

**To explore the factors affecting the feasibility of renewable energy in
South Africa**

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ABSTRACT

Global climate change is a phenomenon that is currently being experienced all over the world. There is a need for each and every individual to actively make changes in their lives, in how they do things in order to help mitigate global climate change.

Carbon dioxide emissions are one of the highest contributors to global climate change. South Africa produces the majority of its electricity through the burning of coal, with the majority of the power stations in the country being coal power stations. It is through the carbon dioxide emissions from these coal power stations that South Africa is adversely impacting the atmosphere by being a contributor to the global climate change.

In order to help mitigate climate change, there needs to be a shift from coal power stations, to renewable energy, which is a much cleaner source of producing electricity.

The study adopted an inductive, qualitative approach which will aid in understanding the different views held by interviewees on renewable energy. In this this study, semi-structured interviews were conducted with thirteen participants, who were able to provide insight into the factors that affect the feasibility of renewable energy in South Africa.

Keywords

renewable energy, intermittency, integrated resource plan,

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 carry out this research.

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1 December 2020

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CHAPTER 1: INTRODUCTION TO THE RESEARCH PROBLEM

1.1 Introduction

The aim of this study is to explore the factors that affect the feasibility of renewable energy in South Africa. The study intends to gather more information which will provide a better understanding on an area that is currently under-researched in the country. The study also intends to gain an improved understanding on renewable energy in the South African context. This study used an inductive, qualitative approach in an aim to gather new insights about renewable energy in South Africa.

1.2 Research Problem

Fossil fuel combustion has been identified as one of the leading contributors of carbon dioxide emissions that are released into the atmosphere. According to Covert, Greenstone and Knittel (2016), coal is responsible for 45% of the global greenhouse gas emissions, a leading contributor to the global climate change. In order to mitigate the global climate change, there needs to be a reduction in the greenhouse gas emissions and one of the ways to do this is by replacing fossil fuels with clean renewable energy (Wang & Zhao, 2018).

Eskom is the leading supplier of electricity in South Africa, with the majority of its Power Stations being coal fired. In order for South Africa to play a major role in the mitigation of global climate change, there needs to be a reduction in the use by Eskom of coal fired power stations, thus resulting in the introduction of renewable energy.

1.3 Background to Research topic

There is a marked increase in the major economies around the world in promoting the need to develop more renewable energy supply so as to mitigate the global climate change through the reduction of greenhouse gas emissions (Wang & Zhao, 2018; Kok, Shang & Yucel, 2018). In and around the world, most countries make use of fossil fuels more than other sources of energy to generate electricity (Covert et al., 2016), hence the need to concentrate at reducing the use of fossil fuels. If there is going to be a change in the effects made to the global climate change, then concentrating on the highest emitter of greenhouse gases becomes the most plausible route to follow.

According to Murray et al (2014), the replacement of fossil fuels with renewable energy reduces the emissions of greenhouse gases that contribute to climate change. The introduction of renewable energies does not only combat global climate change, it also promotes energy security and employment (Wang & Zhao, 2018).

Zerrahn, Schill and Kemfert (2018) state that in the 2015 Paris Agreement, the world agreed on a need to reduce greenhouse gas emissions so as to combat climate change. Renewable energy sources were thus identified as the major strategy for decarbonizing the global economy.

The generation of electricity in South Africa is done predominantly through Eskom and recently through the introduction of very few Independent Power Producers (IPPs) (Scholtz, Muluadzi, Kritzing, Mabaso & Forder, 2017). Eskom generates the majority of its electricity through coal fired Power Stations, thus making Eskom to be the biggest emitter of greenhouse gas emissions in South Africa.

If then South Africa is going to make a marked contribution towards the mitigation of global climate change, then there needs to be much more done by the country towards the introduction of renewable energy. Eskom, as the biggest emitter of greenhouse gases in the country has shown a lot of interest towards the growth of renewable energy, an interest which can be fulfilled in the long-term, when the costs of renewable energy declines and the country's economy shows strong growth (Bhugwandin, Moodley & Naidoo, 2019). A key determinant in the type of renewable energy to be invested in by Eskom depends largely on ensuring that affordable electricity is made available for the people.

Another key determinant is whether can reliable, uninterrupted electricity supply be provided through the use of renewable energy, still ensuring that there are sufficient reserve capacities. In areas where there is no existing transmission and distribution infrastructure to connect to new renewable energy sources, will there be sufficient funding to enable the establishment of this infrastructure, either by Eskom or the IPPs. In instances where it will not be possible to establish new transmission and distribution infrastructure, will it be possible to find an alternative method of supplying electricity to these areas, through the installation of renewable energy technologies in these areas.

1.4 Business need for the Research

According to current available data, the majority of Eskom's power stations make use of coal in their generation of electricity, as 77% of the electricity is generated through the burning of coal (Coal Power, 2020). Eskom is the main supplier of electricity in the country, reducing the country's greenhouse gas emissions thus would mean that there is a need for Eskom to reduce its dependence and use of coal fired power stations. If Eskom then were to reduce its dependence of coal power stations, there will need to be an alternative source of clean energy which will be able to come in as a substitute of coal energy, a substitute which will still ensure that there is sufficient electricity to supply the whole country.

South Africa introduced the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) and managed through this programme to see the successful development and implementation of renewable energy for electricity generation (Scholtz et al., 2017). This resulted in the electricity being added to the grid through renewable energy, thus making renewable energy a reality in the country. This has been on a very small scale though if comparison were to be made to the 77% of electricity generated through the burning of coal.

According to Scholz et al, decreasing the country's dependence on coal by increasing the percentage of renewable energy sources on the electricity grid is something that can easily be achieved due to the abundance of natural resources in the country.

Electricity supply though cannot be limited to the generation part as electricity needs to be transmitted and distributed to households after it has been generated. The country can have an abundance of natural resources to enable the easy development of renewable energy, consideration still needs to be given to the transmission and distribution infrastructure. A further consideration is the intermittency of renewable energy and this needs to be addressed so as to ensure that reliable electricity is available for the people.

In the provision of electricity, Eskom has under their strategic intent statement mentioned the need to provide "reliable, predictable, affordable electricity" and to also reduce their impact on the environment (Eskom, 2020). It then becomes important to balance their impact on the environment with the provision of reliable electricity. Renewable energy can reduce the impact on the environment, at the same time, renewable energy needs to be made a reliable source of electricity. Understanding what factors can affect the

feasibility of large-scale renewable energy while still maintaining an affordable and reliable supply will help not only Eskom in reducing their carbon footprint, but also assist IPPs to address the any limitations they might face.

1.5. Theoretical need for the Research

There is extensive literature available worldwide on renewable energy and factors that affect the feasibility, adoption or implementation of renewable energy. The available information though tends to concentrate mainly on other countries and issues that are specific to those countries.

Theory that is available mentions that the weather conditions tend to be a problem which contributes towards high variability in the use of wind and solar energy, thus leading to intermittency issues (Piel et al., 2017; Duarte et al., 2020). The report done by WWF however positions South Africa amongst the countries that have the best possible climate conditions for solar and wind energy. South Africa according to this report, has wind potential which is large enough that theoretically could allow for the entire country to be supplied through wind energy (Scholtz et al., 2017).

The country also has some of the highest solar irradiance in the world when comparing it to other countries which are already making use of solar energy on a much larger scale, however, South Africa still lags behind these countries in the adoption of solar energy (Scholtz et al., 2017). These weather conditions in the country make the adoption of renewable energy through solar and wind much more favourable as compared to the literature available for the other countries.

An identified problem in the adoption of renewable energy is intermittency which requires proper planning for reserve capacity to address this issue and also ensure stabilization of the Grid (Eskom, 2019). Currently, the electricity in the country is mainly generated through power stations, which provide a continuous supply of electricity as they generate all the time and are not dependent on weather conditions to generate.

The introduction of IPPs has gone a long way in the introduction of renewable energy to the country, this however introduces some stability issues to the grid (Eskom, 2019), an element which needs to thoroughly managed in order to ensure reliable electricity supply to the country.

1.6 Purpose statement

South Africa generates 77% of electricity through the burning of coal (Coal Power, 2020), making it the largest emitter of carbon in Africa (Scholtz et al, 2017). Investing in renewable energy will therefore provide the country the option of reducing its contribution towards climate change (Scholtz et al, 2017).

Fadly (2019) however mentions that investments into renewable energy are faced with several challenges. Start-up costs for renewable energy are high (Fadly, 2019) and the limited availability of certain key infrastructure in South Africa resulting in renewable energy start-up being import intensive (Bhugwandin, Moodley & Naidoo, 2019). Integrating renewable energy into existing transmission and distribution infrastructure, providing economical tariff rates and ensuring continuous availability of renewable energies are some of the challenges faced in the implementation of renewable energy (Fadly, 2019; Bhugwandin, Moodley & Naidoo, 2019).

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The purpose of this research is to understand what are the factors that affect the feasibility of renewable energy in South Africa. Renewable energy has been identified around the globe as the best suitable option to mitigate global climate change in the electricity production industry, even though renewable energy projects seem to be associated with too much risks (Hain et al., 2018). There is definitely a marked increase in the generation of electricity through renewable energy in many countries around the world (von Mollendorff & Welsch, 2017), thus making renewable energy a very viable option to develop and implement.

Shin et al (2016) state that there are 6 main types of renewable energy sources; the sun, geothermal, biomass, landfill gas, wind and hydropower. Biomass and hydropower are the largest contributors to renewable energy, with solar, wind and geothermal energy inputs contributing the least to the world's current renewable energy output.

South Africa currently has a mix of 6 different types of renewable energy; solar PV, wind, landfill gas, biomass, concentrated solar power (CSP) and small hydro, with wind and solar PV currently being the most prevalent renewable energy technologies in the country (Scholtz et al., 2017; Department of Energy, 2017).

Having a more in-depth understanding of renewable energy, its limitations, success factors, risks associated with the implementation and mitigation thereof, benefits of renewable energy, country specific concerns around renewable energy can help to better position South African in how they implement renewable energy.

2.2 Constraints of renewable energy

Wang and Zhao (2018) state that renewable energy is limited in production capacity, an element which influences the availability of electricity through renewable energy as the intermittency introduces an issue of high variability and low efficiency in the generation of electricity, especially when compared to conventional generation systems (Piel et al, 2017; Duarte et al, 2020).

According to Gowrisankaran, Reynolds and Samano (2016), one of the key issues faced with the solar energy is intermittency as production occurs only when the sun is shining. Wind energy also presents elements of intermittency as generation is mostly dependent

on geographical locations, generating at night time in some regions and generation throughout the day in some (Kok, Shang & Yucel, 2018). Renewable energy is mostly dependent on climate conditions for generation, which results in high variability (Duarte et al, 2020).

The sources of renewable energy are more often located in remote areas, which necessitates the need to build significant transmission lines to areas where people reside and where businesses and manufacturing factories are situated (Shin, et al, 2018). Lastly, there could be capacity constraints due to renewable sources that are not consistently available due to changing weather conditions, which results in the limited use of renewable energies (Shin, et al 2018).

One of the objectives of Eskom in their turnaround strategy is that of reducing load-shedding, thus ensuring a reliable efficient electricity supply (Eskom, 2019), which becomes an issue when observing the intermittency of solar and wind energy; renewable energy thus becomes a concern in ensuring reliable electricity production for the country.

An electricity system that is interconnected to neighbouring countries has proven to be quite beneficial in instances where renewable energy is not available due to its intermittent nature. According to Sinn (2017), Germany is interconnected to Norway, which will be beneficial for both countries in providing electricity when one country does not have sufficient electricity. When Germany has an oversupply of electricity from its renewable sources, it can send some of the electricity to Norway and Norway can save some costs by shutting down their hydro lakes. This interconnectivity is also beneficial in times of lack, when there is insufficient electricity in Germany due to limited availability of renewable sources, then Norway can supply Germany with the needed electricity.

According to Acemoglu et al., (2016), in instances where the coal energy industry is well advanced and established, it can be difficult to transition to clean energy. Some of the factors that have to be considered is the development of enabling policies that will aid this transition and also to consider the pace of the transition. Acemoglu et al., (2016) and Murray et al., (2014) suggest that the introduction of carbon taxes would definitely assist in encouraging the use of much cleaner technologies.

Eskom produces 77% of their electricity through coal power plants (Coal Power, 2020), introducing more stringent taxes for their emissions would definitely reduce the amount of coal that is burnt. In China, it is through the application of policy that emissions have been reduced at various levels, thus encouraging the adoption of renewable energy (Wang et al., 2019).

South Africa introduced an Integrated Resource Plan (IRP) in 2010 which was the first one in the country to incorporate a mix of renewable energy in the energy mix. The IRP 2010 according to Scholtz et al., (2017) was meant to be a live document that would be updated every two years to ensure consistency and continuity in the implementation of renewable energy in the country. The government however did not ensure that this IRP is continuously updated as planned, which then resulted in an impasse in the implementation of renewable energy in the country.

According to Eberhard and Naude (2017), one of the key learnings from the REIPPPP is that high-level political support is key to sustaining the procurement programme, thus ensuring continuity in the deployment of renewable energy.

The IPPs have to sign Power Purchase Agreements (PPAs) with the sole off-taker, which is Eskom in this case, which enables them to sell the electricity they produce in their renewable energy plants to Eskom (Eberhard & Naude, 2017; Department of Energy, 2017). The PPAs are key to the success of renewable energy implementation as without there being a buyer for the produced electricity, it would be pointless for IPPs to construct renewable energy plants. According to Eberhard and Naude (2017), the signed PPAs are key when IPPs are applying for funding for their renewable energy projects, as the signed PPAs are a guarantee of profit and thus repayment to the funders.

Scholtz et al., (2017) mention that in 2016, Eskom refused to sign the PPAs citing an oversupply of electricity from Eskom's own generation and also tariffs that were too high as offered by the IPPs (Department of Energy, 2017). The PPAs which were not signed were a constraint in the execution of renewable energy in the country as there was no off-taker for the IPPs which would also result in no funding to execute the projects.

Investors for renewable energy plants require a level of certainty which will guarantee a return for their investments, before they can consider investing in renewable energy. The policy environment for the country needs to be conducive to the deployment of renewable energy. Wang and Zhao (2018) mention the importance of having renewable energy policies that support renewable energy and at the same are not counterproductive to the other markets. It should therefore not be a case where a country focuses only on renewable energy to the detriment of everything else. At the same time, a policy environment that does not support renewable energy will be counterproductive to the growth of renewable energy in the country (Wang & Zhao, 2018). It is important according to Eberhard and Naude (2017) for countries to develop policies that will be customised to the specific needs of a country when it comes to renewable energy as generic policies create gaps in the implementation of renewable energy.

2.3 Cost of renewable energy

In comparing the levelized costs of solar PV to conventional generation, the costs of solar are higher at an amount of \$181.20 per MWh when compared to that of \$66.30 per MWh for conventional generation (Gowrisankaran, Reynolds & Samano, 2016). These high costs do not help in advocating for renewable energy as it would not make sense to transition to electricity that would be expensive to generate and to sell to the end user.

Gillingham and Stock (2018) are however of the view that renewable energy is now a mature technology which continues to show price reductions as more and more countries adopt the technology. The price for renewable energy is expected to continue on a downward trend which will result in the cost of electricity through renewable energy becoming cheaper. In comparing the bidding rounds for renewable energy in South Africa, it is quite clear that the costs are definitely on a downward trend (Department of Energy, 2017; Eberhard & Naude, 2017; Greencape, 2019).

It can be argued that the costs were quite high in the first rounds of bidding as renewable energy was still a new technology in the country, with too much risks of the unknown. It thus follows that when the IPPs were drawing up their contracts, they would have priced for the risk, while little competition in the market also would result in higher contract rates. Renewable energy however is no longer synonymous with high costs, as the technology is no longer expensive.

In South Africa, renewable energy has been added on to the Eskom production system to make use of already existing transmission infrastructure (Bhugwandin, Moodley & Naidoo, 2019), which leads to reduction in capital costs for renewable energy. Increasing the availability of renewable energy will however at some point necessitate capital costs investments in new transmission lines as not all viable areas for renewable energy have easy access to transmission lines.

The banking institutions continue to show an increasing appetite in funding renewable energy projects, which will definitely assist in the deployment of renewable energy projects. According to Eberhard & Naude (2017), 68% of the total funding for the renewable energy projects in the country have been funded by the five major banks (Absa, Investec, Standard Bank, RMB and Nedbank), with funding increasing from one bidding round to the next. The provision of funding for renewable energy also encourages more local business involvement in renewable energy, thus growing the local economy

through the provision of employment and the growth and creation of new businesses as enterprise development is one of the requirements on the IPP contracts.

2.4 Value proposition

Kok, Shang and Yucel (2018) mention that there is definitely a marked interest in growing renewable energy, particularly in solar and wind energy, an interest which is sparked more by the provision of electricity which does not generate carbon dioxide emissions. Furthermore, carbon taxes and research subsidies definitely result in a marked increase in the interest of innovating towards the production clean technology (Acemoglu et al, 2016).

South Africa has been identified as a country which should not be hugely affected by intermittency issues as climate conditions provide a perfect mix for generating solar energy during the day and wind energy at night (Scholtz et al, 2017). This positions South Africa as a country that should be able to easily implement renewable energy, at reasonable costs. It thus becomes important to confirm whether indeed the available wind and solar resources (Scholtz et al, 2017) positions the country favourably towards renewable energy.

Renewable energy is not only an alternative source of electricity, it is a source of clean electricity. At a time when global climate change is a painful reality, renewable energy provides a solution to the mitigation of global climate change as “renewable energies are green and clean resources” (Chang, 2014). Renewable energy reduces the carbon dioxide emission in the atmosphere and the effect of these emission, both on the environment and on people, thus resulting in a healthier environment and people who are more healthier.

There value of renewable energy cannot just be confined to reduced emissions and a cleaner environment. Fadly (2019), argues that renewable energy has to be defended on the basis of its wider economic, social and environmental implications, not forgetting that it results in an improvement in the health of individuals and an improvement in the general productivity of individuals.

The economic benefits of renewable energy are some of the factors which make renewable energy an attractive proposition. As part of the contracts that the IPPs have to sign, there has to be commitment towards job creation, enterprise development, local procurement and socioeconomic development (Eberhard & Naude, 2017). As most

renewable energy projects are in the rural areas, this translates to job opportunities in communities that are poverty stricken and employment is far and few in-between. Socioeconomic development ensures that the local communities are developed as a result of having renewable energy plants closer to them, a low hanging fruit which ensures an improvement in livelihood for the people in the rural areas.

Enterprise development ensures that priority is given to the growth of small business in the country, thus contributing to the overall economic growth of the country. Renewable energy according to the Department of Energy (2017), goes beyond ensuring economic growth as it assists in the attainment of the three pillars of sustainable development, which are “people-planet-prosperity”.

Renewable energy in the country has also resulted in the promotion of foreign direct investment into the country (Eberhard & Naude, 2017). It should be noted that with the construction of large power plants, it was not easy to obtain direct investments into the energy industry due to the high costs of building power plants. Renewable energy however provides many opportunities for investment as it is not expensive to construct renewable energy plants and investing in equipment only is also not problematic as most the components are modular.

South Africa has for a while suffered from load-shedding due to the electricity generated by Eskom not being sufficient to supply the whole country (Scholtz et al., 2017). Renewable energy provides the value of adding extra electricity to the grid, thus reducing the possibility of load shedding. Load-shedding affects the productivity of companies, which results in the companies losing profit thus negatively affecting the economy. Reliable, secure electricity is definitely crucial in order to increase the productivity of companies and thus helping the economy to grow (Department of Energy, 2017).

Eskom has not been able to provide electricity to the entire population of the country as there are some rural areas which are in very far and remote areas, areas which the transmission and distribution network has not been able to reach. The Department of Energy (2017) suggests that the energy deficit has the unfortunate consequence of reinforcing poverty on people who do not have electricity. Renewable energy, through micro grids, is able to provide electricity to people who previously could not be reached by the transmission and distribution network.

2.5 Renewable energy technology

According to Weitzel and Glock (2018), there is rarely a match between energy demand versus supply in the generation of electricity using renewable energy, necessitating the use of energy management systems for the management of the differences between energy generation and demand. To make renewable energy usable despite its volatility, proper storage strategies need to be implemented. Electric Energy Storage Systems thus become a necessity in balancing demand versus generation as they aim to provide a continuous supply of electricity (Weitzel & Glock, 2018).

In Germany, it has been identified that storage facilities that are able to store electricity for an average period of 7 months are required in order to address the volatility issue (Sinn, 2017). There is a need to look at possible storage facilities that can be used in South Africa to address the volatility issue and still ensure that the electricity network is stable.

In the adoption and use of storage technologies, excess renewable power can be stored and be used later when the renewable energy sources are not available (Department of Energy, 2017). The storage does come at an additional cost as storage costs increase the overall cost of renewable energy. An increase in the amount of renewable energy installed in the country, to the extent where about half of the electricity gets generated from renewable energy, will necessitate the use of energy storage systems (Covert et al., 2016).

2.6 Adoption of Renewable energy

Certain countries like Germany have made quite some extensive progress in the replacement of fossil fuels with renewable energies, this though came with its own set of challenges of wind and solar energy volatility. A challenge that Germany has attempted to solve through the use of pumped-storage plants and demand management (Sinn, 2017).

According to Wang, Zhou, Xie and Zhang (2019), fossil fuel, particularly coal made up 75% of the energy consumption in China in 2014, this being in spite of an increase in the use of renewable energy. China, as the world's largest carbon dioxide emitter, is faced with pressure to develop renewable energy and has thus set a target of 20% non-fossil fuels by 2030 (Yi et al, 2019).

South Africa has set a target in reduction of emissions of 34% by 2020 and 42% by 2025, which encourages a reduction in the country's dependence on coal for electricity generation towards more use of renewable energy (Scholtz et al, 2017).

2.8 Conclusion

Global climate change is an issue that is currently being experienced, it is a problem that needs to be addressed if we are to live a habitable world for the future generations. Renewable energy therefore is not just a "nice to have", it is a necessity in ensuring that we play our role in preserving planet earth. Renewable energy is not necessarily a cheap option to implement, it also comes with a lot of specialized technology and requires extensive planning in integrating it to the current electricity grid. Integration to existing transmission and distribution infrastructure also requires a lot of planning, mainly by attempting to position renewable energy plants in close proximity to already existing transmission lines. This research aims to better understand renewable energy for South Africa.

CHAPTER 3: RESEARCH QUESTIONS

Renewable energy is not only considered to be a necessary mechanism to help alleviate global climate change, it also ensures commitment to the Paris Agreement of achieving “complete decarbonisation after 2050” (Department of Energy, 2018). The available literature on renewable energy has been reviewed in the previous chapters. This literature review suggests that there are a number of challenges and factors that are either able to assist or delay the implementation of renewable energy. The aim thus is to understand what are the factors and challenges that affect the feasibility of renewable energy in South Africa.

Research Question 1

What factors influence the implementation of renewable energy?

The DOE designed and introduced the REIPPPP in order to facilitate private sector investment into grid-connected renewable energy. The aim of this programme was not solely just for private sector investment, it would also ensure that renewable energy in the country was implemented according to the IRP (Eberhard & Naude, 2017). It then becomes key to understand what has been the drivers behind the implementation of renewable energy, taking into the consideration the preparatory work that was done by the DOE.

Research Question 2

Is there any perceived value for South Africans in the installation of renewable energy?

The South African energy industry has predominantly been dominated by coal energy. Burning of coal has been cited as the leading contributor towards global climate change. This question aims to understand whether there is any perceived value in installing renewable energy in South Africa.

Research Question 3

What is the state of renewable energy technology?

This question aims to understand the current renewable energy technology and how this technology affects renewable energy implementation in the country. It further seeks to find out whether the country has sufficient renewable energy technology to allow for the electricity needs of the country to be entirely supplied from renewable energy only.

Research Question 4

What is the position of South Africa in terms of transitioning from fossil fuel to renewable energy?

South Africa has a well-established energy industry, that is dominated by coal power stations. There are also coal mines in the country, which provide coal to the power stations. These power stations and coal mines have been instrumental in providing jobs and also small business opportunities for the communities around the power stations and coal mines. In transitioning from fossil fuel to renewable energy, is the country well prepared to transition from this coal industry to the renewable energy industry with all the demands an industry change will entail?

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Choice of methodology

Myers (2013) states that it is by applying interpretivism that one is able to gain an understanding of the intentions of the participants while Saunders, Lewis and Thornhill (2009) mention the necessity of understanding the differences between humans as social actors. Saunders et al (2009) further state that there is definitely a noted difference in conducting interviews among people rather than objects. Interpretivism, which will be the philosophical underpinning of this study, becomes crucial in wanting to understand how the participants view a certain phenomenon and how they relate to it.

There is definitely a clear difference in approach on renewable energy when considering the Department of Energy, Eskom and the IPPs (Scholtz et al., 2017) which could result in the renewable energy objectives for the country being implemented differently. In applying interpretivism, it will thus be easier to get a better understanding of how each of the different stakeholders relate to renewable energy.

The approach that was used in theory development for the purpose of this research was the inductive one. Bansal, Smith and Vaara (2018) state that inductive research when used in a qualitative setting is able to allow for the generation of new insights. Inductive theory uses a bottom-up approach that starts with specific observations and uses these to get to much broader generalized theories. The aim for this research was to build up on theory from analysing data which was obtained through conducting interviews, with the end goal of producing general conclusions or theories from the research (Saunders & Lewis, 2018).

There is limited information available in South Africa on the factors that affect renewable energy and thus an inductive research was able to assist in obtaining new information. There are a number of renewable energy projects that have been successfully implemented and these were used as areas where key learnings was obtained from by the interviews of what has been done wrong and what has been done right in the implementation of the renewable energy in the country.

4.2 Research methodology and design

When choosing a research method, the researcher needs to consider a choice that would work best with the type of data analysis option chosen (Saunders et al, 2009). A mono-method, qualitative choice of semi-structured, in-depth interviews of single data collection will be therefore be used for this study.

Most of the information needed to gain a better understanding of renewable energy in South Africa is not necessarily found in books, but rather is the intellectual knowledge that rests with different individuals. It therefore makes the use of this method of data collection more appropriate as it will be through one-on-one in-depth interviews that the researcher can tap into personal experiences that have been interwoven with technical knowledge of subject matter experts in the field.

The study will be an exploratory study that seeks to determine the effect of renewable energies in the South African context. An exploratory research is used when there is a need to discover new information on a topic or to assess topics in a new light (Saunders & Lewis, 2018).

4.3 Population

In this study, the population can be described as individuals who are subject matter experts on renewable energy technologies and are well informed of the implementation of renewable energy in South Africa. This population was made up of individuals who share some common characteristics in the study that was done. The actors were from both the public and private sectors.

4.4 Unit of analysis

The unit of analysis for this study was individuals who have an in depth knowledge of renewable energy and its implementation in the country. These individuals are currently involved with renewable energy in their current roles and were thus able to provide up to date information on the current status of renewable energy in the country.

4.5 Sampling method and size

Purposive, non-probability sampling was followed to ensure that particular, identified individuals are used for interviews. According to Saunders & Lewis (2018), purposive sampling is used to select the sample members based on pre-identified criteria and certain identified characteristics. The sample size will have to be individuals that fit the identified characteristics for this purpose.

The research aimed to understand the personal experiences that the participants had with renewable energy and also aimed to gather how they felt about renewable energy. In interviewing who lived experience in when dealing with renewable energy, it would be much easier to obtain their most honest answers when it comes to renewable energy, as they would be responding not only from a point of being subject matter experts, but would be transferring through what they had experienced in dealing with renewable energy.

A list of possible interviews was drawn out from articles that the researcher had read on renewable energy in the country. These individuals were then approached through emails or cell phones where their contacts were available, and some through LinkedIn where their contact information was not available. To ensure that there is fair representation of the data collected, 16 individuals were initially identified to be interviewed from different companies and industries in South Africa. According to Merriam and Tisdell (2016), sampling should be conducted until saturation is reached, where there are no more new codes or new information, this then led to the interviews being stopped on participant 13 as there were no new codes from this interview. Figure 1 illustrates the codes generated per interview.

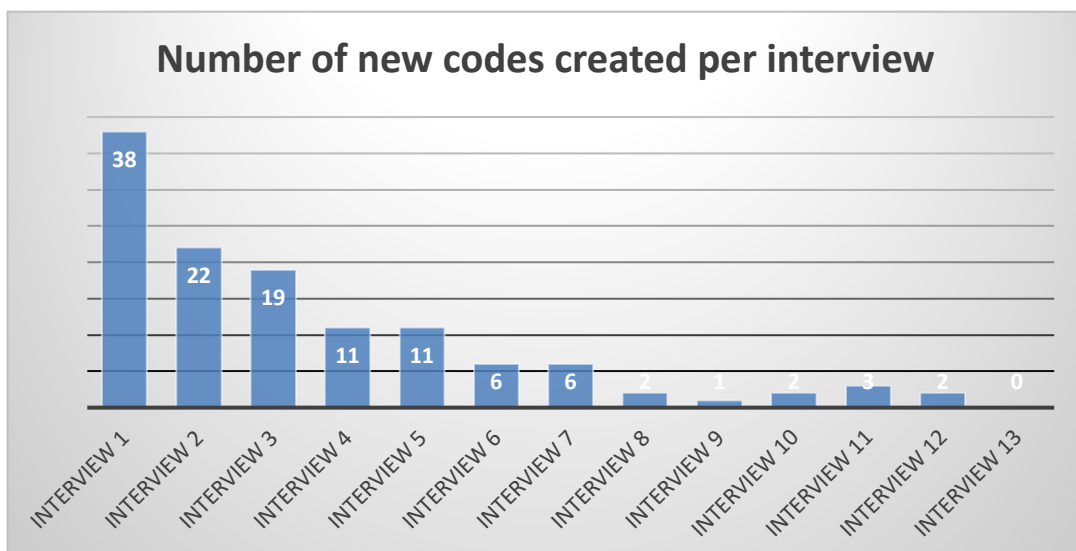


Figure 1: Number of new codes per interview

4.6 Data collection process

Semi-structured interviews were carried out with a total of 13 participants, with interviews ranging from 22 minutes to 72 minutes. The questions were a mix of both straight questions and some open-ended questions to try and get the participants' broad understanding of the topic. The interviewees shared their views differently, with some being very expressive while some were more precise in their responses, which led to the varying lengths in interviews.

Action research necessitates the researcher to be involved in the process as a participant, a strategy that further has a need to solve a problem or to create change (Saunders & Lewis, 2018). An active research strategy will be carried out for the purpose of this research which will be instrumental in gaining a better understanding of renewable energies and what effect these will have for South Africa.

To collect the data for the interview, individuals who meet the identified criteria for the interviews were approached either via email, telephone or LinkedIn where the background and purpose of the research was explained to these individuals. Their permission was then sought to interview them about renewable energy for a duration of one hour. Due to the corona virus, which has resulted in face to face meetings being discouraged, all interviews were set and conducted on Microsoft teams. There were no interviews that were conducted physically at any place of work.

At the start of each interview, each participant was informed that the interview will be recorded to ensure that none of the shared information was missed or lost in translation and to enable the interview to be transcribed later on. Permission to be recorded was requested from each interviewee, before any recordings were done.

An interview guideline was drawn up by the researcher which was then used as the practical tool in all interviews to ensure that the same data is collected from all participants. Table 1 below shows the alignment of interview questions to the research questions

Research Questions	Interview Questions
<p>Research Question 1: What factors influence the implementation of renewable energy?</p>	<ol style="list-style-type: none"> 1. What are some of the pressing issues and questions in terms of renewable energy, its implementation and adoption? 2. What are the major factors a) helping, and b) hindering, prohibiting or constraining renewable energy? <p>Implementation</p> <ol style="list-style-type: none"> 3. How do you see the future of renewable energy projects and production, and the part renewable energy fills in energy production mix? <ol style="list-style-type: none"> 3.1. Is small scale pervasive production of renewable energy, like solar rooftop PVs, not the more viable route for renewable energy, compared to large scale renewable energy production like solar farms? 4. What do the leaders in renewable energy do (better) that makes renewable work (better)? 5. Is South Africa doing all it can in terms of renewable energy? <ol style="list-style-type: none"> 5.1. In terms of renewable energy, what do other countries do better than South Africa? 5.2. Is South Africa behind other countries when it comes to renewable energy? 6. Does renewable energy feature differently in developed and developing countries, and why? <ol style="list-style-type: none"> 6.1. Will renewable energy really feature in developing countries, and why? 6.2. What prevents renewable energy in developing countries?
<p>Research Question 2: Is there any perceived value for South Africans in the installation of renewable energy?</p>	<p>Cost</p> <ol style="list-style-type: none"> 7. Is renewable energy economical and does it make economical sense in the current South African economy? Please elaborate. 8. Does renewable energy have an impact on the cost of energy production? Does this impact increase or decrease energy cost to the end user? <ol style="list-style-type: none"> 8.1. Is there a way around this impact, and will it change in the future? 9. Will renewable energy always or mostly be a case of a trade-off between cost and reduced emissions? 10. In terms of breakdown of costs, what are the major contributors of the cost of renewable energy, and can this be improved upon?

	<p>Value</p> <p>11. What are the main value propositions of renewable energy? Is there any other value or benefit in renewable energy other than reduced emissions, that positions renewable energy above conventional energy?</p> <p>12. Will the poor and most rural population of South Africa benefit from renewable energy?</p>
<p>Research Question 3: What is the state of renewable energy technology?</p>	<p>Technology</p> <p>13. In terms of renewable energy, what are current technology research focuses?</p> <p>13.1 Is there any technology or innovation in the pipeline that can drastically affect renewable energy adoption?</p> <p>13.2 In terms of renewable energy, is there any technology lacking, that must be developed still, to further benefit and help or support renewable energy?</p> <p>14. Can South Africa meet the technology requirements of renewable energy?</p> <p>15. Can currently available renewable energy technologies sufficiently supply the power required by South Africans for 24/7 operations?</p>
<p>Research Question 4: What is the position of South Africa in terms of transitioning from fossil fuel to renewable energy?</p>	<p>Industry and Policy</p> <p>16. How well is policy geared for renewable energy?</p> <p>16.1 Are there any policy issues that can hinder renewable energy?</p> <p>17. How well developed is the energy industry in South Africa?</p> <p>17.1 Does the renewable energy industry require further assistance, if yes, how?</p> <p>18. Are there sufficient players in the renewable energy industry? Should this be improved still?</p> <p>19. If there would be a complete change from conventional energy to renewable energy, how would it affect and change the energy industry, including things like job creation, job security, industry size, industry growth, etc.</p>

Table 1: Linking research questions with interview questions

4.7 Data analysis

All the interviews were recorded and the services of a transcriber were used to transcribe these interviews. The interview transcripts were then loaded onto atlas. ti 8, which is a qualitative data analysis tool (Suanders & Lewis, 2018). Codes were then generated for the interviews on atlas ti 8 so as to identify quotes which spoke into the research. Similar codes were then grouped together to create different themes.

4.8 Quality Control

The strategy of the research was exploratory as the researcher wanted to find out new information with regards to renewable energy in South Africa. In this regard, the validity of the data could not really be tested against anything as everyone's experience of renewable energy and their understanding of renewable energy is their lived experience.

To ensure good quality data is collected, there were sufficient upfront preparations before the interviews. The participants were informed upfront that the interviews would take an hour, so that they could prepare sufficient time on their sides and not rush through the interviews.

Before the start all interviews, there was be a discussion with the participant to ensure that there is a clear understanding of the interview process to be followed. Non-disclosure agreements were signed between the participants and researcher to ensure that the participants are at ease on any information that they would like to share during the interview.

4.9 Limitations

The limitations of the research was the experience of the researcher were some of the participants felt they would be offending the researcher if they spoke out against Eskom and the contribution or non-contribution of Eskom to the renewable energy programme.. Due to the time constraints of this study, a cross-sectional study was done, which could have limited the data collected. The researcher does believe though that there was saturation in the data collected and further interviews would only have wasted time.

CHAPTER 5: FINDINGS

5.1 Introduction

This chapter will present the key findings that were obtained through the interviews that were conducted with twelve participants. Themes emerging from coded interviews were used to address the four research questions that were presented in chapter 3. In analysing the responses from the interviewees, codes were created based on interviewees' responses. These codes were then integrated to generate particular themes which were then linked to the four interview questions. The findings in this chapter therefore will attempt to provide feedback from the interviews, from the perspective of the interviewees.

5.2 Description of sample

A total of 13 individuals representing different industries were interviewed in order to obtain a heterogeneous sample that would provide diverse views which would contribute to the richness of the data gathered. The interviews were semi-structured, one on one and were all conducted virtually due to the limitations presented by covid. All individuals have experience with renewable energy, some are currently researchers in the field, while some are directly involved in renewable energy projects, some are directors or head of departments in the renewable energy space, the job focuses for all individuals is different. The common thread amongst all the interviews is the involvement in renewable energy, some as advocates for renewable energy and some simply carrying out their job deliverables which resulted in a broad view on renewable energy, with different perspectives. All participants had an in depth knowledge of renewable energy, what the country is currently doing about renewable energy and personal views of how renewable energy could impact the country. The personal views of the interviewees were of great interest as these were able to provide robustness to the research, which was beyond the technical knowledge. The participants were made up of 7 males and 6 females, from different industries as listed on table 2 below. The confidentiality of the participants has been maintained by referring to the interviews as participants.

Interviewee	Function	Industry	Area
Participant 1	Senior Manager	Power Generation	Gauteng
Participant 2	Senior Researcher	Educational Institution	Cape Town
Participant 3	Strategy Manager	Power Generation	Gauteng
Participant 4	Centre Manager	Energy Research	Gauteng
Participant 5	Principal Engineer	Research Institution	Gauteng
Participant 6	Executive Director	Climate Change	Cape Town
Participant 7	Head: Energy Centre	Research Institution	Gauteng
Participant 8	Programme Manager	Natural Resources Conservation	Cape Town
Participant 9	Researcher	Power Generation	Gauteng
Participant 10	Chief Engineer: Research	Power Generation	Gauteng
Participant 11	Director	Educational Institution	Cape Town
Participant 12	Managing Director	Renewable Energy	Gauteng
Participant 13	Senior Engineer	Research Institution	Gauteng

Table 2: Summary of participants

All the interviewees were previously unknown to the interviewer which was done to avoid any bias which could have been caused due to familiarity. This also ensured objectivity in interpreting the findings as there was no favouritism or any expectations of loyalty to any of the participants. All participants were provided with the interview guide before the interview and the confidentiality of the interviewees was again confirmed and consent requested to record the interviews.

5.3 Results for Research Question 1

Research Question 1: What factors influence the implementation of renewable energy?

5.3.1 Pressing Issues in terms of renewable energy adoption

Government processes

According to the participants, there are a number of pressing issues that affect the adoption of renewable energy in South Africa. One of the key issues mentioned is the government processes which can be very protracted, thus resulting in the Independent Power Producers (IPPs) having to wait for too long from the actual bidding to the implementation. The challenges around the implementation of this programme has resulted in a lot of uncertainty for the IPPs and possible renewable energy component manufacturers, thus affecting the growth of this industry. South Africa has a REIPPPP that has been hailed worldwide as a great programme for getting renewable energy onto the grid, the implementation of this programme though has not been very beneficial to South Africa thus far.

The country has an IRP which is supposed to be updated every two years. This IRP is supposed to provide guidance on what type of energy, the amount of megawatts to be added and by when it needs to be installed, which works as the guiding document of how much renewable energy has to be put onto the system. The IRP however went through a long period of time in which it was not updated which resulted in an impasse in the implementation of renewable energy as the installations had to come to a halt.

“our last IRP that was signed off was the IRP 2010 and it is supposed to be done every two years” P2

What seems to be a problem in the government process is the political uptake as without a government that fully supports renewable energy, there will be no alignment between the government departments and ensuring that there is full government support for the renewable energy. This lack of alignment between the departments, and lack of alignment in the government process negatively affects the speed of implementation as this delays the renewable energy in the country.

Purchase Agreements with Eskom

One of the issues which were experienced that resulted in delays in the renewable energy programme was the refusal by Eskom to sign the Power Purchase Agreements (PPAs) with the IPPs. The current system operator for the country is Eskom as there is currently no policy which enables municipalities to purchase electricity directly from the IPPs. This then means that the power produced by the IPPs has to be purchased by Eskom and then distributed to the consumers.

Further to this, the transmission and distribution network belongs to Eskom which means that the IPPs need to make use of the Eskom infrastructure in order to distribute electricity to the end user. There thus needs to be a solid working relationship between Eskom and the IPPs and clear alignment to policy in order to make sure that the renewable energy programme is a success.

“you have got government that needs to facilitate Eskom as the off taker and the IPP’s as the producers and those processes need congruency and alignment”
P4

Eskom as an off-taker raised valid concerns on the price that the IPPs were selling their electricity for. The concern was that these prices were much higher than the rate at which Eskom was producing their electricity and would thus have a roll-on effect of Eskom having to operate at a loss as they would be buying expensive electricity and selling it cheaper to the consumer. The refusal by Eskom to sign the PPAs resulted in the programming stopping for a period of about two years, which affected the renewable energy industry as well as investor certainty.

Intermittency of renewable energy

Renewable energy, especially wind and solar, which are the most used types of renewable energy in the country are variable in nature thus are not able to provide stability onto the electricity network. This variability of renewable energy has been one of the issues affecting the adoption of the technology. The Eskom network operates on a demand and supply model, which has forecasts of peak periods during the day, which enables the operator to manage the amount of electricity coming in from the different power stations and going out to the end user. Renewable energy however is available

based on the wind or sun resources thus sending electricity to the operator as and when it is available.

“there’s also the issue around the intermittency in terms of availability of renewable energy” P11

South Africa has a long-standing history of using fossil fuels for generating electricity and has thus become comfortable in using coal as a primary source of energy. The country is still very dependent on coal as it is still very cheap to produce electricity from coal and thus sell it at reasonable prices to the end user. Coal is a trusted source of energy as it has for many years been able to provide reliable, affordable and stable electricity to the country.

The initial contracts that were signed by Eskom with the IPPs were signed at very high rates which favoured the IPPs, thus strengthening the case against IPPs. The country was experiencing load-shedding and renewable energy should have had the added advantage of providing a much-needed extra supply of energy to help alleviate load-shedding.

The historical reliance on coal at cheap costs and the initial IPP contracts signed at unfavourable rates has definitely been an issue that has not helped to sell the case of renewable energy that is intermittent in nature. The cost of renewable energy has however come down from the first round of bidding until the last one, which should in essence then motivate towards the adoption of renewable energy. The variability of renewable energy still seems to be an issue though as reliable, stable renewable energy is achieved only through the use of storage systems and this increases the cost of renewable energy.

“in terms of performance, you know, renewables can now compete with the grid tied electricity, but not entirely because of the variability of renewables right” P3

“a lot of the renewable technologies are intermittent in nature. I think it’s going to require a sort of a shift in thinking, we will have to be able to implement technologies to be able to deal with the variable nature of renewable technologies” P10

Bidirectional legislation

In other countries, the ability for small scale customers of being able to sell off excess electricity to the electricity network operator has proven to be quite beneficial in the adoption of renewable energy. This encourages the smaller customers to put up the upfront capital needed for individual installations as they know that they will in the end generate some income from selling the excess electricity. South Africa does not have this bidirectional legislation which enables customers to sell their excess electricity. The is however also an issue in that Eskom is not able to just add too many renewables onto the grid as the first requirement is that of having a stable grid at all times, which is not so easy to achieve with too many renewables on the system.

“I think also a limitation on the implementation is the grid itself because the grid can only offer stability for a certain amount of renewable” P3

The lack of this legislation is one of the issues raised which limits the uptake of renewable energy by individual customers. Small scale adoption of renewable energy by households and firms is said to be on a lag.

“we have a bit of a lag in outside your utility scale in terms of adoption by households and firms” P6

The uptake by households and firms is key in growing the renewable energy industry as it is these small customers that result in evening and morning peaks in use of electricity, which means that as a collective, they are big users of electricity.

The Just Transition

Most of the power stations have created mini communities and at times small economic hubs around the power stations. These economic hubs are instrumental in establishing a source of income for the communities around the power stations and also the creation of employment opportunities, to some extent. The people who live in the communities around the power stations are mostly employed at power stations. A transition then from fossil fuel energy to renewable energy raises concerns of what will be done about these communities.

“I also think that shutting down the coal power plants will not be easy, as we think it will be, you know, job losses, both in the formal economy and the informal economy related to the coal value chain” P3

“how is then one, you know, looking after the impacts on the workforce and on those communities” P7

“the issue of losing jobs in the core value chain, which I think makes it difficult to have the aggressive rollout of renewable energy that we should have had” P8

“So, the issue of how do we deal with those, the jobs for those people once we introduce renewable energy” P11

The coal used in coal stations provides a source of employment to the people who work in the coal mines. Transitioning to renewable energy again raises an issue of employment for the mine workers. Changing from the coal industry to renewable industry poses an issue of many unknowns in the job sector and also a need to create a new type of skill set. These unknowns have resulted in the politicians and policymakers not driving renewable energy implementation as they should, as amongst other things they have to worry about job losses for a large number of unionised members, which could result in unnecessary strikes in the country.

“The transitioning to renewable energy from a fossil generation mix is not going to be very easy, given the amount of job losses that we will see in the economy related to the coal value chain” P3

“politicians and policymakers are unable to understand how to bridge this new low carbon future versus an old polluting carbon history and moving towards this low carbon future is seemingly very difficult for them.” P12

There needs to be a concerted effort from the decision makers to want to understand how renewable energy can work in South Africa without creating unnecessary job losses so that they will want to drive the transition from one energy source to the other.

5.3.2 Factors hindering renewable energy

Financial constraints

Renewable energy, for both large and small scale projects, requires a lot of upfront capital for the installation. South Africa does not have investors who have enough financial muscle to be able to easily afford the costs associated with large scale renewable energy. This results in the uptake being limited to mostly international investors and South African companies not being able to also install the technology in the local companies due to lack of upfront capital.

Only a limited number of homeowners are able to afford the costs of putting up solar photovoltaic (PV) panels on their roofs. South Africa is a poor country, where the poor are very poor and the rich are very rich thus creating a kind of imbalance on the affordability of solar PV for the entire population. Solar PV is mostly afforded by the most affluent which results in a limited market of homeowners who can afford to install renewable energy. Capital is key and capital seemingly is not what the most of South Africans have.

“and hindering and prohibiting, I would say is financial constraints” P9

“The only factor that hinders it is the is the capital cost” P6

These financial constraints have thus resulted in a lack of massive customer response. It is crucial to have customers for any industry to grow, as a lack of customers results in adoption of the technology not being at a fast enough pace.

Lack of a disciplined roll-out

In order for the country to be able to meet the plans for renewable energy as specified in the IRP, there needs to be a disciplined approach on what needs to be done and there has to be timelines clearly indicating when will the required activities be done in order to comply to the IRP. What seems to be a barrier to implementation is the lack of a disciplined approach. There is no pipeline of projects clearly indicating what needs to be done, by whom, and by when. When looking at the renewable projects that have been previously executed, there was a yearly execution of projects and then thereafter, everything just stopped.

The delays in starting renewable projects is also as a result of not receiving the determinations from the minister timeously in order to know when to stop with the procurement and start to build on those systems.

The lack of discipline in the execution of renewable energy projects creates a lot of uncertainty in the execution of the projects which affects the delivery of these projects.

“even though government has made commitments to a low carbon future, the implementation does prohibit the growth” P1

“In South Africa specifically, there is uncertainty around implementation” P10

In a project environment, success can only be attained through certainty and discipline. There needs to be a clear indication of how things have to be done and who will be responsible. A lack of discipline provides none of those, which results in the delays in starting the execution of renewable projects.

The uncertainty in projects results in a lack of local manufacturers for renewable energy components. Local manufacturers would definitely grow the renewable energy industry as more jobs would be created from the local value chain, thus becoming one of the tangible proofs that renewable energy is beneficial for the country. With a lack of discipline in the roll-out, it becomes difficult to sustain local companies as there is no market for them.

Interconnected renewable energy systems

In South Africa, there are currently six types of renewable energy technologies that make part of the renewable energy mix. The focus though is mostly on wind and solar PV as the two leading technologies installed and the two technologies which will still form the greater part of the energy mix. Due to the variable nature of renewable energy, especially wind and solar PV, it is not possible to have an electrical system that consists of renewable energy alone as this would result in going through periods of time where there will be insufficient supply for the country.

“As indicated, there are instances where both wind and solar without storage have or haven't generated as much as the system operator would like and that is why I say it should be part of a balanced energy mix” P1

Some countries like the European countries and the United States are interconnected to neighbouring countries that have adequately installed capacities which can provide them with back up supply when their renewable energies are generating insufficient electricity

due to limited ability from the sources (wind and solar PV). These interconnected countries are therefore able to be 100% renewable energy as they will have backup supply when it is needed.

When you are interconnected to other countries, it becomes easier to integrate a large amount of renewable energy into your system in order to still maintain system integrity. South Africa however, does not have any countries that have a strong electricity system which they can be connected to in order to get back up supply in times where renewable energy would prove to be insufficient. So, yes renewable energy has a definite future in South Africa, however, this is still a future which is part of a balanced energy mix in order to ensure a reliable, stable electricity supply.

"I still believe that renewables place a significant role in the energy mix but we should be pushing for 100% renewables" P1

"However, renewable energy is variable, and therefore, it will always need some form of backup and until the energy storage becomes more affordable, the renewable energy systems will remain stagnated in South Africa" P3

Policy environment

Government has clearly come out in support of the renewable energy programme and the implementation thereof. What has clearly come out as an issue though is the lack of alignment between government policy and how that policy is implemented. The policy on paper is a good policy, the environment around that policy is not conducive to the implementation of that policy.

"the last bid window was in 2014. And we haven't had significant procurement of renewable energy since then. And uhm, it is all principally centred around government's approach in terms of a scattered approach" P1

"Well, I mean, the thing that is hindering it, is this policy uncertainty" P2

"So yeah, there's a lot of uncertainty with regards to policies and regulations" P10

"I think it's more policy. So, in certain environments, the policy inconsistency, so that becomes a good example, is a problem" P12

Policy is supposed to guide what needs to be done, however implementation of the policy is hugely dependent on government support, towards ensuring that what is on paper is realised practically.

In order for IPPs to be able to execute the renewable energy projects timeously, there needs to be a concerted effort from government to approve the enabling policies timeously. An Environmental Impact Assessment (EIA) is one of the mandatory requirements that need to be approved by government before project execution can start. Previously the time taken for an EIA to be approved was 18 months, which has significantly come down to 6 months. This has allowed for a reduction in the execution time for renewable projects, however, this can still be approved upon to ensure timeous execution of renewable projects.

Furthermore, the policy for small scale embedded generation has not been very progressive around allowing customers to self-supply. The process required for registration and licensing from NERSA is quite long and difficult.

5.3.3 Factors helping renewable energy

Climate change evidence

Renewable energy became the buzz word when mounting evidence showed that emissions are a big contributor towards the global climate change. It then became necessary to find a different type of energy which would still achieve the end goal of producing electricity, just as coal does, but without the emissions produced by coal. There is physical evidence of climate change and global warming, the effects are clearly visible.

“From the point of view of helping, emissions right, so emissions are an issue as Eskom was struggling already” P10

“The major factors, obviously, we look at climate change issues, because of climate change, we cannot avoid using renewable energy” P11

If South Africa wants to play an active role in the alleviation of climate change, then renewable energy has to play a huge part in that. Global warming has far reaching results

and consequences and there has to be a concerted effort by everyone to somehow stall climate change.

The world has made a commitment towards the lowering of carbon emissions, which means the need for renewable energy is bigger than South Africa.

“you have internationally the International Energy Agency and the likes which have come out quite strongly in support of a clean carbon environment” P1

“it is definitely the global decisions that have been made, which have made it to be environmentally sustainable” P9

This case, world over, against carbon emission and towards a cleaner environment, backed up by evidence of climate change surely supports the need for renewable energy.

Good renewable energy resources

The main two renewable energy types that are predominant in South Africa is wind and solar. What gives renewable energy a great advantage over coal power stations is that the coal used in power stations is slowly running out whereas you will always have sun and you will always

have wind. There is no risk of one day realizing that these natural resources are depleting or have depleted so they provide comfort of always having renewable energy.

South Africa has some of the greatest resources for wind and solar as compared to many countries in the world.

“issues that support renewable energy is the fact that we’ve got such wonderful renewable energy resources” P8

Furthermore, there is no risk of ever having a price increase on your fuel source as it is free, unlike the price of coal which increases yearly. This gives the country an extra added benefit of being able to use these two free resources indefinitely, at a great benefit to the country.

Reduction in costs

One of the factors that are key and need to be considered before embarking on any project, is the costs associated with the project. The costs are definitely not only limited to the capital costs, but the lifetime costs of the project have to be considered. When a comparison is done between coal stations and renewable energy plants, it is very clear that while the costs for coal plants are on a rise, the costs for renewable energy plants are on a decrease. It might be easier for South Africa to hold on tightly to what they have known over the last 100 years, which is coal, however the rising costs of coal present a very cold case. The rising costs of coal make it very difficult to want to continue to do business as usual. Renewable energy has over the years proven that they are not just a cleaner option to coal, they are also a cheaper option to coal.

“You can also include the factors helping renewable energy is the cost reduction, with the price reduction over the past several years it is competitive. In many cases cheaper than conventional power” P1

“the cost of renewable energy technologies and renewable energy in general is coming down” P11

“cannot deal with the levels of pollution and cannot deal with a cost and price volatility of fossil fuels, versus renewables that have got a consistent fixed price and clean” P12

Matured technology

The case of renewable energy no longer needs to be proven. There are no longer questions whether renewable energy works or not, or whether renewable energy is sustainable or not. There is sufficient proof world over that renewable energy works, it not only works, it works very well. Like any other technology, there will always be disadvantages and advantages, however those do not mean that the technology does not work.

“the effect that the technology has been pretty much addressed, does help renewables” P1

“But both wind and PV are very mature technologies” P2

Renewable energy is a technology that has matured over the years, it is a technology that has been installed and proven in South Africa as well. The fact that there are few to no unknowns about renewable energy, makes renewable energy a very attractive solution for the country.

Good Integrated Resource Plan

An IRP is crucial for providing an indication of how much electricity capacity is required by the country and further provide a plan of how this capacity will be achieved. A further aim of the IRP is to ensure that the electricity capacity is achieved through means that will also protect the environment by minimizing emissions. Renewable energy thus features in the IRP as one of the energy sources that will ensure emissions are minimized. The IRP that South Africa has, is one of the very best programs in the world.

“we’ve got a very well-developed procurement program for large scale renewable energy that is regarded as a best in the world” P8

It gives a clear direction from government on the amount of large scale renewable energy penetration that is planned for the country and it further indicates the mix of the different types of renewable energy. The IRP therefore makes the implementation of renewable energy much easier to plan for and achieve.

Banks no longer support coal

The costs to build a coal power plants are very high and in the past Eskom has not been able to afford these costs which has necessitated them to approach banks for funding. It is highly unlikely that in the future that Eskom or any private companies would be able to fund the construction of a coal power plant. In the future, funding for coal power plants would still be have to be obtained from banks.

Banking institutes have however clearly come out against coal power plants. They have indicated that they have no further intentions of financing the building of power plants, now or in the future.

“The large banks predominantly all have indicated that they are no longer supporting coal and there are, they have set funding aside for green financing as well” P1

“a lot of funders are saying they are no longer funding fossil fuel technologies. On the other hand, they are more than willing to fund green ventures, renewable ventures” P10

“So, if you look at what is happening globally, there isn’t funding now for fossil projects” P3

It will therefore be very difficult for coal power plants to be built due to a lack of funding. This works very much in favour of renewable energy as electricity will always be a need. So, if banks are not willing to fund coal power plants and rather opt for renewable energy plants, it simply means that renewable energy has a much better chance than coal power plants.

5.3.4 Balanced energy mix

In South Africa, there are currently six types of renewable energy technologies that make part of the renewable energy mix. The focus though is mostly on wind and solar PV as the two leading technologies installed and the two technologies which will still form the greater part of the energy mix. Due to the variable nature of renewable energy, especially wind and solar PV, it is not possible to have an electrical system that consists of renewable energy alone as this would result in going through periods of time where there will be insufficient supply for the country.

“As indicated, there are instances where both wind and solar without storage have or haven’t generated as much as the system operator would like and that is why I say it should be part of a balanced energy mix” P1

“So besides renewable energy, you know, we would still have the, the coal, we would still have the nuclear. I think that both these technologies will still be required to support the grid for the foreseeable future, until energy storage technologies become cheaper” P3

Some countries like the European countries and the United States are interconnected to neighbouring countries that have adequately installed capacities which can provide them with back up supply when their renewable energies are generating insufficient electricity due to limited ability from the sources (wind and solar PV). These interconnected countries are therefore able to be 100% renewable energy as they will have backup supply when it is needed.

When you are interconnected to other countries, it becomes easier to integrate a large amount of renewable energy into your system in order to still maintain system integrity. South Africa however, does not have any countries that have a strong electricity system

which they can be connected to in order to get back up supply in times where renewable energy would prove to be insufficient. So, yes renewable energy has a definite future in South Africa, however, this is still a future which is part of a balanced energy mix in order to ensure a reliable, stable electricity supply.

"I still believe that renewables place a significant role in the energy mix but we should be pushing for 100% renewables" P1

"However, renewable energy is variable, and therefore, it will always need some form of backup and until the energy storage becomes more affordable, the renewable energy systems will remain stagnated in South Africa" P3

"So, I am firm believer that we must diversify our energy mix" P6

"The world is moving towards more energy mixed models. Obviously, renewables can play a big role" P6

5.3.5 Large scale versus small scale projects

South Africa installs both large and small scale renewable energy, both these play an important part in the energy mix. It is not possible to position one above the other or choose one over the other as their advantages and disadvantages are always dependent on a case by case basis.

"large scale solar production, for obvious reasons from an economic economies of scale perspective, make a lot of sense, the more you build, the cheaper it gets" P5

"We still need the large power plants to provide power through the National electricity grid for big consumers, for instance so both are viable options, and they complement each other as far as I see" P11

Large scale renewable energy takes a long time to procure and get onto the grid, whereas small scale renewable energy is much easier to procure and use even though you cannot get it onto the grid. Small scale provides electricity for homeowners or small

companies and large scale connects onto the grid and provides electricity for a number of consumers.

“It's going to require a mix of large grid connected projects to be able to deliver the scale and amount of electricity needed” P12

The disadvantage of small scale is the capital costs required to install the system and the confusion in electricity demand forecasts that it introduces for the electricity operator when those customers have to go back and use the grid electricity due to variability on their individual systems.

“if you are talking about a lot of household or even shopping centres etc. it is much more difficult for a distribution operator, never mind a transmission operator to control all of those” P2

A way to manage this variability would be for those homeowners to procure battery storage system which can provide electricity at times when the sun is not shining. Battery storage is still very expensive and it is thus not easy for everyone to procure it. Small scale is not easily available for most households as only a few people are able to afford it. This affordability factor makes small scale to not be an option that should be considered a lot especially when the objective is to provide electricity for everyone.

“you navigate economies of scale with rooftop solar and your problem is if you in the South African context, rooftop solar can only be afforded by fairly affluent households. So, it's not an affordable option for low income households” P8

It is possible to have both small scale and large scale renewable energy. Large scale is definitely beneficial in providing electricity for everyone, small scale should however also be considered, especially in cases where the intention is to do micro grids for communities where the transmission and distribution network does not reach. Small scale is also beneficial when trying to reduce the effects of load-shedding.

5.3.6 Strategies of leaders in renewable energy

The renewable energy technology has matured, which makes it easy to implement. The technology is modular in design and thus allows for ease of installation, which has resulted in there being many participants in this field. The competitive market thus has

resulted in leaders who realise the importance of knowing their work if they are to retain customers.

The leaders in renewable energy are technically very good and also understand that the market is competitive and thus they have to always deliver their projects on schedule and within budget in order to be able to retain customers. These projects which are delivered on time also ensure that the leaders do not get project overrun costs which would negatively affect their finances and cashflow, it allows them an edge to remain profitable.

“So then understand the technology and that is why all our renewable energy projects were delivered on time” P8

Leaders in the space understand that they are hugely dependent on government and government policies in order to deliver their projects timeously, they thus partner with government which allows for improvements in project execution as government gets to learn more about the benefits and opportunities of the technology and how government processes can be optimized upon to deliver the best results.

“there's a lot more work now happening across the renewable energy sector to partner with government as opposed to being adversarial. You know, and then, you know, being critical of government policy, and rather try and inform it constructively. So that's a shift that I'm seeing” P7

Research done on the technology has resulted in the improvement in the technologies, providing the most viable and technologies which have also over time resulted in continued reduced costs. The leaders are able to leverage on both the technology improvements and competitive prices to provide products that are both technologically savvy and at competitive prices.

“we have the people leading in the academics side who come to contribute a lot in terms of the research. That research contributes in terms of lowering the cost of production” P11

Renewable energy projects allow for the creation of a totally new economy, leaders are able to provide better and different entrepreneurial opportunities for the communities

close to where they install their plants, which allows for commitment and thus better adoption of the technology.

“So, the better commitment, the better consensus you have around the adoption, the better the market works” P12

5.3.7 Renewable energy in developing and developed countries

Renewable energy features differently between developing and developed countries as this is mainly influenced by the different needs that these countries have. Developing countries are mostly looking at solutions which will enable the largely dispersed populations to get some or other form of electricity at costs that everyone will afford. In developed countries, the need is not necessarily for basic electricity as these countries are mostly fully electrified so it becomes easier for them to just concentrate on changing towards a cleaner technology. Developed countries are generally more aggressive in their renewable energy implementation as compared to developing countries. Developing countries cannot be very aggressive in their approach as the introduction of renewable energy, through micro grids, will at times become the only solution for electricity to reach the far-out places which the transmission and distribution networks cannot easily reach. The introduction of micro grids though will require proper planning, and this will affect the rate of renewable energy implementation. As developing countries are gaining more knowledge on renewable energy and how this technology can be strategically used for the future, they are slowly increasing the implementation rate of renewable energy.

“there are some places in South Africa that the grid will never get to” P4

“the developed countries have largely driven it from a climate change perspective. They've completed the electrification programs; everyone has access to electricity” P7

“I think it's less developed in developing countries, it's more the extent to which you have existing electricity grid penetration” P8

Renewable energy implementation in developing countries is also affected by a lack of developmental financing which is not an issue for developed countries. Developed countries are able to deploy new technologies early as they have enough finances to do upfront research and development and take chances, while developing countries will

mostly be the followers rather than initiators of a new technology as they are more prone to adopt when they are sure the technology will work. Developed countries are mostly not too risk avoidant as they have enough capital to take and absorb risk while developing countries are very risk avoidant.

“developing countries are not that cash flushed, that they can put a lot into R&D, you know, research and development, you know and take chances.” P2

Developed countries also have sufficient inhouse resources for the implementation of renewable energy while developing countries have to import these technologies which increases the cost of implementation. The lack of local value chains increases the costs of implementation as technology has to be imported which results in increased execution costs.

The policy environment and project uncertainty in developing countries like South Africa results in problems being experienced in establishing local value chains as no companies can manage to be sustainable and profitable without consistently maintained manufacturing orders.

The costs of renewable energy were also initially expensive for the consumers and absorbing these costs would not be easy in developing countries as most consumers would not afford high electricity costs. As the costs of renewable energy have significantly come down, there is now an increase in the deployment of renewable energy in developing countries.

“There's a lot of deployment now, because the costs have just come down significantly” P5

“And that cheaper technology then presents a massive opportunity for developing countries like South Africa, to now use that much cheaper” P6

5.4 Results for Research Question 2

Research Question 2: Is there any perceived value for South Africans in the installation of renewable energy?

5.4.1 Economy of renewable energy for South Africa

Eleven out of the twelve participants are all in agreement that renewable energy definitely makes economic sense for South Africa, while one participant believes that it is not economical for South Africa. One participant feels that the current costs that the IPPs have charged Eskom for the first three rounds of bidding are way too high and this makes renewable energy in its current form not to be economical for the country. The costs that were charged are much higher than the costs of Eskom when using coal for electricity generation. Above the contractual costs that the IPPs are selling electricity to Eskom for, there are also the transmission, distribution and network charges which Eskom needs to cover as the IPPs are not paying for these costs. So renewable energy is expensive to Eskom as it costs them more than coal energy, which does not make economic sense then for Eskom as it would result in extra costs for Eskom.

“The independent power producer is only paying for the production of that electricity, while as Eskom pays for the transmission and distribution to the customer. So, you cannot say then that the IPP is cheaper” P3

Renewable energy according to the rest of the participants can stimulate the economy, it just needs some government support in order to grow the economy in different ways. Support from government would ensure consistency in renewable projects, thus being able to develop proper manufacturing companies in South Africa and also creating more jobs in the value chain that support both the manufacturing companies and the companies doing the actual execution of renewable energy projects.

“Renewables can stimulate the economy if we have a government that is supportive, that has a single-minded view in terms of focusing on economic growth” P1

“So renewable energy can be able to assist the economy grow if it is done properly” P2

“The benefit is more around the growth side of the economy because remember that growth not only creates more jobs, but it also allows for the growth of the tax base” P6

Furthermore, renewable energy comes in cheaper than coal energy and will thus reduce the overall system price, which will result in cheaper electricity costs for everyone.

“All of our modelling indicates that the lowest cost and energy mix has a substantially increasing amount of renewable energy” P7

Renewable energy is also able to assist with load-shedding which is currently affecting most companies in a negative way and results in reduces production and also loss of business which is not good for the economy. So, adding renewable energy to the grid will increase electricity supply which then becomes a net positive for businesses already in operation.

“I mean in the current situation it might actually even assist with load shedding, because it adds to the system when we have a shortage of energy” P2

The current coal power plants at Eskom are old and some have reached decommissioning stage, there is therefore a need for additional electricity. Replacing the decommissioned plants with renewable energy saves the country a lot of money in terms of debt through Eskom building new coal power plants as renewable energy brings in investors that come mostly from outside of the country. These investors bring a lot of money into the country by building these renewable energy plants which is an economic boost for the country. The renewable energy plants are modular and can this be constructed much faster which reduces any risks of extra costs during their execution phase.

“Now, we have foreign investment lining up to invest in the country, we have great resource. The moment you have great resource, it makes the projects viable” P9

5.4.2 Cost of renewable energy to the end user

It cannot be denied that the first three bidding rounds for renewable energy were quite expensive as the technology was still fairly new in the country, which carried a lot of risks with it. There is also a view that the breaking up of Eskom into different entities will

introduce additional administrative costs from the different entities onto the overall cost of renewable energy, thus an increase in costs to the end user.

There other view is that the initial costs of the IPP contracts that Eskom signed at high costs, will simply be passed on by Eskom onto the end user, thus increasing the electricity costs to the end user.

“Eskom is having to buy the electricity from those providers at between three and four times the cost of what, in fact, even more, in some cases, of what they can produce it themselves on their own power stations. So, they're not paying for that cost, they're going to pass it on to the user, which is us” P4

The view from the rest of the participants though as the costs are continuously coming down and will definitely be a net positive for the end user. As the technology continues to be used in the world and in the country, the costs of renewable energy continue to go down with every bidding round while the costs of coal energy continue to go up.

“At the moment it will actually bring the cost down to the system. You know I mean the new wind and the solar is much cheaper than Medupi and Kusile electricity for instance” P2

“So if you look at the cost of power from a Medupi and Kusile at one rand five cents to one rand 15 cents a kilowatt hour, and you look at what would have come out of round for around five, and you're talking about 65 and 70 cents, the figures aren't even comparable” P12

The reduction in costs in renewable energy, will automatically translate to a reduction in costs for the end user. The technologies with most reduced costs and which are used mostly in South Africa is wind and solar PV. CSP is still extremely expensive, this is not an issue currently though for South Africa as there was minimal introduction of CSP in the IRP 2010 and the IRP 2019 has no allocations for CSP.

“So probably, if you factor everything in it might not be much cheaper than coal, but it's certainly not more expensive” P8

“Yes, and no, depending on the technology, concentrated solar power is still quite expensive” P9

“The cheaper the electricity you put into the power pool, the greater it's going to lower the cost of wholesale electricity production, that is the value of renewables” P12

Installing micro grids in rural areas where the transmission and distribution networks cannot reach, will not only result in electrifying most areas, but will also provide these rural areas with cheap, accessible electricity.

“In a particularly rural area, it may be that it's better to rather just deploy the renewable solutions, which are much cheaper these days, as opposed to trying to get the network out there” P5

5.4.3 Trade-off between cost and reduced emissions

When renewable energy projects first came onto the grid, the cost of installation were still very high which resulted in these costs being transferred to the cost of electricity from renewable energy. The installation costs were largely influenced by the costs of the components that were used for installation. Transportation of the components also contributed to the installation costs as the components are quite large and had to have specialized trucks designed just for the components.

“I think there was a very high cost in the beginning in South Africa to get all the transport right” P2

Transportation costs are however no longer an issue going forward as the country now has those specialized trucks available. Capital costs are still the major contributors of costs in renewable energy projects, these costs are however continuously decreasing as more and more installations are done and the technology continues to improve. The financing costs of renewable projects are still high in South Africa due to project uncertainty, so the risk of project uncertainty gets costed onto these projects. Reducing project uncertainty will therefore also result in the financing costs continually decreasing thus an overall net decrease in renewable energy projects.

“because we are regarded as a high risk market at the moment, the cost of financing here is expensive, borrowing money to fund a project is expensive” P12

Costs are therefore not an issue for renewable energy projects as there is also no continuous costs of maintenance and fuel like coal in coal power plants. Wind and sun are free resources and do not add additional costs to renewable energy.

When renewable energy projects were started, their costs were quite high which at the time seemed like there would be some kind of trade-off, that of getting reduced emissions but at high costs. With the continued reduction in renewable energy overall costs, there is no longer a trade-off. Renewable energy is now a net positive to the country. Reduced emissions result in cleaner air for the country, which will result in a reduction in health costs as a result of emissions. Renewable energy thus brings the value of being both continuous reduction in costs and reduced emissions.

“So, it is no longer a trade-off. It is more an added benefit in terms of now you are getting a technology that can generate at a cheaper price or at the same price but wait a second, you are also getting reduced emissions” P1

“I think globally, that's also been showing that there's no more trade-off between costs and emissions they used to be, but not anymore” P5

“there need not be a trade-off, you can get the best of both worlds, but it takes a concerted effort to want to do that” P12

5.4.4 Value proposition of renewable energy

Renewable energy is not just a mitigation to delay global warming through reduced emissions nor is it a cleaner environment. There is much value that the country will benefit through the introduction of renewable energy.

The reduction in the emissions produced will lead to a cleaner environment, which will generally result in healthier people who are breathing air which is much cleaner.

“So, there is a health benefit” P12

Renewable energy projects are small in size as compared to building coal power plants. These projects will therefore provide opportunities for more players in this industry.

“You can have a much more players in the market” P2

The life cycle costs of renewable energy are much less when compared to coal power plants. There are no maintenance costs for renewable energy, so no additional cost increases which would result in electricity cost increases. The price of renewable energy has consistently been coming down as the technology continues to improve. This will result in cheaper electricity for the people as more and more renewable energy gets added to the grid.

“You can provide for cheaper energy source if you do it the right way” P6

*“greater adoption of renewables, helps lower the wholesale price of electricity”
P12*

Renewable energy is not only a free, limitless energy source, it also provides energy diversity which results in energy security.

“I see it as an alternative product to grid tight electricity” P3

The components used for the installation of renewable energy projects are modular which allows for easy and faster installation thus saving on the normal extra costs that are normally generated during construction of coal power plants. This modularity also allows either for small scale installations or large scale installations, which means renewable energy is more accessible.

“You could use embedded generation, you could do a small installation, or you could do bigger solar farms” P10

Lastly the country is currently running out of its water resources. Renewable energy has a great value of saving the water resources, while coal power plants use too much of the countries water resources.

“we need it for growing food, not for cooling down power stations” P12

5.4.5 Rural communities and renewable energy

Electrification

The rural communities, especially those which are in very awkward places that the transmission and distribution networks are not able to reach, currently do not have electricity. The current infrastructure is not able to reach these places and the cost of capital to add extra transmission or distribution lines seems to be too high for Eskom to be able to bear the costs of these once off installations.

“there are many areas in the country where it is just too expensive to have a transmission line running from wherever, from which ever substation to that local uhm, that rural community” P1

Renewable energy is able to electrify these far off places through the introduction of micro grids, thus ensuring that everyone in the country has access to electricity. It currently is the best technology that can take electricity to everyone, thus benefitting even the most rural and very poor communities.

“you can now have electrification in an area that was previously deemed too expensive to run your infrastructure to” P1

“Renewable energy is one of the ways in which they can get electrification faster than unfortunately, waiting for Eskom connection or municipal connections” P9

“like as Eskom tries to electrify South Africa, where they are rural villages where it doesn't make economical sense to connect them to the grid, it might make sense to set up a micro grid in that area to provide electricity to them” P10

Renewable energy is able to provide a lot of possibilities for the country, especially to rural communities where it provides options that were not previously there or would not be there if the only option was to connect everyone to the grid.

Community development

An interesting suggestion by one of the participants, was the provision of water to rural communities through the use of renewable energy technology. The idea is that of using solar pumping to pump water from the air to water sources like tanks or solar geysers for areas that struggle even with the basic necessity of running water. These communities would not only benefit by getting electricity, but would also get a chance of having running water.

“So, you would end up with these almost sort of contained routes that would have electricity and water accessibility facilitated by renewable energy technologies in an energy efficient manner” P4

It is not easy to manufacture components for coal power plants locally, whereas much of the renewable energy components can be manufactured locally. If these manufacturing plants were built in areas closer to the rural areas, this provides an opportunity of smaller businesses for those rural communities.

Renewable energy plants are many smaller projects compared to the mega projects of building coal power plants. These smaller projects provide an opportunity of much more community ownership as renewable energy contracts have a requirement of community ownership as a condition. This would result in many more rural communities developing through these plants that would be scattered all over the country. One of the conditions in these contracts is that a percentage of the economic benefits these projects need to benefit communities within a fifty-kilometre radius of these projects.

“It's money that those communities never had, its income they never had. It's certainly starting to improve their lives and it's a tangible benefit that's going to be there for 20 to 25 years, guaranteed income flow” P12

“Because it is smaller projects you can have much more community ownership. So, it is good for economic development in the country” P2

“So, you know, bringing in more economic activity into a region that didn't necessarily have that before” P5

Rural communities can either be directly involved in renewable projects through the community ownership condition that is part of these contracts or they could also be

indirectly involved through the provision of transport, services, catering or whatever else could be identified as business opportunities in these projects.

Another condition in the renewable energy contracts is that of enterprise development by the project owners. So rural communities will not only be provided with business opportunities, but will also be assisted in developing these businesses.

“In the long run, we anticipate that with much more education, even local people will be able to be worked into the kind of BEE shareholding in the renewable energy projects” P11

5.5 Results for Research Question 3

Research Question 3: What is the state of renewable energy technology?

5.5.1 Research on renewable energy

Current research focuses

Renewable energy is a technology, and like any other technology, the interest is always on improving the technology for it to work better. At times, the technology focuses or interests do not mean there is a gap in the technology, only that technology is not static, there is always room for improvement.

The current research focus for solar PV is on improving the efficiency of the panel which will result in the solar panels doing more at reduced costs. The focus for wind technology is on finding ways of extracting as much energy out as possible from the wind turbines, which would result in turbines that can generate increased capacities at reduced costs.

Another point of interest is the study being done on agrivoltaics which will provide a better understanding of how the same area of land can be used for both agriculture and solar PV.

There is also an increasing interest that is currently shown in understanding more about offshore wind farms and how this type of renewable energy can be added to the electricity grid.

Energy storage remains a constant research focus with interest mainly being on improving the efficiency of storage while at the same time decreasing storage costs which will enable easier adoption of renewable energy as storage has the added benefit of decreasing variability.

There is also research being carried out on how to better integrate renewable energy onto the grid, distributing this electricity as much as possible, with as minimal interruptions to the electricity supply as possible.

The storage of energy through the use of hydrogen fuel cells is currently showing a lot of interest internationally as this seems to be one of the clean technologies that can be used for storage. It seems that there are not really any new research focus areas, rather the research that is currently being carried out is aimed at improving the technology that is currently there so as to enable the better functioning of renewable energy.

Technology that could affect renewable energy

A reduction in the storage costs of renewable energy would definitely affect the adoption of renewable energy as this would mean that there will be less intermittency when renewable energy is being used.

The charging time for battery storage also needs to be improved upon, there is focus on technologies that will enable accelerated charging of the batteries and general focus on the cycling time as this needs to be improved upon. The intermittency of renewable energy is an issue in the adoption of the technology, an improvement in the efficiency of storage systems and a reduction in storage costs would definitely be a winner in the renewable energy industry.

Small nuclear reactors have an added advantage of being installed in coal power plants that are being decommissioned. This would mean that the decommissioned electricity is replaced with small nuclear reactors without having any concerns of the transmission and distribution network as these would already be connected to the coal power plants. Commercialization of small nuclear reactors could thus affect renewable energy adoption as this would be an introduction of clean technology that is not variable.

Lacking technology

There is general consensus amongst the participants that there is currently no technology lacking that still needs to be developed which could benefit or support renewable energy adoption. The research currently being done aimed at improving the efficiency and availability of renewable energy, is sufficient.

If there could be more done, then this would be looking at concentrated solar power and how the costs can be reduced to enable better adoption of this technology. Concentrated solar power has the advantage of being a stable supply of electricity as it is not variable which makes it a solution not only to reducing emissions but also to providing reliable, stable supply of electricity through renewable energy.

5.5.2 Renewable energy technology in South Africa

If South Africa was required to manufacture renewable energy components, this could easily be done as the country does have the technical expertise required to manufacture renewable energy technology. There are obviously certain components which would still remain cheaper if manufactured in China, however, given sufficient time and certainty of renewable projects continuing, South Africa could meet the technology requirements for renewable energy.

“So basically, that means that even if we could manufacture our own technology, the gaps in the process create an issue so now we have to order them internationally” P2

“we've got deep industry and we have manufacturing capability” P7

Sufficient electricity from renewable energy

There are mixed views amongst the participants on whether the currently available renewable technologies can provide sufficient electricity for South Africa all the time. Four of the participants are in agreement that it would be theoretically and technologically possible to supply sufficient electricity to the country. A concern raised amongst these participants is whether the country would really want to attempt this though as it would be very costly to do so.

“Do you want to do that, why would you want to do that? Right, because it is not just whether the technology can do it, it is the cost associated with that” P1

“Is that the clever thing to do? Probably not. Whether it is financially viable, you know, that is the question” P2

A second concern is that this would result in there not being any baseload that would be able to supply electricity to the country in times of high variability, when renewable energy supplies are not available due to weather conditions that interfere with the source of renewable energy. Renewable energy, due to their nature of dispatchability, require additional electricity supply that would be a baseload which ensure a reliable and stable electricity supply to the country.

“Well, theoretically, yes but we'll never be able to keep our grid going if we don't have some kind of baseload” P8

Renewable energy is decentralized to all over the country and this works as an advantage in the favour of renewable energy. When source is not available at any one point in the country, it will definitely be available in another and this allows for a continuous source of supply.

“If the wind is not in Puff Ader, you can be sure it will be blowing in Cape Town and if it's not blowing in Cape Town, you can be sure it will be blowing somewhere in the free state” P12

The rest of the participants are of the view that available renewable energy technology cannot supply the country with enough electricity all the time because it is variable in nature.

“No, because it is variable in nature” P3

“We still are going to rely on our baseload coal for many years to come” P9

“So, we cannot be able to do that without the support of the coal power stations at the moment” P11

5.6 Results for Research Question 4

Research Question 4: What is the position of South Africa in terms of transitioning from fossil fuel to renewable energy?

5.6.1 Implementation of renewable energy in South Africa

There seems to be a mixed view on whether South Africa is behind other countries in terms of renewable energy implementation. Two of the participants felt strongly that South Africa's implementation should not be compared to other countries because the other countries started with their implementation long before South Africa did and also because the needs of South Africa are different and the country should therefore have its own implementation model.

“So, whether we need to actually, you know, imitate other countries? I don't I don't necessarily agree with I think South Africa will or should develop a plan at a pace and scale that is in line with our social economic conditions” P3

“I wouldn't want to say behind because we started later, they started before us” P4

The rest of the participants are all in agreement that South Africa is behind the other countries and is also ahead of other countries in terms of implementation. There however is contrasting views on whether South Africa is a leader or not in the continent.

“It's behind the leaders, but it's ahead of others” P8

“At international level it is behind some of the countries, at continental level most of the countries are trying to follow South Africa, so we are the leaders” P11

“We certainly are way behind many of our North African counterparts. We even lagging compared to what someone like Ethiopia is doing” P12

One of the major reasons cited for South Africa being behind was the impasse in installations which was caused by the IRP not being signed. An IRP was promulgated in 2010 and there was nothing after that for quite some time, with the IRP after that only being promulgated in 2019.

“Then paused, like I said, and that's where we made a bit of a mistake and have fallen behind as a result, it's obvious that it's there's no use in crying over spilt milk”

The biggest problem that South Africa seems to have is a policy environment which is not very conducive and thus leading to a lack of discipline when it comes to implementing renewable energy. It does not benefit the country much to have a world renown IRP programme if it will not be followed in terms of installation and making sure the timelines specified on the IRP are adhered to for getting the renewable energy plants onto the grid. A concern in South Africa is also the lack of alignment between the government departments in ensuring that the renewable energy megawatts are delivered as per the IRP.

“They don't have these four years of nothingness” P2

“And then when the impasse happened between DMRE, DBE, Eskom and IPP office, everything essentially ground to a halt. We've lost about four years of implementation in that uncertain period” P7

Other countries have a political champion for renewable energy who drives only the implementation of renewable energy which South Africa does not have as the minister of energy has to ensure all types of energy are procured to achieve the target megawatts. The other countries have also managed to address the challenges and conflicts between coal and renewable energy environments and have thus reached a consensus on what needs to be done which has made implementation to be much easier and faster. Overall, South Africa is definitely behind other countries in renewable energy implementation and this is mostly as a result of lack of discipline and a lack of alignment amongst the departments, which has resulted in implementation not being done as stipulated in the IRP.

5.6.2 Policy for renewable energy policy in South Africa

One of the most important elements that are key in ensuring that renewable energy implementation is successful in any country, is the policies required for executing renewable energy projects. According to the participants, South Africa has great policies for renewable energy execution.

“brilliant policy in South Africa, we have really good policy” P2

"In the country, the policy is well geared for renewable energy" p11

The country has some of the most progressive policies in place which would allow for good implementation of renewable energy projects, however, not much is being done about these policies. The issue mostly that South Africa has, is in not adhering to the policies which then results in a negative impact for renewable energy execution. There needs to be an improvement to policy alignment so as to allow for better implementation of the policy.

"We have all the policies in place, we just actually need to just get going with implementing" P6

So, it's our implementation of our policy, that that still seems to be a constraint" P7

There could be some improvements though on the policies for small scale renewable energy. Homeowners and companies are allowed to put on small scale solar PV projects, however there are no policies which allow them to connect to the grid.

"there's policies that are not yet placed that allow for embedded generation" P4

"there are policy issues around you know, embedded generation that needs to be resolved" P6

Policies that allow small scale solar PV to be connected to the grid would assist in providing extra electricity to the grid. This would also increase the penetration of renewable energy in the country.

There is a problem around Eskom being the sole buyer of renewable energy in the country. This has delayed the renewable energy programme in the past when Eskom was refusing to sign IPPs. Government needs to develop and finalise policies that allow municipalities to buy renewable energy from IPPs so as to make sure that the country does not experience that problem again.

"The whole Eskom being the only people that are only company that's allowed to buy electricity right now is a problem" P9

Another issue in the country is a clear policy around the decommissioning of the old Eskom coal power plants which will also show a clear indication of how renewable energy will be phased in to cater for the electricity lost on the grid when these plants are decommissioned. A clear policy for just transition is also required as this will give a clear indication of how the country will transition from coal power plants to renewable energy, clearly indicating what is the plan for the people who will be losing jobs when coal plants are closed and replaced with a totally different technology which will require a different skill set.

5.6.3 Renewable Energy Industry in South Africa

The coal energy industry in South Africa is well developed, it is however vertically integrated as there has been only one player in the industry for a very long time which has monopoly over the industry. Eskom has been the sole supplier of electricity for many years and the introduction of renewable energy into this industry was initially not well received by Eskom.

Introducing some competition in the generation of electricity will definitely improve the energy industry as this would result in Eskom improving their performance and will also result in the country having a more stable, reliable supply of electricity.

“Well, the coal energy industry is very well developed” P4

The renewable energy industry is slowly gaining momentum towards becoming a well-established industry. Progress could be much better in this industry if there were government officials who are willing to make the tough decisions with regards to implementation of the policies, ministers who would have the best interest of the country at heart, rather than ministers who are mostly driving political agendas. The government also needs to provide more conducive policies especially for small scale renewable energy which will assist in growing the renewable energy industry. The industry is currently highly regulated which adds unnecessary red tape in the execution of projects thus delaying implementation.

“Please get some ministers that will act in the interest of the citizenry of this country and who are not scared to take decisions” P12

The renewable energy industry has sufficient players, which provides for competition in the industry thus resulting in better execution of renewable energy projects. Renewable

energy investors are however mostly international companies and this needs to be improved upon so as to have more local investors.

"I don't see South African wholly owned companies" P3

"I think that there are sufficient players, but from a South African point of view, we need to improve on it and localize it" P10

An added advantage for the renewable energy industry is the ability to manufacture components locally, thus creating jobs and also having easy access to components. Government needs to however provide better certainty on renewable energy projects so as to ensure that local manufacturers can remain operational. There definitely needs to be a marked increase and improvement in the establishment of local manufacturing companies and in ensuring that these remain sustainable.

"So, there's room for improvement there in terms of being able to get South African industry that manufactures renewable components" P4

"The other issue areas around the original equipment manufacturers, there needs to be a lot more local partners" P6

"I would like to see more South African companies playing in the space" P9

The energy industry in South Africa is currently a mixed one, with coal power plants making up the majority of this industry. It is possible to do a complete change from conventional energy to renewable energy, however this change would have to be done gradually with a lot of attention placed in maintaining employment numbers and not leaving people out of employment after the transition.

The participants have differing views on whether it would be possible to provide employment for everyone who loses their jobs when closing down coal power plants and coal mines. Some participants are of a strong view that many jobs will be lost, while some participants maintain that the renewable energy industry would result in more employment opportunities as renewable energy employs more people per megawatt.

"not only more job creation but actually better jobs you know, not working close to coal fire power stations and so on" P2

“the number of jobs that renewable energy projects generate compared to coal and gas, and they are less, they are significantly less” P9

“Renewable energy projects will create jobs during construction phase, and afterwards, the jobs kind of dwindle as opposed to coal fired power stations” P11

“Yes, they are going to be more jobs per megawatt” P12

What is clear though is that a total transition would definitely result in a whole new industry. A total transition therefore needs proper planning, there has to be a just transition policy that caters for every eventuality.

“new industries born right and new jobs will be born, new type of work will be born” P3

“I wouldn’t change everything at the same time, it’s also part of a transition” P5

5.7 Conclusion of findings

This chapter presented the research findings from the 13 interviews that were conducted based on the four research questions presented in chapter three. The findings suggest that there are a number of issues in South Africa that affect renewable energy adoption. Over and above these issues, there are both positive and negative factors that affect the implementation of renewable energy in the country.

In the adoption of a new technology and further implementation of such, it becomes important to understand whether there is interest and readiness for the new technology to be adopted. The findings have definitely provided the level of readiness of the country to adopt renewable energy. This level of readiness is measured both from a technical perspective and on whether there is support from government towards this adoption and the general interest shown by individuals. The findings further provided insights into the perceived value of renewable energy for the country. Over and above the perceived value, the chapter provides the actual value that renewable energy would provide for the country.

CHAPTER 6: DISCUSSION OF FINDINGS

6.1 Introduction

This chapter discusses the research findings from the interviews, as presented in chapter five. The discussion will be presented according to the four main research questions which were presented in chapter 3. The results are compared to the existing literature review in order to identify new insights that will contribute towards understanding factors that affect the feasibility of renewable energy in South Africa.

6.2 Discussion for Research Question 1

Research Question 1: What factors influence the implementation of renewable energy?

6.2.1 Pressing Issues in terms of renewable energy adoption

Government processes

The government processes, as experienced by the participants, have played a huge role in delaying the implementation of renewable energy in South Africa. In order to ensure and maintain sustainable success in the implementation of renewable energy, there needs to be a clear plan of action from the government which can be followed by the IPPs who will be executing renewable energy projects. According to the participants, South Africa introduced a world renown IRP, which if followed accordingly, would have resulted in South Africa having made quite an extensive progressive in the implementation of renewable energy. This IRP, should have been updated every two years to ensure that it is in continuous alignment to the needs of the country for renewable energy.

According to Scholz et al (2017), the IRP was created with intention of it being a “living plan” that would be drafted and sent to stakeholders for comments which would be consolidated and promulgated every two years, starting in 2010. The intention of stakeholder involvement was to ensure that concerns, lessons learnt and improvements were captured and made part of the latest promulgated document so that the country could be aligned to the industry and the latest global improvements.

The first IRP was promulgated in 2010, after which there was a long impasse until the latest IRP which was promulgated in 2019. This resulted in unnecessary delays in the

implementation of renewable energy in the country as there were many years of nothingness.

The participants strongly believe that with more government support, there would have been better alignment between the government departments in ensuring that the IRP is promulgated every two years as previously planned, which would have resulted in better implementation of renewable energy projects. One of the key learnings in the REIPPPP programme according to Eberhard and Naude (2017) is that high-level political support is key to sustain the procurement programme.

Purchase Agreements with Eskom

The refusal by Eskom, as the company that has monopoly over the generation, transmission and distribution network, to sign PPAs has undoubtedly lost the country many years in the implementation of renewable energy projects. To ensure success of the IPPs, it is necessary for Eskom as an off taker, to sign contracts with IPPs that allow for the purchasing of renewable energy and its addition to the Eskom grid. Without signing the PPAs, the IPPs are not able to continue with the execution of renewable projects as they will have no one to sell their electricity to which would result in huge financial losses to the IPPs.

The majority of the participants are in agreement that Eskom had a sound argument for refusal to sign these PPAs as the cost of renewable energy electricity from the first three rounds of bidding were too high when compared to the cost of electricity generated by Eskom. Signing the PPAs would definitely ensure that the renewable energy programme is not stalled, however, this would have been at a huge cost to Eskom. This would have resulted in Eskom operating at a loss, which would definitely have had an impact on government as Eskom is a parastatal and a loss in revenue to Eskom is a loss in revenue to government. According to the Department of Energy, Eskom offered to sign the PPAs from round 4 of bidding, provided that the costs of electricity from the PPAs would be reduced to a price cap of 77c/kWh (Department of Energy, 2017).

There is however a differing view from the renewable energy industry which strongly believes that Eskom should have just signed these PPAs. This industry does not fully discuss nor consider the disadvantages of Eskom signing these PPAs, the only concern is Eskom delayed the renewable energy programme and this should not have been allowed to happen (Scholtz et al, 2017). Eberhard & Naude (2017) further allude to the fact the PPAs should sufficiently protect both the buyer and seller, which seemingly

differed in this case as Eskom as the buyer assumed less risk compared to international PPAs.

There was an impasse between Eskom and the PPAs, and seemingly both sides had valid arguments. In order to reach an agreement, it would have been necessary for government to intervene, with the aim of achieving a win-win solution for both sides, without any side being left far off financially.

Intermittency of renewable energy

In South Africa, wind has the highest penetration for the currently installed renewable energy, with the penetration of solar directly behind wind. One of the issues experienced with renewable energy is its intermittency, especially for wind and solar. Scholz et al. (2017) argue that in South Africa, solar energy is mostly available during the day and wind energy is mostly available at night and this should negate any effects of variability.

The participants however are all in agreement that both wind and solar are variable and require some sort of storage or base load to balance the variability. This is supported by Biel, Zhao, Sutherland and Glock (2017), who argue that wind power is non-dispatchable due to its intermittent nature, which requires users of wind power to utilize effective strategies that will enable them to address the intermittency. There is further support from Gowrisankaran et al. (2016) on the intermittent nature of solar energy which is due to solar being able to generate only when the sun is shining.

Eskom provides electricity to the entire country and as part of their strategic intent statement, they intend to provide reliable, predictable, affordable electricity to the country (Eskom, 2020). The intermittent nature of renewable energy then poses an issue to Eskom as the off-taker from the IPPs as Eskom is still the overall supplier of electricity to the end user. It thus becomes the responsibility of Eskom to ensure that the demand and supply forecasts are properly managed and there are no consumers who are without electricity. Wind and solar are not able to provide Eskom with surety, instead they introduce an element of variability onto the electricity network.

The intermittent nature of renewable energy results in the IPPs only providing electricity to Eskom when and if it is available, as made available by the availability of the source. If there is no sun, then there is no electricity and if there is no wind, then there is no electricity. This uncertainty in the production of electricity from renewable energy does introduce an element of scepticism in the adoption of renewable energy.

Eskom has a long standing relationship with coal which is able to provide electricity throughout the day and is not dependant on weather conditions. Coal energy does not require backup storage to manage intermittency as is the case for renewable energy. Storage is not an ideal solution for renewable energy as it increases the cost of electricity to the end user. Variability can be managed through the use of storage; however, the costs of storage increase the costs of renewable energy, thus making renewable energy to be less attractive for adoption.

Bidirectional legislation

Bidirectional legislation makes allowance for small scale customers to sell their excess electricity to the electricity network operator. South Africa currently does not have bidirectional legislation which means that any excess electricity generated by the small scale users simply goes to waste. The ability to sell excess electricity has in other countries resulted in more willingness for small scale users to install their own systems as they will be able to generate some sort of income in selling electricity to the network operator. Scholz et al. (2017) argue that government has failed to establish an enabling policy framework for bidirectional cogeneration which has resulted in reduced interest in small scale generation.

Just transition

According to Flagyl (2019), when considering the added benefits of renewable energy in the development of emerging countries for socio-economic, environmental and geopolitical grounds, it becomes clear that a transition from traditional fuels to renewable energy is inevitable.

Coal power plants have been in operation over a period of more than 50 years. These power plants have according to the participants managed to build their own communities around the power plants. Decommissioning of these coal power plants or shutting down of these power plants will result in job losses for the people who live around these power stations and further cause job losses for people who work in the coal mines.

In transitioning from coal power plants to renewable energy there needs to be clear plan of what will be done with the jobs lost and how will these communities be catered for in a way that will not necessarily disrupt their way of life.

According to the Department of Energy, there needs to be a clear plan of action when transitioning from fossil fuel to renewable energy in order to ensure that the transition is well positioned to deal with the impacts on jobs and the local economies (Department of Energy, 2019). If the communities are catered for, then the adoption of renewable energy becomes much easier. Scholtz et al. (2017) mention the need of addressing poverty and inequality when transitioning from coal to renewable energy. It is clear that a well-planned transition process, which clearly indicates how the current jobs in coal plants and coal mines will be catered for in the renewable energy industry will receive a lot of support from the stakeholders, especially the unions which have to ensure that the peoples jobs are not affected.

6.2.2 Factors hindering renewable energy

Financial constraints

The participants who were interviewed have mentioned the lack of upfront capital as one of the factors that hinder renewable energy. Upfront capital is a necessity, either for businesses that want to do large scale renewable installations or for homeowners who would like to install solar rooftop PVs. To increase the uptake for both large scale renewable energy projects and also solar rooftop PVs, there needs to be more options available to provide funding, at reasonable conditions and interest rates.

The studies which have been done in South Africa are in contradiction with the believe that there is not enough upfront capital for South Africans which will allow them to partake in large scale renewable energy. Eberhard and Naude (2017) believe that the REIPPPP program has been very successful in generating interest in the renewable programme, both in the local and international front, thus being able to obtain sponsors internationally and locally. The South African banking sector has provided the largest funding for the renewable energy programme, as out of R201.8 billion that was invested in renewable energy project costs, only R48.7 billion was from foreign investors and financiers (Deloitte, 2019; Eberhard & Naude, 2017).

The issue that South Africa has, is not that the country is not able to fund renewable energy projects. The problem experienced by local companies is the stringent qualifying criteria which is required for large scale operations. South Africa is not a rich country, it becomes difficult for small companies to be able to provide the required leverage that would enable banks to provide them with funding.

Lack of a disciplined roll-out

South Africa started the renewable energy programme in 2011 after the first IRP was promulgated in 2010. The first IRP however did not provide specific timelines of when the renewable energy projects were expected to be online, it only provided a range of years by which certain amounts of megawatts from renewable energy need to have been added to the grid. The IRP definitely has a completion date, whereby it clearly outlines what needs to be done by 2030, however, there is no yearly targets.

According to the participants, more clearer timelines and more specific deliverables within those timelines would result in better implementation of renewable energy projects. A disciplined roll-out would also result in an increase in the establishment and sustainability of local manufacturing firms for renewable energy components as these firms would planning on more concrete information.

The issue with the IRP2010 is that it had broad policy targets and these were not able to provide sufficient certainty for investors to enter the market (Eberhard & Naude, 2017; Greencape, 2017).

Interconnected renewable energy system

South Africa does have great resources for wind and solar PV, which has resulted in the majority of renewable energy being solar PV and wind. The problem with both these technologies is their variability which becomes a problem in trying to provide reliable, uninterrupted electricity to the country. The participants believe that this variability could be mitigated through the use of neighbouring countries who would provide electricity at times when renewable energy is not available. The problem raised by the participants is that South African is unfortunately not interconnected to any neighbouring countries, which then rules out the option of getting electricity support from neighbouring countries.

The South African renewable energy installation can be likened to that of Germany, which too has wind and solar PV as the majority installed renewable energy. Germany has previously used coal power plants as the their main supply for electricity. Introduction of wind and solar PV then introduces the element of volatility, Germany though is interconnected to Norway and will thus be able to make use of the hydro lakes in Norway as a back-up supply when wind and solar PV are not available (Sinn, 2017). This advantage of interconnectivity, is one which South Africa does not have which poses a disadvantage in the adoption of volatile renewable energy.

Policy environment

South Africa has got good policies which are very much in support of renewable energy and the growth of renewable energy in the country. An issue raised with the policy by the participants is a lack of alignment by the government departments to these policies, which translates to the execution of renewable projects being delayed by the lack of policy alignment. Wang and Zhao (2018) mention the importance of not having policy that is only conducive to renewable energy development, while it creates controversies in indirect markets.

There is also the issue of the IRP which was not updated as planned and this caused further delays in the execution of renewable energy projects. An IRP that is not updated, is as good as an IRP that does not exist.

Eberhard and Naude (2017) mention the importance of developing policies that are customised to the specific requirements of the country and not just generic policies as it is in these generic policies that it gaps in implementation are created. In order for South Africa to see much progress in renewable energy implementation, government needs to be a partner that is onboard specifically with the intention of growing renewable energy through both large scale and small scale projects, and thus leading and guiding the process to achieve renewable energy targets.

6.2.3 Factors helping renewable energy

Climate change evidence

Global climate change can no longer be ignored as the evidence can be seen everywhere. If there is hope of mitigating the effects of global climate change, then it becomes necessary to reduce the carbon dioxide emissions that go out to the atmosphere.

South Africa has a history of generating electricity mainly through coal power plants, with Eskom, as the main electricity producer generating 77% of its electricity through coal power plants (Coal Power, 2020). In order for South Africa to play an active role in mitigating global climate change, then the figure of 77% has to drastically change. The Paris Agreement, which South Africa is a signatory off, is a constant reminder to South Africa that climate change is a bigger than South Africa and thus compliance to the reduction of carbon dioxide emissions has to adhered to by all countries.

South Africa has also pledged to reduce the country's emissions and set specific targets for the reduce emissions by 34% in 2020 and by 42% in 2025, which is one of the driving factors that encourage the country to commit to the mitigation of climate change (Scholz et al., 2017).

Good renewable energy resources

According to the participants, the two main renewable energy types predominantly used by the country is wind and solar PV. This is guided mostly by the fact that these are the two easily available resources in the country, and which happen to be the cheapest renewable energy technologies. South Africa, according to Scholtz et al. (2017) has some of the best resources for wind and solar PV as compared to some of the countries, worldwide.

This abundance in wind and solar is a huge advantage for the country as these resources are available in abundance in all nine provinces of the country, which encourages the option of having a well distributed installation of renewable energy.

Reduction in costs

All the participants are in agreement that the costs of renewable energy have been coming down over the years, throughout the world, a fact that South Africa has proved through the reduction of contract costs from the IPPs as seen from the different rounds of bidding. The first round of bidding presented the highest round of contractual costs from the IPPs with the last round presenting the lowest costs, costs that were very competitive.

Reduction in costs in renewable energy has been seen and experienced throughout the world and this reduction is expected to continue as the technology matures and more and more countries are adopting these technologies (Gillingham & Stock, 2018). Costs have not only shown a reduction from inception of renewable energy world-over up until now, but according to Gillingham and Stock (2018), renewable energy costs are expected to continue with the downward trend in cost reduction.

While the costs of renewable energy continue to come down, the cost from coal power plants continue to go up. It is clear that renewable energy is not only a clean technology that will help mitigate global climate change, it is also a cheap technology. Furthermore,

renewable energy electricity is produced from free wind and solar resources, while coal energy electricity is produced from a paid for coal resource.

Matured technology

Renewable energy has an advantage of being a technology that has been tested and proven to work world-over, and also in South Africa since its inception in the country. A technology which has been proven to have so many advantages, presents itself very easy to adopt.

Good Integrated Resource Plan

The participants believe that the IRP that South Africa has developed, is a great IRP which is world renown. The IRP 2010 has been very instrumental in the country achieving the currently installed renewable technology base. According to Scholtz et al. (2017), the IRP 2010 is the first IRP in South Africa which included renewable energy in the electricity mix for the country.

The IRP2010 has been able to provide direction on how much renewable energy has to be installed and the different types of renewable energy technologies that will be used to achieve these planned renewable energy targets. According to the Department of Energy (2018), the IRP 2010 also provides the future requirements for the transmission network which will enable the expansion in renewable energy to be met by the country.

The IRP has thus ensured that there is a roadmap towards achieving an energy mix that will meet the electricity requirements of the country and has further identified supporting policies, stakeholders and resources that will be required to achieve the energy mix targets, renewable energy being part of this mix.

Banks no longer support coal

It has come out quite clear from the participants that building of coal power plants will be very problematic in the future as the funding to build has previously been provided by banks and banks currently have come out strongly against provided future funding for coal power plants. The refusal by banks to provide funding for coal plants while strongly supporting renewable energy and providing funding for renewable energy is definitely a factor that further advances the case of renewable energy.

The five major banks in South Africa (Absa, Investec, Standard Bank, RMB and Nedbank) have clearly shown support for renewable energy. As at June 2018, these five banks had provided 68% of the renewable energy funding in South Africa which ensured that renewable energy is implemented and continues to grow in the country (Deloitte, 2019; Eberhard & Naude, 2017).

6.2.4 Balanced energy mix

The IRP 2010, clearly makes allowance for renewable energy to be part of the balanced energy mix in the country. The participants have mentioned that due to the variable nature of renewable energy, especially wind and solar, which are the predominantly installed renewable energy technologies in the country, it is not yet possible for the country to rely solely on renewable energy.

Another factor raised by the participants which needs to be considered, is that South Africa is not interconnected to neighbouring countries which would have been an option in providing back up supply at times when renewable energy is not available. South Africa does not have the advantage which some international countries have which enable them to consider utilizing renewable energy only for their electricity supply.

According to the IRP 2019, which provides direction of the latest energy mix for the country up to 2030, renewable energy will still form part of the energy mix as the country is not in a position that will enable it to rely solely on renewable energy (Department of Mineral Resources, 2019).

6.2.5 Large scale versus small scale projects

South Africa has got a mix of both small scale and large scale renewable energy, and both these are necessary in the energy mix. According to the participants, the country has a need for both large and small scale projects as these fulfill different roles in the energy mix. Renewable energy is flexible in that it can be deployed on a small scale where it can benefit households, companies and small communities and also on a large scale where it can be connected to the grid (Department of Energy, 2017).

Small scale projects have a disadvantage of being expensive for most households, which results in them being afforded by the most affluent households. A further disadvantage of small scale is their difficulty in being integrated into the electricity grid, which makes it difficult for the network operator to forecast electricity demand.

Small scale rooftop PVs are mostly used during the day when the sun is shining, with their users reverting back to the national electricity supply when the sun is not available. It can in essence be said that the solar rooftop PV owners make use of national electricity grid for supply (Scholtz et al., 2017) which then introduces confusion to the electricity demand forecast.

Solar rooftop PVs, due to their size, are much easier and faster to install and can therefore be used to meet some of the targets for renewable energy as specified in the IRP.

Large scale renewable energy produces electricity which will be fed into the national grid. This electricity is then used to provide electricity for everyone who is on the national grid, and not just for a selected few households. So large scale renewable energy has got the added advantage of providing electricity for everyone who is on the national grid and not only a select few.

6.2.6 Strategies of leaders in renewable energy

The research findings suggests that the leaders in the renewable energy space have become leaders because they have sound technical knowledge which has assisted them to understand the renewable technologies much easier and faster. Renewable energy components are modular in design, which makes their installation much easier. In order to gain leverage in this industry, it thus becomes important to have technical knowledge which will enable you to identify areas where you can outsmart your competitors.

It has become important for leaders to ensure that they deliver their projects on time and within budget so as to gain investor and stakeholder confidence. In order to remain at the forefront of the competitors, the leaders have managed to become well known in their field through their well-executed projects. Some of the international backed IPPs have managed to secure projects continuously throughout the bidding rounds which has resulted in them opening local offices (Eberhard & Naude, 2017).

The leaders have, according to the participants, partnered with government in order to ensure that key learnings from executing the projects are passed on to government so that government processes can be better optimized to allow for better execution of renewable projects. These leaders have realised that in order for them to become

leaders, they have to continuously improve the manner in which they execute renewable energy projects.

6.2.7 Renewable energy in developing and developed countries

Renewable energy has been welcomed in both developing and developed countries, at times for different reasons. In developing countries, renewable energy has provided a solution of providing electricity for everyone, especially for people in the rural, far-off areas that were not easy to reach through the normal transmission and distribution network. It is through the use of micro grids from renewable energy that these areas can also get electricity, without having to be connected to the national grid. Renewable energy technologies introduce an option of micro grids that can be implemented in rural communities to provide good quality electricity, where it was previously not possible to do so (Department of Energy, 2017). The focus in developing countries is two-fold; to transition from coal power plants to the use of cleaner technologies and also to provide electricity for everyone in the country.

In developing countries, the focus is mainly on the reduction of carbon dioxide emissions as these countries are mostly fully electrified. It will therefore be much easier for these countries to be aggressive in their transition from dirty electricity to cleaner electricity as the focus is solely on clean electricity. With the focus being in transitioning to the use of cleaner technologies as quickly as possible, the developing countries are able to fund research and development initiatives which will enable them to be at the forefront of technology adoptions which allow them to deploy renewable energy technologies faster. An added advantage of developed countries is having enough funding which allows them to execute new technologies as they are being introduced, while they are still very expensive for countries which are poorer.

Clean Development Mechanism (CDM) is an international collaboration between developed and developing countries which adopted a principle which will enable developing countries to be at the forefront for deployment of renewable energy technologies so that these developed countries would develop technologies in their countries and only transfer successful technologies to developing countries (Department of Energy, 2017). This would ensure that developing countries are implementing technologies which has been tested and proven, thus enabling them easier and less costly implementation.

6.3 Discussion for Research Question 2

Research Question 2: Is there any perceived value for South Africans in the installation of renewable energy?

6.3.1 Economy of renewable energy for South Africa

Most of the participants strongly believe that renewable energy makes economic sense for South Africa. Renewable energy projects are able to stimulate the economy through the provision of employment opportunities and also the provision of business opportunities. There has been numerous jobs that have been created through renewable energy projects, with a total number of 26 790 people who have been employed due to renewable energy projects; investment into the establishment of local manufacturing firms and the promotion of foreign investments into the country (Scholz et al. , 2017; Eberhard & Naude, 2017).

Renewable energy also assists in reducing load-shedding in the country by adding more electricity to the electricity grid. A more consistent supply of electricity will result in less disruptions in the day to day operations of the businesses, which translates to more job productivity and thus more income generation opportunities. The Department of Energy (2017) suggests that secure access to electricity is important for increasing productivity and thus promoting economic growth for the country.

Renewable energy does not only ensure economic growth, it goes beyond that by assisting in the attainment of all three pillars of sustainable development, which are “people-planet-prosperity” (Department of Energy, 2017).

It has also become much cheaper to build renewable energy plants as compared to building coal power plants, which means more investments into assets with better returns and growth for the economy (Guidehouse, 2020).

6.3.2 Cost of renewable energy to the end user

There are contrasting views on whether renewable energy will result in an increase in or decrease in electricity costs for the end user. Two of the participants are of the view that the originally signed IPP contracts will result in increased electricity costs for the end user.

The rest of the participants believe that the continued decrease in the costs of renewable energy will result in reduced electricity costs for the end user. As the technology continues to be used in the world and in the country, the levelized cost of electricity for renewable energy continues to come down which results in continued reduced costs for the end user (Greencape, 2019; Department of Energy, 2017; Eberhard & Naude, 2017). Renewable energy will definitely result in continued decrease of electricity tariffs for the end user.

The cost of electricity from Eskom, even from the new recently build coal power plants, is much higher than the electricity from renewable energy. Electricity costs from coal energy continues to be on an upward trajectory, while electricity costs from renewable energy continue to be on a downward trajectory.

6.3.3 Trade-off between cost and reduced emissions

According to Gowrisankaran, Reynolds and Samano (2016), the levelized costs for solar PV are \$181.20 per MWh which is higher than the costs of conventional generation of \$66.30 MWh. These high renewable energy costs were clearly an indication of a technology that was still new and in the initial stages of adoption. The initial adoption of renewable energy was therefore a case of moving from coal energy to cleaner technology, at a premium as renewable energy was more expensive than conventional energy.

The participants have mentioned the fact that the first round of bidding for renewable energy in South Africa was at very high costs, costs which were much higher than the electricity produced by Eskom. According to some of the participants, the initial contracts with the IPPs were signed at electricity costs which were mostly three higher than the costs of the electricity generated by Eskom.

It is however clear from the participants when considering the last bidding rounds for renewable energy that there has been an improvement in the costs for renewable energy, as the levelized cost of renewable energy is currently cheaper than the cost of coal energy. The prices of the winning tenders in the last bid rounds for wind and solar PV came in much cheaper than the average costs of electricity for Medupi and Kusile (Eberhard & Naude, 2017; Greencape, 2019).

According all participants, there is no longer a trade-off between cost and reduced emissions, as renewable energy is currently both reduced emissions and reduced costs.

6.3.4 Value proposition of renewable energy

Responses from the participants clearly indicate that there is much more value to be gained from renewable energy, besides reduces emissions and a cleaner environment. Renewable energy needs to be defended on the basis of its wider economic, social and environmental implications (Fadly, 2019), it should not be limited to a clean environment or reduced emissions. Eberhard and Naude (2017) mention a further benefit of renewable energy being the promotion of foreign direct investment to the country and also private sector investment into the South African energy sector, which was not previously easy to achieve due to the high construction costs of coal power plants.

A reduction in the use coal energy for electricity generation will result in a cleaner environment, with less gases in the air thus resulting in healthier people. According to Fadly (2019), fossil fuel dependence results in lower productivity caused by carbon dioxide and an increase in health risks, so reduction of emissions will have the opposite positive effect.

Renewable energy projects are normally smaller in size as compared to coal plants and will therefore be able to provide employment and business opportunities for more people, with a spread over all the provinces.

The sources for renewable energy are free and limitless, so renewable energy sources will always be available at no costs. The sources are spread throughout the country which allows for a diverse and secure energy supply. Renewable energy also provides energy security according to Flayl (2019) and it also introduces cheaper electricity for the end user (Guidehouse, 2020). In transitioning from coal power plants to renewable energy, the country stands to benefit much more in the long run than is currently the case with coal power plants.

6.3.5 Rural communities and renewable energy

Electrification

The participants were in agreement that renewable energy will definitely add a lot of value to rural communities. According to the participants, there are areas in the rural communities which have not been electrified due to these areas being very far from the transmission and distribution network. Installation new transmission lines that would reach these communities has proven to be both financially unsound and not very practical. According to the Department of Energy (2017), the government plans to provide electricity for all households, at times through the application of micro grids, where micro grids are the only solution to provide electricity.

Renewable energy is able to provide these remote rural communities with electricity through the use of micro grids, which ensures that everyone in the country will have electricity. A lack of electricity has definitely affected the rate of development in these areas, which will be mitigated through the introduction of renewable energy electricity to these communities. Historically, the focus by Eskom has been on expanding the grid, with little focus being displayed on off-grid expansion. The off-grid solution has come out as the best possible option to provide electricity, even to rural communities (Department of Energy, 2017).

Community development

In implementing renewable energy in rural communities, there needs to be a strong focus on how these communities will benefit from renewable energy. Over and above the benefits of providing electrification for these communities, there are added benefits like running water that these communities would benefit from. An idea suggested by one of the participants is that of using solar pumping to pump water from the air to an identified water containing source in areas that struggle with the basic necessities of running water.

Community development, is a key requirement for all renewable energy projects. It would not make business sense for renewable business projects to be developed in communities where they have little or no impact (Eberhard & Naude, 2017). In these communities, renewable energy partners are required

As part of community development, enterprise development and socio economic development form an important part. Socio economic development (Eberhard & Naude,

2017) ensures that the local communities are provided with opportunities which will enable them to provide better opportunities for the surrounding communities, through the identification of the needs of the local communities and then ensuring that these needs will be met.

Enterprise development ensures that local businesses are provided with an opportunity to develop and become growing concerns (Eberhard & Naude, 2017). This provides local businesses with an opportunity of succeeding, not only through providing funding but also training which enables these local business owners to develop the necessary skills required to make their businesses a sustainable and growing concern.

6.4 Discussion for Research Question 3

Research Question 3: What is the state of renewable energy technology?

6.4.1 Research on renewable energy

Current research focuses

The current research focuses for renewable energy are not limited to any particular stream or need, but it is more general research that is mostly aimed in ensuring that the technology undergoes continued improvements.

There is currently research on improving the efficiency for both solar PV panels and wind turbines. There is also continuous research being carried out on improving the efficiency of storage mechanisms while decreasing the storage costs.

The current research focuses are mostly based on improving technology that already exists, rather than the adoption of new technology.

Technology that could affect renewable energy

Renewable energy currently is used without storage which does not mitigate the variability of this technology. There is always a need to mitigate storage costs thus introducing a more stable supply of electricity. A reduction in storage costs would according to the participants definitely affect the adoption of renewable energy as this would mean that renewable energy is less intermittent, at reasonable costs.

They cycling time of batteries would definitely affect the adoption of renewable energy as a decrease in cycling time would mean more availability of storage.

Small nuclear reactors would be able to generate the electricity previously generated by coal power plants, without having to change the location of these coal power plants.

Lacking technology

There is currently no technology that is lacking which would benefit the adoption of renewable energy. The participants are in agreement that the only research currently being done or required is in improving the efficiency of already existing renewable energy technologies.

6.4.2 Renewable energy technology in South Africa

The participants are of the opinion that South Africa does have the expertise and capabilities required to manufacture renewable energy technologies. The only issue which has previously affected the manufacturing of renewable energy technology has been the lack of certainty in renewable energy projects to ensure sustainable company growth.

Sufficient electricity from renewable energy

There are mixed views amongst the participants on whether South Africa is able to supply the required electricity for the country through renewable energy only. It would, according to the participants, be theoretically and technologically feasible to supply the entire electricity for the country through renewable energy. It would however not make practical sense to do so due the variability of renewable energy and the lack of a baseload electricity supply which would be available in times of high renewable energy intermittency and also a lack of back up supply which could be provided by interconnected neighbouring countries.

6.5 Discussion for Research Question 4

Research Question 4: What is the position of South Africa in terms of transitioning from fossil fuel to renewable energy?

6.5.1 Implementation of renewable energy in South Africa

There is a mixed view amongst the participants on whether South Africa is behind or ahead other countries in terms of renewable energy implementation. Some of the participants believe that South Africa is ahead, while others believe that South Africa should not be compared to other countries and the rest of the participants believe that South Africa is behind other countries.

According to the Department of Energy (2017), South Africa ranks second in the continent, with Ethiopia holding first position in terms of renewable energy implementation. When compared to the BRICS countries, South Africa ranked last.

It is quite clear that South Africa is not the leader in the continent and that South Africa is behind most countries in the implementation of renewable energy. The period in which the IRP was not updated and the time when Eskom was not willing to sign the IPPs seems to have caused the delay in execution. These two issues have since been solved; deployment of renewable energy should now continue with no hiccups.

6.5.2 Policy for renewable energy in South Africa

South Africa has got some of the most progressive policies which should allow for good execution of renewable energy projects. The problem raised is a lack of adherence to these policies which then delays the execution of projects.

There is a lot of red tape in getting the required approvals for small scale projects and this could do with some improvement.

6.5.3 Renewable energy industry in South Africa

The renewable energy industry in South Africa is making good progress towards being well established. This industry does need some strong government support which would enable the timeous resolution of problems when encountered.

Government needs to provide a political champion that would champion the transition to renewable energy, with the sole focus of the sponsor being on renewable energy. This would be able to allow for much needed progress in the renewable energy space as this person would be the driver of renewable energy in the country.

CHAPTER 7: CONCLUSION

7.1 Principal findings

The research into renewable energy was structured around four main questions. The principal findings will be presented as guided by those questions.

7.1.1 Factors that influence the implementation of renewable energy

One of the key and most critical concerns is the IRP which was not updated every two years, as was originally planned. It is only through the IRP that proper planning and implementation can be done to meet the planned installation targets for renewable energy (Scholtz et al, 2017; Department of Energy, 2017).

South Africa had the IRP and the REIPPPP, and through these a platform was created for the growth of renewable energy industry in the country, which also led to the introduction of the private sector into the energy industry, through renewable energy. It is clear from the findings that the first few years of introducing renewable energy into South Africa achieved growth which was quite astounding and pleasing to the renewable energy industry. The government however failed to update the IRP and this led to an industry which was on a great growth path, to just reach an impasse. The renewable energy industry had four full years of nothingness, and this had a huge negative impact on the renewable energy industry.

When the renewable energy programme was developed in South Africa, one of the key stakeholders for the success of this programme was Eskom, as the only electricity operator in the country, that also has monopoly over the transmission and distribution network (Department of Energy, 2017; Scholtz et al., 2017; Greencape, 2019) .

All the electricity that would be generated from renewable energy plants, would have to be sold to Eskom as an off-taker. Eskom would then be responsible for distributing this electricity to the end user. The IPPs proposed initial contract rates were unfeasible, Eskom refused to sign these contracts. The refusal by Eskom to sign the contracts also delayed the implementation of renewable energy projects.

Intermittency of renewable energy is an issue that is experienced all over the world. The predominantly installed renewable energy in South Africa is wind and solar PV, and both of these are highly variable (Gowrisankaran et al., 2016; Biel et al., 2017). This nature of renewable energy of being variable introduces instability into the electricity network and thus reduces the appetite towards renewable energy adoption.

South Africa does not as yet have bidirectional legislation which would make for small scale renewable energy customers to sell their excess electricity to Eskom. This does result in reduced interest from potential small scale customers to install their own solar rooftop PVs as they will have excess electricity which will just go to waste. Small scale customers have to self-fund their installations, being able to sell excess electricity would definitely encourage more small users to install the technology.

One of the biggest issues that somehow delays the adoption of renewable energy is the just transition. According to Flagyl (2019), transitioning from fossil fuel to renewable energy is inevitable. There is however a lot of concerns from the South African government on how this transition will affect the jobs and businesses of people who are reliant on the coal industry. There currently is no clear plan of action of how employment will be maintained once coal power plants and coal mines have been shut down. This unknown, which has the potential of having a huge impact on the livelihoods of individuals, does reduce the appetite towards a complete transition to renewable energy.

The uptake towards renewable energy businesses in the country has not shown much growth. The majority of the renewable energy companies are international companies and this does not encourage the interest towards the renewable energy industry from local people. The findings from the interviews were that the country does not have sufficient money to fund these projects, while the evidence from the IPP office is that most of the funding for renewable projects was obtained from the five major South African banks (Eberhard & Naude, 2017; Greencape, 2019). The issue is not the lack of funding, it is the stringent qualifying requirements from the banking institutes which makes it difficult for local companies to get funding.

There is no disciplined roll-out for renewable energy projects and this leads to a lack of committed execution for the projects. This lack of discipline does not encourage more companies to partake in the renewable energy projects as there is no guaranteed of business sustainability.

The international countries which have been very aggressive in their deployment of renewable energy, have the advantage of being interconnected to neighbouring countries. These neighbouring countries are able to provide back-up electricity supply in instances where renewable energy sources are not available to generate electricity (Sinn, 2017). South Africa is not interconnected to any country and this does affect total adoption of renewable energy.

The research done and the interviews conducted, suggest many issues and factors that hinder the adoption and implementation of renewable energy in South Africa. It is these factors that have slowed down and industry which had started off well and was promising. In order for the country to gain traction in the implementation of renewable energy, these issues have to be addressed so as to create an environment which is more conducive to the growth of renewable energy in South Africa.

There are however a few factors which assist in growing this industry. South Africa has some of the best resources for wind and solar (Scholtz et al., 2017) and the evidence that climate change is a reality (Covert et al., 2016) are factors that definitely encourage the adoption of renewable energy as the route to be followed going into the future.

Renewable energy has the added advantage of costs that are continuously coming down while coal energy costs are continuously increasing (Gillingham & Stock, 2018). This costs element makes renewable energy a very attractive option. The banks are green when it comes to the protection of the climate as they have come out strongly against the financing of coal power plants (Eberhard & Naude, 2017), while they are in support of financing renewable energy. This shift in funding definitely encourages businesses to concentrate more on the growth of the renewable energy industry.

The country has a very good IRP, it is indeed this IRP that has managed to take the renewable energy industry to where it is currently. The IRP 2010 is the first IRP in the country to have included renewable energy in the energy mix (Scholtz et al, 2017) and it is the reason why the country was for a while aggressive in the implementation of renewable energy. According to the IRP 2019, renewable energy is still part of the energy mix (Department of Energy, 2019) and this will definitely result in the growth of renewable energy in the country.

Renewable energy has the advantage of being modular which results in ease of installation as compared to coal power plants. This modularity allows for both large scale installations and also small scale installations, thus not placing any restrictions in renewable energy installations. This modularity encourages the adoption and implementation of renewable energy. South Africa has a need for both large and small scale renewable energy (Department of Energy, 2017; Scholtz et al., 2017; Department of Energy 2019).

The needs of renewable energy in developed and developing countries are quite different. One of the most important needs for South Africa is to electrify the whole country and renewable energy is the only option currently that ensures that electricity reaches even the most remote and most rural areas (Department of Energy, 2017), an advantage above coal power plants which definitely encourages the adoption of renewable energy.

7.1.2 Perceived value for South Africans in the installation of renewable energy

Renewable energy is definitely not perceived benefits, but rather tangible benefits for the country. The majority of the renewable energy projects are executed in rural areas, where as one of the contractual terms for IPPs, the local communities have to be improved (Eberhard & Naude, 2017; Greencape 2019).

Renewable energy has been able to stimulate the economy in rural areas, where it has provided jobs and business opportunities for these communities, thus alleviating poverty and improving the quality of life in these communities. It is not only the rural communities that benefit from renewable energy, the manufacturing companies for renewable energy components provide employment opportunities for people in urban areas, renewable energy companies also provide skilled employment for individuals in urban areas.

The rural communities have in the past been the poorest and most affected by poverty, it thus becomes important to always find means and ways to benefit these communities, which renewable energy has been able to do (Department of Energy, 2017; Eberhard & Naude, 2017).

Construction costs for renewable energy plants have continuously come down over the years (Guidehouse, 2020), which has resulted in opportunities for investment that will yield better returns. This reduction in costs, automatically translates to reduced costs for renewable energy to the end user. The levelized cost of electricity for renewable energy continue to come down which results in reduction in costs (Greencape 2019; Department of Energy 2017; Eberhard & Naude, 2017). A reduction in electricity tariff costs for the end user is definitely a great value which is only experienced through renewable energy.

The case for renewable energy has mostly always been that of reducing carbon dioxide emissions, thus mitigating global climate change (Wang et al., 2019; Murray et al., 2014; Acemoglu et al., 2016). There has been a shift towards the interest shown in renewable energy as it is no longer just an environmental issue, renewable energy is currently both

a reduction in costs and a reduction in carbon dioxide emissions, which further advances the case of renewable energy.

7.1.3 The state of renewable energy technology

Renewable energy is a very matured technology, which has proven its efficiency over the years. Current research on renewable energy is aimed mostly at improving the technology so that it can be able to achieve more, at reduced costs both to the end user and the renewable energy installer.

Due to the fact that this is a matured technology, South Africa is able to manufacture renewable energy components, the only issue to be addressed is sustainable business certainty which will encourage more businesses into the industry, thus resulting in the growth of the renewable energy industry.

According to the findings from the interviews, South Africa would be able to supply the country's electricity requirements from renewable energy only, however this would introduce the risk of too much instability due to the variable nature of renewable energy. The country being technologically able to supply all its electricity through renewable energy, needs to be balanced with a baseload supply which will ensure a continuous, uninterrupted supply of electricity.

7.1.4 The position of South Africa in terms of transitioning from fossil fuel to renewable energy

South Africa has progressed very well in the implementation of renewable energy, the country currently ranks second in the continent in terms of renewable energy implementation (Department of Energy, 2017).

The initial progress that the country made in the deployment of renewable energy managed to position the country very well when compared to other countries. There just needs to be consistency going forward in the updating of the IRP and this will definitely ensure that the country once again becomes aggressive in deploying renewable energy.

7.2 Implications for business

This study has provided insight into the factors that affect the feasibility of renewable energy in South Africa. The country is well positioned to execute renewable energy

projects and it is possible to increase the amount of electricity which is produced from renewable energy. There is a concern of variability when considering a complete transition from fossil energy to renewable energy, which is currently a valid concern which would need to be addressed in the future.

Renewable energy has resulted in a lot of economic growth for the country, especially around the rural areas, where these projects have resulted in an improved quality of life. It is through renewable energy that some of these remote areas have been electrified, thus gaining opportunities to also develop businesses in those areas. Overall, renewable energy has been very beneficial to the country as it has also brought in foreign investments into the country.

The installation of solar rooftop PVs by companies, provides these companies an opportunity to save on electricity costs while also ensuring that these companies will have a constant supply of electricity during times of load-shedding. These rooftop PVs thus ensure that productivity is not lost in these companies, making the companies more sustainable.

Renewable energy is definitely beneficial to the country, it not only provides electricity that is much cheaper, it provides clean electricity which means better health for the people, it also provides jobs for the people, it grows the economy and it uplifts communities that had no hope of being uplifted.

There is a need for the government to step up their act and not be a stumbling block when it comes to renewable energy implementation. The issue with government who is not proactive needs to be addressed as the renewable energy industry should not be disrupted in their deployment by lack of government updating their IRP.

Financing opportunities need to be improved upon, especially for small scale project. The renewable energy industry needs to find a solution for this.

Literature has clearly proved that the costs for renewable energy are continuously coming down, with the last round of bidding providing practical evidence in this regard. Why are there not more large scale if the cost of renewable energy is lower than conventional energy?

7.3 Limitations of research

The limitations to this research are:

The study was exploratory in nature, which allowed for the generation of new insights and thus a better understanding of renewable energy in South Africa. Further follow-up research can be done.

The research made use of a small sample, in line with its nature.

As the researcher is employed within the energy industry (Eskom), this could have affected some of the responses from the participants as they would not have wanted to offend the researcher which could have resulted in some of the responses being swayed.

7.4 Suggestions for future research

There seems to be limited information available on the just transition which currently is a huge problem when transition from coal power plants is considered. A proper study in this area, which will provide not only numbers, but will guide how affected jobs will be catered for in the renewable energy industry is required. Small nuclear reactors have cited as a possibility when considering base load for electricity which is not variable. There needs to be more research done of these small reactors and how they would possibly address the variability produced by other forms of renewable energy.

There is an opportunity for further research on government policy/partnership with the renewable energy industry in order to better understand it. Research on funding of small scale projects is also an area to be pursued.

Interconnectivity is an area of interest when considering backup supply for renewable energy, further research is suggested on neighbouring countries interconnecting.

Research which would provide more information on the feasibility of small scale owners selling electricity to the neighbours and also the supplier.

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Annexure A: Consent form



I am currently a student at the University of Pretoria's Gordon Institute of Business Science and completing my research in partial fulfilment of an MBA.

I am conducting research on renewable energy in South Africa and am trying to find out more about the factors affecting the feasibility of renewable energy in South Africa. Our interview is expected to last about an hour and will help us understand more on renewable energy in the South African context. **Your participation is voluntary, and you can withdraw at any time without penalty.** All data will be reported without identifiers. If you have any concerns, please contact my supervisor or me. Our details are provided below.

Researcher name: Sinazo Magocoba

Email: 29514615@mygibs.co.za

Phone: 072 149 0577

Researcher Supervisor name: Brian Barnard

Research Supervisor Signature: _____

Email: barnard.b@polka.co.za

Phone: 076 041 0116

Signature of participant: _____

Date: _____

Signature of researcher: _____

Date: _____

Annexure B: Interview Guide

Interview Questions

1. What are some of the pressing issues and questions in terms of renewable energy, its implementation and adoption?
2. What are the major factors a) helping, and b) hindering, prohibiting or constraining renewable energy?

Implementation

3. How do you see the future of renewable energy projects and production, and the part renewable energy fills in energy production mix
 - 3.1. Is small scale pervasive production of renewable energy, like solar rooftop PVs, not the more viable route for renewable energy, compared to large scale renewable energy production like solar farms?
4. What do the leaders in renewable energy do (better) that makes renewable work (better)?
5. Is South Africa doing all it can in terms of renewable energy?
 - 5.1. In terms of renewable energy, what do other countries do better than South Africa?
 - 5.2. Is South Africa behind other countries when it comes to renewable energy?
6. Does renewable energy feature differently in developed and developing countries, and why?
 - 6.1. Will renewable energy really feature in developing countries, and why?
 - 6.2. What prevents renewable energy in developing countries?

Cost

7. Is renewable energy economical and does it make economical sense in the current South African economy? Please elaborate.
8. Does renewable energy have an impact on the cost of energy production? Does this impact increase or decrease energy cost to the end user?
 - 8.1. Is there a way around this impact, and will it change in the future?
9. Will renewable energy always or mostly be a case of a trade-off between cost and reduced emissions?
10. In terms of breakdown of costs, what are the major contributors of the cost of renewable energy, and can this be improved upon?

Value

11. What are the main value propositions of renewable energy? Is there any other value or benefit in renewable energy other than reduced emissions, that positions renewable energy above conventional energy?
12. Will the poor and most rural population of South Africa benefit from renewable energy?

Technology

13. In terms of renewable energy, what are current technology research focuses?
 - 13.1 Is there any technology or innovation in the pipeline that can drastically affect renewable energy adoption?
 - 13.2 In terms of renewable energy, is there any technology lacking, that must be developed still, to further benefit and help or support renewable energy?
14. Can South Africa meet the technology requirements of renewable energy?
15. Can currently available renewable energy technologies sufficiently supply the power required by South Africans for 24/7 operations?

Industry and Policy

16. How well is policy geared for renewable energy?
 - 16.1 Are there any policy issues that can hinder renewable energy?
17. How well developed is the energy industry in South Africa?
 - 17.1 Does the renewable energy industry require further assistance, if yes, how?
18. Are there sufficient players in the renewable energy industry? Should this be improved still?
19. If there would be a complete change from conventional energy to renewable energy, how would it affect and change the energy industry, including things like job creation, job security, industry size, industry growth, etc.

Annexure C: Ethical Clearance



MastersResearch2020 <MBAResearch2020@gibssa.mail.onmicrosoft.com>
to me ▾

**Gordon Institute
of Business Science**
University of Pretoria

Ethical Clearance
Approved

Dear Sinazo Magocoba,

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.

Annexure D: Atlas. Ti codebook

Ability of solar and wind to provide ancillary services
Affordability prevents RE in developing countries
Annual newbuild constraints on wind and solar PV in the IRP
Availability and price of gas
Available RE cannot supply all the power required by SA
Balanced energy mix improves system security
Better health for people
Can have more RE players in the market
Cheaper energy source
Coherent policies and plans in other countries
Commercialization of small scale modular nuclear reactors
Complete change would result in more jobs
Completely new industry
Contracts initially signed with IPP were signed at high rates
Cost reduction helps RE
Create consistent jobs
Current RE technologies can supply SA with sufficient power
Decreasing storage costs
Delay in IRP is a hinderance to RE
Delays in signing power purchase agreements with Eskom
Developed countries have implementation resources
Developing need more competitive capital
Disciplined rollout ensures proper planning
Distributed installation of RE improves electricity availability
Easy installation allows for robustness
Enabling system integration and improving system stability
Energy industry is well developed
Eskom should be allowed to participate in RE bid windows
Eskom system needs to be balanced
Evidence of climate change helps RE case
Financial constraints hinder RE
Focus on improving component efficiency
Global implementation of RE helps RE
Good Procurement Program helps RE
Good RE resources helps RE
Government processes

Hardware price and variable costs increase overall cost of electricity.
Having energy diversity
Households don't have upfront costs to install own renewables
Hydro and gas stations can stabilize the system
Implementation of the policy is the problem
Implementation uncertainty hinders RE
Increased accuracy of forecasts
Interconnectivity improves RE integration
Intermittency/Variability
International positioning of the country
Job opportunities helps RE
Just transition is an issue
Lack of localized manufacturing hinders RE
Lack of massive customer response
Large scale RE is easier to manage
Leaders are technically very good
Liberalized system introduces more competition
Linking meteorology and power systems for better forecasts
Load shedding is a driver for the adoption of RE
Major costs are Capex
Matured technology helps RE
Micro grids from RE can electrify rural communities
Modular and scalable, easily accessible
More SMMEs from RE projects
No cost reduction for CSP
No disciplined rollout hinders RE
No further assistance required
No legislation to connect small scale RE to grid
No technology lacking
Not implementing fast enough
Not sufficient players in RE
Other countries are more disciplined
Other countries do RE differently, not better
Policy uncertainty hinders RE
Political issues around RE is a pressing issue
Pressing issue of policy alignment
Project uncertainty in developing countries prevents RE
Prominent banks no longer support coal, aiding adoption

RE can benefit poor and rural population
RE features differently between developed and developing countries
RE increases cost to end user
RE industry is not well developed
RE industry requires further assistance
RE is being developed alongside the demand
RE is both reduced costs and reduced emissions
RE makes economical sense
RE not economical
RE reduces the electricity cost to the end user
RE saves the countries water resources
RE will play a role in the energy mix
Regulatory environment hinders RE
Regulatory framework needs improvement
Reliability, security, safety
Research focus on energy storage
Research into agrivoltaics
Research on link between renewables and hydrogen grid molecules
Research on offshore wind
SA behind other countries in RE
SA being too dependent of coal is a pressing issue
SA can meet RE technology requirements
SA has a great policy
SA is a leader in the continent
SA is doing everything it can in terms of RE
SA is not behind, the other countries started earlier
SA is not doing all it can in terms of RE
Small scale and large scale are needed
Small scale not necessarily a better option
Small scale RE more beneficial for developing countries
Solar farms add electricity to the grid for everyone
Storage could affect adoption
Storage increases costs
Storage making RE expensive for adoption
Sufficient players in RE industry
The policy can be improved upon
Too much investment risks in developing countries
Transmission and distribution network are a hinderance to RE

Unknown around jobs hinders RE

Use of biofuel reduces need for RE in developing countries

Value of being able to do either small or large scale

Value of less maintenance on RE

Value proposition of economic impact and creating more jobs

Water can be provided to rural communities through solar pumping to pump water from the air