Tariff framework for the integration of Solar Photo Voltaic Small Scale Embedded Generation power plants on the South African electricity grid

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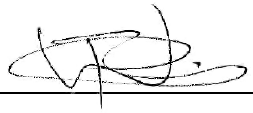
DECLARATION

I, Buhle Bujela, declare that this consultancy report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.



Buhle Willfred Bujela

Signed at Rosherville

On the 2nd day of December 2018

DEDICATION

I dedicate this to my two lovely princesses, **Busisiwe** and **Thandeka Bujela**, who are very ambitious and have big dreams for their bright future. I say to them, hard work always pays off at the end, and hard work will always beat talent when talent is not working hard, anytime!

Keep grinding on, keep dreaming and keep your head up!

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I would like to acknowledge my rock and pillar of strength, my life partner and my best friend, my soul anchor, **Miss Nontobeko Sekhosana**, for her continued support and words of encouragement during times of darkness. I vow to always be at your side.

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Thank you to my supervisor, **Mrs. Kajal Pillay**, for her positive and upbeat guidance, reading my report(s) and providing invaluable feedback to strengthen the content. Her courageous critique and wisdom went a long way during times of writer's block and dissertation blues.

I will miss the coffee meetings!

A special thank you goes out to all my respondents, peers and colleagues for their courage to share their knowledge, experience and expertise with me. This report is stronger because of you.

SUPPLEMENTARY INFORMATION

Supervisor: Mrs. Kajal Pillay

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Supplementary report and Appendices

Interview transcripts and audio recordings

† Including Executive Summary, References, etc.

EXECUTIVE SUMMARY

South Africa's renewable energy landscape is on the threshold of taking off and reaching high profitability in large scale deployment. Notwithstanding this impressive uptake, the small scale embedded generation (SSEG) market has experienced poor growth, despite having reached grid parity, owing to a lack of a competitive tariff structure for energy trading between consumers, municipalities and utilities. It is worth noting that, the custodian of tariff structures and rule maker is the National Energy Regulator of SA (NERSA). The value proposition of this consultancy report is to investigate the economic factors which contribute to the low maturity in the rooftop solar PV market and hence to recommend a tariff framework which can be endorsed by the regulator.

The literature review on best practices globally revealed regions in Europe, North America and Asia that have successfully implemented tariff models to cultivate the market in the SSEG sector which has yielded significant uptake from the residential, commercial and industrial economies. The tariff instruments which have been used are feed-in-tariff (FiT), portfolio targets, tax credits, net-metering (net-FiT), renewable obligation, contract for difference, critical peak pricing and time of use tariffs. These instruments are excellent tools to execute a national agenda that is aligned to the market drivers in those countries. The challenge for South Africa is to identify the socio-economic driver(s) that have an influence on the SSEG market.

The research design and method adopted is qualitative. The research instruments used to collect data are semi-structured interview questions administered by the researcher, who is also a research tool. An audio recorder was used to enable transcribing of the data later for analysis. Coding of the data was done on Microsoft Excel and the identified themes and sub-themes captured with their causalities. A mind map is presented to illustrate how the emergent themes interact and what desired outcomes can be expected with certain socio-economic drivers as inputs.

The most compelling theme that emerged from the respondents is the lack of definitive drivers, an independent system operator and the non-existence of an energy trading market in South Africa, similar to Europex in Europe.

Moving forwards, how does the regulator institute an effective and pragmatic tariff structure when the rules of engagement have not even been defined? Other themes that emerged include the policy considerations by Department of Energy which must yield the Integrated Resource Planning and/or Integrated Energy Planning that sets the targets for the country's energy mix. The political economy also came out strongly as respondents noted the influence and executive authority vested in municipal jurisdictions and how they can react to protect their revenues and market position. The regulator's role is accepted to be very crucial and yet its unresponsive, uncertain, and reactive stance is felt as an indictment on it for the growing industry and society frustrations.

There are strong sentiments for market reform from the respondents and in the literature. There are new business models that can be activated by a sector in transition through the right reform strategy to open up the competitive landscape. Recommendations are for the development and definition of clear socio-economic drivers that will also form the basis for the policy. Moreover, NERSA needs to use the IRP to defined specific portfolio targets for each province, based on the solar resources. Then municipalities can define the competitive renewable FiT or Net-FiT to be adjudicated and adjusted by NERSA for fairness to both consumer and utility.

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CHAPTER 1: INTRODUCTION

1.1 Background Information

1.1.1 South African Capacity

The nominal electrical capacity generated by Eskom is 44.1 GW, of which 82.6% accounts for coal-fired generators (Eskom, 2018, February 13). The country's demand peaks at around 33 GW during the summer, autumn and spring, and peaks at around 37 GW in winter (Hurford, 2017).

1.1.2 An Industry in Transition

The landscape of electricity generation has transformed on a global scale with more countries erecting more green technologies for generating electricity and doing away with fossil based technologies (MIT Energy Initiative, 2016; Porter & van der Linde, 1995). European countries like France and Germany are taking the lead with the installation of renewable technologies in their energy mix. The question of creating value and capturing value (Verdin & Tackx, 2015) arises for critical decision making in this field.

The lifetime cost of solar and wind technologies has dropped significantly over the past decades, and this has made the technologies more economically viable as an alternative means of generating electricity. Moving forward, this is the main reason for the observed widespread adoption of these renewable technologies by many regions in their energy mix portfolios.

In a similar way, the African continent has one of the biggest challenges regarding electrification (Marquard, Bekker, Eberhard, & Gaunt, 2007) and providing access to electricity to disenfranchised communities that remain unserved, largely because they are too remotely positioned from the electrical grid infrastructure. This is why options such as micro-grid(s) present an excellent opportunity to address this fundamental human rights need. However, the South African nation

still lacks clear and concise regulation on the governance and classification of these renewable technologies for the said applications.

The renewable energy and consumption pattern may enable consumers to be less dependent on the utility for their energy needs, and can further introduce consumers to other energy retailers with lower tariffs in a more competitive business environment. Various business models already exist on the global market for the integration of renewable energy resources into the electricity grid through the participation of the private sector. This has enabled economic growth with increased job creation and rising Gross Domestic Product (GDP) of those countries.

1.1.3 Inappropriate Tariff Design and Response

The cost of electricity production for Eskom is 0.45c/kwh and this electricity is sold to the end-user at 85c/kwh. In response to the Paris agreement on climate change, Eskom purchased electricity from the independent power producers (IPPs) at R2.20/kwh, on a locked-in contract of 20-25 years. The City of Tshwane has released its credit-reverse-tariff proposal of 10c/kwh to compensate its consumers for excess electricity fed back into the grid when it charges between 132.7c/kwh up to 182.4c/kwh over and above the fixed charges relating to grid access (NERSA, 2018). Also, solar PV has a least cost of energy (LCOE) or total life time cost is 0.62c/kwh (Bischof-Niemz, 2015; Wright, 2018).

There are serious irreconcilabilities here. This is a significant problem which indicates uninformed decision making, a lack of clear guidance, and ongoing crisis. Nonetheless there are published media news reports about the city of Cape Town’s plans to push ahead with 20% renewable energy injection by 2020 (Cloete, 2018). Uganda on the other hand, is signing agreements to protect its small-scale energy projects (African News Agency, 2018).

1.1.4 Regulatory uncertainty

The South African market needs clear regulation from the National Energy Regulator of SA (NERSA) to guide the process and provide a clear procedure and fair considerations for utilities, especially municipalities in the integration of the Small-Scale Embedded Generators (SSEGs) into the electricity grid.

One of the main reasons municipalities are unwilling to allow the connection of SSEGs into the grid is the fear of losing revenue to private generators who will sell the generated electricity to the municipality and create a situation where the municipalities end up owing the private generator customer. However, an important point which is often overlooked is that this electricity has the potential to help provide relief to the grid during times of constraints and overcapacity, and there is an opportunity of deferring expensive capacity building infrastructure.

1.1.5 Life at Risk

All things considered, the lack of a clear regulation framework presents safety challenges (van der Walt, Bansal, & Naidoo, 2018) since there are already many unaccounted for illegally connected SSEGs onto the South Africa electricity grid, most of which are for self-consumption. There is no clear account of which customer is connected to which distribution network. Also, network operators are not safe because there is the risk of working on live networks while the technicians are under the impression that the networks are on outage mode and isolated.

Additional risks are with the domestic and commercial users who may not be technically astute on the installations, safety compliance requirements and also not aware of what technical credentials the installers must comply with. These households and businesses may be subject to fires and electric shock with considerable damage to their properties and equipment. In light of these safety concerns, mechanisms such as anti-islanding need to be put in place to ensure the safety of human life and property, and a level of standardisation needs to be specified by NERSA for compliance purposes by all participants.

1.2 Problem Statement

What are the economic factors contributing to low maturity in the Small-Scale Embedded Generator (SSEG) rooftop solar PV market in South Africa?

1.2.1 Sub problem 1

The lack of a tariff structure is one of the contributing factors for the SSEG rooftop solar PV integration and market uptake.

1.2.2 Sub problem 2

The dominance by a single state owned utility, Eskom, limits the ability of independent SSEG rooftop solar PV producers to influence pricing.

1.3 Thesis Statement

There exists a tariff structure for the integration of renewable SSEG into the utility electrical grid and to have a positive intended contribution on the economic factors of the South Africa economy.

Also, there is potential to significantly grow the rooftop solar PV industry by enabling various business models. Peripheral benefits relate to the promotion of a diversified energy mix as described in the Integrated Resource Plan (IRP).

1.4 Delineation and Limitations

The following list presents the delineation and limitation of the study. This report:

- will not dwell on the political motivations for accepting or rejecting renewable energy integration
- nor on any associated perceived corruption in policy implementations, and
- also, it will not deal with the in-depth details about the socio-economic and environmental considerations, such as:

    - Funding models for SMEs/SMMEs, and
    - Policy design.
- Finally, this report will not develop, test, verify or validate any empirical models for electricity tariff prescriptions, but it will use pricing strategies to understand the market and recommend tariff frameworks.

The audience of the report is NERSA. Consequently, the research will rely mainly on grey literature, peer reviewed publications and semi-structured interviews for its data collection, analysis and interpretations.

1.4.1 Caution

The unintended consequence that has been identified is the risk of turning the discussion during the interview stage into a party political debate about who or what political party is best suited to run the nation and has the ability to yield better results. Every attempt is made to avoid this.

1.5 Assumptions

Ceteris paribus, the study will only focus on the pursuit of a tariff framework, assuming that all other factors of considerations have been addressed.

- The most current information contained in the South Africa Integrated Resource Planning (IRP) (Republic of South Africa, 2011) is as detailed in the 2016 revision (Republic of South Africa, 2016) and at the time of writing this dissertation no other revision existed.
- The national electricity Grid Code (NERSA, 2016) remains the only available regulatory framework from NERSA when governing the technical integration of renewable energy technologies in the electrical utility grid.
- Moreover, municipalities have their own discretion on how they choose to respond to the growing demands for SSEG integration, and there is no standardised approach in existence at the time of writing.

1.5.1 Macro-Assumptions

The following assumptions are made:

- The IRP2010-2030 allocated projection of 8.4GWp of capacity to come from SSEG does not reduce.
- Compliance to the IRP and Electricity Act is mandated and regulated by NERSA.

1.5.2 Micro-Assumptions

There are two assumptions which govern a monopolistic market structure:

1. The monopolist secures its resource ownership through patents and economies of scale.
2. There is no clear price regulation (or limited) from government regarding the SSEG market.

1.6 Significance of the Study

The recommendations arising from this study may provide a direction which NERSA can use as a tool to cultivate and provide tariff certainty for the SSEG market.

1.7 Conclusion

The research topic has been introduced with a clear and brief background of its need, problem statement, urgency and importance. Potential unintended consequences have been identified and highlighted because strategies will have to be devised for their mitigation.

The overarching problem statement has been broken down into two sub-problem statements that need to be responded to in the completion of this research. A list of the assumptions made by the researcher is also provided and a concise

delineation accompanies the problem statement to set the scope of work and boundaries for the research.

1.8 Chapter Overviews

The dissertation is organised in the following manner. Chapter 2 presents a comprehensive literature review on the local and international economic theory and pricing strategies.

Chapter 3 details the chosen method for collecting the needed data and how the data will be analysed and interpreted to reach definite conclusions. A clear justification for the method is provided and its strength and weaknesses are pointed out. Furthermore, ethical considerations are addressed pertaining to how the data will be collected and how the participants and data will be protected.

Chapter 4 presents the results and coded themes from the transcripts. Chapter 5 focuses on the detailed discussion of the results .Chapter 6 concludes the entire report and offers some recommendations for NERSA and future research topics are considered.

CHAPTER 2: LITERATURE REVIEW

2.1 Economic Market Theory

2.1.1 Electricity Trading

Electricity is no longer seen as a luxury but rather a commodity (Caplin & Leahy, 2010). There are economic laws which govern the supply and demand of this commodity. Electricity is a commodity that is a by-product of a complex process that involves the mixing of several raw materials. To produce electricity labour is required to perform the work. Hence, electricity is understood as having both the product and service components and double form is the input to how the tariff is priced.

The product being supplied is standardised and this allows the organisation to reach process efficiency. For a very long time the product and service offered by Eskom and municipalities in South Africa has never had an economically viable close substitute, and this further strengthened their positions as being monopoly entities. Most close substitutes such as Solar and Wind were expensive for a very long time. Also, the vast infrastructure that Eskom and municipalities have, combined with licensing requirements creates significant market barriers for new entrants (Kumar, 2006).

2.1.2 Market Structure

Eskom is the only utility company in South Africa. This means Eskom is the sole licensed producer and supplier of electricity, and as a result the state owned organisation has enjoyed the status of being a pure monopoly, as was intended and designed by the legacy government. One of the benefits of being a monopolist is the lower average costs of production achieved through economies of scale in the long run, where the plant is taken as variable. A second benefit of

being a monopolist is that the firm becomes the price maker because it controls the total quantity supplied (Harstad, 2001; Mohr, 2015).

The role of government is to provide market regulation to enable and enforce fair practise, thus protecting the consumer and supplier. However, in the case of South Africa, the national regular simply enforces market domination by the utility and municipalities. On the distribution side, a competitive impression has been created by allowing over 200 municipalities all over South Africa to distribute the electricity to end-users, but these municipalities are allocated customers through market segmentation by spatial segregation, also determined by government.

This means, for a particular geographic segment, there can only be one distributor and this distributor will be licensed by the NERSA to service that entire area, alone. In doing so, the regulator further ensures that the particular municipal entity has no competition and enjoys pure monopolists' status and behaviour.

2.1.3 Who Controls the Price?

The demand curve for the monopolist is in fact the market demand curve because the monopolist is the industry. The monopolists demand curve is generally downward sloping because the market demand curve is not perfectly elastic (Janse van Rensburg, McConnell, & Brue, 2015). To demonstrate, if Eskom or municipalities dropped tariffs then there would be more electricity demanded by consumers.

This has the following implications: the marginal revenue received by monopolistic utilities is less than the price. The monopolistic utility can influence the total supply through its output decision and this in turn allows it to control the product price and thus the balance of power lies on the producer.

It is important to note that the pure monopolist utility has no unique relationship between price and quantity, and this is why it has no supply curve (Dotsey, King, & Wolman, 1999). Also, because market demand and individual demand is the same to the monopolist utility, then the monopolist utility will always find it

profitable to sell small quantities of its product at a higher price, and this is why it yields neither productive nor allocative efficiency (Caplin & Leahy, 1997).

The monopolists price will always exceed the minimum average total costs, and this profit-maximising output results in the under-allocation of resources because the monopolist finds it profitable to restrict output and employ fewer resources than is economically justifiable (Janse van Rensburg et al., 2015). This creates a deadweight loss for the society and this has always been the case for South Africa.

2.1.4 The Opportunity

The opportunity presented by renewable energy resource is several fold; a competitive market where consumers have multiple substitute product and choice, zero non-price competition, elimination of barriers to entry and opening up the industry to many firms who will be price takers since the market will be distinguishable from the firm and the market will set the price and thus the balance of power will shift to the consumer.

Government will have to look at the conversion of public sector entities to private sector and introduce an enabling and truly competitive market. Currently in South Africa, there is an increasing demand for renewable energy resource but this is not met with an increasing supply. In general, the movement of demand and supply will shift the curves to yield a different equilibrium price all the time. NERSA has to monitor the demand and supply curves and if they are yielding unfair prices for the buyers or seller then NERSA should place legal limits on how high or low the prices must be set. This is the essence of price ceiling and price floor.

2.2 Market Power and Pricing Strategies

The market structure is generally designed on a continuum sale based on the degree of competition (Humphries & Dr Wilding, 2003). As a result, the classifications are a monopoly with zero competition, oligopoly with a low degree of competition, then a monopolistic competition with medium competition and then

lastly there is perfect competition with maximum possible competitions amongst the firms. Competitive firms do not have market power, and hence they are price takers and the market sets the price (Janse van Rensburg et al., 2015).

Notably, the pricing strategy for a perfectly competitive firm would be different from that of a monopolist in that the former charges the equilibrium price and does not earn economic profit while the latter is slightly more complex because of the fact that they have market power.

Expanding on concept of the firm with market power, it can charge all its customers a single price by setting the price in accordance with the output it chooses to produce in order to maximise its profit. Alternatively, it can charge different prices to different customers for the same product using price discrimination and this allows it to earn greater economic profit over a single price monopolist (Deng & Maz 2010).

The broad requirements for a firm to pursue a pricing strategy are twofold:

- The firm must have market power, and
- The firm must prevent resale and arbitrage.

Reviewing the aforementioned requirement, it is noticeable that this is exactly how South African utilities and municipalities have been able to set their own prices by ensuring price discrimination (Stole, 2006) and preventing its customers from reselling its products amongst themselves via business-to-business (B2B) models such as wheeling.

2.2.1 Demand and Supply

There are certain requirements of knowledge needed by the firm about its producers in order to implement accurate pricing strategies, and this information is referred to as customer demand pattern prediction. Do customers have the same demand, or are they varied? When faced with customers that have different demand curves, the firm can implement a price discrimination strategy.

However, the firm will have to identify if it has the ability to identify customer demands before the customer makes a purchase or identify the customers' differing demands only after the customer makes a purchase. If it is the former, then perfect price discrimination can be implemented but if it is the latter then indirect price discrimination strategies will have to be adopted (Syverson, Goolsbee, & Levitt, 2012).

Lastly, if the firm's customers have the same demand curves, then the firm can pursue strategies which allow it to offer different unit prices to the same customer for different quantities purchased or by charging lump sum fees on top of the per-unit prices. It must be noted that from the firm's point of view, all it wants is to extract the most producer surplus possible.

In a perfectly competitive environment, there are many buyers and sellers and hence there is no single firm that has influence over market outcomes and each firm is a price taker. As we have seen the monopolist is the complete opposite.

2.2.2 Pricing Strategy

The generic typology for price discrimination is formulated around the level of information the seller has about the buyer which yields pricing in four broad categories; personalised pricing, group pricing, menu pricing and uniform price.

Table 1 below presents the pricing strategies at the disposal of a firm with market power:

Table 1: Pricing strategies or capturing consumer surplus (Syverson et al., 2012).

Description of strategy	Impact
Direct price discrimination	Charging different prices to different customers based on something that a firm can observe directly about its customers' identities.
Perfect price discrimination	Selling each unit of product at different price.
Segmenting	Charging different prices to different groups of customers due to imperfect information.
Indirect price discrimination	Giving customers various pricing choices and allows the customers to choose among them.
Quantity discount	Customers who buy larger quantities of a good pay a lower per unit price.
Versioning	The firm offers different product options designed to attract different types of consumers.
Coupons	Retailers would like to charge shoppers who have less elastic demands more for products while setting a lower price for consumers who are more sensitive to price.
Bundling	Putting together two or more products that a firm produces and selling them as a single package with its own price.
Mixed bundling	Firms simultaneously offer the products separately and as a bundle and then let the consumer choose which to buy.
Pure bundling	Offering only the bundle.
Advanced Pricing Strategies	Use varying unit prices offered to the same customer or charging lump-sum fees on top of per-unit prices.
Block Pricing	Packaging multiple units of an identical product together and selling them as one package.
Two-Part Tariffs	Price paid by the consumer involves two components, a per-unit price and a fixed fee.

Figure 1 presents a flow charge of the decision tree for the right tariff structure or framework for a firm with market power.

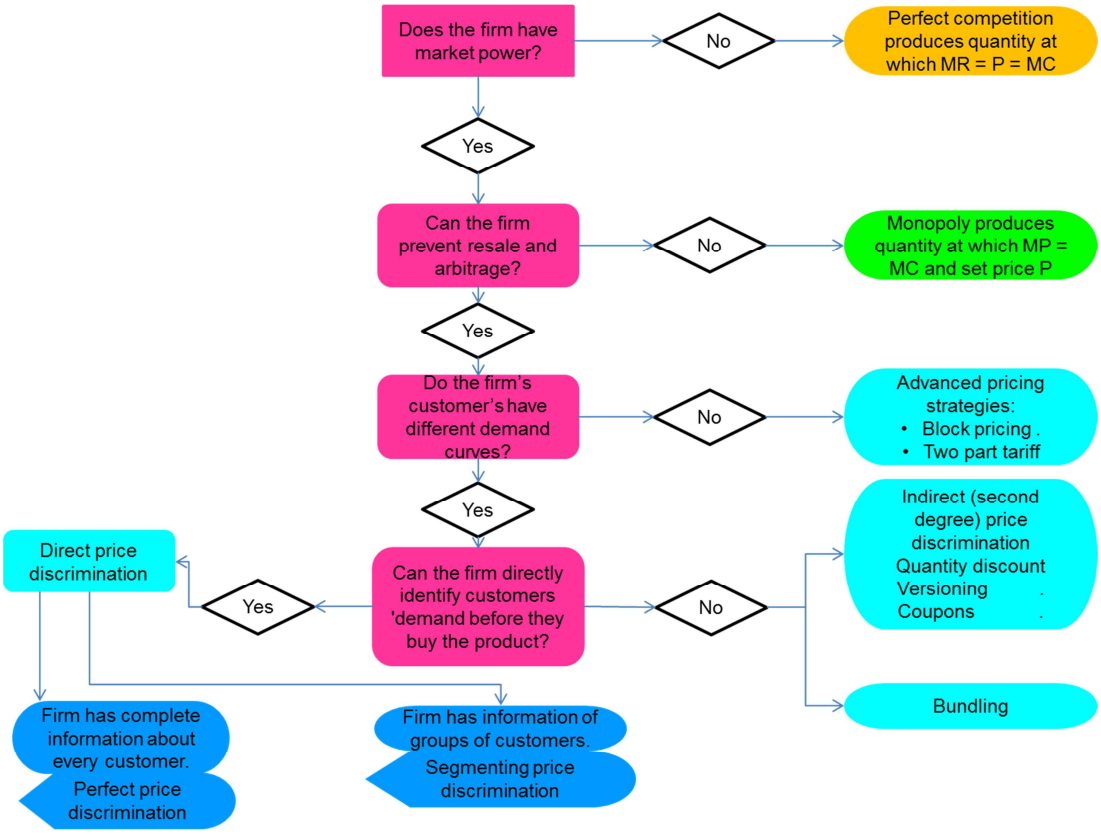

Figure 1: An overview of pricing strategies (Syverson et al., 2012).

According to **Figure 1** above, a firm's optimal pricing strategy is determined by characteristics of the firm, the product or services it produces and lastly, its consumers. Additionally, the firm will take into consideration its degree of market power, possibilities of the product being resold by another retailor downstream, and its knowledge of its customers demand patterns for the product or service. South African utilities and municipalities predominantly use the block pricing, two-part tariff, indirect price discrimination, and bundling frameworks.

2.2.3 Government Role

The government's role, through NERSA, is to intervene and implement policies that prevent unfair business practice or supernormal profits, and also to prevent

the abuse of market power. Other policy strategies available to government are levy taxes, government ownership of natural monopolist, regulation or de-regulation and competition policies (Joskow, 2014; Mohr, 2015). This can further lead to activation of various business models that can be explored to create new market or tap into new customer segments as elaborated on in greater detail in the supplementary report, on page 20.

2.3 Regulation and Policy Considerations

In South Africa, it is the responsibility of the Department of Energy (DoE) to design a legislative policy that sets the nation's priorities and targets regarding the energy mix to be adopted by the country. The implementation of this policy is the responsibility of the national energy regulator, NERSA, which also regulates the energy market, defines rules and issues licences for the entire energy value chain (Republic of South Africa, 1998, 2001, 2006, 2011, 2016).

2.4 Available Electricity Tariff Models

The main purpose of electricity pricing and charges should constitute the following attributes (MIT Energy Initiative, 2016):

- Price for electric energy (must be inclusive of the active and reactive components of power),
- Prices and charges related to operating reserves or firm capacity required by consumers,
- Charges for the electrical network infrastructure and lastly,
- Charges to recuperate the policy cost (these can be government instruments like taxes and the costs sustained to support energy efficient initiatives and climate change mitigations).

The fundamental objective of pricing and charges is to communicate economic drivers to the participants in the electrical grid from generation of electricity

through to the distribution of electricity to end users and to recover regulated costs (MIT Energy Initiative, 2016).

The identified renewable feed-in-tariff (FiT) structures (Australian Capital Territory, 2015; Bekker et al., 2013; Fritz, 2013; Grover, 2013; KPMG, 2015; Millson, 2014; MIT Energy Initiative, 2016; Ndanga & Gorn, 2012; Nolden, 2015; Ofgem, 2018; Rickerson, Bennhold, & Bradbury, 2008; Schnittger & Fisher, 2017; Watson Farley & Williams LLP, 2015; Weiler & Bretheau, 2015; Winkler, 2005) which have been successfully applied in the international market and ones which show positive opportunities for the South African market are listed below:

- Net-metering for energy credits
- Feed-in-Tariff (FiT) and/or Net-FiT
- Renewable FiT (RE-FiT)
- Renewable obligations
- Contract for Difference
- Time of Use tariff (TOU)
- Critical Peak Pricing (CPP)
- Tax credits
- Portfolio targets
- Low Interest Loans

There is a need for a modus operandi of tariff prices and regulated charge structures for SSEGs in order to allow a fair competition or collaboration between the centralised and distributed energy generation, and it must be reflected in the time and spatial domain (MIT Energy Initiative, 2016).

2.5 Previous Consulting Engagements

Significant work has been conducted by highly regarded researchers in the field of energy and organisations such as the Association of Municipal Electricity Utilities (AMEU), South African Local Government Associations (SALGA), Sustainability Energy South Africa (SEA), Stellenbosch, and the CSIR to provide guidance to

municipalities on international best practices, the impact of renewable energy on municipal revenues and how cities and municipalities should respond to these growing activities and concerns. The detailed discussion and documentation is presented in the supplementary report, on page 24.

2.6 Conclusion

The report has introduced the economic factors influencing pricing, market structures and the various roles of important stakeholders in the energy sector. Best practice tariff structures have been presented for consideration and application in South Africa.

CHAPTER 3: METHOD

3.1 Introduction

The literature review in Chapter 2 has already established the boundaries of the this study and it is clear that with a convoluted problem of this nature one of the more suitable approaches would be the use of detailed structured and/or semi-structured interviews with industry experts and expert stakeholders actively involved in the field.

The researcher chose to use qualitative research methods for this study because of the depth of knowledge required to provide answers to the deep-rooted problems identified. Ultimately, this chapter deals with the 'how' aspect of the research procedure and it is the combination of theory, research design and method which constitute a research strategy (Bryman, Bell, Mills, & Yue, 2011).

3.2 Research Design

The nature of the research undertaking here falls into the category of applied research, which aims to seek a solution to an immediate problem experienced by a company, sector/industry, which is the renewable sector in this particular instance. Consequently, this will be a descriptive research undertaking or the so called ex post facto research (Kothari, 2004).

The aim of the study is to arrive at a set of recommendations on economic factors, tariff structures, and pertinent interventions that the renewable industry can make and what to do in order to redress bottlenecks in the system.

The qualitative inquiry research design (Creswell, 1997) follows a similar path to a descriptive study, field study, participant observation, case study and naturalistic research in the sense that they all attempt to obtain rich insight by getting very close to the data in their natural setting. This type of research technique can use

both secondary and primary data, whereby the former is used to devise interview questions and the latter is what is acquired from the interviews conducted.

The research strategy will follow the process similar to the deduction research process (Bryman et al., 2011) with the exception that instead of commencing with an hypothesis, it will have interview questions to guide the inquiry. The formal process is known as an inductive reasoning, which works almost opposite to the deductive reasoning. Lastly, it must be mentioned that while at first glance the process may appear to be linear, when applied in practice it does not always follow a linear flow due to the following reasons outlined by (Bryman et al., 2011):

- Other researchers may publish new findings or solution to the same research questions before one completes their study and publishes their work.
- Information pertaining to the appropriateness, or lack thereof, of the dataset may only be revealed after the data collection phase.
- During post analysis phase of the data, findings may conflict with the original hypothesis and this can lead to a change in the strategy of further data collection.

So deductive research can lead to findings that were not originally anticipated, hence an iterative process can even be adopted based on findings, and this may lead to an inductive research approach finally being pursued.

3.3 Method

The chosen method for this study is the structured and semi-structured prolonged interviews in order to do a qualitative analysis of the findings. The sample size will be small, by design. This is consistent with the intent of a qualitative research since the interviews are meant to be long and in-depth in order to get to the individual's expert opinion; and based on received responses the interviewer may prompt to dig deeper. Moreover, the method is appropriate for analysing complex, interdependent and dynamic issues. Consequently, this is precisely the nature of the SSEG renewable tariff structure in South Africa.

1.1.1 3.3.1 Research instruments

The sampling was done purposefully with the intention of capturing the range of experiences and views from the participants since this is a very diverse topic. The idea is to seek conceptual applicability as opposed to quantitative representability.

The main instrument used is the interview questions administered by the researcher and the researcher as the chief instrument for interpretation of results. In light of this, care will need to be taken when conducting these interviews to safeguard against conscious and unconscious bias since it has the possibility of contaminating the search findings and rendering them invalid. This can be achieved by the interviewer refraining from expressing their own opinions or leading testimonies from the respondents since this can skew the findings (Atieno, 2009; Creswell, 1997).

The researcher needs to be aware of the potential sources of error emanating from the respondent's reluctance or fear of expressing honest views which they may deem to be controversial in nature, their being unaware of their own ignorance, and transient issues such as fatigue, boredom, and anxiety about the consequences of their responses (Atieno, 2009; Creswell, 1997).

In addition, interviewees may be reluctant to express their true opinions because they are afraid they won't truly remain anonymous. Finally, the interviewer may distort the responses by rephrasing questions; his/her behaviour and demeanour has the potential to discourage particular responses from the respondents, and other errors may arise during data analysis. Sound measurements can be ensured by performing tests to ensure validity, reliability, transferability and practicality, as will be discussed in sections below.

1.1.2 3.3.2 Assumptions

The following assumptions are made about the methodology and data collection techniques:

- The research will involve fieldwork, and in other instances telephone and internet connectivity.
- Participants are assumed to be English speaking.
- Participants are assumed to be already informed and well versed in the dynamics and developments surrounding renewable energy and how it affects South Africa.

1.1.3 3.3.3 Advantages and Limitations

The advantages of qualitative research are that it is good at simplifying and managing data without destroying the complexity and context. Secondly, qualitative research methods are good when dealing with inquiries especially in cases where pre-emptive reduction will prevent discovery. It also has the positive advantage of being able to generate new ways of seeing existing data. Finally, qualitative research methods are particularly strong when the intention is to seek depth in understanding of unexplained phenomena (Atieno, 2009).

On the other hand, the disadvantages of qualitative research are that because only detailed descriptions are pursued, no attempt is made to assign frequencies to linguistic features in the data. Secondly, ambiguities that are inherent in human language may not necessarily be recognised in the analysis. Lastly, the main disadvantage is that the finding of the research cannot be extended to wider populations with the same degree of certainty as quantitative research methods (Atieno, 2009; Creswell, 1997).

This last feature is because of the lack of testing of statistical significant and chance occurrences of the findings. In closing, it must be mentioned however that data triangulation and method triangulation can be incorporated to improve the strength of the research outputs and quality of the results and mitigation against these identified limitations.

1.1.4 3.3.4 Data Collection

There are several methods for data collection such as participant observation in a focus group type of study, case study, formal and informal interviews, videotaping the participants, archival data surveys or reviewing documents. Each has its strengths and weaknesses; however, for this particular study the formal and informal interviews will be the chosen method of data acquisition.

It is generally impractical, inefficient and sometimes even impossible to study the whole population for a particular study. This is why it is important to select a sampling technique. This is why the sample should be representative in relation to the whole population so that the findings of the study can be generalised back to the whole population.

Quantitative research methods are known for using probability sampling techniques for sampling the population group for the study. However, these probabilistic techniques turn out to be inappropriate for qualitative research (Marshall, 1996). Random sampling is also inappropriate for qualitative research because random samples offer the best way to generalise but lack the ability to derive deep-rooted understanding of complex issues (Marshall, 1996).

Qualitative research rests on the premise that some informants are richer in depth of knowledge than others and can provide greater insight and depth of greater benefit to the researcher. A flexible approach that is iterative will have to be instituted in sampling and data collection, Finally, an appropriate sample size in qualitative research is one that adequately answers the research question posed (Cassell & Symon, 2004).

The convenience sampling strategy for qualitative research is the least rigorous and is largely based on the most accessible respondents, and it has the advantage for being least costly in terms of time, money and effort. However, its disadvantage is that it can result in poor quality data and hence a lack of intellectual credibility. The judgement method is the most common and it involves the researcher purposively and actively selecting the most productive sample to

answer the research questions (Cassell & Symon, 2004; Etikan, Musa, & Alkassim, 2016).

In this study the researcher will use frameworks to shortlist candidates, their practical knowledge, and the literature as the basis for their choice. In addition, sometimes candidates are able to recommend other useful participants; this is termed snowball sampling. It is preferable to implement the judgement (snowball/network) sampling of the population for this research study (Etikan et al., 2016). A contrast between qualitative and quantitative methods is presented in **Table 2**.

Table 2: Reviewing the quantitative and qualitative research methodologies (Marshall, 1996).

Description	Quantitative	Qualitative
• Philosophical foundation • Aim • Study plan • Position of researcher • Assessing quality of outcomes • Measures of utility of results	• Deductive, reductionalist • To test pre-set hypothesis • Step-wise, predetermined • Aims to be detached and object • Direct tests of validity and reliability using statistics • generalisability	• Inductive, holistic • To explore complex human issues • Iterative and flexible • Integral part of research process • Indirect quality assurance methods of trustworthiness • Transferability

The type of interviewees for this particular research study are very technically inclined, with the majority consisting of environmental practitioners, policy makers, and engineers or individuals working within the engineering field, more specifically the electrical energy utility and consumer sector.

A non-probability technique was applied in the selection process for the sample through a restricted sampling framework. There is a great caution to be noted with this approach since it possesses a serious danger of being susceptible to the

researcher's own bias and furthermore, any sampling error cannot be estimated. The advantage of this method of sampling is that it greatly reduces the cost and time required to complete the study (Cassell & Symon, 2004).

The interviews will be oral face-to-face and also telephonically for participants that are remote to the researcher. Some of the advantages and disadvantages of the face-to-face interview methods are listed in **Table 3** and **Table 4** below:

Table 3: Face-to-face interview advantages and disadvantages.

Advantages	Disadvantages
• Very rich and in-depth content can be gathered. • There is flexibility in that questions can be restructured to suit engaged respondent, even more when the questions are unstructured. • There is greater control of the sample and thus reduced count of missing or no responses. • Greater control over who responds to the questions, which is something lacking in a questionnaire type of survey. • Element of surprise can increase spontaneity of respondents also something which is lacking in a mailed questionnaire.	• There is always the possibility of bias of the interviewer and the respondent. • Some influential potential respondents may be difficult to reach such as government officials, and company executives. • Sometimes the interviewer on the field may be over-stimuli to the respondent on the field. • The task of interviewing can always introduce systematic errors. • The lack of interview skills form the interviewer may solicit skewed responses from respondents.

Table 4: Telephonically administered interviews advantages and disadvantages.

Advantages	Disadvantages
• Generally more flexible • Time saver • Cost saving due to no need of field agents • Greater coverage of potential respondents who otherwise would be excluded due to remote access.	• There tends to be greater presence of bias from the interviewer • Questions must be short and quick to the point. • Not suitable for intensive interviews where long comprehensive answers can be provided. • Respondents are given sufficient time to consider their responses

The targeted profile of respondents is presented in **Table 5** below.

Table 5: Profile of prospective respondents.

Description of respondent type	Number planned to be interviewed
Research Leader	1
Engineering Manager	1
Senior Engineer	1
Engineering Magazine Editor	1
Chief Engineer	1
Original Equipment Manufacturer	1
Government Representative	1
Consultants	2
Academia	1
Developer	1

3.3.5 Capturing, Processing and Critical Analysis of Data

Processing of the data refers to a process of editing it, classifying it according to categories already decided on, and arranging it in tables. The data is then more easily interpreted, and relationships between the variables extracted.

Caution must be raised on the difficulty with dealing with 'Don't know' responses or refusal to comment due perhaps to conflicts of interest. Microsoft Excel spreadsheets were used as the primary tool to capture the data and performing analysis as well. The analysis was thematic and largely descriptive.

3.4 Ethical Issues

There are several issues which relate directly to ethics in the field of business and management research, some of the most relevant ones to the study will be highlighted here. The main areas of concern are summarised as follows:

- harm to participants,
- lack of informed consent by the researcher to the participants,
- lack of data protection,
- invasion of privacy, and
- deception.

It is the responsibility of the researcher to ensure that research outputs are gathered in a responsible manner and always take note that the end does not always justifies the means.

The researcher must ensure that the participants have full disclosure and provided with informed consent before interviews commence. As a matter of fact, this must be done before interviews are conducted in order to allow the participant sufficient time to consider whether to agree or decline. Lastly, it is also important to protect the identity of the participants through anonymity (Republic of South Africa, 2013), and it is the responsibility of the researcher to guarantee this protection. Furthermore, care must be taken by the researcher administering interview questions not to invade participant's privacy.

Participants may not be comfortable with responding to certain questions for a variety of reasons such as political and religious inclinations, employer conflicts of interest, or even, plain offence. Sometimes in these instances confidentiality agreements through non-disclosure agreements (NDA) paperwork can be instituted to open up the dialogue in a more protected space and the participants may feel safe to share information more openly. Conversely, deceptive tactics are completely unethical, since they are a serious human rights transgression and legitimate grounds for costly litigation; and they violate the University of the Witwatersrand Student Policies and Code of Conduct (WITS, 2017).

With this in mind, the researcher must exercise emotional sensitivity and empathy when dealing with controversial and sensitive issues and pay close attention to both verbal and non-verbal cues from the participants and react accordingly.

Personal bias must also be obviated as far as possible. In order to protect the integrity of the study, the researcher must establish reciprocity through openness and honesty in communication and trust with all participants, promote objectivity, and conduct the interviews on the basis of trust and transparency. Human rights are preserved in the study.

Under these circumstances, professionalism and respectfulness must always be maintained at all costs, remembering that it is not a debate that is being pursued but rather a quest for new knowledge which the participants are there to hopefully provide. Therefore, the researcher must ask questions and merely listen and only provide clarity on request.

In closing, the aim is not to embarrass, humiliate and discourage stakeholders and participants but rather to seek truth. In evaluating the risk of harm to respondents, consideration was extended to non-participants as well since some of the outcomes may be damning to them. The researcher wished to record (audio tape only) the interactions with the participants, and the participants were informed as such and their consent requested.

3.4 Reliability and Validity

Validity speaks to how well the test instrument being administered actually measures what it is intended to measure. In particular, for this research study, content validity will be of utmost interest for reasons to be discussed. Secondly, reliability deals with the accuracy and precision of the procedure, in other words, how consistent the instruments used to conduct the research study are. Finally, practicality addresses issues of the economy, interpretability and transferability of the responses including convenience (Bryman et al., 2011; Cassell & Symon, 2004).

The reliability of the research study is a measure of how well the research process is dependable, consistent and auditable by researchers who were not part of the study. Also, reliability looks at how stable the process is over time. Furthermore, this is really looking at the nature of how the interviews are conducted, the tone of

the interviewer and at what consistent level the questions are pitched for each participant (Bryman et al., 2011; Cassell & Symon, 2004).The interviewer has to be reliable over the course of the different interviews.

Internal validity is a measure of how well the results are sensible and have credibility in the eyes of the participants of the research; this is really the authenticity test of the findings. This is especially important in this particular study since all the participants in the study have a high calibre of intellectual capacity and extensive experience. In fact, some of the participants are authority figures in their respective fields of knowledge and specialisation (Bryman et al., 2011; Cassell & Symon, 2004).

The conclusion is derived from the analysis and interpretation. The external validity test measures how well the pertinent conclusions can be transferred to other contexts in the same filed or related fields and how fitting they will be. Consequently, this validity is very important to the researcher because the scope of renewable energy extends far beyond just solar PV energy generation and small-scale power plants. The author will be seeking to transfer some of the conclusions to be applicable to wind, biomass, small-hydro, battery storage and electric vehicles, with some limitations.

It is also the goal of the research to maintain a neutral, unbiased stance while conducting the interviews and during analysis, interpretation and drawing of conclusions. Certainly, this stance can be tested using the objectivity or confirmability test to see how well the conclusions are representative of the researcher's unacknowledged biases.

Finally, because this is a consultancy report, it is important to the researcher that the findings are constructed in a pragmatic fashion such that the audience is able to welcome the findings and translate the recommendations into implementable policy. Generally speaking, this activity will be measured via the utilisation test which really looks at how action oriented the study is, and is there a call for action based on the conclusions and recommendations.

3.5 Conclusion

The significance of having a research methodology for a successful execution of a research undertaking has been clearly articulated and a research design has been proposed and presented. A methodology of how the research work will be executed from the preparation of the proposal to the gathering of the data and then the analysis and interpretation of the findings has also been discussed. The choice for the qualitative research method has been presented with its advantages and disadvantages, and a plausible justification for the choice is provided.

The tools used to conduct the research and analyses of the data has been presented and accompanied by the available population sampling methodologies. Ethical considerations relating to the collection of the data and engagement with participants on the study, privacy issues and protection of personal information are also issues of major importance and have been highlighted accordingly.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

This chapter is intended to present the results obtained from the in-depth interviews conducted using a semi-structured interview questionnaire. The topic of discussion is fairly new for South Africa and hence the quality and depth of knowledge from the participants is more important than the quantity of participants interviewed. The structure of this chapter is such that the results are presented and each topic accompanied by an explanation.

4.2 Demographics of Participants

The research started with only 12 invited participants, and from the first three interviews conducted the potential sample size of invitees grew to 20 potential participants who were all invited. However, the original size of 12 dropped to five. It is assumed that due to the sensitivity and confidentiality of the functional roles of the incumbents, this is why no response could be solicited from the eight other subjects. This is not an issue of concern because the original sample quality identified by the researcher was able and willing to participate and the size is also appropriate for this type of study. It should be noted that, because of the political economy of South Africa, some of the targeted participants hold classified information. The demographics of the secured sample of 5 participants are presented in **Table 6** below:

Table 6: Participant demographics of five participants

Gender	Race	Province	Interview Style	Sector
Male	4xWhite South African	4xGauteng	3xSeat down	2xR&D
	1xBlack South African	1xWestern Cape	2xSkype based	2xPrivate Sector
				1xPublic Sector

4.3 Framework Analysis

The process followed to arrive at the results is summarised by **Figure 2** below. A list of identified tariff frameworks is used in combination with the interview questions to extract information which will allow the researcher to provide answers to the problem statement. This process ensures the most appropriate satisfiers are identified and also contributes to the reliability and confirmability of the study as will be discussed in the next chapter.

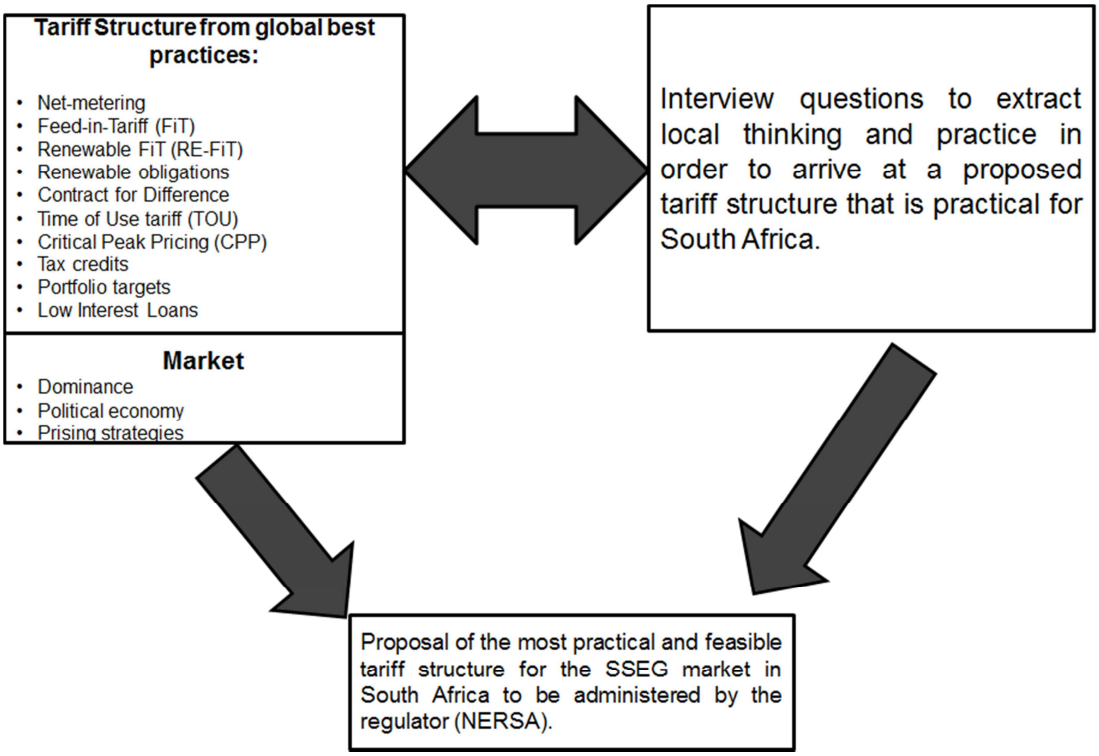

Figure 2: Triangulation process guiding the research.

The interviews were conducted in offices and boardrooms at the premises of the participants for their convenience. The participants who could not meet with the researcher in person, were interviewed via Skype™. All interviews were recorded with an audio device. The interviews were later transcribed manually onto Microsoft Excel® by the researcher.

The Excel platform was also used to code the raw data using an emergent approach to root out the themes and sub-themes from the respondents. It is also

through this deductive process that potential levers are identified which relate to unlocking the SSEG market in South Africa.

4.3.1 Coding of Results

The literature review was done with the intention of conducting exploratory research and produce new ideas that should be considered in South Africa in relation to the SSEG market, particularly for tariff design. Several tariff structures were identified and used in the interview questions to guide the data acquisition process.

The coding of the acquired raw data, taken from the transcripts, follows an explanatory research framework which aims to identify the cause and effect between the established themes. The emergent themes are presented in **Table 7** and **Table 8** below. As expected, it is difficult in the context of South Africa to speak about energy tariffs without having to mention market dominance, revenue protection and cost recovery by state-owned utilities.

South Africa has extensive experience in retail tariff design, with its oldest utility, Eskom, being 95 years old at the writing of this report. This explains the emergent themes such as retail tariff, incentive and discouragement instruments for consumer behaviour and net-based models.

The themes and antecedent emerging from the second question in the interview revealed climate change objectives and solar resource abundance as potential drivers. Other themes of interest are: the redress of the political economy, policy and law to enforce compliance and the strategic stance on centralised versus decentralised planning.

Since 2011, South Africa has some developed credible experience with a competitive bidding process referred to as the Renewable Energy Independent Power Producer Procurement (REIPPP) programme. This explains why variations of this programme were brought up by the respondents to redress the lack of a

viable tariff. Concepts such as PPAs and IRP targets and market reform constantly emerged throughout the discussions.

Table 7: Part (a) of coded sub-themes and main-themes.

Question Category	Themes	Tool
Question 1 - What do you think is the practical tariff structure for small-scale rooftop solar PV in the South African context?	Market Dominance by Monopoly structure	In-depth Interview
	Lack of Renewable energy trading market	
	Lack of Independent System Operator	
	No clear drivers for the solar rooftop PV	
	Feed-in-Tariff (FiT)	
	Incentive vs discouragement	
	Retail Tariff	
	Cost Recovery vs Avoidance Cost	
	Revenue Protection	
	Target Portfolio	
	Net-Consumer vs Net-Producer (Net based tariff)	
	Business Case Bankability vs PPA	
	MFMA and PFMA	
	Consumer Behaviour	
	Financing options through banks	
	Political economy	
	Adopt international tariff	
	Bidding Model	
	Poverty and Inequality in SA	
Question 2 - What mechanism do you think is required for opening up the energy market in South Africa to address the lack of market power by the Independent Power Producer (IPPs), more specifically SSEGs?	Public participation in the energy market	
	Good grid citizenship	
	Electricity Policy and Act	
	Economies of scale	
	Wholesale energy market	
	Solar resource	
	Business Case Bankability vs PPA (REIPPPP)	
	Climate change	
	IRP and IEP targets	
	Standardisation	
	Supply Demand organic Growth	
	Centralised vs decentralised	
	Open free-market	
	Reform energy market	
	Independent system operator	
	Information gap	

Table 8: Part (b) of coded sub-themes and main-themes.

Question Category	Themes	Tool
Question 3 - Do you think the National Energy Regulator of South Africa (NERSA) is playing its role	Uncertainty with Energy Regulator	In-depth Interview
	Energy Regulator reactive not proactive	
	Regulator not doing much	
	Regulator waiting for DoE	
	Lack of National database	
	Growing frustration	
Question 4 - Are there any other suggestions/recommendations that you would like to make?	National Leadership Needed	
	Driver Determination	
	Reform - Kill Monopoly Market	
	Enabling Framework	
	Consider Battery Storage and electric vehicle Impact	
	Caution on Unintended Consequences	

Questions 3 and 4 in the interview reveal themes which resonate with the sentiment of the general public, public and private sectors in dealing with the energy regulator of South Africa. Emergent themes are uncertainty, a reactive approach versus a proactive approach, and growing frustration with the utility. All respondents agree on the lack of national leadership and as a result expressed caution on the unintended consequences of not doing anything or doing the wrong thing.

4.3.2 Conceptual Network Mapping

A conceptual mind-map is designed to create a visual impression of the results and clearly illustrate the antecedents and consequent relationships of the identified themes. This mind map is depicted in **Figure 3** below. The main themes which offer a resolution of the problem statement are the:

- drivers of the renewable energy tariff
- political economy in South Africa
- energy trading market and policy
- regulator, and

- the tariff structure and consumer behaviour.

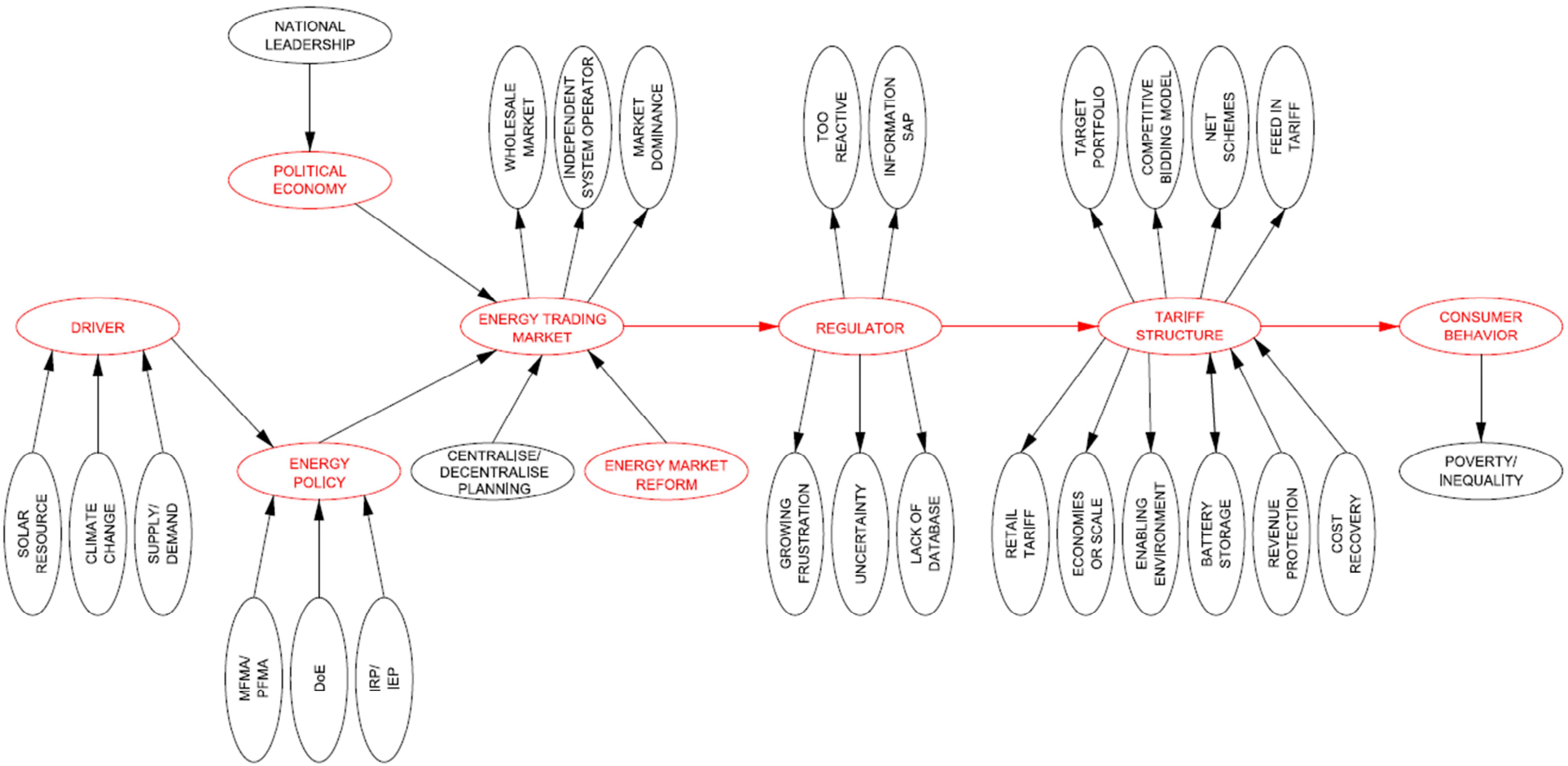

Figure 3: Mind-map of the sub-themes and main themes.

4.4 Conclusion

The data from the interviews has been presented. A framework analysis has been discussed which demonstrated how the raw data was transcribed and coded to produce the themes and sub-themes. A triangulation structure has also been presented to demonstrate how the value from the interviews is related back to the literature review and answer the research questions. A mind map was presented to illustrate the causality of the themes.

CHAPTER 5: DISCUSSION OF RESULTS

5.1 Introduction

The aim of this chapter is to provide an in-depth discussion of the results presented in Chapter 4 and demonstrate how these results provide rational answers to the problem statements posed in in the introductory chapter. This chapter also ties the outputs derived from the respondents to the insights gained from the literature review in Chapter 3.

This chapter will close with a discussion on how the reliability, validity and ethical practice committed to in Chapter 4 is fulfilled.

5.2 Stature of Respondents

The respondents have extensive experience in the electricity and renewable energy industry, with careers spanning over 10 years. One respondent has over 28 years working experience in various sectors including the building services as a consultant. Another respondent has a Ph.D in electrical engineering and has written most of the standards and guidelines used by utilities and municipalities in South Africa.

One of the respondents has extensive private and public energy sector experience in the modelling of renewables for the purposes of finding least cost solutions and contributes significantly to the department of energy IRP office and serves as technical advisory to the Presidency of South Africa in the National Planning Commission (NPC) department. This respondent is also pursuing his Ph.D in the energy economics within the Southern African Development Community (SADC) region.

Lastly, another respondent also has a Ph.D and has been involved with quite a few tariff estimation, litigation and arbitration matters and regulatory submissions in South Africa on behalf of private and public energy and gas clients. The other respondent works in the regulator office of South Africa.

5.3 Theme Discussion

This section present a detailed discussion on the identified reoccurring themes from the interviews conducted and presented in Chapter 4.

5.3.1 Drivers

The respondents really struggled to provide a specific and direct answer to the practical tariff structure question for South Africa. The main reason cited is lack of clarity about the economic drivers (Engelken, Römer, Drescher, Welpe, & Picot, 2016; Nel, 2015) for South Africa's intent to deploy SSEG, or any renewable energy infrastructure for that matter.

There are climate change commitments South Africa made to the United Nations (UN) on the Paris Agreement. Moreover, there are regions within South Africa that are well endowed with solar resources. Furthermore, South Africa has not developed a clear consensus on the supply and demand as a driver to propel the SSEG market.

Crucially, South Africa continues to struggle with the stifling and pervasive growth of unemployment figures, deepening inequality, and rising poverty levels. Should this also form part of the motive and driver of the SSEG market and thus should the tariff structure be designed to close these gaps? This means there is a lot of homework to be done by South Africa in order to ensure a pragmatic response with the appropriate tariff to drive the desired agenda.

5.3.2 Energy Policy

Having determined a coherent driver for South Africa to deploy and capacitate the SSEG market, the next step is to respond with an appropriate policy (Chester, 2010) to ensure an implementation mechanism receives the right support. Aspects of this policy should include a review of the energy policy and the Electricity Act of South Africa (Valenti, 2015; Winkler, 2005). All respondents agreed that this task falls within the jurisdiction of the DoE.

Other considerations should be the procurement process for state entities which relates to the MFMA and PFMA. A particular revelation made during an interview was that in order for individual residential consumers to trade energy with utilities and municipalities, they would have to be registered in the Central Supplier Database (CSD) with treasury as vendors and classified accordingly. Furthermore, they would also have to have tax certifications and VAT numbers for invoicing. Currently, there is no framework which enables customers to fulfil these requirements. This is indeed a hurdle.

No consideration has been made on how such a mechanism will be implemented by the state at a national level or through local municipalities. No consideration has been made on whether such residential customers would need to register as businesses in order to trade energy with municipalities. The policy would come in the form of the IRP or IEP from DoE and be implemented by NERSA.

5.3.3 Political Economy

The designed policy will need to be implemented throughout the country either at a national level by the state or through the local municipalities. Due to the nature of the political economy of South Africa, local municipalities have executive authority and autonomy over their jurisdiction and they tend to react when they perceive the state to be unduly imposing on them. The intensity of the reaction is increased when the municipalities feel excluded from the entire process (Nel, 2015).

The political economy stems from the manner in which officials governing municipalities are elected through the democratic process. The strategic, economic and infrastructure investments are all politically motivated and influenced. Decisions are seldom rational, based on socio-economic indicators or involve sufficient public participation. This also explains why there is growing frustration from the general public and business, both of whom are met with poor service delivery.

5.3.4 Energy Trading Market

Another significant revelation from the interviews was that, as things stand, South Africa does not have an energy trading market and mechanism. As alluded to in the subsection above, there is no process whereby individual consumers may conduct energy trading business with municipalities due to the lack of clarification regarding CSD registrations and acquisition of VAT numbers.

South Africa has experience with net schemes where a net meter can be installed at the point of connection between the consumers and the grid. Consumers are then allowed to push back their own generated electricity to the grid, but only to accumulate credit which ultimately yields lower monthly bills for the consumers. However, this process has never been used to reimburse consumers in monetary terms. Also, the law prevents consumers from storing their generated electricity in the grid for later use.

South Africa has also gained some more refined experience with a tender bidding process introduced by DoE referred to as the Renewable Energy Independent Power Producer Procurement (REIPPP) programme. It bears mentioning that this programme is for large scale renewable power plants from IPPs to be sold to the sole licensed generator, i.e. Eskom. This mechanism does not exist or extends to SSEGs, and it is not open to municipalities.

However, to date, South Africa does not have a wholesale energy trading market in which residential, commercial and industrial customers can participate to purchase electricity at a competitive price from multiple suppliers. This then makes it difficult to prescribe and administer a tariff to an environment where there is no market. This further complicates the regulator's task.

Because of the political economy of South Africa, centralised planning has yielded market dominance by monopolies in price setting and this result in tremendous limitations for IPPs or residential/commercial consumers within the SSEG space in influencing tariffs.

For South Africa to have a competitive market, electricity industry reform (Newbery, 1997) is essential to remove the conflict of interest that exists between the electricity generator, transmission and system operator. This would enable an independent system operator to manage the wholesale energy trading market and allow for competitive pricing and increase participation from least cost (Sklar-Chik, 2017) IPPs. This would also enable decentralised planning and introduction of aggregators and new business models in the market (Astarloa, Kaakeh, Lombardi, & Scalise, 2017).

5.3.5 Regulator

There was strong consensus from the respondents that the regulator has not been doing enough to regulate the market, provide certainty, tariff clarity and ensure compliance by all parties. The regulator is deemed to be taking a reactive approach instead of being proactive. The SSEG sector still lacks a national database of how many of these plants are connected off-grid and integrated into the grid, where they are installed and who owns them. There are safety implications in this.

The mandate of the regulator is to implement policy and regulate the market. The lack of a decisive approach adds to the growing discontent (Chauke, 2018) from all other stakeholders who look to the regulator to provide tariff clarity and to introduce rules (Moroeng, 2018), guidelines and standards to which all stakeholders must adhere to.

There is a tremendous information gap which further exacerbates the inequality between the small municipalities and the big metropolitan municipalities. This makes for inconsistent tariff designs, protectionist revenue stances, and inappropriate solutions with serious safety implications. Ultimately, this leads to missed opportunities and maintains the immaturity of the SSEG rooftop solar PV market.

5.3.6 Tariff Structure

Traditionally, tariff design has followed a process where the tariff is lumped into a volumetric figure which includes the cost of the supply, ancillary services, grid access charges, administration and billing charges, and the size and location of customer. The observation was made that municipalities and utilities are still to follow this same process for the determination of a tariff for renewable energy. In this way, the whole is kept the same in the volumetric tariff but more amounts are shifted on the fixed/basic charges to ensure a lower energy charge for the feed-in-tariff (FiT). This ensures that the municipalities retain their revenue and are able to recover their costs.

Some of the big metropolitan municipalities even go as far as instituting restriction on participants being net-consumers, meaning they must purchase more from the grid than they plan to sell. This is one of the reasons that the tariff frameworks currently being propositioned by municipalities and utilities are non-bankable, and prevent an enabling environment for energy trading to develop.

There are various forms of tariff structures and mechanisms which have the potential to work in the South Africa context as presented in the literature review in Chapter 3. Some of these are target portfolios, net-schemes, competitive bidding models, and FiT (Lilliestam & Pitz-Paal, 2018; Meyer-Renschhausen, 2013; Scott, 2016). South Africa needs to decide on the agenda being driven by the SSEG deployment and then determine a tariff structure which works well to support it.

Some respondents mentioned the potential threat posed by cheap and affordable battery storage and how they may enable consumer to fully go off-grid since they will be able to store their generated resources for later use. This limits their dependence on the grid and thus further reduces cost recovery and revenues collected by municipalities and utilities.

It is worth noting that it is still possible to achieve economies of scale through rooftop PV SSEG mass deployment. South Africa must simply decide on how the deployment needs to be approached, and centralised planning versus

decentralised planning. Is the tariff determined and administered at a national level, similar to the REIPPP programme, or are municipalities given free rein to decide what works for them? The bankability of projects is determined by the PPAs since they offer guarantees to banks, funders and investors for their investments. This may be considered for the SSEGs, but the duration should not be 20 years as in the REIPPPP.

5.3.7 Consumer Behaviour

An appropriate tariff has the ability to drive a specific narrative on consumer behaviour. As one respondent noted, the grid represents a sign of advanced civilisation and all nations that have the grid are world leaders. As such, South Africa needs good grid citizens. Consumers who cooperate with the grid and provide a form of grid relief during difficult times are incentivised. Consumers who only want to use the grid for their own benefit, such as net-zero buildings (Momberg, Klerk, & Braune, 2017), should be discouraged and penalised.

Additionally, South Africa wants to close the inequality gaps and provide employment and further reduce poverty. This can be achieved through cross-subsidies and tax incentives. Benefits could be realised through electrification programmes for the rural and disenfranchised communities and providing subsidies for SMEs and SMMEs. The right tariff structure can be used as a tool to achieve much greater good and still be profitable.

5.3.8 Open-Ended Questions

There was great concern from the respondents as to how well capacitated the department of energy (DoE) is. There has been delay upon delay with releasing the revised IRP and further launching the IEP policy documents which the industry awaits. There is a strong sentiment that perhaps DoE does not have sufficient competency to address this task.

5.4 Unintended Consequences

The following unintended consequences have been identified and need to be treated with caution:

- The targeting of renewables solar PV SSEG forces a rise in consumer tariffs because utilities and municipalities need to recover their costs. This has been the observed in European countries such as Germany and France who have some of the most expensive consumer tariffs because of their integration of renewables in their grid.
- The effect of the increased retail tariffs will result in reliable paying customers discouraged by the expensive electricity to an extent that they will seek other alternatives such as going off-grid or using other cheaper energy resources. This will lead to utilities and municipalities losing out on revenue and cost recovery.
- Municipalities are using a strategy of splitting the volumetric cost of electricity to propose an economic FiT for rooftop solar PV SSEGs. The aim is to shift most of the costs in the fixed network charges and allow for a cheaper energy charge. This uneven split of the volumetric cost will lead to cheaper energy charges (i.e. R/kwh) but at the same time it will not promote energy efficiency initiatives.
- If municipalities continue with offering an unattractive FiT for SSEGs in an attempt to protect their revenue, this will force interested consumers (residential/commercial/industrial) to invest in cheaper energy storage in an effort to solely rely on their own PV plant or private micro-grids and use very little electricity from the grid thus further increasing the threat of revenue loss and cost recovery for the municipalities.

5.5 Validation

Validation of the research is achieved through the research instruments, being the researcher and the sharp, direct, innovative and insightful interview questions, to solicit enough breadth and depth of content from the respondents. The researcher

is well versed on the subject matter and is able to detect when respondents are going off-topic. The research questions ensure congruent responses are solicited to answer the problem statement as demonstrated by **Figure 2,** in Chapter 4.

5.5.1 Internal Validity

Internal validity is ensured by the combined depth of knowledge derived from the respondents.

5.5.2 External Validity

External validity is ensured through the generality of the discussion to always touch on the broader context of renewable energy resources, which to some extent includes other technologies. Hence, there is always a link to the research whenever the conclusions are transferred to other related technologies.

5.6 Reliability

The research questions were asked through reading the text on a printed piece of paper to ensure consistency in how the questions are asked. If at any moment the respondent mentioned something interesting, the researcher probed further. However, the researcher will always go back to the structured interview questions to ensure the discussion does not meander off. Audio recording for the interviews conducted are retained for audit compliance and confirmation by third parties.

The transcripts were generated by a two person team, independently. This is to ensure the process is cyclical enough to ensure no subtle themes are missed.

5.7 Credibility, Confirmability and Dependability

The impressive resumes of the respondents, their breadth and depth of experience, and their willingness to share invaluable knowledge on the subject matter through publications, conference proceedings and interviews speaks volumes to their credibility.

The presented triangulation process ensured consistency of the process and can be confirmed by anybody who did not participate in the study. The interviews were not brief; most of them went on for over an hour to ensure all the topics were discussed at length. Prolonged engagements allow for respondents to get comfortable and share openly and willingly other relevant aspects which may not even have risen explicitly but very pertinent to the domain.

The researcher also used peers and colleagues who are in the same field as test subjects for the development of questions and also to test different viewpoints. The researcher's credibility plays a factor in the interpretation of the results and as mentioned already, he is well versed in the subject and immersed in the discussion at large, since he works for the biggest utility in South Africa and Africa as a senior engineering researcher.

5.8 Transferability

The literature review and supplementary information has made mention of other renewable technologies such as small wind farms, biomass, battery storage and electric vehicles which do not have tariff frameworks for energy trading capability as it currently stands. The recommendations derived from this research can easily be transferred and applied to those technologies with some minor modifications.

With a well-established energy wholesale market, energy derived from all these other technologies and resources can fulfil an appropriate energy mix and ensure the most least cost option is purchased at all times. This is the case in some European countries as established by the literature review in Chapter 2 and the accompanying supplementary report.

5.9 Conclusion

This chapter has presented and discussed the interpretation of the results from the interviews conducted. Cause and effect relationships have been established on the identified emergent themes and sub-themes from the respondents. Crucial

unintended consequences have been discussed to caution the regulator on the impact of certain decisions and on any lack in decisive decision taking.

The lack of an energy trading market has been highlighted. It has a great impact on the difficulty of prescribing a specific tariff structure for the rooftop solar PV SSEG market. The validity, reliability and transferability of the results have been discussed. This study should hopefully open up the next step of the process of creating a viable space for renewables in South Africa.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

South Africa cannot implement a feed-in-tariff model similar to the one in existence in Europe, Europex, because of the current absence of a free competitive energy trading market and lack of clear definitive drivers. This is largely because South Africa does not have an independent system operator, which is a key enabler for the free competitive market of electricity trading. However, in the interim, the regulator could still implement the renewables portfolio targets at a national level to be specified by DoE through the IRP, but it should not be prescriptive. The regulator can then allow regions or provinces and municipalities to work out their own models for compensating customers for SSEG feed-in using frameworks such as FiT or Net-FiT.

It is imperative that DoE work urgently to introduce an electricity reform policy which will enable the development of an electricity trading market which complies with the PFMA/MFMA policies for utilities and municipal procurement procedures.

6.2 Key Takeaways

The lack of a clear and lucid driver(s) is the biggest feature emerging from the respondents' interviews. This has the highest impact on the low maturity of the rooftop solar PV SSEG market. This also explains why there have been so many inappropriate responses from DoE and the regulator in facilitating the development of this market and proposing tariffs.

A strong focus needs to be dedicated in developing and defining the driver(s) for South Africa to build an alternative energy industry. Such drivers could be climate change, transitioning of underperforming ageing fossil based infrastructure, to facilitate eradication of poverty, closing the inequality gap and job creation to lower the unemployment rate. Whatever driver it is, let it be clear and understood by all stakeholders. The right driver(s) will then lead to the most appropriate policy

being developed to address all attributes of the driver and the economy where appropriate.

The right policy will further lead to processes and guidelines put in place to directly respond to electricity industry reform questions. We need to facilitate the creation of potential wholesale market that will enable energy trading. This will open up opportunities and business models that will revitalise the economy and breathe new life through the development of the right tariff structure(s).

The regulator, NERSA, must be brave and act with courage to take a stand against non-competitive behaviour in the market and provide much needed independent energy economic regulation. NERSA should do this by providing information to the public and all interested parties, be decisive to eliminate uncertainty and reduce frustrations, and take account of the national database. This will enable NERSA to take decisive action on the policy implementations to foster the market. This can be done by using instruments to incentivise or penalise participants in the market.

NERSA has the support of the South Africa community at large and business society; it must be bold and act with independence and autonomy to address the socio-economic needs of South Africa in a global economic context.

6.3 Recommendations

The following recommendations are made for the medium-term consideration, since the private sector and residential communities continue to deploy SSEG:

- An energy trading market (Bischof-Niemz, 2015) must be established with absolute urgency since South Africa already has unaccounted for rooftop solar PV SSEG plants installed throughout the country and this has safety implications.
- The department of energy (DoE) to plan and specify renewable portfolio targets, specifically the solar rooftop PV, at a national level.

- DoE must also expedite its processes to finalise and release the revised IRP and launch the IEP, since at this point they are well overdue.
- NERSA, as the implementer of the aforementioned policy targets, should allocate each province a target based on the endowment of the solar energy resource.
- Local municipalities and utilities will then be responsible for the setting of an attractive FiT tariff which will also need to be approved by NERSA to ensure fair and competitive behaviour.
- The FiT must be accompanied with a PPA agreement of between three to five years to ensure guarantee of investment recovery by the financiers, lenders and bankers.
- NERSA in collaboration with local municipalities should promote the potential partnership with banks to provide funding models to enable inclusion of the all population groups, even the lower LSM.

In the long term the following recommendations should be considered:

- Very clear drivers that will inform policy need to be defined.
- NERSA needs to advice DoE that market reform is urgently required in order to ensure that an open competitive market is created which will be in line with the competition commission and tribunal rules (Bischof-Niemz, 2015).
- To accompany this reform, the existing conflict of interest at Eskom between generation, transmission and system operator must be resolved by creating an independent system operator.

6.4 Suggested Future Work

The following research topics are suggested to further contribute to and extend knowledge in this field:

- Detailed research into any unique qualities pertinent to other renewable technology plants such as small hydro, biomass, biogas, small wind to

ensure any customisation can be made for the most appropriate tariff structure.

- The immediate impact of battery storage and electric vehicles in South Africa because the cost of batteries continues to decline at substantial rates and this may require that some of the assumptions to be challenged, especially those made by the national planning commission and DoE for the IRP reports.
- More research is needed on the various presented business models in the literature review and supplementary documents on the provision of ancillary services, energy management services and demand responses that may be applicable to the South Africa. The right tariff structure can yield an enabling environment and promote such business models.
- Quantitative or model building research is required to pinpoint an exact FiT tariff figure that is beneficial to both municipalities and customers for rooftop solar PV SSEG.
- Broader research is needed at a policy level to address the political economy in South Africa to eradicate the market dominance by monopolies.
- More research is required to design flexible packages for bankers and investors to fund SSEG infrastructure investments for the poor and disenfranchised communities in South Africa. We may close the inequality gap and contribute towards economic growth through job creation and capacitating the SME sector for both formal and informal economies.
- Investigate how advanced analytics through the use of big data, internet of things and the imminent 4^{th} industrial revolution can be leveraged to beneficiate the new business models for renewable SSEG plants energy trading.

6.5 Conclusions

It has been established that South Africa does not have clear drivers and an energy trading market which would ensure participation by residential, commercial

and industrial consumers and aggregators in a competitive least cost transacting of electricity. The development of such a market is paramount as an antecedent to the growth of the solar rooftop PV SSEG industry.

It has been recommended that the regulator could use portfolio targets that are established at a national planning level to define how much energy should be produced from rooftop solar PVs for the whole country. The regulator can then use these portfolio targets to allocate capacity to the different provinces. Each municipality will then design and present its FiT (*or net-FiT*) tariff to the regulator for approval and said tariff will then be implemented as a tool to enable the competitive procurement of renewable resources by municipalities and consumers.

Items of worth noting from the recommendations relate to the much needed electricity sectoral reform in order to liberate the market and ensure a clear path to the utilities of the future. Such utilities will make way for the new business models that would enable sustainability and continued profitability of utilities and contribution to the growth of the South African economy.

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