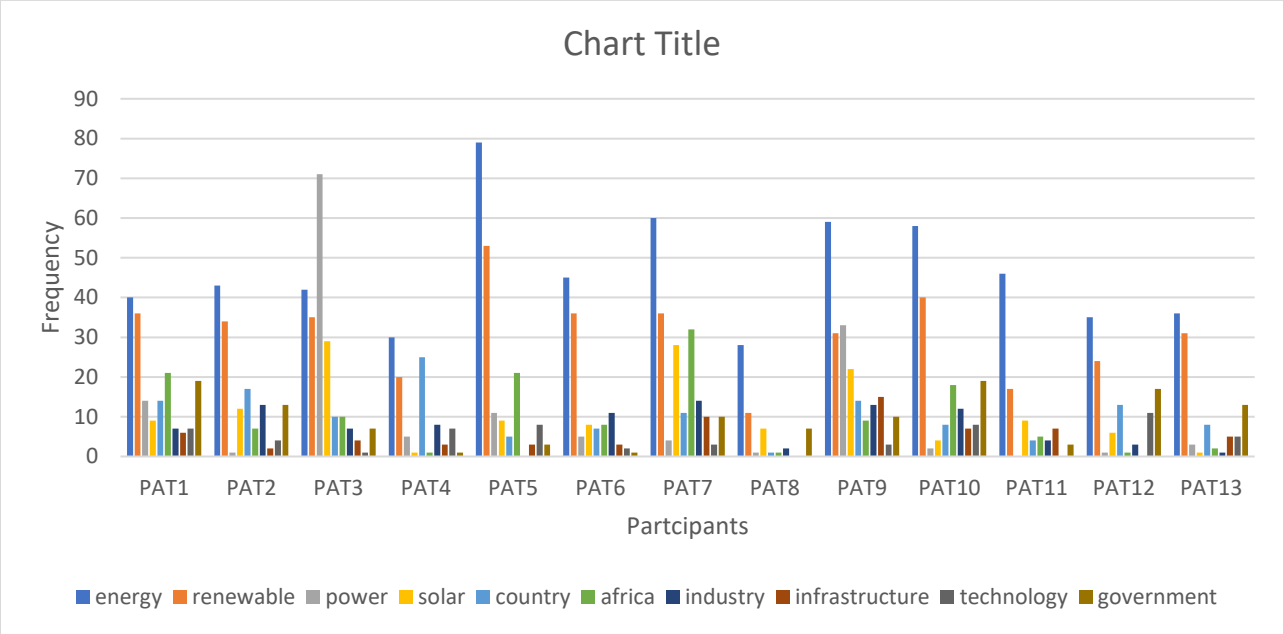


Figure 4: Showing the prevalent words in the study across interviews (Atlas ti)

5.2.4 Saturation analysis

In qualitative research, saturation is the most popular criterion for deciding whether a purposive sample is adequate (Guest, Namey & Chen, 2020). The authors suggested a method for expressing saturation as the difference between the quantity of added information, offering insight or proof that saturation has been reached at a certain level of data processing of less than 5%. Of the 189 codes, the based codes were 115 from five interviews, the minimum number of interviews required for a semi-structured narrative design (Saunders, Lewis & Thornhill, 2016). This was followed by a run length of two, with saturation reached after 11 interviews. This though it was not at 0%, it was at 3%, a minimum threshold of less than 5% proposed by Guest, Namey and Chen (2020).

Table 2: Saturation assessment of base size and run length

Interview number	1	2	3	4	5	6	7	8	9	10	11	12	13
New codes	115					26		16		18		6	
%Change over base						23%		14%		16%		3%	

Figure 5: Saturation dataset

5.3 Themes of the study

There were two research questions formulated to understand how the up-scaling of renewable energy can solve the energy problem in South Africa, described in Chapter 1, recapped in this chapter. The first research question is:

- How can renewable energy be scaled up in South Africa?

and the second question is:

- How can circular economic principles contribute to scaling up renewable energy?

Line-online coding was conducted on empirical data resulting in almost 230 codes which, upon cleaning and removal of duplication, resulted in 201 codes and 453 quotations. The full list of these codes can be obtained from Appendix 7. The codes were then merged into groups resulting in 20 code groups or sub-themes, and these formed six themes. The extracted themes of the study understood the state of energy and renewable energy in South Africa, processes of scaling up renewable energy, challenges for scaling up renewable energy, opportunities available to stakeholders to develop new energy, the primary sources of

financing renewable energy transition in South Africa, and attitudes and perception of stakeholders towards energy.

Table 3: Research questions, themes, and sub-themes

Research question	Theme	Category or code group according to Atlas ti
"How do we scale up renewable energy in South Africa?"	Understanding the state of energy and renewable energy in South Africa	- Understanding state non-renewable energy - Understanding state renewable power
	Processes of scaling up renewable energy	- Available Infrastructure - Components of production
	Challenges for scaling up renewable energy	- State of political leadership - State of skills - Government policy - Challenges of scaling up - Acceptance of renewable technology
	Opportunities available to stakeholders to develop new energy	- Opportunities in scaling up - Consequences of scaling up - Renewable energy transition concerns
"How can circular economy principles contribute to scaling up renewable energy?"	Primary sources of financing renewable energy transition in South Africa	- Financing - Investing in renewable energy - Concerns about circulatory initiatives

Research question	Theme	Category or code group according to Atlas ti
	Attitudes and perception of stakeholders towards energy	- Other available technologies - Climate change - Household willingness to changes - Stakeholder participation - Reuse and recycling initiatives

5.4 Renewable energy in South Africa

The first research question in the study is:

- How can renewable energy be scaled up in South Africa?
- How can renewable energy be scaled up in South Africa?

The research question was answered using two themes: understanding the state of energy and renewable energy in South Africa, Challenges for scaling up renewable energy and opportunities available to stakeholders to develop new energy.

5.4.1 State of renewable energy and non-renewable power in South Africa

The state of renewable energy in South Africa was such that there was a growing demand for energy in South Africa, with 50% of the power consumption attributed to industries. The state of load-shedding resulted from the inability to meet the power demand of the country. Most participants felt that the country might run a risk of experiencing a total blackout owing to the insufficiency of power supply by Eskom. Even with load-shedding, the prices of non-renewable energy products, such as oil and petrol, had been unstable, therefore, affecting the prices of these elements and making them expensive for consumers.

The consequence of low power supply and load-shedding was observed and confirmed by the participants in the micro and macro-economy of the country, where industries were forced to be efficient in all aspects of production to allow efficient use of energy sources, such as oil,

as the prices fluctuated on a daily and weekly basis, therefore, decreasing the chances of survival for businesses that cannot survive this fluctuation. There was a need for an increased supply of power to increase production, and, as a result, increase fuel the economy of the country; however, the increase in production would further increase the power demand, therefore, there was a need for a stable power supply.

> Given the growing demand for energy that the country is experiencing. PAT1

> We might be running a risk of actually experiencing a total blackout in our lifetime. Aren't just not cheating, so my view that is that we do need to transition towards clean energy. But let's take it at a pace where it's safer for the great or the network to be operated. PAT2

> On a technical space, these issues and also on the on the, on the micro, on the economic space, it's a lean industry, right. If you know the price of the fluctuation of the price of oil determines whether you survive today or tomorrow. So, so, so you have to be efficient in all aspects of your operation. That is the bigger challenge because I mean it means every cent, every drop of oil that you get, you must make the most of it. PAT4

> but the fact that there's a shortage of power because all they have to put in is to put in something that's going to generate power. That's going to drive the economy and actually create further demand of power. It is going to snowball itself to increase to, to growing the economy. PAT3

5.4.2 Understanding the state of renewable energy

The state of renewable energy in South Africa was such that 8 participants felt that South Africa's renewable energy was measuring well, with areas, such as the Northern Cape and the Eastern cape having grids serviced by renewable energy; however, the grid capacity had to be increased as mentioned by 6 participants. The increase in grid capacity was still to be determined by policy, as a policy was important in scaling up renewables; however, when renewable energy entered the country, the regulated streams worked well and, therefore, proved that scaling up was tentative and would be a successful attempt. Four of the participants stated that, South Africa and its neighbouring country Namibia were thought to have good renewable resources meant South Africa could afford to use renewable energy sources for power production and power supply; however, the unreliability of these renewable

sources needed for South Africa is considered starting on a hybrid model using renewable and non-renewable resources.

> The renewable industry in South Africa is actually measuring quite well. So, an extent where the northern keep grid capacity has been reached, we can't, we can't plug anything into the notion cave for now until they increase the grid capacity and that is also quickly happening also in the Eastern Cape, right, because that's where a lot of the wind resource is. PAT1

> I think policy is quite an important and driver and in the up-scaling of renewables. I think when the renewables started in the country, they were success, they were subsequent beat windows that take out that was run by the DMRE at the time it was still E. For those that were regulated, it was actually quite attractive for them to participate and go through the big one. PAT2

> The fact that these countries that have good renewable resources, like South Africa, Namibia, their pursuing green hydrogen. PAT3

> But it is the necessary energy mix that we need. PAT1

Table 4: Thematic codes (Atlas ti)

Codes	Sub-theme	Theme
Load-shedding		
Price fluctuations	Understanding state non-renewable energy	
Increased power demand		
Renewable power grids		Understanding the state of energy and renewable energy in South Africa
Effect of policy		
Hybrid model	Understanding state renewable power	
Load-shedding		

5.4.3 Processes for scaling up renewable energy in RSA

Scaling renewable energy, suggested by 5 participants, was to run plans at a slower and less intense rate, which will allow to manage energy demands and make it easier to switch between renewable and non- renewable energy. Participants remarked that there was some infrastructure for renewable energy, and the infrastructure in small towns and cities could also be used for renewable energy. This would allow investors to commit to the opening fractions of renewable energy as the government would have revealed good faith in the renewable

energy projects by using the infrastructure. Six participants felt it was important to follow the plans exclusive to South Africa as other countries' production components were different and unscalable.

> We'll make it will make managing the energy demands much easier, because you can switch on, switch off renewable energy way more efficiently than you can. PAT1

> Like all these small towns and the infrastructure is there, right? Like for instance, like the road agency has actually built really good roads.PAT1

> Like they don't commit to like opening fractions like that because they don't trust the government. PAT1

> I think the short answer is there is some infrastructure for. PAT10

> To call the production of components that go into renewable energy, but it's different things and it's not at scale. I think a good a good report for you to look at is one that's the South African renewable energy master plan. PAT10

Part of the scaling up process includes having the base load of energy for coal-powered stations and then including renewable energy as supplementation to the baseload and building capacity to produce components in-house in South Africa. Five participants also mentioned increasing grid capacity to reach maximum supply; however, this would require support from the government to accelerate production and supply power production using renewable energy through policy; however, several participants remarked that planning was important. Planning would pique the interest of foreign investors, which could make the logic chain and supply chain cheaper and more efficient, therefore, allowing for growth and expansion. Planning would also allow the monitoring of transformers and determine their lifespan, which would allow proper planning for the replacement and servicing of transformers. Planning also allows for budgeting, as it provides time to look for quotes and compare prices.

> Look in my in my view, I know that there's been actually try from the government with support from the industry to actually accelerate. PAT2

> If they have planning, we could actually interest, you know, people from outside investors from outside to come open factories here. And it'll just make the whole logistic and supply chain even much, much cheaper, much more efficient.[PAT1]

> For me, it's more of a probability determination. How often do we lose this transform? If it happens one in five years? I mean, really, that gives us enough time to actually.[PAT2]

> With the pricing structure it I'll say it goes back to education if you know what you want and probably know how much this would cost you, you wouldn't go for something that will cost you 123 because at the at the same time they were quotes that I was getting for 90K for the same. [PAT2]

Table 5: Thematic Codes 2 (Atlas ti)

Codes	Sub-themes	Themes
Capable infrastructure		
Eskom is the key performer		
Investors' lack of trust	Components of production and infrastructure	
Capable infrastructure		
Coal to provide base electricity		
Enhance local production		
Policymaker involvement		
Proper planning is essential	Planning and support	Processes of scaling up renewable energy

5.4.4 Challenges scaling up renewable energy in South Africa

5.4.4.1 Acceptance of renewable technology

The acceptance of renewable energy in South Africa is owing to the challenges in power supply; with frequent power cuts because of load-shedding, people are pursuing alternative power sources and, therefore, are forced to investigate renewable energy. Other reasons for the acceptance of renewable energy are owing to the health benefits of clean energy, such

as less pollution, and with participants looking into healthier options, renewable energy has become an option. Four participants also mentioned the opportunities in rural development renewable energy offers, such as solar and wind farming and increased business opportunities as motivation for accepting renewable energy. Among participants, there was a general knowledge of renewable energy and an acceptance of it as an alternative power source for South Africa.

> We might be running a risk of experiencing a total blackout in our lifetime. Aren't just not cheating, so my view that is that we do need to transition towards clean energy. But let's take it at a pace where it's safer for the great or the network to be operated [PAT2]

> Like the health benefits are like obvious one, like we have less pollution, you know, less. Like, we're hoping that, like, by reducing our emissions that is going to have a positive impact on the environment.[PAT10]

> The opportunities that it brings with is a lot business wise company, business wise and environmentally wise renewable is environmentally friendly so.[PAT10]

> Load-shedding is forcing people to be receptive.[PAT1]

5.4.4.2 Challenges of scaling up renewable energy in South Africa

Although a feasible solution for South Africa, renewable energy has challenges. Some challenges mentioned by 7 participants were battery storage, which was a required entity in using renewable energy, such as solar and wind energy, to store the power for use later. Solar power and wind energy could only generate power but not store it; therefore, there was a need for batteries to store the generated power for later usage. Using solar and wind energy, although cheaper, the batteries needed for power storage were expensive for participants. Another concern presented by renewable energy was the baseload that renewable energy provided. 5 participants felt that the baseload of power provided by renewable energy was not enough to cover the existing power supply divergence in South Africa, and would, therefore, still need to be supplemented by other sources of energy.

7 participants stated that, some other challenges in scaling up are the lack of regulations in

the prices of the renewable energies, resulting in high costs for renewable energy usage in homes and businesses, and because electricity is affordable, people prefer it over renewable energy, this ties in with issues in policy alignment where participants felt that the policies around renewable energy were not clear or aligned across government departments; therefore, it was difficult to align and regulate renewable energy usage and selling without clear policy structures.

> They cannot operate solely on solar or wind, you know, so you will still need that heavy battery storage and currently battery storage is expensive.[PAT11]

> We are dealing with the baseload issue, and we are trying to find you know a lot of renewable energies, energy solutions that can probably solve the divergence that we are seeing.[PAT4]

> It goes back to this market being regulated really, if there's proper regulation, then prices should also.[PAT2]

Adding to the cascade of challenges of scaling up highlighted by some participants were compliance issues with using renewable energy, as most renewable energy users were non-compliant with the regulations for power supplies or found it difficult to follow the regulations either owing to expenses or lack of structural policies. Another challenge, not mentioned often, was investor lack of trust in the South African economy of renewable energy. Without major investments, renewable energy products would still be expensive to produce and use. This would lead to expensive renewable energy, therefore, complicating it for the average working class and below working-class citizens of South Africa to afford it.

Another challenge was the lack of localisation in the production of renewable energy products. 5 participants felt the government was not driving localisation, and yet they had been promising localisation; however, this was not met with any action. Adding to the government's lack of action on localisation was the lack of leadership, a driving force with a vision to make renewable energy accessible to South Africans. Participants felt there was a heavy reliance on imports for renewable technology and a weak procurement plan in place, as they felt that renewable energy technology procurement should have been much bigger a while ago to meet the capacity and demand for renewable energy in the country.

> We do need to build local capacity production, but we also should balance that with appropriately taxed imports.[PAT10]

> I think if we were to go back to manufacturing ourselves, you know again creating jobs and be able to also scale-up the businesses. [PAT11]

> The components are not manufactured locally in large numbers. What that means is we will rely heavily on. [PAT6]

> I think it's in the procurement. I moved with the stance that the procurement should be much bigger. The capacity we need of renewable energy should have been much faster a long time ago.[PAT5]

5.4.5 Government policy

A participant recalled it was only in 2021 when the president announced there was an increase in the limit of self-generation of power to 100megawatts, which was a testament to how restrictive government policy was on alternative power sources, not government-owned. Although the increase in the limit of self-generation power was late easing the power demands on Eskom, especially because load-shedding had been a concern for South Africa for several years, since 2007, 6 participants felt it was a step in the right direction that this policy change was enabling and would help regard renewable energy and eradicating load-shedding.

9 Participants also felt that although the government attempted to implement a policy for renewable energy, there was much red tape owing to the bureaucratic process of the government politically motivated. This then affected businesses and their ability to sustain production until the load-shedding was sorted or there was a sign-off on renewable energy; however, the waiting was only sustainable and accomplishable if businesses had the means concerning finances to wait.

> I would say that's how policy can and I'm feeling quite optimistic that what has been done now is hopefully going in five years' time we should be able to hopefully eradicate loadshedding.[PAT3]

> On their end they they're processes are so bureaucratic that it takes forever. [PAT1]

> That's one of the biggest challenges that a lot of companies are facing and it is only massive companies that have the finances to hold off until the government eventually signs.[PAT1]

5.4.6 Lack of political leadership

Part of the challenge in scaling up renewable energy is the lack of political leadership participation in implementing renewable energy policies and structures. 7 Participants felt they had no confidence in the political leaders of South Africa in implementing structures for renewable energy, and although there has been some political attention towards renewable energy, it has not been enough, therefore, showing it was not a priority for politicians. This was evident in the lack of commitment to planning and executing plans for energy and renewable energy supply, even though power supply had been one of the major issues in South Africa owing to load-shedding.

> So, the leadership needs to take this serious and not run it like a government thing, like almost be a dictator. And in the energy sector and be like, hey, all you guys have amended to connect within 18 months, if you mess it up, you, you're going to pay heavy penalties.[PAT1]

> Strength of leadership, being able to collect everybody around the table and say guys, this is what we want to do, this is how we enable it, and this is where I'm going. [PAT7]

> The leadership structures themselves, it doesn't give me much confidence. [PAT3]

> We don't plan and commit to the plans, or rather, let me say call we don't plan well and if we commit to the plans, it's not helping us scale as fast as we actually could. We can't afford not to have electricity as stage six was horrific, some of us may have been out of power for like, whatever hours, but it's good for businesses. [PAT1]

5.4.7 The skills divergences in the renewable energy sector

Although the cost of renewable energy was expensive, 5 participants felt it is becoming more accessible and cheaper; therefore, participants emphasised that it was important for the government to make sure there was awareness of renewable energy products for people to know what is out there and what options they choose with alternative power technologies and the available polices implemented for those technologies.

This tied in the issues of jobs and job security as most people working in non-renewable energy industries were anxious about the state of jobs should South Africa move towards renewable energy; therefore, there was a need for communication from the relevant parties to the public, letting them know there are jobs in these renewable energy resources that could absorb workers. This would bring less panic and increase renewable energy acceptance; however, when comes to the skills, most participants felt there were sufficient skills in the country within the renewable energy space and that these skills would be enough to begin industries of renewable energies.

Some participants felt there were inadequate skills to begin renewable energy industries. The country was financially in the position to acquire the needed skills. One option would be to train people for jobs in renewable energy or importing skills. This presents an opportunity for South Africa to position themselves as experts in skills to enter renewable energy within the African continent.

> We could also be position ourselves as leaders, at least in the African space, where people can come to South Africa, two get renewable energy skill.[PAT10]

> Interlinking with people on an individual face, they awareness is still needed for us to know what is out there and what options can we opt for. I think government needs to focus too much on awareness in this regard. Policies are in place, but we don't know much about those policies.[PAT13]

> Concerning skills, I don't think we have enough skills. Because we haven't had a long history of having renewable energy. [PAT6]

> The skills gap that will continue to be the and especially for the you know our engineers and scientists now who've graduated resetting at home, looking for jobs and to go work at a coal mine for example. They don't have the skills to start working on a solar. [PAT11]

Table 6: The codes and sub-themes of Theme 3 (Atlas ti)

Codes	Sub-themes	Theme
● Grid collapse	Acceptance of renewable	Challenges in scaling renewable

Codes	Sub-themes	Theme
○ Health benefits owing to a cleaner environment	technology	energy
○ Improving life for the better		
○ Increased business		
○ Increased demand		
○ Load-shedding is forcing people to be receptive		
○ Rural development		
○ Battery storage	Challenges of scaling up	
○ insufficient baseload		
● Challenge: Market regulation		
● Challenges: Financial constraints		
● Challenges: Grid constraints		
○ Cheaper Renewable alternatives		
○ Compliance issues		
○ Investors' lack of trust		
● Lip service to localisation		
● No policy alignment		
○ Reliance on imports		
○ Weak leadership		
○ Weak procurement planning		
	Government policy	
○ Enabling policy		

Codes	Sub-themes	Theme
○ Energy industry		
○ Energy mix		
○ Government has removed barriers		
○ Government is now doing a lot		
● Government red tape		
	State of political leadership	
○ Leadership not there		
○ Leadership: Not effective		
○ No confidence		
● Political will lacking		
● Political will not lacking		
○ Priority has been provided to renewable projects		
○ Prohibiting progress		
○ Continental renewable energy skills champions	State of available skills	
○ Costs are coming down		
○ Create awareness through market education		
○ Develop new products		
○ Requisite skills sufficient		
○ Train people		
○ Transition for those who can afford		
○ Transition to renewable to be conducted gradually		

5.5 South Africa’s opportunities to develop new cleaner energy

5.5.1 Potential in scaling up renewable energy

9 participants listed several opportunities—some opportunities in scaling up renewable energy were the discovery of new strategic industries that benefit the environment and the economy, providing diverse career opportunities. Although there was still awareness needed, 4 participants revealed unexplored career options in the renewable energy industry. The other opportunities in scaling renewable energy mentioned by participants were the influence of renewables on designated local content, which refer to the changes renewable energy would bring to the country's local content. The influence of renewables on jobs and on the consumer came with a new generation of leaders with more experience. They could become experts globally, therefore, leading to opportunities in new investments and economic improvements through socioeconomic development by increased taxes and capacity development by training in newly created skills.

The other opportunities in up-scaling renewable energy mentioned include community upliftment, where companies could attach themselves to small-town schools and provide things like computer labs, the solving of the energy crisis through clean, sustainable energy. Other participants mentioned that scaling up renewable energy was a chance for banks to fund households by giving normal citizens the ability to purchase home solar kits to power their private homes. The benefits of renewable energy plants were that it took a couple of months to build the plants and connect them to the grid system and that this was an opportunity for users to be independent grid users, which then allowed for less demand on Eskom for electricity, therefore, possibly eradicating load-shedding.

Participants mentioned that the scaling up of renewable energy also provided opportunities for improvement in the life quality for people in villages without electricity and because of cannot participate in economic activities that require technology. Scaling up of renewable energy could help in painting a positive perception in South Africans of renewables, it has a positive influence on carbon emissions because it decreases the levels of carbon emissions and provides women vast opportunities to work in the energy sector.

We will say that the global clean energy economy will make a way for industrial opportunities. Strategic ways will come up. And if we investigate new commodities that we have not been focusing on previously, just last week I discovered about commodities like vanadium that could be good for the environment and that we could use for renewable. PAT13

There are so many jobs, right. There are lawyers, there's environmentalists, there's a lot of things that people could be doing within the industry. But I think there's a lack of awareness of the career opportunities and the career paths that are available. PAT10

I think if you can invest, especially where we don't have kids now and I will talk off grid system, I know they are costly, but they're rewards for that. I think even for the economy development of the country, if there's a village where there's no electricity and there's no creed to supply that village, you can set up a microgrid there. PAT2

I think you know if the banks can come in, you know to provide some level of funding to be able for the normal South African citizen to actually purchase, you know, a home solar kit. PAT11

One participant described the direct influence of RE on carbon emissions and stated that, "Your renewable energies can bring down your emissions, your cupboard footprint".PAT12

5.5.2 Disadvantages of renewable energy to the South African economy

There are consequences of scaling up renewables in South Africa and some participants made known that although renewable energy reduces carbon emissions, one participant stated that "the reduction of carbon emissions is linked to job losses as most of the jobs in South Africa are industrial jobs relying on burning fossil fuels, such as coal.

"PAT8. "… consequence of scaling up renewable energy is the Impact it has on customers in that participants felt renewable energy was costly for customers to buy at the initial stages and that there was not enough land for the solar panels to be planted so that there could be the production of vast amounts of power…PAT10

"Consequences were continuous technological challenges regarding grids due to the different voltage levels of specific equipment in factories, schools and homes that will need specific voltages to be supplied…" PAT7

3 Participants mentioned that:

> "Grids always seemed to experience technical challenges, and it is a concern how these challenges will be mitigated in renewable energy use. Another consequence of scaling up was that electricity is a raw material for most production factories; thus, renewable energy must be able to aid in sufficient power for production purposes…" PAT11

5.5.3 Renewable energy transition constraints

The observation of renewable energy, as mentioned by 9 participants, should be that it will make managing energy demands much easier; however, there were concerns about transitioning to renewable energy, such as ethical concerns, such as proper mining practices of some of the natural resources used in renewable energy and the cost of the renewable energy will it be affordable to everyone. Other concerns involving costs are the high input costs of renewable energy and the transmission level costs which only meant that the upper middle class and the well-off could afford renewable energy and, therefore, scaling up would require making it affordable for all South Africans, especially those in the rural areas.

There would be a need to protect such infrastructure from theft because of the excessive cost involved in renewable energy. The limitations of renewable energy, such as the inability of solar energy and wind energy to provide a 24-hour power supply even with the presence of battery storage; therefore, some businesses could resist renewable energy as it could slow them down. 8 Participants alluded to need extensive fields of solar to store enough energy. Another limitation was a need for a pragmatic use of solar and wind energies as they used rare earth materials in their machinery, which still required mining. The tight regulations on renewable energy also pose limitations in up-scaling renewable energy, therefore, making progress in making these sustainable slow.

Concerns about production were mentioned, and the 7 participants revealed that ample production was conducted in foreign countries owing to foreign investment in renewable energy; however, South Africa needs production within the country, enabling job creation. Some participants felt that the implementation process needed to be conducted

professionally, carefully, and slowly considering the need to grow the economy by gradually retiring the coal stations with renewable energy stations because of the ability of coal to provide large amounts of power.

> Everything is like renewable, renewable, but realistically renewable can't stay in 24 hours, so like can only work in these when the sunlight and even if you have storage, it wouldn't it? You'd need like a mess field to store enough power. PAT1

> We do need to build local capacity production, but we also should balance that with, with, with appropriately taxed imports. PAT10

> So, I think if we were to go back to manufacturing ourselves, you know again creating jobs and be able to also scale-up the businesses. PAT11

Table 7: Codes and sub-themes of Theme 4 (Atlas ti)

Codes	Sub-themes	Themes
○ Discovery of new strategic industries	Opportunities in scaling up	Opportunities in scaling up
○ Diverse career opportunities		
○ Economic benefit		
○ Impact of renewables on jobs		
○ Impact on the consumer		
○ New generation of leaders		
○ new investments		
○ Socioeconomic development		
○ Capacity development		
○ Creation of new skills		
● Opportunity for banks to fund households		
● Opportunity for clean energy		
● Opportunity to solve the energy crisis		
● Opportunity: Community upliftment		
Opportunity: New project investments		
○ Socioeconomic development		
● Positive influence on carbon emissions		
● Positive influence on grid dependence		
● Positive influence on load-shedding		
● Positive perception of renewables		
○ Quality of life		
○ Quicker to build a renewable plant		
○ Vast opportunities for women		
○ Technological challenges	Consequences of scaling up	
○ Technical challenges during deployment		
○ Influence on consumer		
○ Treat electricity like raw material		

Codes	Sub-themes	Themes
○ Reducing carbon emissions threatens jobs: Job losses	Renewable energy transition concerns	
○ How renewable energy should be observed		
○ Limitations of renewable energy		
○ Price manipulation		
○ Questionable financial viability		
○ Renewable may pose affordability challenges		
○ Renewables		
○ not for immediate solution		
○ Renewables on ESG		
○ Theft of infrastructure		
○ Tight regulation		
○ Ethical concerns		
○ High input costs		
○ High transmission costs		
○ Limited infrastructure		
○ Local production		
○ Resistance to renewable energy		
○ Transition to renewable to be conducted gradually		
○ Transition for those who can afford		

5.6 Sources of financing renewable energy in South Africa

The second research question is:

- How can circular economic principles contribute to scaling up renewable energy?

Two themes were discussed, indicating the primary sources of financing renewable energy in South Africa and the attitudes and perceptions of stakeholders towards renewable energy, respectively.

5.6.1 Green energy/RE investment in South Africa.

When participants were asked what financing options were available for South Africa in up-scaling renewable energy, they included foreign investments, such as direct foreign investments. This includes companies that funded the development of renewable energy projects in South Africa and other foreign investments, such as world banks and global multinational funders. Other funding options included local banks, especially those with small-scale funding, such as renewable energy for housing and other developmental funding. IDC

and TBS are already attempting to fund renewable energy infrastructure. The government fund initiatives; however, 10 participants felt that the government could communicate better on why certain things were completed and improve their vision for solving the energy crisis in South Africa, as renewable energy is a need and a worthwhile investment.

> Besides the foreign funding and then obviously IDC and TBS are attempting to do their part and the banks as well. I think they could have done more. I think they could be more aggressive, and I think they could communicate what they want to do more because I think if you don't tell people why you want to do things, then there's a lot more resistance. If you say this is what we want to do, this is why we want to do it. PAT10

> Norwegian company is investing a huge amount of money into static in South Africa to develop renewable energy projects and build them. PAT7

> They seem to be misaligned and I think somewhere along the line that needs to come and help you know large scale and newborn energy companies to be able to, you know, work together, work together with the government as a one unit and so that you can, you know fast track these large projects. PAT7

> At a smaller scale, commercial and industrial commercial banks can fund. PAT6

5.7 Concerns about circular economic initiatives

The participants' concern about circulatory initiatives were that circular initiatives had better technology and improved inverter technology that operates even more efficiently than previously available, which alluded to the rapid advancement in the technology. The other concerns were economy related, and some participants felt that the circular economic concepts were not established, whereas others felt there was an economic benefit to circulatory measures, such as saving money.

The 6 participants also felt that circularity required innovative business models. The initiatives were difficult to apply in energy as a reuse. Reduced principles were difficult to implement in energy. They expressed concern whether the material in renewable energy could be used in other industries. A final concern was the need for evidence on renewable energy in circularity

talks, such as is renewable energy better than other technologies, as there is little data available on it.

> Reduce, reuse and in energy it's a bit difficult. Like once the wind turbine you know has, we should end of life. What do you do with that? But then there's a question of what happens to the solar panels at the end of the life of the of like, the plant. Can you use it in other industries? The things that we found were like what they what would be considered as sort of a way to get to a circular economy for energy would be going into the renewable space because you're not putting in any energy yet. You're just you're just using the sun, etcetera. PAT10

> And that says that renewables are and instantly better than other technologies with respect to that because you know, we still need to. You need a huge length mess to do these things. And then we still need to dispose of these things and all the and all those things, I think that. a lot of data still is still required for us. You can compare different technologies. It's always it's always difficult when you compare something you know, you call industry that's got hundred or hundred plus years of data with. PAT9

> So, it really technology wise it's doing great and even inverters that are now coming out, they operate way more efficiently. They fail. The failure rate is much less. PAT1

Table 8: Codes and sub-themes of Theme 5 (Atlas ti)

Code	Sub-themes	Theme
○ Developmental finance ○ Direct foreign investment ○ World bank ○ Large multinational funders ● Government communication essential ○ Government Departments working in silo's ○ Local banks ○ Worthwhile investment	Financing	The primary sources of financing renewable energy in South Africa
○ Better panel technology ○ Circular economy concept not established ○ Circularity requires innovative business models ○ Circularity talks in renewable energy need evidence	Concerns about circulatory initiatives	

Code	Sub-themes	Theme
○ Difficult to apply in energy		
○ Economic benefit of circularity		
○ Improved inverter technology		
○ Job losses		

5.7.1 The attitudes and perceptions of stakeholders towards renewable energy

5.8 Alternative technologies

Some technologies that participants have come across include biomass, energy recovery energy which recovers energy from waste products, nuclear, solar, wind, geothermal, and molten salt, which some of the participants think are worth investigating. The other option that participants observed as worth examining was combining renewable energy with other kinds of energy, such as coal; however, capacity must be enhanced in making these components in South Africa, by investigating the infrastructure in townships and small towns. Even though there were available technologies, it is still important to teach consumers to manage resources and be responsible for them.

> I think the short answer is there is some infrastructure for called the production of components that go into renewable energy, but it's different things and it's not at scale. I think a good a good report for you to look at is one that's the South African renewable energy master plan. P10

> Once you take people, once you teach people on demand-side management, you also teach them to switch off lights that are not that that they don't need. You also teach them to, you know, minimise on the use of electricity, not necessarily because they are they are. But because of the whole value chain or energy management or environmental conscious. PAT4

> We should also look at nuclear as well. solar wind, geothermal energy on molten salt. PAT3

5.8.1 Global warming and climate change in South Africa

Evidence of climate can be observed in the increase in temperatures and floods in places such as Durban. Although 5 participants felt that climate is real and that the influence of climate change is all around us, participants also felt there is considerable politics involved in climate change and that using renewable energy does not negate climate change. Using

renewable energy still requires coal to provide a base level of electricity, and backup renewable energy should renewable energy not meet the power demands of the energy supply.

> We can see what we can see the impacts of it all around us. We don't have to look even hard, you know, like so Africa has. PAT10

> There has been some politics involved. Having the renewable energy doesn't necessarily mean. You have cancelled out climate change. PAT6

> You can use a renewable energy or solar system and then you use your electricity as a backup.PAT12

5.9 Energy transition and perception

The household's willingness to change, stakeholder participation, reuse and reduce initiatives is imperative. Participants feel this will help communities build sustainable, energy efficient communities. They are also happy to be revealed uniquely so they can deal with energy use in their daily lives. 4 Participants felt there were fora available, directed at renewable energy, with diverse stakeholders and industries, but participants felt stakeholders did not have the appetite or any specific solutions for the problem at hand. Participants felt that reuse and recycling might influence the environments, reducing landfills and less waste, making our environmental challenges less than what we are facing.

> “So, you could actually build communities, right, because a lot of the good resources tend to be in these smaller towns, which are kind of neglected by the never. PAT10

> “It makes you then realise that maybe the discussions that are happening there, they are not discussing the problem at hand with specifically what I've just alluded to say the script constraints and there's no appetite either from Eskom and these guys and to say guys. PAT2

> “If we can use if we can reuse and use every single thing that that we put into a system, it means that there'll be like obviously less landfills, less waste”.PAT10

Table 9. Thematic Codes 6 (Atlas ti)

Code	Sub-theme	Themes
○ Biomass	Other available technologies	
○ Capable infrastructure		
○ Combining renewable energy with other kinds of energy		
○ Comfortable with the cost		
○ Energy recovery energy		
○ Enhanced capacity		
○ Ensure productive use		
○ Environmental resource management		
○ Molten salt energy		
○ Nuclear energy		
○ Solar, wind, geothermal		
○ Climate change is political rhetoric	Climate change	
○ Climate change is real		
○ Coal to provide base electricity		
○ Effect of climate change		
○ Electricity to backup renewable energy		
○ Evidence of climate change		
○ Alternative energy source for households	Household willingness to changes, stakeholder participation	
○ Paradigm shift		

Code	Sub-theme	Themes
○ Provide tangible benefits	Reuse, reduce, recycling initiatives	
○ Reuse and recycling influence the environment		
○ Reuse and recycling are important		
○ Reuse will reduce waste and conserve the environment		

5.10 Summaries of findings

The first research question is:

- How can renewable energy be scaled up in South Africa?

To understand the scaling up of renewable resources, there was a need first to understand the state of power resources in South Africa, the state of non-renewable in South Africa was such that there was load-shedding owing to the high demand for power and low supply. The price of oil was on a continuous rise, and companies were struggling to keep up and plan for their production cost. The first step to scaling up renewable energy was accepting renewable energy as a viable alternative power supply. The other was understanding the challenges surrounding scaling renewable energy, which rested much on government policy, political leadership, and financing. Participants felt that the policies surrounding renewable energy were restrictive and bureaucratic and that the removal of these restrictions coupled with effective leadership as the driving force in implementing policy and renewable energy infrastructure could be a considerable forward movement towards the up-scaling of renewable energy.

The second question is:

Circular initiatives, such as innovation, are big drivers in the circulatory environment, and these are principles needed for renewable energy. Local financing, such as banks and developmental funding established in circular systems, could also be implemented in the

scaling of renewable energy, as renewable energy is not an affordable commodity to all people of this country. The principles of circular systems, such as fora, exist in the renewable energy sector; however, these fora do not to solve power solutions; therefore, they need to be active and take initiatives that drive renewable energy as an alternative, although for now much of the weight of power supply will be on coal to ensure the steady transition from coal to renewable, especially in the job creation and job sustainability sector as well in cushion the limitations that come with renewable energy.

5.11 Conclusion

This chapter proffers the study's findings and presents rich quotes and evidence collected from participants with knowledge of implementing renewable energy in South Africa. The study finds opportunities to scale renewable energy in South Africa to alleviate the energy challenges; however, there are several technological innovation constraints regarding financing, skills, and policy considerations.

CHAPTER 6: DISCUSSION OF THE FINDINGS

6.1 Introduction

The study findings from the empirical data are presented in Chapter 5. These findings were research questions based using the extracted themes. The rigour and credibility of the findings were ensured by the approach taken from design to data analysis presented in Chapter 4 (credibility and trustworthiness). This was also validated by ensuring saturation, as discussed in Chapter 5, and relevance of the profile, confirming the relevance of the data from the purposive sampling. In qualitative research, purposeful sampling is critical for acquiring information-rich participants concerning the phenomenon of interest. Campbell et al. (2020) contended that an effective purposive sampling procedure for participants could increase the study's methodological rigour and credibility. The findings confirmed the relevance and adequacy of the sample (Gutterman, 2015). In this chapter, the findings are discussed, focusing on the research questions. The findings are contextualised and contrasted with the literature reviews from Chapter 2.

6.2 Scaling up of renewable energy

The first core research question of the study focused on the scaling up of renewable energy in South Africa and can be recapped from Chapter 3:

- How can renewable energy be scaled up in South Africa?

This is a topical concern from a business and societal perspective as South Africa is battling with energy security issues, while it is identified as one country that can play a pivotal role in sustainability with an effective just transition. South Africa significantly depends on Eskom for its high energy consumption, yet the supply is insufficient. Eskom is implementing daily load-shedding to prevent the national system from collapsing owing to the imbalance between demand and supply. Research into the benefits of expanding South Africa's renewable energy sources has been mixed, as mentioned by most of the participants.

The study findings reveal that scaling renewables requires an understanding of contextual

factors, understanding the processes and components needed for scaling up, understanding the challenges that inhibit the scale-up of renewable energy in South Africa and the opportunities presented by the scaling up (Figure 6)

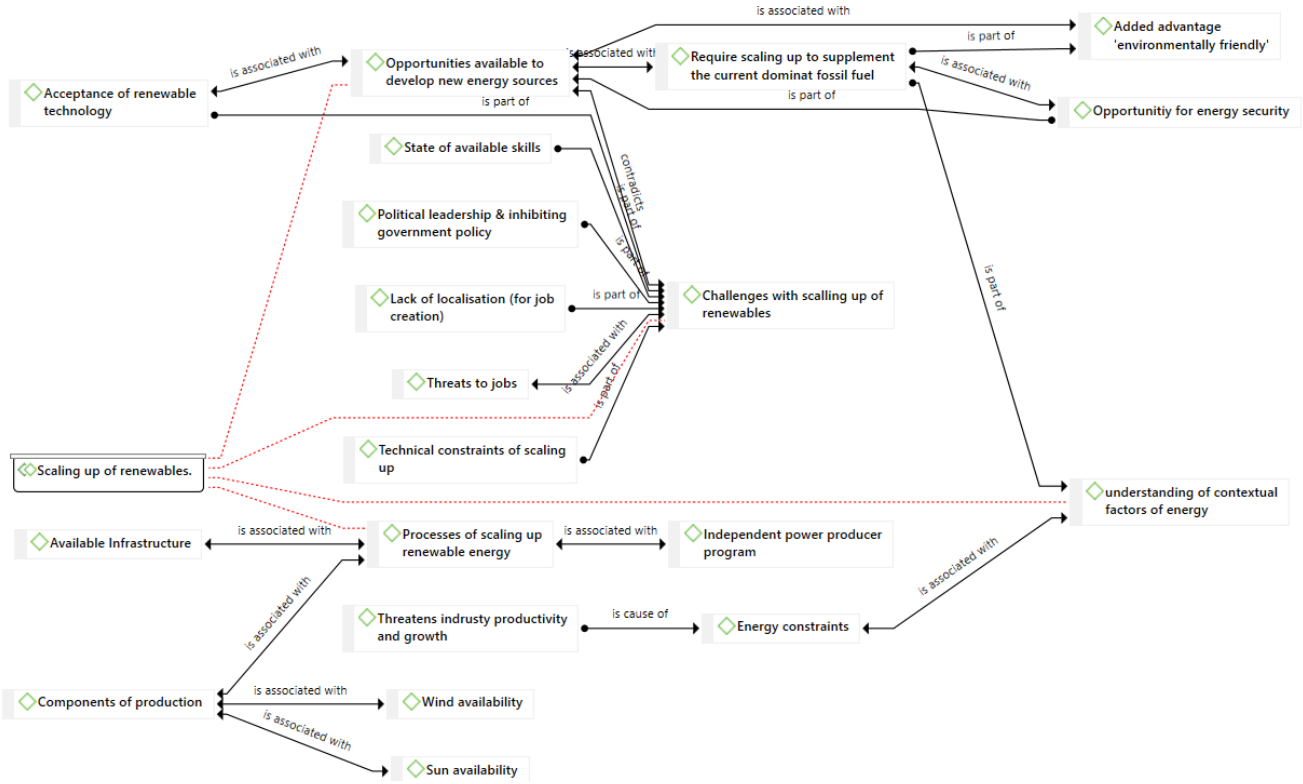


Figure 6: Thematic analysis of scaling up of renewables (Atlas ti)

6.3 Contextual factors

The findings reveal an increasing need for energy in South Africa, with industrial use accounting for half of the country's total power consumption. Owing to Eskom's inability to fulfil the country's power demand, the country has been in a condition of load-shedding. There is a continuous risk that the country could go dark, which can significantly influence industry survival, growth, and sustainability. This requires effective intervention to increase energy availability. The need for an increase in energy available confirms the observations of Baruah and Enweremadu (2019), contending that energy access might be improved by investing in

renewable energy. This approach can have an advantage beyond the energy availability. It can also ensure a transition to ‘clean energy’. This also confirms the observations of Banday and Aneja (2019). They contended that there is empirical data to suggest that expanding using renewable energy sources can contribute to an increase in GDP in BRICS countries while simultaneously cutting carbon emissions and greenhouse gas emissions.

This is important as South Africa's overreliance on coal has led to a serious carbon dioxide emission problem, making it imperative for the country to invest in renewable energy sources to combat this concern (Ekwueme et al., 2021). The findings reveal that load-shedding has caused price fluctuations in fossil fuel energy products, such as oil and gasoline, making them more expensive for customers. Industries were compelled to be efficient in all facets of production to allow efficient use of energy sources, such as oil, as prices fluctuated daily and weekly, decreasing the chances of survival for businesses that could not survive this volatility. This effect was observed on the micro and macro levels of the country's economy. A need exists for a greater power supply to boost output, which would feed the country's economy; however, the rise in production would lead to a rise in power consumption, making a reliable supply of electricity even more important.

6.4 Processes and components of renewable energy

The South Africa Renewable Energy Independent Power Producers Procurement Programme has been the primary source of funding to expand renewable energy in South Africa (Kruger & Eberhard, 2018). The development of a solid energy policy should serve as the starting point for expanding renewable energy use in South Africa (Pathak & Shah, 2019; Bhat, 2018). The findings indicate that scaling renewable energy must include running plans at a slower and less intense rate. This will make it possible to control the energy demands and make it easier to move between renewable and non-renewable energy sources. The findings emphasise some infrastructure for renewable energy and that the existing infrastructure in cities and small towns could be used for renewable energy if adapted appropriately. Because the government would have demonstrated that it has faith in renewable energy projects by using the existing infrastructure, this would make it possible for

investors to commit to the opening fractions of renewable energy. It was critical to adhere to the plans unique to South Africa because the components of production from other nations were distinct and unable to be scaled.

Critical infrastructure storage capacity and availability of energy sources (sun and wind) are critical for successfully scaling up renewables. The problems with renewable energy include that solar and wind power can't provide power 24 hours a day, even with batteries. This means that some businesses might not want to use renewable energy because it could slow them down. The findings reveal a need for extensive fields of solar panels to store enough energy. Another problem was that solar and wind power needed to be used practically because they used rare earth materials in their machinery. Tight rules about renewable energy also make it hard to use renewable energy on a larger scale. This delays the progress of making these energy sources more sustainable.

6.5 Challenges of scaling up renewable energy

The study findings identify challenges and opportunities, such as the availability of skills, costs of renewables, state of political leadership and policy uncertainty, technical constraints of scaling up, threats of job losses, and acceptance of renewable technology. Scaling up renewable energy sources also leads to training and new ideas, which could increase the number of environmentally friendly jobs in the economy hence confirming (Matsuo & Schmidt, 2019). Some speakers pointed out that most jobs in South Africa are in the industrial sector, which relies on the combustion of fossil fuels, such as coal, and that reducing carbon emissions is directly linked to job losses.

The findings emphasise that renewable energy was expensive for customers to buy into at the beginning stages, with inadequate land for planting solar panels, enabling massive power production. Since diverse types of machinery in workplaces, classrooms, and residences require various voltages, this presents ongoing technical hurdles for power grids. Delegates voiced concerns over how technical issues with grids will be discussed in the transition to renewable energy sources.

There were mixed observations on the skills of renewables; however, with the skills, some participants felt there were sufficient skills in the country within the renewable energy space and that these skills would begin industries of renewable energies. Other participants observed insufficient skills in the country within the renewable energy space. But several participants believed there were not enough people with the expertise to launch renewable energy enterprises. This confirms Sun et al. (2022) that the lack of human capital to invest in renewable energy is another significant obstacle that must be overcome before renewable energy can be scaled up. The lack of necessary skills throughout the nation is a substantial barrier to expansion in two ways.

Sun et al. (2022) authors concur with the observation from the findings of lack of skills and in justifying this observation. A lack of workforce exists in the industry with the experience and expertise to support the scale-up of renewable energy. There is a lack of finance to recruit and train technicians, maintenance specialists, and planners in the renewable energy sector. A need exists for skilled human resources to install and service renewable energy infrastructure in short supply. There is a shortage of skilled human resources to install and service renewable energy infrastructure. There is a shortage of skilled human resources required. Developing qualified human resources also takes significant time and calls for careful preparation.

The findings also revealed that the government has been inept at declaring an increase in the limit of self-generation of power to 100 megawatts by the year 2021. This demonstrated how restrictive government policy was on alternative power sources not owned by the government. The findings emphasised that the government, with the recent changes, was moving in the right direction and that this policy change was enabling and would help regarding renewable energy and eradicating load-shedding. Although the increase in the limit of self-generation power came late when reducing the power demands on Eskom, especially considering that load-shedding had been a concern for South Africa for a few years, since 2007. Despite these delays, the government was moving in the right direction that this policy change was enabling. This confirms Naicker and Topic (2021), who emphasise that deregulation of the power grid, growth in demand, increases in commodity prices, introducing

prepaid metres, and the allocation of connection fees are all vital cogs in the wheel—the power value chain. Because of the contracts and legislation that now favours Eskom as a monopoly producer, the power value chain might be a barrier to expanding using renewable energy.

A lack of energy policy in findings impedes skills transfer and human capital development is a significant barrier to expanding renewable energy in South Africa. Which confirms Drago and Gatto (2022) emphasise that the existing legal and regulatory structure must be in place to facilitate the shift towards renewable energy. There are deficiencies, most notably in the areas of tariffs and the function of important stakeholders, such as towns and local authorities (Trollip et al., 2022). Findings confirm Pathak and Shah (2019) emphasised that the formulation of a solid energy policy is essential. Effective adoption of renewable energy sources on a larger scale in South Africa can be sped up through collaboration and partnership (Olatunji et al., 2022). Several governments and businesses must develop a strategy for expanding using renewable energy and labour stakeholders (Funder et al., 2021; Marais et al., 2018).

The study findings also revealed that building a renewable energy plant and connecting it to the grid required a few months, and once it was operational, its customers could reduce their reliance on Eskom and, in theory, do away with load-shedding altogether; however, the literature emphasises that the connection to the grid is complicated, contrary to the study findings. Incorporating renewable energy sources into the national electricity system continues to be difficult owing to infrastructure problems, and the monopoly held by Eskom thus confirming (Constantinides, & Slavova, 2020; Ting & Byrne, 2020). It is impossible to enter the market for renewable energy without first obtaining the licences and any other necessary special permits, and the processing of some of these permits might take significant time confirming (Ayamolowo et al., 2022). Without a transmission system specifically designed for renewable energy sources, it is not viable to provide renewable energy to private residents (Andreoni et al., 2022).

The threat to jobs for people in employment in the traditional or fossil fuel section, combined

with the lack of employment opportunities, as most of the renewable work was done in foreign countries, creases one of the biggest challenges for the scaling up of renewables. This is particular in South Africa, which has the highest unemployment rate of 33.9% (Stats SA, 2022). Worse with youth unemployment of over 60%. Concerns were also raised about production, and the findings emphasised that a lot of the production was conducted in foreign countries because of foreign investment in renewable energy; however, South Africa needs production within the country, enabling job creation. There was a need for communication from the relevant parties to the public, letting them know there are jobs in these renewable energy resources that could absorb workers. This would bring less panic and increase acceptance of renewable energy.

6.6 Opportunities for scaling up renewable energy

The opportunities in the findings are for certainty for energy security, and improvement of environmental sustainability. People in South Africa are looking for alternative power sources because of the frequent power cuts caused by load-shedding. Despite this, there are challenges associated with acceptability from policymakers with high levels of inconsistency and uncertainty owing to some questioning their reliability. This confirms Folly (2021), who posits that numerous solutions have been proposed for the energy situation in South Africa, but stakeholders are still uncertain about the solution and the path forward (Kumar, 2019). They are forced to investigate renewable energy sources because they have no choice but to do so.

This led to the acceptance of renewable energy in South Africa. The adoption of renewable energy can also be attributed to the health benefits provided by clean energy, such as less pollution, and businesses and, to some extent, communities are pursuing better solutions, which has resulted in renewable energy becoming an option. There are opportunities for rural development that renewable energy offers, such as solar and wind farming, and increased business opportunities as a motivation for accepting renewable energy. There was a general knowledge of renewable energy and an acceptance of it as an alternative power source for South Africa.

Although the price of renewable energy has been high, increased development currently, therefore, makes renewables becoming more accessible and less expensive. The government needs to ensure that there was an awareness of renewable energy products for people to be aware of what is available and what options they have with alternative power technologies and the policies implemented for those technologies. This connected the issues of jobs and job security because most people working in non-renewable energy industries were concerned about the state of jobs should South Africa move towards renewable energy.

Participants suggested that villagers who lack access to modern economic prospects owing to a lack of electricity have observed their life quality improve because of the expansion of renewable energy. To reduce carbon emissions and expand women's participation in the energy workforce, expanding using renewable energy sources in South Africa could help change the public opinion of these sources. Most low-income populations' inability to afford electricity, improvements to inefficiency, the creation of sustainable cities, improvements to renewable energy systems, the influence of market design, governance issues, and the economic influence of electrification are all major obstacles to the widespread adoption of renewable energy confirms (Amir, & Khan, 2021).

6.7 Contribution of circular economy principles to scaling up renewable energy

The second core research question focused on the contribution of circular economy principles to scaling up renewable energy. The research question is recapped from Chapter 3:

Research Question 2:

- How can circular economic principles contribute to scaling up renewable energy?

Qazi et al. (2019) posit that South Africa's economic growth depends on the country's ability to create a sustainable energy plan. Olabi, 2019 posit that in contrast to traditional recycling, the circular economy approach emphasises the reuse of products, components, and materials; re-manufacturing; refurbishment; repair; cascading; and upgrading; and the use of solar, wind, biomass, and waste-derived energy throughout the entire product value chain

and "cradle-to-cradle life cycle." The adoption of the circular economy has resulted in several economic benefits, listed below. These benefits include, but are not limited to, the reduction of energy leaks and consumption, waste management, emissions controls, environmental legislation, environmental taxes and insurance, developing new markets, innovations, and energy sustainability (Agrawal et al., 2022).

The study findings driven by the circular economy principles included the contribution to scaling up of renewable energy, which can be conducted by financing the development of new energy markets, reuse and recycling initiatives, transition to just energy, development of innovative new technologies, emission control which help with climate change and stakeholder participation for sustainability (Figure 7).

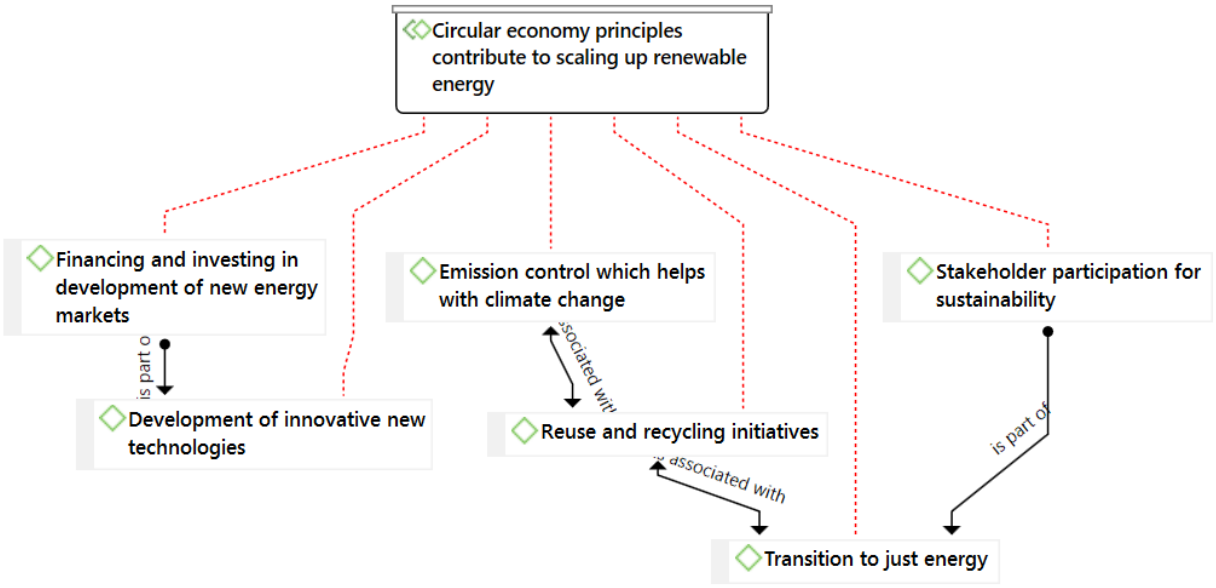


Figure 7: Thematic analysis of circular economy principles contribution to scaling up of renewable energy (Atlas ti)

6.8 Financing and investing in developing new energy markets

Findings identified foreign investments, including direct foreign investments, such as those made by companies that funded the development of renewable energy projects in South Africa, and other foreign investments, such as those made by world banks and global multinational funders, as potential sources of funding for South Africa's efforts to scale-up its use of renewable energy. Local banks were a good option for funding renewable energy on a smaller scale, such as in renewable energy for housing, as were other developmental funding options, such as the IDC and TBS, which were already attempting to do their part in funding renewable energy infrastructure.

Although government funding programmes were visible, findings reveal that the government need to improve its communication of why certain things were completed and its strategy for resolving the energy crisis in South Africa, where renewable energy is a necessity and a promising investment. Foreign investors are important, but it's also clear that domestic investors, such as IDC and TBS, are striving to contribute. If people are not told what needs to be accomplished, the opposition can occur and cause a failure to implement the improvement initiative. The requirement of proactivity and expressiveness is necessary to achieve the objectives.

Findings reveal that, for example, e a Norwegian firm is putting considerable money into developing and building renewable energy projects in South Africa. They do not seem to agree, believing that large-scale and start-up energy firms need assistance from some outside source to collaborate effectively with the government and move these massive projects forward. In explaining funding, Kruger and Eberhard (2018) emphasise that the South Africa Renewable Energy Independent Power Producers Procurement Program has been the primary source of funding to expand renewable energy in South Africa. Despite this, when observed from the vantage point of an emerging market, one of the most significant problems must be overcome is the financing aspect of the transition to renewable energy. In emerging markets, the mobilisation of finance is a crucial component of the energy transition and the scaling up of renewable energy (Zhang, 2020). Innovation is essential to expanding

renewable energy production in South Africa (Elia et al., 2021).

Because of excessive inflation, driving up the cost of capital, the state of the world economy does not afford rapid, scalable answers. This is because of the global debt crisis. Obtaining funding for renewable energy infrastructure projects can be difficult (Sachs et al., 2019). Li and Ho (2022) also advised that the cost of financing renewable energy sources is high. Countries in emerging markets, such as India and China, successfully switched to renewable energy, spending significant money building the infrastructure required for this transformation. In South Africa, there is an urgent requirement for a well-defined plan of financing, a model of finance, and a solid strategy that involves all the relevant stakeholders from the public sector, the private sector, and the business sector. Up to this point, the auction for renewable energy generation has been a success, and there is potential to build on these successes already achieved; however, there have been no studies conducted to assess how much more expensive renewable energy is per unit when compared to the price of power today (Dalala et al., 2022; Mungai et al., 2022).

6.9 Reuse and recycling initiatives

Findings reveal that reuse and recycling initiatives will aid in developing environmentally friendly and economically stable communities. They like being taught an alternative approach to manage their daily energy needs. Although fora focusing on renewable energy existed, featuring representatives from a wide range of businesses, they believed these representatives lacked the motivation to discuss the concern or offered no concrete solutions. Most respondents agreed that recycling and reusing materials might have a significant positive effect on the environment by decreasing the need for landfills and waste produced. This confirms (Adeleke et al., 2021), that the divergence in energy demand can be closed by renewable energy through recycling and reuse, also where the circular economy idea finds its application here.

6.10 Transition to cleaner energy solution

Solar power and recyclable materials to produce landfill gas are the two most important forms

of renewable energy with access to the people of Gauteng. The population of Gauteng produces thousands of tonnes of waste annually, which the province's municipalities can recycle to generate electricity (Adeleke et al., 2021). The circular economy finds an excellent application in this field. A need exists in South Africa to raise knowledge about the recycling and reuse of garbage by the public. This can influence the electricity used and lower the strain placed on the power infrastructure. There are also possibilities to conserve resources, such as water, because the consistent use of these resources takes either energy to maintain them or energy to carry the waste to landfills. There are also opportunities to conserve other resources. Therefore, the conservation measures present a potential for expanding using renewable energy at scale (Mbazima et al., 2022). Because of this, the towns must launch an education initiative aimed at their citizens to promote the responsible management of resources, including energy storage (Longe et al., 2019).

6.11 Development of innovative new technologies

The findings emphasise those innovative technologies, such as biomass, energy recovery energy (which recovers energy from waste goods), nuclear, solar, wind, geothermal, and molten salt, can be effective in scaling up renewables. These are worth exploring the possibility of merging green energy sources with others, such as coal. It's important to note, however, that South Africa's manufacturing capacity for these parts needed to be improved by tapping into the existing infrastructure in the country's townships and smaller towns. Although there were technological solutions, it was still vital to educate buyers on proper resource management and accountability. Because of the avail of sunlight, South Africa has mostly concentrated on developing its wind and solar energy industries and their required renewable technologies (Akinbami et al., 2021).

Because of the state of its ageing power plants, most of which are fuelled by coal, South Africa is a substantial contributor to continental carbon dioxide emissions. The emission handles over 20 per cent of the total emissions produced by the African continent. South Africa is one of the most significant contributors to global emissions (Salahuddin et al., 2019). Despite the focus on the wind and sun, biomass has an enormous potential in South Africa,

especially in more rural locations. Using biomass energy as a source of renewable power is important. It originates from solids, liquids, and gas, derived from organic components, the source of such energy (Sanderson et al., 2020). This energy source can be used by South Africa and globally. Johnson et al.,2019 posit that South Africa has a competitive advantage, particularly in rural areas with high-generation biomass that can link to the national grid, notably in municipalities and other rural settings. Despite a plentiful supply of biomass in rural regions, most of it has not yet been put to commercial use. These areas still generate its power from the combustion of wood and the waste products of animals. To prevent the adverse effects of destroying trees for use as an energy source, there can be laws in place—particularly in rural regions (Maji, Sulaiman, & Abdul-Rahim, 2019).

Concerns raised about the circulatory initiative by participants included that such initiatives possessed superior technology and advanced inverter technology that operates even more effectively than what was previously available. This emphasised the rapid advancement that has occurred in technology. Other concerns were economic, and findings were mixed with some participants believing the principles of circular economics were not proven, while others believed there was an economic benefit to circulatory actions, such as saving money. Circularity causes developing novel business models. It was challenging to apply the initiatives to the energy sector because the reuse and reduction principles were difficult to implement in the energy sector. The material used in the renewable energy sector could be used in other industries. The other problem was the need for proof of renewable energy in circularity debates. For example, there is little data available on renewable energy; therefore, questions such as "is renewable energy better than other technologies?" are difficult to answer.

Technology is one of the most significant obstacles to overcome to integrate renewable energy in South Africa successfully. The economics of renewable energy reveals that significant money has been invested in developing the technology, and there are also inherent dangers associated with its deployment. The administration has revealed no interest in investing in other forms of energy. Eskom creates a monopoly, and there is resistance to the installation of renewable energy because of the direct competition it possesses. This

resistance comes from unions, labour, and other stakeholders as per (Pagels, 2010; Mutombo, 2016; Naicker & Thopil, 2019). According to Su, Pang, Tao, R., Shao, and Umar (2022), the Fourth Industrial Revolution has altered the development process of renewable energy and technological advancements, resulting in a significant reduction in C02 emissions; that was the case.

6.12 Emission control, which helps with climate change

Evidence of climate change can be observed where temperatures have been rising, and floods have been occurring more frequently. Climate change is an actual phenomenon, and its effects can be observed all around us. They were also of the opinion that there are several politics involved in climate change and that using renewable energy does not cancel out the effects of climate change. And that using renewable energy still required using coal to provide a base level of electricity and to back up renewable energy if renewable energy could not fulfil the power demands of the energy supply. The effects are visible, and there has been some involvement in the political realm.

The findings indicated that having access to renewable energy sources does not automatically mean the effects of climate change are ruled out. It is possible to use a solar or another renewable energy system and then use a regular electrical supply as a backup. This confirms Quinn et al. (2018) also pointed out this need for alternative energy, with data corroborated by research conducted in other African nations, such as Rwanda, Kenya, Tanzania, and Uganda. The need to scale-up and create alternative energy for home consumption in rural regions is critical to minimise the demand on the power grid. These nations have been able to scale-up their production of clean cooking energy in rural regions, notably through the production of biogas and biomass.

Climate change is a significant variable, also the topic of renewable energy. Discussions regarding climate change, optimisation, and economics are ongoing. Climate change requires the formulation of a comprehensive plan at the international level. Considering the detrimental effects that fossil fuels have on the natural world, renewable energy has emerged as a potential replacement for traditional energy sources. Governmental restrictions still

complicate investing in renewable energy, particularly in developing markets and countries in sub-Saharan Africa.

A growing concern exists regarding the decrease of greenhouse gas emissions resulting from industrial operations; South Africa cannot be exempt from these difficulties. (Seymore, Inglesi-Lotz, & Blignaut, 2014). According to Olabi and Abdelkareem (2022), using renewable energy sources has the potential to help ease the difficulties caused by climate change and promote sustainable development. There is a significant quantity of pollution and carbon emissions because of the transportation system in South Africa is reliant on fossil fuels. The widespread adoption of electric vehicles can mitigate some of the adverse consequences of fossil fuels.

6.13 Stakeholder participation in sustainability

New possibilities, especially green jobs in the energy sector and tax revenue, are two additional social benefits that flow from the widespread adoption of circular economic principles and the expansion of renewable energy sources. Improvements in the areas of new technology, clean energy, and the environment will have far-reaching effects on people's standard of living, their willingness to help one another and their community, their willingness to learn and acquire new skills, their level of professional achievement and satisfaction on the job, and their ability to help slow the rate at which the planet is warming (Korhonen et al., 2018). This can be achieved with stakeholder participation for sustainability.

Despite these critical and progress initiatives that the circular economy principles contribute to scaling up renewable energy, Korhonen et al. (2017) warned that come with some built-in restrictions, and these restrictions need to be discussed before the benefits of a circular economy can be realised. The restrictions can be the thermodynamic limits, which approach the inherent nature of how cyclical systems consume and generate waste and emissions; the system-bound limits, which approach the spatial and temporal infrastructural problems; the physical scale of the economic activities; and the path dependence and lock-in theories, difficulties in administration and management in South Africa's energy sector, and the social and cultural meaning of the circular economy.

A circular economy, and its connection to renewable energy, were subjected to an analysis by Corvellec et al. (2022), which offered a critical perspective supported by solid evidence. According to these criticisms, the circular economy has hazy boundaries and a hazy theoretical basis and putting it into practise is fraught with structural challenges. It asserts that the circular economy is predicated on an ideological objective subjugated by technical and economic accounts, which cause questionable contributions to sustainability and depoliticises sustainable growth.

6.14 Summary and conclusion

The chapter discusses the study findings, focusing on the two core research questions, which focused on the scale-up of renewable energy in South Africa and the contribution of circular economy principles to scaling up renewable energy. The discussion concluded that their renewable energy is an alternative to fossil fuel that can be scaled up. For this to succeed, a need exists to understand this energy and its dynamics, its process and components of scaling up, challenges, and opportunities. Circular economy principles included the contribution to scaling up of renewable energy, which can be conducted by financing the development of new energy markets, reuse and recycling initiatives, transition to just energy, development of innovative technologies, and emission control which helps with climate change and stakeholder participation for sustainability.

Multiple aspects, such as technological cost, cost of investment, technical challenges from elements, such as storage space, support from stakeholders and enabling policies from the government, need attention for successfully up-scaling renewable energy. If this is conducted well, it can provide an excellent opportunity for South Africa, its businesses and its communities as it can contribute towards energy security and reduce the prevailing challenges of load-shedding and can improve the environment, therefore, improving the quality life.

The findings and discussion of the study provide insights into developing a theoretical framework in Chapter 7, which can provide direction on the energy transition in the journey of scaling up renewable energy consumption, providing insights on challenges and

opportunities. This is important, as several studies in the literature, such as those by Banday and Aneja (2019). They investigated the consumption of renewable and non-renewable forms of energy and carbon emissions in the BRICS nations (Brazil, Russia, India, China and South Africa) was not based on any theories.

The same applies to the empirical study by Akinbambi et al. (2021) on the scale-up of renewable energy in South Africa. Also, Khobar et al. (2021) investigate the relationship between employment and using renewable sources of energy in South Africa. The evidence presented above provides credibility to the hypothesis that the body of written work about this field of research is still in its infantile stage of growth. In the next chapter, the conclusions are also made, and the limitation is provided to contextualise this study while providing conditions for the transferability of the findings.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This study examined the potential and challenges of scaling up renewable energy in South Africa. The research used the population of participants in the energy sector to collect empirical data to answer the two primary research questions:

- How can renewable energy be scaled up in South Africa?

- How can circular economic principles contribute to scaling up renewable energy?

The data were collected through Microsoft teams, coded, and uploaded to software for thematic analysis. The study was saturated with 13 key participants knowledgeable about the energy sector in South Africa. These questions were investigated using a qualitative design. The fifth chapter presents the research results and content, and thematic analysis was used to present the results according to the research questions systematically. The sixth chapter proffered the research discussion and debates using the circular economic model to explain how and why there is potential to upscale renewable energy and the contribution of circular economic principles in the upscale of renewable energy.

This chapter presents the principal findings, which provide comprehensive insights into the study. This is followed by developing the theoretical framework, which can guide stakeholders engaging in energy security using renewable up-scaling as a pillar of that initiative. The seventh chapter presented the implications for managing renewable energy producers, government, and policymakers. The study closes by providing the limitations of the research, which contextualise the study, the conclusions, and the suggestions for future research.

7.2 Principal findings from the study

This research aimed to examine the scaling of renewable energy in South Africa. The findings from this inductive study and the research literature review indicated several obstacles to overcome before renewable energy is implemented and part of the energy mix. A recap of

the key findings from the study is discussed below.

The results of the study indicate that renewal energy up-scaling can significantly contribute to energy security in South Africa. The loading shedding problems have ignited a debate about energy security and transition in South Africa and the need for scalable solutions to alleviate the problem. The potential for renewable energy directly affects solving some problems attributed to global warming and climate change in South Africa (Oladipupo, Rjoub, Kirikkaleli, & Adebayo, 2022). The literature result demonstrates that South Africa still depends much on fuel and coal, which negatively affects the environment and sustainable development and growth (Hassan, 2022).

The potential for renewable energy is expansive across the economy, and there are linkages in the value chain that can benefit all stakeholders in implementing renewable energy. The value chain for renewable energy includes skills development, finance, policy development, infrastructure, knowledge transfer and innovation (Zhang, Wang, Adebayo, & Altuntaş, 2022). Therefore, the synergy created by renewable energy is massive and might ameliorate some of the societal problems in South Africa, such as poverty and unemployment.

An enabling regulatory framework, policies, and governance structures are essential to support and rapidly scale renewable energy and put South Africa towards a secure energy trajectory; however, a lack of strategic alignment between government, labour, and business exists regarding the direction and scale of renewable energy implementation in South Africa. So far, the strategy is to license independent power producers to support the scale-up of renewable energy.

The findings from the study display that successful renewable energy up-scaling would require massive investment in effective human capital management and stakeholder engagement. The need for engineers, supply chain professionals, policymakers, analysts, investment analysts and other similar skills is critical to effectively implementing renewable energy in South Africa; however, there are severe challenges in attracting some of these talents to the organisation. As it stands, few organisations participate in renewable energy implementation. A good strategy would involve coal mining industry participants diversifying

into renewable energy to make any meaningful influence and alleviate the energy shortage problem in the country.

The findings from the research demonstrate that renewable energy has the potential to create more clean energy jobs in South Africa. Because of the requirement, more research, training and development would be necessary to increase the skill level and raise the quantity and quality of the workforce to participate in renewable energy. There is evidence to display that the energy sector in South Africa has a shortage in the workforce; therefore, to sustainably implement renewable energy, a need exists to train more people (Li, 2022). Therefore, job parity management is central to support and effective implementation of renewable energy up-scaling.

The findings from the study demonstrate that technological and related technical developments and improvements are required for RE effective and sustainable scaling in South Africa. A need exists for battery packs, optimum sources, and other infrastructure for energy storage and renewable energy transmission to the national grid to supply customers; however, there are still massive challenges around technology and infrastructure to support the operationalisation of renewable energy on a large scale to support Eskom's capacity constraints.

The results of the study demonstrate a massive divergence between the financing needs of renewable energy and what is available from the private sector and government to invest in renewable energy in South Africa. The study also indicated that the financing mechanism requires robust development to effectively help fund renewable energy scaling up in South Africa. South Africa must attract private sector investment into the renewable energy space; however, there are challenges regarding operating licence requirements, infrastructure, tariff rates and other concessions for private investors coupled with policy constraints.

7.3 Theoretical framework

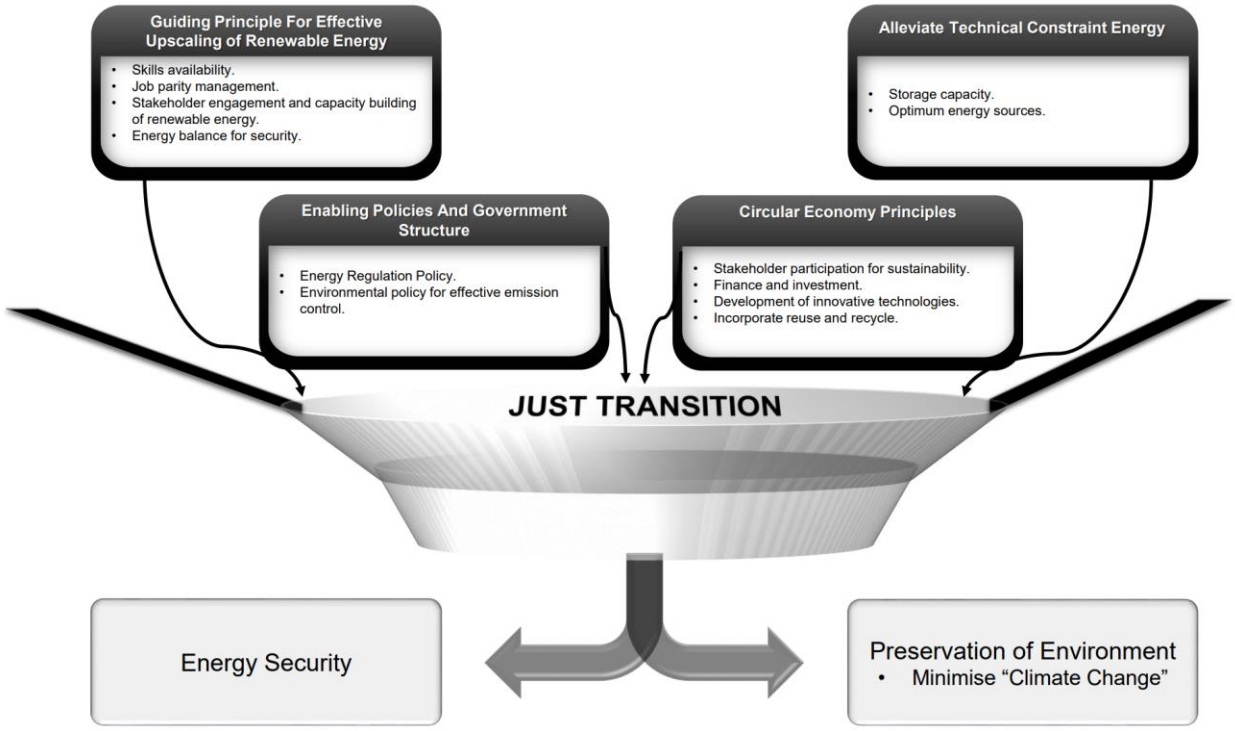


Figure 8: Theoretical framework from the study (Researcher's compilation)

It is evident from the study and the relevant literature looked at that South Africa needs to ensure and have energy security because there are struggles with load-shedding, where not enough energy is available for business and society; however, the question that prevails is what form of energy should supplement the shortfall of energy. What is evident based on our SDGs, which South Africa is also committed to, is that climate change must be considered in encountering and ensuring this energy security. Meaning that South Africa must ensure that efforts are made to decrease the effects of climate change, as it is one of the biggest emitters of carbon dioxide in Africa because of the industries and type of energy operations that exist; however, there must be an excellent balance. First, guiding principles must ensure an effective up-scaling of renewable energy to enable a just transition.

One of the first principles that must be the place is good capacity building to ensure the

availability of skills. Renewable energy technologies can be advanced and need to be operated appropriately to obtain optimum output when it is in operation. Having the skills available to operate, fix, and optimise is one of the fundamental guiding principles in effectively up-scaling renewable energy.

The second principle is about job parity management; however, there is a drive for climate change to ensure and secure the future. There must be caution in ensuring chaos is not created owing to some efforts to ensure the future. This is against the background of South Africa, struggling with the challenges of unemployment, inequality, and poverty. One to ensure up-scaling of renewable energy succeeds is to ensure that job parity, where there is a move to increase the localisation of technology and the related miscellaneous of renewable energy to create employment within the country, is to at least attempt to pair some of the potential losses that occur within the environment. This can also be conducted by ensuring good parity in stakeholder participation, including the government and other entities. They have a developmental mandate according to the circular economy principles, ensuring that they create employment, provide for the popular, and assist with fiscal improvement.

Another guiding principle is to ensure enough engagement with stakeholders, society, community, business, and everyone, on what renewable energy is about. How can you obtain support, participate and not be left worse off? In doing so, one critical guiding principle is that it must only be transitioned at some cost. It might still ensure an energy balance security between fossil fuel and renewable energy to ensure that the economy does not suffer, primarily since South Africa has traditionally relied on a heavy energy consumption economy, such as mining, manufacturing, and other highly industrialised engineering sectors. This can be achieved if the government has an enabling regulatory framework policy and a governance strategy, ensuring an energy policy that benefits all private and public stakeholders. Also, ensuring synergies with the policy relating to the environment controls the missions that come with the processes.

In line with the principles of the circular economy, stakeholder partnerships, such as public-private partnerships, can work and partner with the government. Second, this can also assist

in the need for financial investment from the government and private sector, as energy is expensive. This is against the backdrop of where, for example, in Europe, programmes assist with financial security. There is also a need for continuous development of technology.

The technology is to incorporate, reuse and recycle, to use the natural resources in South Africa, such as the sun, wind, biomass and others. This can elevate the technical constraints and make sure that there is an optimum energy source. Since wind and sun are not available 24/7, a need exists for energy storage technologies to ensure that, at least when put on the grid, it can stand on its own. This can help to ensure a just energy transition, ensuring there is energy security for South African economic development and preservation of the environment by minimising climate change.

7.4 Implications of the study

The research contributes to knowledge in critical areas of scholarship, such as theory, methods, context, and literature.

First, this study contributes to the theory by applying a nascent theory of circular economic principles in the scale-up of renewable energy in South Africa. Extant literature has often used resource-based observations and institutional theory to explain renewable energy use in emerging markets and developing countries. This study provides a new theoretical lens to understand how renewable energy can be implemented using a circular economic model. Using the 3Rs (recycle, reuse and reduce) principles is the most appropriate enabler to support renewable energy scale-up.

In addition, the study contributes to context and emerging markets research into renewable energy. The research adds new literature to the body of knowledge examining sustainable development in emerging markets. It discusses the research divergence and attempts to close this existing divergence.

Moreover, methodologically the study contributes to emerging issues, such as renewable energy, global warming, and climate change. Qualitative research provides opportunities for

scholars to contribute through the generation's new empirical datasets to emerging complex issues and provides insights into how renewable energy can be used in South Africa. Last, the study provides young scholars with an overview of the theoretical and methodological lens used to operationalise renewable energy in emerging markets.

7.4.1 Implications for managing renewable producers

Renewable energy is an emerging topic of global warming and climate change. This study has implications for the management of renewable energy producers and policymakers, according to the significance of the study for these stakeholders. It provides stakeholders with attractive investment opportunities by presenting empirical evidence on how to scale-up renewable energy in South Africa. The study has implications for investment, local content and beneficiation owing to the scale-up of renewable energy in South Africa. This demonstrates the need for government to create enabling policies and conducive investment incentives for private participation in renewable energy.

The need for research and development in the renewable energy sector is imperative, and renewable energy producers, such as IPPs and coal mines, can increase diversity into renewable energy through building and scaling up capacity and technology, alleviating the supply of energy constraints through discussing specific supply-side constraints, such as technology and workforce development challenges.

Stakeholder engagement is critical in the scale-up of renewable energy; otherwise, it creates resistance to change and innovative ideas to alleviate energy problems. Key stakeholders, such as communities, must be educated about the potential and usefulness of renewable energy and encourage participation. At a community level, biomass and other recyclables are necessary to reduce the divergence in energy demand; therefore, this research provides stakeholders with empirical evidence about the potential of using renewable energy in South Africa and how it can be achieved.

Last, the research has implications for private-public partnerships in the renewable energy sector. The rise in energy demand owing to population growth and other supply-side demand

constraints is a warning to the country to encourage public-private partnership discussions to find alternative energy sources and solutions.

7.4.2 Implications for policymakers

This research has implications for policymakers and legislation. First, creating a framework for effective coordination and management of energy in the country is critical. Good policy is an excellent enabler for investment in renewable energy initiatives. The government must develop policy incentives that encourage renewable energy sources in domestic and residential areas where possible. The policy is geared towards creating monopolies in the energy sector and discourages entrants from new competitors.

The research has implications for the government and policymakers in that a need exists for the government to clarify the long-term energy security in South Africa and deliberately design a policy to achieve these goals. The government must clarify the option of partnering with IPPs and advancing the developmental agenda.

Last, a need exists to optimise energy resources to promote sustainable growth. This study provides empirical evidence for government, stakeholders, policymakers, and analysts to use in designing and implementing a robust energy policy for South Africa that promotes the 3ps (People, Profit and Plant). These goals can be achieved only through a clear and consistent policy framework.

7.5 Limitations of the research

The study experienced limitations, such as similar research in the same field. The limitations described below are necessary to help contextualise the study's findings and the methodical limitations mentioned in Chapter 4. These limitations are emphasised. Sample size for generalisability. The study was exploratory and used qualitative research, meaning it inherently had a small sample size. This was adequate for the study; however, it also meant that the findings could not be generalised. It is transferable to similar settings. Since the study achieved saturation and the findings were triangulated between the various stakeholders in

energy production, these findings are expected to elucidate the government, private sector, and communities.

One of the critical limitations of the research lies in the methodology selected; however, qualitative research is appropriate for studying new phenomena with limited contextual and extant literature, such as renewable energy. This study's primary area for improvement is that it requires transportability and transferability into new contexts, especially in sub-Sharan African countries. The best methodology design for the research would be a mixed methods approach which combines the qualitative and quantitative datasets and rigorous analysis to extrapolate and explain the phenomenon. Qualitative research is too descriptive, and analysis methods could be more robust. It generates a corpus of qualitative datasets; therefore, decision-making needs to be clearer about what to report.

Most study participants were from the IPP sector, with a split of *70:30.* Because of this, there is inclined to be some bias and imbalance in the findings. A mix of participants from other sectors, such as the government, labour and business, would present balanced and independent views. Especially from the government, serious concerns about the operationalisation of an effective energy policy that can pull South Africa out of the current disarray. Therefore, participants from the Department of Energy and other sectors would help present robust and scalable solutions to the present problem.

There was a need for a voice from labour because implementing renewable energy is a threat to some stakeholders. The argument of job losses, especially at Eskom, has been part of the public debate. Therefore, resistance to change from these critical sectors is likely; therefore, the population for the study presents a severe limitation to its findings; however, this limitation was encountered because renewable energy is still a nascent area of research. The participant needed to be knowledgeable about the study area, contextually locate the problem, and solve how to approach it. There needs to be more time to contact all the key stakeholders to engage them in the study.

A fundamental limitation exists regarding the theoretical lens, and framework deployed in the study. Although the circular economy principle was best to study this problem, there are limitations to this theory. The government must be involved in implementing circular economy principles, such as recycling, reuse and reduction. Recovery, redesign, and re-manufacture principles have yet to be part of the agenda for renewable energy. The government's role is essential, especially in policy and investment.

Several theories, such as resource-based observation and institutional theory, can provide a robust theoretical framework for the study. This argument is plausible because the key issues or barriers to implementing renewable energy are resource and policy related; therefore, the institutional theory would enable vigorous implementation of renewable energy. The resource-based approach would allocate resources and investment in the renewable energy sector.

Despite the above-stated limitations, this research has value or utility and significantly contributes to the literature. The design and analysis used are vigorous to support the findings and critical assumptions adopted in the literature and this study. The evidence supports the thematic analyses employed in the study gleaned from crucial participants knowledgeable about the context and phenomena of renewable energy in South Africa. Last, the finding from this study are supported by empirical evidence in the literature and other similar research conducted in sub-Sharan African countries, which points to similar challenges in scaling up renewable energy, such as policy constraints, investment, infrastructure, technology, skills, and resistance.

7.6 Conclusion

This research discovered key evidence from thematic analysis to support the premise and research divergence from the literature. The results indicate the need to scale renewable energy to discuss the energy shortage. The domestic renewable energy use can be critical in ameliorating the shortage and capacity constraints.

First, a key finding from the study demonstrates an urgent need to provide political leadership

in discussing the energy crisis in South Africa. The political elite has made several promises to solve the energy problems, but there has yet to be much progress. Some participants interviewed for this research reiterated that the government lacked political leadership and decisive action to discuss the problem. Previous attempts have yielded little fruit but resulted in frustration from critical stakeholders.

Second, a key finding from this research indicates a severe skills divergence. Because of this, the scale-up of renewable energy must also invest in discussing the skills shortage to build capacity and knowledge transfer. This is important because renewable energy requires research and innovation to ensure that the technology deployed has the right skill sets to manage and put to beneficial use. South Africa's energy sector relies more on fossil and coal energy as its primary mix; therefore, more research is warranted to diversify the energy sector, which requires workforce planning. The need for technological acceptance is essential.

The government needs to develop a robust policy to alleviate the energy problem in South Africa. The policy has gaps; therefore, new policy and legislation will be appropriate to revamp the current policy, deregulate the energy sector, and reduce the Eskom monopoly. Coal mining firms can play a significant role in energy transition and building capacity to use more renewable energy resources; however, they would require policy enablers and concessions to promote investment. The research demonstrates that South Africa is blessed with an incredible amount of renewable energy resources, such as wind, sun, water, and solar power. These present opportunities for the exploitation of these resources. Windmill potential has been exploited in places, such as the Northern Cape, although on a small-scale. The scaling up of windmill potential in the Northern Cape could solve some of the energy concerns. In KZN, biomass resources are available, and using biomass to supplement the energy requirements, especially in KZN, can significantly reduce energy demands from Eskom.

The research findings display that technology uptake and proliferation in the renewable energy sector in South Africa still needs to be higher. The capacity constraints present challenges and opportunities that the private and public sectors can exploit; however, the

need for enablers to exploit these opportunities is essential. Another key finding from the study display that the core circular economic principles, such as reuse, recycling, reduction, recovery, redesign, and re-manufacturing, are vital in the scale-up of renewable energy in South Africa; however, the findings display that there still needs to be more evidence to support adopting these principles in the private sector and the public sector. What is required is the population's education about this principle's importance. The government should offer incentives and opportunities for investors. The potential for these principles would cause job creation for the use and building of critical infrastructure, an enabler of energy transition and easing the problem of pollution, global warming, and climate change.

7.7 Suggestions for future research

Based on the study findings, its limitations, and emerging insights. These suggestions are made for future research. First, future scholars should **v**alidate the developed framework. Studies should be conducted to validate the developed framework of the study using quantitative research. This can be conducted by understanding the relationship between the guiding principles, enabling policies, elevated technical constraints, circular economy principal contributions on RE up-scaling, and effective just transitions. This can be conducted using multiple regressions or structural equation modelling.

Second, a need exists for future scholars to develop a sustainable financial model to support investment into renewable energy in South Africa. The financing model developed must effectively capture the key incentives required to motivate the private sector into funding. RE needs to be feasible and sustainable. The empirical evidence from this research demonstrates that RE up-scaling is required for current and future energy contributions to security. Despite improvements in the cost, the RE technology remains expensive and requires further improvements and developments, which will also have high financial implications. Against this background, it is recommended that a study on optimised financing mechanisms be conducted to ensure that the technology is accessible to the economy in a manner that will not further perpetuate the problems of inequality that the country is struggling with and hindering its economic development.

Lastly, a need exists to understand the influence of scaling renewable energy and its link to a greener economy and green job creation initiatives**.** It is recommended that a study is conducted to create a framework and enabling conditions where renewable energy can have job creation initiatives and platforms through elements, such as localisation and collaboration with entrepreneurs and small businesses, to make the RE industry contribute towards the economic development of the country.

7.8 Concluding remarks

The recent power cuts have provoked debate by all sectors of the country about energy security in South Africa. The research offered an alternative observation of scaling and adopting renewable energy to close the divergence in Eskom power generation capacity constraints. The evidence from the research demonstrates this was a viable option because of South Africa's ability to generate energy from wind, gas, biomass, and solar. This deliberate strategy would create more job opportunities, encourage sustainable economic growth, and mitigate climate change; however, the critical constraints in scaling up renewable energy, according to the evidence from the participant, include lack of investment, skills shortages in the energy sector, inconsistent government policy, a lack of infrastructure, and the attitude and perceptions of some key stakeholder holders towards renewable energy.

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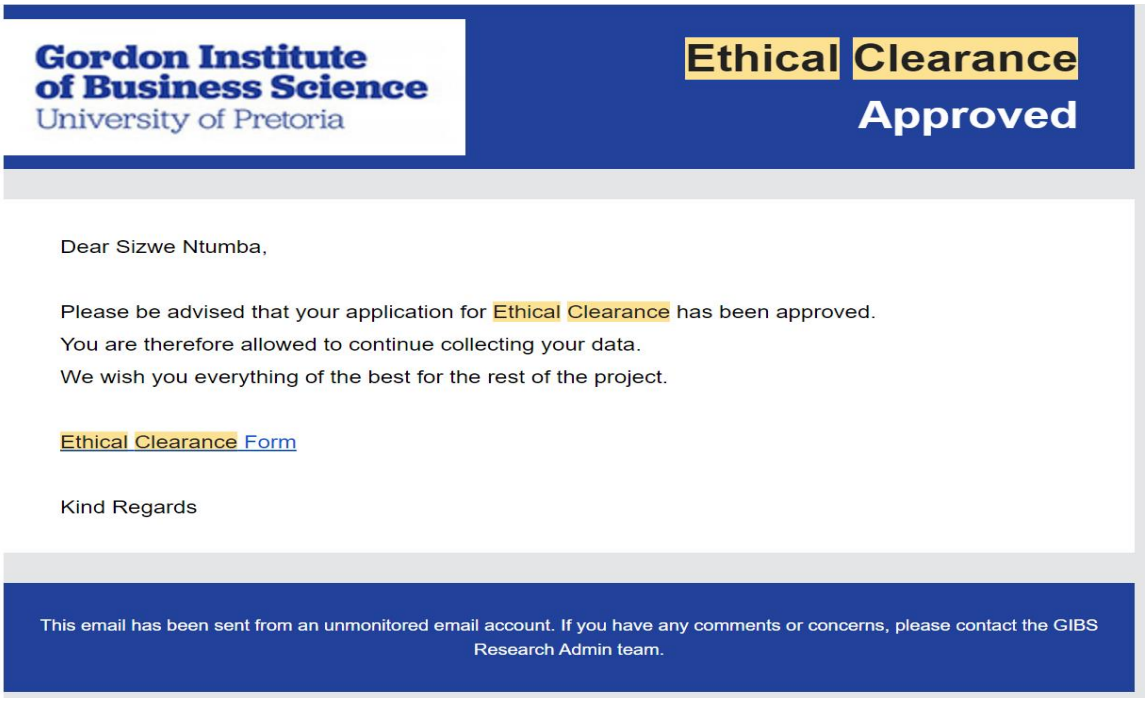
APPENDICES

APPENDIX 1: ETHICAL CLEARANCE APPROVAL



Gordon Institute of Business Science
University of Pretoria

Ethical Clearance Approved

Dear Sizwe Ntumba,

Please be advised that your application for Ethical Clearance has been approved.
You are therefore allowed to continue collecting your data.
We wish you everything of the best for the rest of the project.

Ethical Clearance Form

Kind Regards

This email has been sent from an unmonitored email account. If you have any comments or concerns, please contact the GIBS Research Admin team.

APPENDIX 2: SEMI-STRUCTURED INTERVIEW GUIDE – CONSENT FORM

Dear Sir/Madam

I am currently enrolled at the University of Pretoria – Gordon Institute of Business Science (GIBS) and completing my research for MBA. I am researching the Energy Transition: The Scaling up of Renewable Energy Consumption in South Africa, Challenges and Opportunities.

This research aims to give insights into the area and provide insights into the challenges and opportunities of scaling up renewable energy. The study generates propositions and data that scholars can test to make informed decisions about importing sustainable renewable energy transition in South Africa. Your participation will be voluntary and can withdraw at any time without any penalty. All data collected will be kept confidential, no names of the interviewees will be mentioned and confidentially is guaranteed and an informed consent letter will be available and used for the interview.

The interview, per participant, will take between 45-60 minutes depending on time management and other interruptions during the process of interviews. All data collected will be kept confidential and anonymity will be maintained. 34 questions will be posed and please do see the interview questions attached.

For any queries please feel free to contact me or my supervisor. Our contact information is below:

	Researcher	Supervisor
Name & Surname:	Sizwe Ntumba	Hugh Myres
Mobile number	082 666 9926	082 302 3802
Email address	20807407@mygibs.co.za	myresh@mygibs.co.za

Participant's Signature: Researcher's Signature:

_____ _____

Date: Date

APPENDIX 3: SEMI-STRUCTURED INTERVIEW QUESTIONS

Introduction

Q1: What sector in the energy industry do you work in? (Eskom, Government, Independent power producer, coal mining industry)

Q2: How many years of experience do you have in the industry?

Q3: Describe some challenges your company/industry faces?

Q4: Describe some solutions developed to ameliorate these challenges?

Theme1: Challenges for scaling up renewable energy

Q1: Have you heard about renewable energy?

Q2: Do you observe renewable energy as a viable solution to South Africa's energy problems

Q3: Can you describe some challenges in scaling up renewable energy in South Africa?

Q4: Do you know about the technology used in renewable energy space?

Q5: How can stakeholders coordinate and scale-up the deployment of renewable energy technology in South Africa?

Q6: Can you describe the function of planning and public policy development in the scale-up of renewable energy in South Africa?

Q7: Describe the compatibility of the infrastructure and how it can slow down the scale-up of renewable energy?

Q8: Describe the skills divergence in South Africa's energy space and how this significantly affects renewable energy?

Q9: Describe how pricing strategies can affect renewable energy?

Q10: How do leadership weaknesses influence renewable energy scale-up?

Theme II: Opportunities available to stakeholders to develop new energy

Q1: Describe the opportunities you observe in South Africa because of the scale-up of renewable energy?

Q2: What benefits do you envisage because of the scale-up of renewable energy in South Africa?

Q3: Do you observe the increase in access to energy increasing because of the scale-up of renewable energy?

Q4: Describe how the scale-up of renewable energy significantly decreases load-shedding experience in South Africa?

Q5: Can you describe some benefits of renewable energy on the environment?

Q6: Describe the function of renewable energy in developing a clean and sustainable energy source for South Africa compared to coal?

Q7: Describe the function of renewable energy in social-economic development in South Africa?

Q8: Describe the function of renewable energy technologies in the energy security of South Africa

Theme III: The primary sources of financing renewable energy transition in South Africa

Q1: Can you describe the financing sources for the renewable energy transition in South Africa?

Q2: Can you describe the cost of renewable energy transition in South Africa?

Q3: How is the high initial cost of investment in renewable energy a challenge for renewable

energy?

Q4: What is the influence of stagflation on renewable energy investment scale-up in South Africa?

Q5: Describe the investment in renewable energy in South Africa?

Q6: Describe the need for investments in renewable energy in South Africa?

Q7: What are the cheap alternative sources of investment in renewable energy?

Theme IV: Attitudes and Perception of stakeholders towards energy

Q1: Describe the sources of renewable energy that you are aware of?

Q2: Describe your concerns about climate change and how it can be ameliorated?

Q3: Describe your perception of climate change and if you think it is a politically driven concept?

Q4: would South Africans be receptive to renewable energy as an alternative energy source?

Q5: Describe what you know about reuse, reduce, and recycle principles?

APPENDIX 4: CONSISTENCY MATRIX

#	Research Question	Literature Review	Data Collection	Data Analysis
RQ1	How can circular economy principles contribute to scaling up renewable energy?	Hadebe, Hansa, Ndlhovu, & Kibido, (2018). Russo, & Miketa, (2019). Amankwah-Amoah, (2015).	Primary Data (Interviews)	Thematic Content Analysis
RQ2	How do we scale up renewable energy in South Africa?	Fouché, & Brent, (2019). Amir, & Khan, (2021). Longe, Myeni, & Ouahada, (2019)	Primary Data (Interviews)	Thematic Content Analysis

APPENDIX 5: COPYRIGHT FORM

Student details			
Surname:	Ntumba	Initials:	ST
Student number:	20807407		
Email:	20807407@mygibs.co.za		
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Qualification details			
Degree:	MBA	Year completed:	2022
Title of research:	The Scaling Up of Renewable Energy Consumption in South Africa; Challenges & Opportunities.		
Supervisor:	Hugh Myres		
Supervisor email:	Myresh@gibs.co.za		

Access

A.	My research is not confidential and may be made available in the GIBS Information Centre and on UPSpace.

I give permission to display my email address on the UPSpace website

Yes	X	No	

B.	My research is confidential and may NOT be made available in the GIBS Information Centre nor on UPSpace.

Please indicate embargo period requested

Two years		Please attach a letter of motivation to substantiate your request. Without a letter embargo will not be granted.
Permanent		Permission from the Vice-Principal: Research and Postgraduate Studies at UP is required for permanent embargo. Please attach a copy permission letter. Without a letter permanent embargo will not be granted.

Copyright declaration

I hereby declare that I have not used unethical research practices nor gained material dishonesty in this electronic version of my research submitted. Where appropriate, written permission statement(s) were obtained from the owner(s) of third-party copyrighted matter included in my research, allowing distribution as specified below.

I hereby assign, transfer and make over to the University of Pretoria my rights of copyright in the submitted work to the extent that it has not already been affected in terms of the contract I entered into at registration. I understand that all rights with regard to the intellectual property of my research, vest in the University who has the right to reproduce, distribute and/or publish the work in any manner it may deem fit.

Signature:	Date: 30/10/2022
Supervisor signature:	Date: 30/10/2022

APPENDIX 6: CERTIFICATION OF DATA ANALYSIS SUPPORT

I hereby certify that (please indicate which statement applies):

- ***I RECEIVED*** *additional/outside assistance (i.e. statistical, transcriptional, and/or editorial services) on my research report:*
  Editor

If any additional services were retained– ***please indicate below which:***

☐ ***Statistician***

☐ ***Transcriber***

X ***Editor***

☐ ***Other (please specify……..)***

Please provide the name(s) and contact details of all retained:

NAME: Academic and Professional Editing Services (APES)

EMAIL ADDRESS: Liza@apespro.com

CONTACT NUMBER: 082 347 4148

TYPE OF SERVICE: Thesis editing and spell check for errors.

I hereby declare that all *statistical write-ups and thematic interpretations of the results for* **my study were completed by myself without outside assistance**

NAME OF STUDENT: Sizwe Ntumba

SIGNATURE:

STUDENT NUMBER: 20807407

STUDENT EMAIL ADDRESS: 20807407@mygibs.co.za

APPENDIX 7: LIST OF CODES

Number	Codes
1	A more robust combination of energies
2	Alternative energy source for households
3	Area of work
4	Assertive leadership
5	Battery storage
6	Better panel technology
7	Biomass
8	Capable infrastructure
9	Challenge
10	Challenge: insufficient baseload
11	Challenge: Market regulation
12	Challenges: Financial constraints
13	Challenges: Fruitless discussions
14	Challenges: Grid constraints
15	Cheaper Renewable alternatives
16	Circular economy concept not established
17	Circularity requires innovative business models
18	Circularity talks in renewable energy need evidence
19	Climate change is political rhetoric
20	Climate change is real
21	Coal to provide base electricity
22	Combining renewable energy with other kind of energy
23	Compliance issues
24	Continental renewable energy skills champions
25	Cost structure
26	Costs are coming down
27	Create awareness through market education
28	Develop new products
29	Developmental finance
30	Difficult to apply in energy
31	Direct foreign investment
32	Discovery of new strategic industries
33	Diverse career opportunities
34	Drawbacks of Solar Panels
35	Economic benefit
36	Economic benefit of circularity
37	Effect of climate change
38	Electricity to back-up renewable energy
39	Enabling policy
40	Energy firms to collaborate with the government

Number	Codes
41	Energy industry
42	Energy mix
43	Energy recovery energy
44	Enhance local production
45	Ensure productive use
46	Environmental resource management
47	Eskom is the key role player
48	Ethical concerns
49	Evidence of climate change
50	Experience and role
51	Experience in the industry
52	Export
53	Export talent
54	Foreign funders
55	Foreign funders: Large multinational funders
56	Foreign funders: World bank
57	Government communication essential
58	Government has removed barriers
59	Government is now doing a lot
60	Government red tape
61	Grid collapse
62	Health benefits due to cleaner environment
63	High input costs
64	High transmission costs
65	Human's contribution to climate change
66	Hydro energy
67	Impact of renewables on designated local content
68	Impact of renewables on jobs
69	Impact on the consumer
70	Importance of political leadership
71	Improved inverter technology
72	Improving life for the better
73	Increased business
74	Increased demand
75	Investors' lack of trust
76	Lack of technical advisors to government
77	Lacking requisite skills
78	Land availability
79	Leadership not there
80	Leadership: Not effective

Number	Codes
81	learn more about grid access
82	Limitations of renewable energy
83	Limited infrastructure
84	Lip service to localization
85	Load shedding is forcing people to be receptive
86	Load shedding solution: economic use of electricity
87	Local banks
88	Local production
89	Long-term profitable investments
90	Managing supply and demand, as well as electricity, is difficult.
91	Molten salt energy
92	More connections in less time
93	Need to educate market
94	New generation of leaders
95	No effect on load shedding
96	No policy alignment
97	Not a magic solution
98	Not real long-term solutions
99	Nuclear energy
100	Opportunities
101	Opportunities: Cost saving
102	Opportunities: Jobs
103	Opportunities: Market education
104	Opportunity
105	Opportunity cost
106	Opportunity for banks to fund households
107	Opportunity for clean energy
108	Opportunity to solve the energy crisis
109	Opportunity: Community upliftment
110	Opportunity: Creation of new skills
111	Opportunity: new investments
112	Opportunity: New project investments
113	Opportunity: Skills development
114	Opportunity: Socio-economic development
115	Opportunity
116	Opportunity: Socio-economic development
117	Other funding mechanisms
118	Our strength
119	Our weakness
120	Paradigm shift

Number	Codes
121	Part of the solution
122	Policy benefits big corporates
123	Policy development
124	Policy uncertainty
125	Policymaker involvement
126	Political leadership
127	Political leadership: No confidence
128	Political will lacking
129	Political will not lacking
130	Politics between renewable and coal
131	Positive impact on carbon emissions
132	Positive impact on grid dependence
133	Positive impact on load shedding
134	Positive perception of renewables
135	Possibilities exist in circularity
136	Potential leader in green energy
137	Preserving livelihoods during transition will make it more just and successful.
138	Price instability
139	Price manipulation
140	Prohibiting progress
141	Project bidding
142	Proper planning is essential
143	Provide tangible benefits
144	Quality of life
145	Questionable financial viability
146	Quicker to build a renewable plant
147	Rapid decision making is crucial
148	Reducing carbon emission threatens jobs
149	Reducing carbon emission threatens jobs: Job losses
150	Regulatory requirements
151	Reliance on imports
152	Renewable (PV) technology not cheap
153	Renewable energy industry
154	Renewable energy initiatives have been prioritized.
155	Renewable energy is a viable solution
156	Renewable energy is not cheap
157	Renewable energy is topical issue
158	Renewable energy not useful for load shedding
159	Renewable energy to exist alongside fossil fuel
160	Renewable may pose affordability challenges

Number	Codes
161	Renewables
162	Renewables on ESG
163	Renewables: not for immediate solution
164	Requisite skills sufficient
165	Resistance to renewable energy
166	Reuse will reduce waste and conserve environment
167	Reuse and recycling are important
168	Reuse and recycling impact environment
169	Revenue for government
170	Role in position
171	Rural development
172	Scaling up
173	Scaling up will decrease load shedding
174	Scaling up: investor perspective
175	Scaling up: should decrease load shedding
176	Self-sustainability
177	Shortage of power
178	Skill will need to be developed
179	Solar, wind, geothermal
180	South African not eager to learn
181	Stakeholder engagement
182	Stakeholder groups
183	Sticking points
184	Technical challenges during deployment
185	Technological challenges
186	Technology to track renewable's status
187	The market needs education about renewable energy
188	The proper perspective on renewable energy
189	The state of vulnerability
190	Theft of infrastructure
191	Tight regulation
192	Train people
193	Transition for those who can afford
194	Transition to renewable to be done gradually
195	Transition: coal to renewable: do it slowly
196	Treat electricity like raw material
197	Vast opportunities for women
198	Weak leadership
199	Weak procurement planning
200	Worthwhile investment
201	Years in industry