Analysing the impact of the renewable energy revolution in South-Africa

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ABSTRACT

The development of the energy industry in South Africa together with the development of distributed generation from Independent Power Producers and the establishment of small-scale energy structures and off-grid solutions that are based on renewable energy sources are all indicators that the country is in the midst of a renewable energy revolution. This revolution can assist in the establishment of a sustainable energy infrastructure should all the involved stakeholders collaborate intensively with common objectives. It is at this stage of the revolution therefore important to ask whether South Africa is ready to utilise the opportunities that are presented to them with regards to renewable energy and whether the country is able to take advantage of the abundant natural resources to pursue the future of energy development. This study aims to answer this question to a large extent.

This study is divided in three main constructs i.e. a coal generation perspective, a renewable energy perspective and a political perspective. A specific research methodology was followed for both a literature review and an empirical study. The literature review is structured in such a manner that evidence is gathered to describe the perspectives of each of the afore-mentioned constructs. The empirical study was then constructed on selected findings obtained in the literature review and tested by performing a qualitative study. The qualitative study necessitated interviews with ten individuals that comprise various experience and backgrounds in the energy industry of South Africa.

The observations made in the qualitative study were then strictly correlated with the findings in the literature review from which decisive conclusions were derived. The final chapter of this study aims to answer the core research question and also validates the stated research objectives of the study. The purpose of this study was therefore to answer the question: Will the impact of the renewable energy revolution be positive or negative considering the growth of the energy industry of South Africa from a holistic perspective? Substantial evidence is provided that supports the answer to this question.

Key words: Renewable energy, Renewable energy revolution, Coal generation, Eskom, Economic growth, Energy mix, Energy scenario analysis, Energy tariffs, Independent Power Producers

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
BBP	Bronkhorstspruit Biogas Plant (Pty) Ltd.
C&I	Control and Instrumentation
Co_2e	Carbon Dioxide Equivalent
CSIR	Council for Scientific and Industrial Research
CSP	Concentrated Solar Power
DBOUS	Design Base Operating Unit Support
DBSA	Development Bank of South Africa
DEA	Department of Environmental Affairs
DoE	Department of Energy
DPE	Department of Public Enterprises
DTI	Department of Trade and Industry
EGSA	Electrical Generating Systems Association
EIA	Environmental Impact Assessment
ERC	Energy Research Centre
*Eskom Holdings SOC. LTD.	Eskom Holdings State-Owned Company Limited
GDP	Gross Domestic Product
GBCSA	Green Building Council South Africa
GHG	Greenhouse Gas
GT	Group Technology
GW	Gigawatt
GWh	Gigawatt hours
IFPRI	International Food Policy Research Institute
IPP	Independent Power Producer
IPPPP	Independent Power Producer Procurement Programme
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
JSE	Johannesburg Stock Exchange
kWdc	kilowatt direct current
kWh	kilowatt hours
kWp	kilowatt peak
LCOE	Levelised Cost of Energy
LPG	Liquefied Petroleum Gas
MPRDA	Mineral and Petroleum Resource Development Act
MW	Megawatt
MWp	Megawatt peak
NED	Network Engineering and Design

NERSA	National Energy Regulator of South Africa
NOS	Network Operations and Support
NT	National Treasury
O&M	Operations and Maintenance
PC&C	Protection Coordination and Configuration
PPA	Power Purchase Agreement
PV	Photovoltaic
REFIT	Renewable Energy Feed-In Tariff
REIPP	Renewable Energy Power Producer
REIPPP	Renewable Energy Independent Power Producer Procurement
REIPPPPP	Renewable Energy Independent Power Producer Procurement Programme
RETEC	Renewable Energy Technical Evaluation Committee
ROI	Return on Investment
SABIA	Southern African Biogas Industry Association
SADC	Southern African Development Community
SALGA	South African Local Government Association
SANEA	South African National Energy Association
SAPVIA	The South African Photovoltaic Industry Association
SAREC	South African Renewable Energy Council
SAWEA	South African Wind Energy Association
SBO	Single Buyer Office
SIS	Strategic Intent Statement
SSEG	Small-scale Embedded Generator
STASA	Solar Thermal Association of South Africa
UCT	University of Cape Town
UNEP	United Nations Environmental Programme
VAT	Value-added tax
WACC	Weighted Average Cost of Capital

*Reference is made to Eskom Holdings SOC. LTD. on multiple occasions in this document. For ease of reading, the full name “Eskom Holding SOC. LTD.” will not be utilised when referring to the utility. Instead, the utility will simply be referred to as “Eskom”.

CHAPTER 1: NATURE AND SCOPE OF THE STUDY

1.1 INTRODUCTION AND INDUSTRY OVERVIEW

A revolution is defined as a major adjustment or improvement in the manner that a specific industry operates and behaves (Cambridge University, 2018). This includes a change in the way a governing entity applies and executes specific policies and procedures. Defining a revolution from a technical point of view indicates that the term is considered an extremely important change in the way a political system and associated stakeholders do things. A revolution is thus a circular trend or movement of a specific industry that is dictated to and governed by a central policy.

South Africa is currently on the verge of an energy revolution as disruptions occur in industries that were previously considered impenetrable. This is attributed to the fact that the energy sector of the country is confronted with a scenario in which policy-makers, regulators and planners find it difficult to forecast customer behaviour and demand (Taylor, 2016). Energy consumers have developed high expectations for energy transitions in recent years that pose a challenge to the utility, Eskom Holdings SOC. LTD. – the sole licensed supplier of coal-generated electricity in South Africa. The challenge lies in the fact that the utility struggles to cope with the rapid changes required to meet the expectations of the consumer and technological advancements. There is thus a conflict of interest between the public and private sectors regarding energy policy and regulation which makes long-term planning obsolete. The scenario depicted thus indicates that there are driving forces within the energy sector of the country that create competition among consumers, energy producers in both the public and private sector and infrastructure owners. This competition will have a severe effect on the future of the energy mix of South Africa and contributes to the energy revolution currently taking place – a trade-off between coal generation and renewable energy.

Eskom utilises more than 90 million tons of coal annually through predominantly coal-fired power stations in order to generate roughly 90% of the country's electricity (Eskom, 2018). It is important to consider the fact that Eskom is one of the major contributors to the South African economy which can be attributed to the fact that coal is used as the prime fuel source of generation. Should Eskom not be utilising coal generation at all, a number of industries would be severely affected including manufacturing, mining, financial services and social services.

Should the utility bring coal generation completely to a halt, 81 000 direct jobs and approximately 170 000 indirect jobs will be affected in the coal industry (Omarjee, 2018). This is a clear indication that coal mining is a noteworthy contributor to the economy of South Africa. According to a study done by Stats SA, the mining of coal made the most significant contribution (28%) to the income of the entire mining sector in 2015 which was R 117 958 million (Lehohla, 2015:7). The overall mining sector industry contributed 0.3 of a percentage point in Gross-Domestic Product (GDP) growth (which rose by 2.5%) in the second quarter of 2017 (Manamela, 2017:2).

Renewable energy, on the other hand has increased from producing 1212 GWh in 2011, to producing 6126 GWh in 2015 only in South Africa according to a study by the International Renewable Energy Agency (IRENA, 2017). In 2016, Eskom purchased 11 529 GWh from Independent Power Producers (IPPs) which calculated to a 30.8% increase from the previous year (Singh, 2017). This is a clear indication that the utility has the tendency to gradually move towards the investment of renewable energy in the foreseeable future. Increasingly, renewable energy generation is promoted to create new job opportunities, assist in solving the great need for sustainable electricity and will also provide many consumers with the opportunity to become independent of the national electricity grid.

The Integrated Resource Plan (IRP) of 2018 was recently published by the Department of Energy (DoE) and presents the strategic plans of the government pertaining to the management of the electricity demand of South Africa up until the year 2030 (DoE, 2018). The IRP 2018 (DoE, 2018) supersedes the IRP 2010 (DoE, 2011), which was first promulgated in 2011 as a living plan and ought to be revised on a regular basis by the DoE. Due to a lack of periodic and regular revision of the IRP 2010, policy uncertainty regarding the country's energy mix was extremely high for an extensive period of time. The IRP 2018 is thus long-awaited by all stakeholders within the renewable energy industry as it governs the industry in a very specific manner and provides companies in the private sector with a direct indication of where the industry is heading. Considering the major changes from the IRP 2010 to the IRP 2018, indicates that for the financial year ending March 2018, the actual overall consumption of electricity is roughly 30% less than initially projected in IRP 2010.

Corresponding to the declining electricity demand is the fact that the existing Eskom plant performance is not at anticipated levels as the utility's report indicates plant availability to be below the assumptions made in the IRP 2010 which are 80% and above (Omarjee, 2018).

The afore-mentioned policy changes therefore provide a clear indication that the energy revolution can be more specifically defined as a renewable energy revolution due to significant and recent trends in the industry. Not only is it the policy changes that contribute the renewable energy revolution, but also the long-awaited IPP contracts that were recently signed by the Minister of Energy, Hon Jeff Radebe (Creamer, 2018). The minister declared on 04 April 2018 that 27 IPP projects were signed for approval of construction after it was delayed for a period of 2 years. The 27 IPP projects are the largest procurement process by the DoE in history which is equivalent to an investment value of R56 billion (Khumalo, 2018). This is considered a major breakthrough after a long period of indecisiveness in the renewable energy industry. The combination of policy changes and political intervention in IPP procurement therefore presents a new dawn for the renewable energy fraternity as the uncertainty for private sector investors has now been clarified to a large extent.

The DoE sets out specific key periods of certainty in the IRP 2018 that define the renewable energy revolution for additional capacity requirements in specific timeslots. The highest degree of certainty is from 2018 up until 2020 and is attributed to the fact that the DoE has provided the energy sector with clear strategic direction for specific renewable energy technologies. The period from 2021-2030 is considered a period of medium-high certainty of which the main contributing factor is the decommissioning of old Eskom power plants and gradual growth in demand. The period 2030-2050 indicates that the degree of certainty gradually declines over time as no clear strategic direction is provided for further development of renewable energy technologies and is also dependent on investment decision for the technologies in the previous period.

The period of certainty is presented in Figure 1.1-1 below.

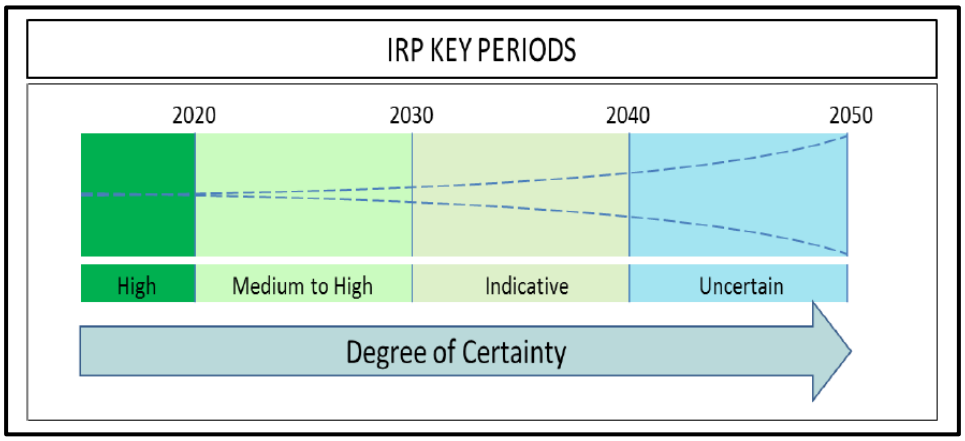


Figure 1.1-1: Key periods of certainty of the IRP 2018

Source: Adopted from the IRP 2018 (DoE, 2018)

The energy industry in South Africa is therefore reaching an inflection point as a significant change in the progress of the industry can be observed. This inflection point is thus considered a turning point after drastic political intervention took place that could yield positive or negative results. The determinant of whether the results will be positive or negative all depends on how the revolution is managed by both the public and the private sector stakeholders. The implication of this inflection point is that specific fundamental changes are required by both Eskom and the private sector in order for the renewable energy industry to become sustainable. This aim of this study is therefore to determine what these fundamental changes ought to be for the energy industry of South Africa to be sustainable.

1.2 PROBLEM STATEMENT AND CORE RESEARCH QUESTION

The problem being investigated in this study is that the supply and demand sides of the electricity industry in South Africa are changing at a rapid pace and if this change is not managed optimally by both Eskom and the renewable energy stakeholders in the private sector there could be catastrophic consequences. On the one side of the spectrum a so-called “supply” phenomenon is identified where the costs of renewable energy technologies are declining severely and continuously (van Staden, 2018). Currently Eskom’s business model is completely out of sync with the ever-evolving energy market of South Africa.

The utility is thus confronted with the fact that they need to reinvent themselves from being the sole supplier of electricity to the supplier of residual load after the IPPs have dispatched their own energy capacity. This is a high expectation for the utility, but it cannot be ignored as the country has abundant renewable resources that can be utilised. This phenomenon is considered a tall-order for Eskom as they are expected to make a transition from inflexible base-load generation to flexible back-up generation to enhance a least-cost future electricity industry that incorporate renewable energy as a framework.

On the other side of the spectrum, a so-called “demand” phenomenon is identified where substantial structural changes have taken place in South Africa. The core of this phenomenon lies in the fact that Eskom was mandated by the government in 2007 to build two new coal-fired power stations (Medupi and Kusile) at a time when the demand forecast was high (DoE, 2011). The strategic intent of the additional capacity was that it will be fully utilised once the power stations were online, but the industry was severely affected by the economic meltdown in 2008 (Temin, 2010). The expected demand growth therefore did not realise and Eskom is now confronted with the dilemma to recover their fixed costs from declining sales as the utility did maintain a sales growth since 2007.

Eskom is pressurised by various industry forces and therefore is placed in a paradoxical situation that is extremely challenging to escape from due to contradictory situations on both the supply and demand sides of the industry. The mutually conflicting and dependent conditions of the industry are attributed to the supply and demand trends not being aligned to yield the same expected outcomes. Unless all-inclusive and intensive collaboration and participation takes place between all stakeholders from both the private and public sector, this problem will persist while growth of the energy industry of South Africa deteriorates over time. This study will therefore investigate the current state of the energy industry on South Africa with the afore-mentioned problem statement as the core hypothesis.

The core research question is therefore the following: Will the impact of the renewable energy revolution be positive or negative considering the growth of the energy industry of South Africa from a holistic perspective? The effect of this revolution being positive or negative directly depends on how well the collaboration between coal generation and renewable generation is managed in the foreseeable future.

The government working in collaboration with the DoE favours renewable energy generation through recent policy adjustments. Although renewable energy technologies are supported by the government, the implementation of it is still vague and poses a challenge to public and private sector stakeholders that might cause an increase in policy uncertainty.

There is therefore substantial evidence that the answer to the core research question of this study can result in two completely opposite outcomes. On the one side of the spectrum renewable energy ought to be promoted to enhance job creation and inevitable economic growth and on the other side renewable energy is suppressed by the coal generation industry. The aim of this study is to analyse both ends of this scale.

1.3 RESEARCH OBJECTIVES

1.3.1 Main objectives

The primary research objectives of this study are derived from the core research question stated in section 1.2. From the core research question, the following primary research objectives are established for this study:

- To determine the most suitable scenario for South Africa that will enhance sustainable energy development with regards to electricity generation i.e. coal generation, renewable energy or mixed technology generation.
- To craft out a transition plan that will benefit and incorporate both the public and private sector stakeholders during the renewable energy revolution.
- To determine the extent to which the accountability and risk of renewable energy projects belong to public and private sector stakeholders respectively.
- To determine the extent to which the energy mix forecast defined in the IRP 2018 is realistic, attainable and favourable for South Africa’s energy needs.
- To identify the major barriers that ought to be overcome for South Africa to flourish in the renewable energy fraternity and provide strategic recommendations on how these barriers can be overcome.

1.3.2 Secondary objectives

The secondary research objectives of this study are considered to be supplementary to the primary research objectives. These objectives are therefore structured in such a manner that the primary research objectives are fulfilled when the secondary objectives are met. The following secondary objectives are established for this study:

- To establish if a direct relationship exists between the GDP growth of South Africa and the application of renewable energy sources to feed into the national electricity grid.
- To establish the various indicators that result from the renewable energy revolution and to rank these indicators according to importance.
- To perform a feasibility study and comparison between coal generation and renewable energy generation with the aim of determining which method of generation holds the greatest return on investment.
- To determine if the electricity tariff per unit changes significantly if the renewable energy industry becomes revolutionised.
- To determine the extent to which the coal generation industry will be affected from a financial point of view should there be substantial progression in the renewable energy industry.
- To determine the effect of carbon tax and how it will influence the various renewable energy strategies set out by the DoE as well as the coal generation industry.

1.4 THE DELIMITATIONS AND ASSUMPTIONS OF THE STUDY

1.4.1 Delimitations (scope)

The scope of this study is thus to analyse a significant scenario that South Africa is confronted with at the moment. The underlying factor that makes this topic of research relevant and worthwhile at this given point in time is that the renewable energy industry has the potential to severely impact the operations and financial stability of Eskom, the solely licensed electricity provider of South Africa.

Eskom contributes immensely to the economy of the country mainly because of coal-fired power generation and increasingly renewable energy sources that feed into the national grid will mean that less coal generation will be required in the foreseeable future. Different strategies are already established in collaboration with the DoE to promote the development of renewable energy in the country as depicted in the IRP 2018.

This study will therefore provide an in-depth investigation and analysis of whether the afore-mentioned phenomena will have a positive or negative impact on the economic growth of the country. The core elements of this study will be based on a scenario analysis that is depicted by the relationship between two factors i.e. renewable energy development and sustainable economic growth. Table 1.4-1 below illustrates all possible scenarios in this analysis:

Table 1.4-1: Scenario analysis of this study

Scenario type	Renewable energy	Economic growth of South Africa
Scenario 1	High on demand	High
Scenario 2	High on demand	Low
Scenario 3	Low on demand	High
Scenario 4	Low on demand	Low

Source: Own compilation

The scenario-based analysis presented in Table 1.4-1 is dependent on numerous factors that collectively contribute to the defined renewable energy revolution currently unfolding in the country. The impact that renewable energy has on the economic growth (utilising the GDP as an indicator) will be assessed in this study, although the scope of the study is not limited to it being the only indicator. The scope of the study is therefore increased to take other factors into account that contribute perhaps even more to the renewable energy revolution than GDP growth. The outcome of this study, however, will determine what the current scenario type of the revolution is as well as to most probable future scenario of the revolution.

The additional factors that are analysed and discussed in this study are the following:

- Job creation
- Water-usage
- Environmental aspects i.e. carbon tax
- Stabilisation of energy tariffs
- Decreasing demand for coal
- Reduction in the demand for electricity from Eskom
- Socio-economic factors i.e. community empowerment

1.4.2 Assumptions

Given the unexpected changes in economic development, policy certainty and general political landscape in South Africa, the following assumptions are made with regards to the proposed study:

- The assumption is made that no significant policy changes take place in the strategic plans and IRP of the DoE as this study is based on the objectives of these plans – especially the IRP 2018.
- It is assumed that the renewable energy strategies of Eskom remain constant and that the utility remains a state-owned company, i.e. the utility does not become privatised or partially privatised for the remainder of the study.
- Although the majority of contributions towards the GDP of South Africa are energy intensive, it is assumed that the other contributors (non-energy intensive) to the GDP remain relative constant. This does not mean that an assumption is made that no changes will take place in these contributing sectors but rather that this study is based on the fact that no drastic changes will take place in these sectors e.g. inflections points in other industries.

- It is assumed that the Renewable Energy Feed-in Tariff (REFIT) established by the National Energy Regulator of South Africa (NERSA) remains a framework in South Africa for the remainder of the study.

1.5 RESEARCH METHODOLOGY

1.5.1 Describing the holistic research design procedure

The research methodology consists of two separate procedures namely a literature review and an empirical study. The methodology is structured in such a manner that information regarding the research title is identified, selected, processed and analysed. The purpose of this methodology is to critically evaluate the reliability and validity of the study by demonstrating the technique used to analyse the information as well as the technique used to collect and generate the relevant data. The literature review of this study is based on an objective assessment of the problem statement and core research question defined in section 1.2. From the literature review, the data-collection instruments that were utilised in the empirical study were constructed. The literature review and empirical study are therefore correlated with one another. This makes it possible to merge theoretical findings with practical trends related to the energy industry of South Africa.

The study will be cross-sectional in nature due to the following:

- The study takes place at a single point in time.
- The focus of the study will be based on a scenario matrix as indicated in Table 1.4-1 section 1.4.1.
- An observational study is conducted between two main variables: Renewable energy and the economic growth of South Africa. The study aims to take a snapshot of how these two variables influence one another and hence determining the relationship between the two variables at a given point in time.
- The renewable energy revolution has changed over time and therefore a specific time slot is considered for the analysis of each scenario.
- Only a single scenario will be applicable at a given point in time which proves that this study is purely cross-sectional of nature.

- The severity of the impact renewable energy has on the economic growth of South Africa will be studied for a specific time period after which the prevalence will be calculated for the demand for renewable energy (whether it was high or low).

- A scenario-based analysis will not only be conducted for the economic growth, but for other significant factors that are also considered to be direct indicators of the renewable energy revolution.

- The analysis of the additional indicators is also cross-sectional as the trends over specific time periods are considered and analysed.

1.5.1.1 The literature review

The research methodology followed as far as the literature review is concerned, is categorised in three constructs – all of which has a significant contribution to the renewable energy revolution. In order to maintain an objective and holistic understanding of existing research about the topic, the three constructs are considered perceptions from completely different angles.

The three constructs in question are:

- A coal generation perspective

- A renewable energy perspective

- A political perspective

The three constructs are considered a continuum where coal generation and renewable energy are the two extremes and the political intervention, accountability and responsibility is somewhere in the middle. The extent to which the government and adjacent political forces and entities favour either one of the two afore-mentioned extremes is analysed in the literature review. Although these constructs exist in completely different dimensions, several correlations between the constructs exist that contribute collectively to the renewable energy revolution. These correlations will also become apparent during the course of the literature study.

The first construct deals with the literature from a coal generation perspective which in essence is an analysis of the impact the renewable energy revolution has and possibly will have on Eskom in the near future.

This section of the literature is the origin of this research as it starts off with defining the paradoxical situation that Eskom is confronted with which is the problem statement that this research is based on. The causes and effects of this paradoxical situation will therefore be researched and presented in the literature review as a starting point for the entire research process. This construct will then be elaborated on in terms of the extent to which the coal generation industry impacts the economic growth of the country taking various indicators and scenarios into account. The construct will be concluded with an in-depth investigation on the levelised cost of coal model in order to quantify the cost per unit of electricity. The research methodology of the first construct is presented in Figure 1.5-1 below.

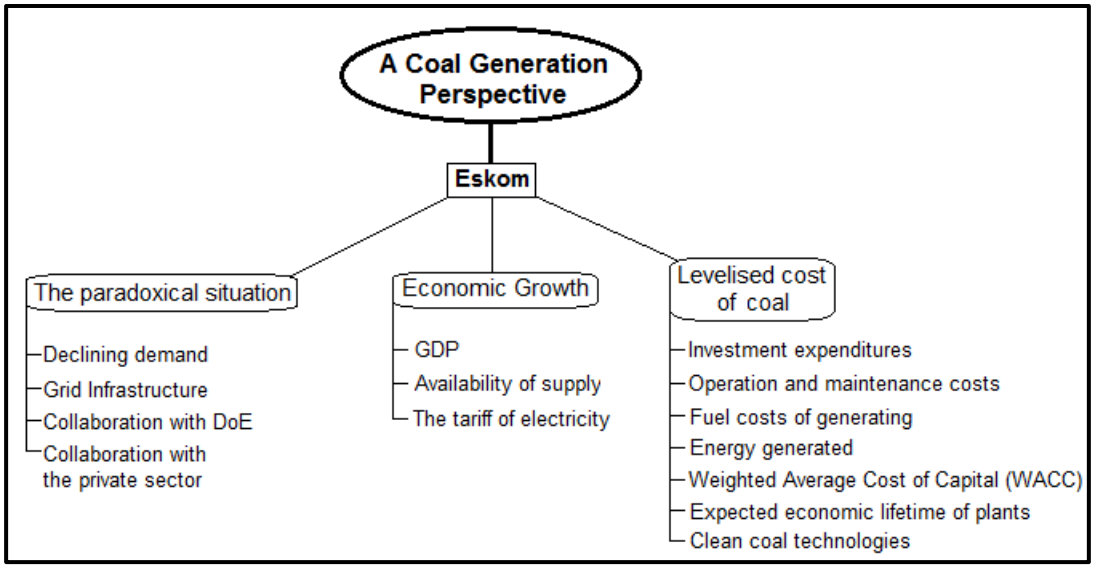


Figure 1.5-1: Literature review research methodology – construct 1

Source: Own compilation

The second construct deals with the literature from a renewable energy perspective where the viability of the various renewable energy technologies is investigated. The renewable energy technologies in question are solar, wind, biogas, hydro and Concentrated Solar Power (CSP) – each technology comprising unique qualities and benefits that are presented in the literature review.

The levels of innovation applied to utilise these technologies in practice are then further investigated in the literature review together with the impact it has on the revolution in terms of the feasibility of energy costs and how it's integrated with key industry stakeholders.

IRENA is an intergovernmental organisation that offers support to numerous countries to make a smooth transition towards a sustainable energy future (IRENA, 2018). The entire renewable energy fraternity of the country is governed by The South African Renewable Energy Council (SAREC) – responsible for promoting predominant renewable energy technologies in the country (SAREC, 2018). Under this umbrella, the various technologies are governed according their own specific requirements and legislations – the governing bodies are:

- The South African Wind Energy Association – SAWEA (SAWEA, 2018)
- The South African Photovoltaic Industry Association – SAPVIA (SAPVIA, 2018)
- The Southern African Biogas Industry Association – SABIA (SABIA, 2018)
- The Solar Thermal Association of Southern Africa – STASA (STASA, 2018)

The second construct will be concluded with the following specific programmes/processes that are put in place by major industry stakeholders with the purpose of enhancing the development of renewable energy in South Africa:

- The Renewable Energy Independent Power Producer Procurement Programme – REIPPPP (DoE, 2018)
- The REFIT (NERSA, 2009)
- The Green Star Rating System established by the Green Building Council South Africa – GBCSA (GBCSA, 2017)

The research methodology of the second construct is presented in Figure 1.5-2 below and encapsulates governing bodies of the renewable energy industry of South Africa, the various renewable energy technologies and the processes/ programmes in place to augment the development of these technologies.

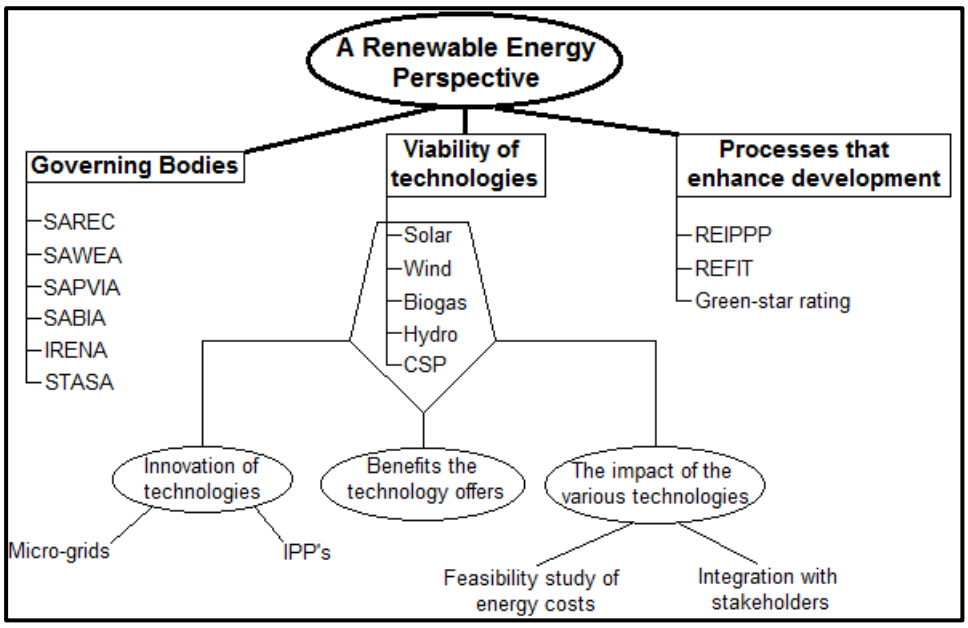


Figure 1.5-2: Literature review research methodology - construct 2

Source: Own compilation

The third and final construct deals with the literature from a political perspective where specific policies are established by key role players that influence the first two constructs i.e. both the coal generation and the renewable energy industry. The IRP 2018 is considered the core policy around which this study revolves because it is the most recent published strategic plan by the DoE (DoE, 2018). Several other IRPs have been published and updated prior to the recent one due to the fact that numerous developments have taken place in the energy sector of South Africa. The policy changes of the following IRPs are discussed in the literature review and serves as an analysis of the adaption to the mentioned energy developments:

- IRP 2010 (DoE, 2011)
- Updated IRP 2010 (DoE, 2013)
- Draft IRP 2016 (DoE, 2016)

Apart from the IRPs, additional policies are put in place and are applicable to this construct as it governs the energy industry from different perspectives. The following policies are therefore supplementary to the IRPs:

- The National Development Plan – NDP (Republic of South Africa, 2012)
- The Strategic Plan of the DoE (DoE, 2014)
- The Mineral and Petroleum Resource Development Act (MPRDA)
- The Electricity Regulation Act 4 of 2006 (Republic of South Africa, 2006)
- The National Energy Act 34 of 2008 (Republic of South Africa, 2008)

The afore-mentioned policies are established with a number of key role-players in the energy industry that work in continuous collaboration to ensure a diversified energy mix (among other functions) for South Africa. The following key role-players are thus considered to be stakeholders of the energy sector of the country and have a substantial influence on the renewable energy revolution:

- The DoE
- NERSA
- National Treasury (NT)
- The Department of Trade and Industry (DTI)
- The Department of Public Enterprises (DPE)
- The Development Bank of South Africa (DBSA)
- The Department of Environmental Affairs (DEA)
- The South African National Energy Association (SANEA)
- Provincial departments and municipalities
- The Department of Economic Development

The third construct is therefore established to investigate the impact that policies and key stakeholders have on the energy industry and the manner in which it correlates to the renewable energy revolution as depicted in Figure 1.5-3 below. A number of challenges and proposed scenarios exist as a result which comprises the final literature section of this construct.

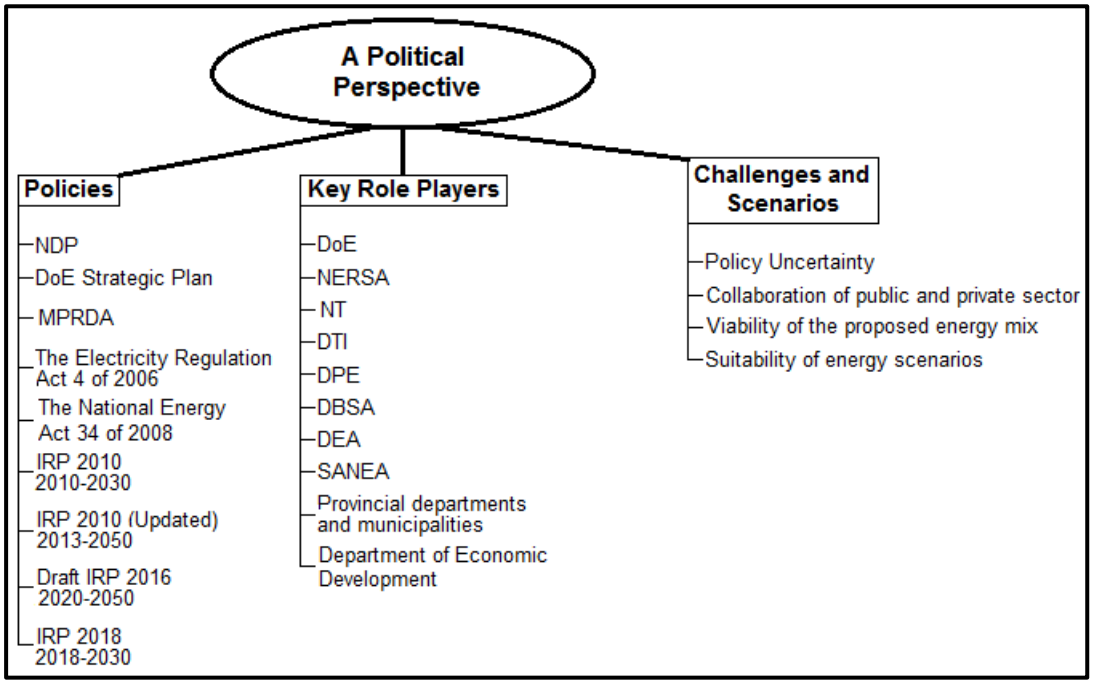


Figure 1.5-3: Literature review research methodology - construct 3

Source: Own compilation

1.5.1.2 The empirical study

The research methodology followed for the empirical study is structured in such a manner that substantial knowledge and insight is gained through interaction with experienced professionals and specialists in the energy industry of South Africa. The intention throughout the entire study was to establish correlating links between the literature review and the empirical study respectively. The literature review therefore serves as a foundation on which the empirical research is designed i.e. utilising the three different constructs originating from the literature research methodology.

From the literature review it was therefore possible to design the data-collection instruments as presented in Appendix F. The literature review made observations based on specific phenomena within the energy industry possible after which hypotheses were derived as a result. Utilising the data-collection instruments, it was possible to test and evaluate the respective hypotheses.

1.5.1.2.1 The research design approach

The study is qualitative in nature and is attributed to the following motives:

- The study is associated with the social science (human behaviour). Renewable energy and its growth are dependent on how people influence and manage processes and projects. A critical component of the application of renewable energy is dependent on the research and development by experts in the specific field. Furthermore, the extent to which renewable energy develops in South Africa is dependent on the manner professionals applies the concepts in the industry.

- Credible and accurate data were collected from a number of professionals and experts in the field of electrical engineering by means of interviews. Therefore, the social environment was studied as a paradigm that consists of different opinions, views and expectations.

- Numerous open-ended questions were asked during these interviews as the intention was to obtain holistic and diversified views from experts that form part of the renewable energy revolution in South Africa.

- The process followed to gather the data took place in an emerging manner i.e. the interviews started off with the discussion of specific concepts and evolved into more generalised concepts. Specific hypotheses were developed prior to the interviews and from the data collected during the interviews; the hypotheses are evaluated and shaped according to what was expected in from the literature review. This was a time-consuming and resource-intensive process which are characteristics of a qualitative research approach where the collection of accurate and relative data takes place (Weare *et al.*, 2004).

- The data collection is based on an in-depth explanatory data from a small sample group (rich, deep and thick data).

- The empirical study is based on the interview participants' viewpoints.

- The theory and concepts that are analysed emerge from interview data.

Although the study is based on a qualitative research approach, the open-ended interview questions were supplemented by closed-ended questions as well. This is to ensure that the understanding and interpretation of the findings in the empirical study is improved. Furthermore, the closed-ended questions made it possible to perform a scenario analysis of various concepts i.e. it was possible to analyse and determine alternative possible outcomes of the renewable energy revolution.

It was therefore possible to establish some form of projection in terms of where the renewable energy revolution is heading as it is not possible to deliver an exact representation of the future of the revolution.

The closed-ended questions are structured, controlled and prescriptive with the aim to obtain specific interpretations from the interviewee. The questions are therefore designed to represent specific outcomes on a Likert scale ranging from 1-6, thus avoiding a midway response from the interviewee. Sequential data gathering was therefore established by first obtaining data from the interview participants of the closed-ended questions where definite outcomes are established after which open-ended questions were asked to explain their interpretations of the respective outcomes. The reasons for combining the open-ended and closed-ended questions in the qualitative study are the following:

- Improved insight – a qualitative framework is established in order to identify specific scenarios relating to the energy industry. Combining the two methods ensures that the insights of the interviews are enhanced by not only selecting scenarios but also explaining the selection.

- Proper examination – the hypotheses drawn based on the qualitative work are thoroughly tested by the scenario analysis and closed-ended questions.

- Results are confirmed and validated – the results obtained from the closed-ended questions are either verified or rejected when it is compared to the interpretation of the open-ended question outcomes.

1.5.1.2.2 The research design

The empirical research design of this study comprises seven distinct phases, each phase considered as a building block to collect, validate and structure interview data. The design process starts off with scheduling interviews with experts in the energy industry whereby pre-set questionnaires (data collection instruments) are prepared and provided to the interviewees. This ensures that the interviewees can sufficiently prepare for the interviews in order to provide in-depth knowledge on the topic at hand. The closed-ended questions are provided first for the interviewees to complete after which the open-ended questions are discussed during the interviews (sequential data). The first stage of observation thus takes place where a foundation is established in terms of gathering data and relating it to the research topic (closed-ended questions). The second stage of observation takes place where notes of reference are made in terms of the views of the interview participants (open-ended questions). The combination of the 1^{st} and 2^{nd} stages of observation therefore makes it possible to perceive the renewable energy revolution phenomenon and make an enquiry to the interviewees relating to its causes. The benefit of sequential data gathering is:

- The interview time is minimised.
- Any concerns related to the closed-ended questions are clarified and discussed.

Once the stages of observation are completed, the views and opinions of the various interview participants are compared with one another. Hypotheses are formulated from the collective views of interviewees and provide a general explanation of the renewable energy revolution phenomenon. This is considered the first stage of data validation as the hypotheses are tested by correlating interviewees' views with one another and hence determining if specific trends exist. If the interviewees' views are similar to one another relating to the specific phenomenon, it is matched with a specific hypothesis. However, in cases where the interviewees' views differ extensively from one another, it is moved over to the next stage of the research design procedure – the testing phase.

During the testing phase of the research design, reflection takes place on the interview results where the second stage of validation takes place. The phenomena where the interviewees' views differ substantially are clarified and discussed with the interview participants. This ensures that exceptions to the hypotheses are grasped and inferred.

The evaluation phase of the research design procedure is where the hypotheses formulated from the literature review are correlated with the hypotheses formulated from the interviews. The similarities and differences of the two sets of hypotheses are documented and the final stage of clarification with the interviewees' takes place. This final stage of clarification is crucial as it ensures that the views of the interviewees' are expressed accurately and represents a true reflection of how the data gathered from the interviews.

The final stage of the research design procedure is the interpretation phase where the interview data are structured and divided into various themes relating to the causes and effects of the renewable energy revolution phenomenon. These themes are grouped and interpreted and finally correlated with the formulated hypotheses of both the literature review and the empirical study. In summary, the research design is based on the formulation of hypothesis after which interview data are collected and analysed to test the hypotheses. Conclusions are derived as the final stage of the research design through the interpretation of interview results. A graphical representation of the empirical research design and data collection procedure appears in Figure 1.5-4 below.

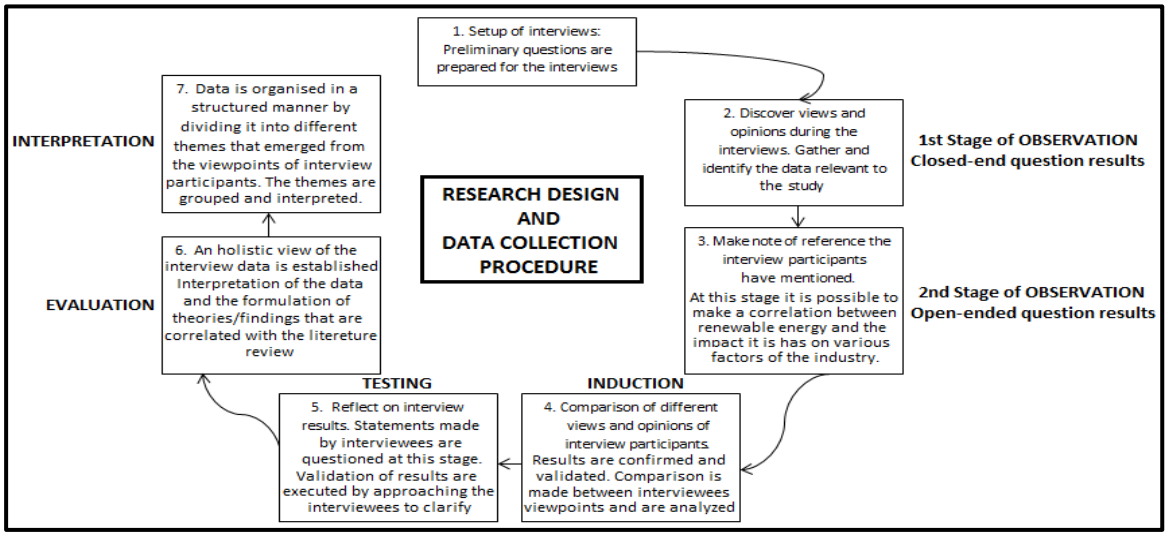


Figure 1.5-4: Empirical research design and data-collection procedure

Source: Own compilation

1.5.1.2.3 Population and sampling

The following aspects are taken into consideration with regards to the study population (Berg, 2001):

- Entry and access to the study population should be possible.
- The target population should be available.

Being employed by Eskom provides the researcher with a vast amount of research opportunities and collaboration with experts in the electrical energy industry. Eskom has renewable energy strategies they are planning to implement for the next few years (up until 2025) which will assist the researcher in gathering accurate, relevant and realistic data.

In order to obtain objective data relating to the renewable energy revolution, the target population consists of experts employed both inside and outside of the organization. Accessibility to these experts was arranged through the employer of the researcher which is Eskom. The permission letter from Eskom to conduct empirical research within the organization and the relevant stakeholders outside the organization is available in Appendix D. The target population outside the organization is accessible due to the fact that the selected individuals are stakeholders of renewable energy projects raised by the organization.

The practical considerations that ought to be accounted for with regards to sample size are time and costs (Maree, 2007). The most important consideration from these two factors for this study is time as interviews were conducted with experts in the field of electrical engineering who operates in a dynamic environment. Time was of the essence as interviews were conducted with ten professionals in the energy fraternity that comprise sound business experience. The data obtained from the interviews were therefore extensive and numerous back-and-forth discussions from both the researchers and the interviewees had to take place to interpret the data correctly and accurately.

1.5.1.2.4 Data collection

An unstructured interview style was followed by starting off with limited and loosely defined topics after which open-ended discussions took place. The common objective of the interviews was to understand the interviewee's world, background on and knowledge of the subject which is why the unstructured interviewing approach was followed. The foundation of the interviews was logical but also flexible order of topics in order to determine the actual impact of the renewable energy revolution relating to several business aspects including but not limited to:

- Electricity tariffs and how it affects stakeholders.
- The economic growth of South Africa.
- The influence of political trends and policy uncertainty.
- Job creation specifically in close proximity with renewable energy plants.
- Environmental impacts and assessment thereof.
- The paradoxical situation Eskom is confronted with currently.
- Socio-economic impacts such as community empowerment.
- The financial benefits renewable energy might hold.
- The extent to which various stakeholders in the entire energy industry are managing the revolution.
- The viability of the various renewable energy technologies.
- The innovation applied to the renewable energy technologies.
- The collaboration between stakeholders of the public and private sector.

In a book written on research methodology specifically in business and management contexts (Bryman & Bell, 2014), the criteria for a successful interview are defined with the following key learning points that were focused on:

- The interview was open i.e. when the interviewee stated something important the response was intentionally provided on those specific aspects to confirm the reason for the importance. In all of the interviews this opened up a whole new dimension of data that was critical for the outcome of this study. This is because the researcher did not know what was unknown at the specific times of the interviews.
- Adequate preparation was done for each interview in order to become knowledgeable on the research subject and what ought to be achieved. This provided focus and direction to the all the interviews.
- The interpretation of what was said by the interviewees was extremely important to the researcher. Statements made in the interview were thus clarified and in some instance the interviewees were asked to once again elaborate statements that were unclear to the researcher.

The data-collection instruments that appear in Appendix F were therefore constructed by taking the following into consideration:

- The literature review as a framework.
- The research design and data-collection procedures as depicted in Figure 1.5-4.
- The diversity of the target population group.
- The criteria for a successful interview.

The reason for taking the afore-mentioned into consideration is it was of critical importance that the correct data collection instruments be designed to ensure that:

- The relevant topic at hand is analysed hence avoiding deviation from the topic.
- Data collection takes place in a structured manner although interviews are open.
- The-data collection instruments are applicable to the specific target population.
- The interpretation of the data is a true reflection of the interviewees' viewpoints.

1.5.1.2.5 Data analysis

The following were taken into consideration in the process of performing in-depth data analysis:

- The specific method of analysis that was used is content analysis. This technique simply entails that hypotheses are formulated in terms of what is expected to emerge during the interviews. These hypotheses are then confirmed and identified with from the data collected from the interviews.

- During the interview stages a post-mortem narrative analysis technique is applied where the interviewees share a story within their organisation or society. The aim was thus to understand the way in which they think and what they intend to achieve by analysing their statements.

- The aim of the qualitative research approach was to draw out patterns from concepts and insights with regards to the primary research question.

- The qualitative data analysis is based on an interpretive philosophy where the intention is to scrutinize the significant and representative content of the data.

- An inductive approach to the analysis of the data is followed i.e. an emergent framework is used to group the data after which specific relationships between data elements are identified. The intention is therefore to refer to specific scenarios during the interviews and move over to generalized rules or principles.

- The causal relationship between several business aspects and recent energy trends are considered, analysed and interpreted.

- The third variable problem that emerges and is analysed in this study is the political influence and governance of energy development in South Africa. This is in addition to the renewable energy industry being a driving force on the one side of the spectrum (private sector) and the coal generation industry being on the completely other side of the spectrum (public sector).

- In the four scenarios identified (as depicted in Table 1.4-1) there are patterns of relationships between the two main variables. It is important to note that the two variables considered (renewable energy and economic growth) have either a

positive or negative relationship depending on numerous factors. The analysis of data will indicate whether this relationship is in fact positive or negative taking into consideration the paradoxical situation Eskom is confronted with currently.

- Based on the experiences and statements of the experts and professionals from the interviews, specific scenarios will be defined where each scenario is correlated with certain conditions.

- The scenario analysis that results from the empirical study makes it possible to make a verdict as to what the actual impact of the renewable energy revolution is in a South African context.

- The scenario analysis that is based on the framework shown in Table 1.4-1 is, however, not the only determination of the impact of the renewable energy revolution and is merely a single indicator. The other indicators that emerged from the interview data are therefore also be analysed and structured to make a prediction of the impact of the renewable energy revolution. This is done by segmenting the data into various themes and establishing causal relationships between the various data elements.

In summary, the process followed to analyse the data are the following:

- Organise the data – closed-ended questions are graphically represented to identify trends and open-ended questions are transcribed.

- Identify my framework related to the research question – data will be defined to be either explanatory (it is guided by the research question) or exploratory (it is guided by the interview data).

- Sort the data accordingly.

- Use this framework for a descriptive analysis (identifying recurrent themes).

- Second order analysis – patterns in the data will be identified and searching further for data to answer my research question.

1.5.1.2.6 Data quality assurance

There is no use approaching a unit of analysis if there is not a scientific problem attractive to the specific study population i.e. the problem statement clarifies the unit of analysis (Altheide & Schneider, 2013). The reason for selecting this specific research problem is due to the fact that it sparks great interest within the specific study population due to current revolution taking place within the renewable energy society. The unit of analysis (which is mostly experts in the energy fraternity) is therefore extremely interested in the topic and the outcome of the research. It is therefore for this reason that the study population will not easily refuse an opportunity to take part in and contribute to this kind of research.

Over and above the fact that the ease of access is already probable because of great interest by the study population, the following motivations further contribute to the ease of access to the unit of analysis:

- The researcher became acquainted with the study population long before this research was conducted and is able to comfortably interview the leaders and experts in the industry.

- The researcher is employed in the industry; the unit of analysis is thus easily approachable and accessible as they have a common interest in the topic. The majority of the unit of analysis has also conducted similar research on this topic in which they can share their experiences. The specific element, however, that sparked their interest is the business aspects this research aim to address as most of their research was purely technical.

- The researcher works in close collaboration with the neighbouring industries which are included in the target population.

- The researcher is a stakeholder involved in renewable energy projects which made the unit of analysis easily approachable.

The unit of analysis therefore shows significant interest in the research topic and the outcome of the research. They are aware that renewable energy has a significant impact on South Africa, but they are yet to find out how it can be quantified to determine the exact impact which is what this study aims to achieve.

The strategy followed to collect data ensures the quality of the study as a qualitative research approach is utilised of which the sampling strategy is probability sampling. The idea around this strategy is that a sample is selected that scientifically represents subgroups of a larger population. This technique is derived from the book written by B.L. Berg titled “Qualitative research methods for the social sciences” (Berg, 2001). Elaborating on probability sampling, a construct of various hypothesis tests were presented during the interviews with the study population. A consideration has been made of what possible population groups (related to the energy industry of South Africa) can be used to gather data from. The simple random sample strategy was followed to select candidates for interviewing. Considerations have also been made taking in account a number of requirements (as explained in section 1.5.1.2.3) pertaining to all the elements within the entire energy industry that are intended to be investigated. Inevitably a construct of elements was established to determine the sample size.

Specific statements are made regarding what could be expected to emerge from the study and as a result a hypothesis is developed as prescribed by the book titled “Research methods: the essential knowledge base” (Trochim, 2016). The prediction is that the renewable energy revolution does have a significant positive impact on South Africa. This prediction is therefore defined as the alternative hypothesis. There are, however, other possible outcomes of this study which are defined as the null hypothesis. These outcomes are the following:

- The renewable energy revolution has a significant negative impact on South Africa.
- The renewable energy revolution has no significant impact on South Africa.

In this study a prediction is thus made that specifies a certain direction. The no-difference prediction (null hypothesis) and initial prediction (alternative hypothesis) are of the opposite direction and therefore this is considered a one-tailed hypothesis. The logical reasoning regarding this hypothesis will therefore ensure that the outcome of this study is of quality and is rigorous in nature.

1.6 LIMITATIONS OF THE STUDY

The limitations of the study are the following:

- The impact of nuclear energy is not considered in this study as it is not a pure form of renewable energy and is not catered for in the IRP 2018 until at least the year 2030.

- Although the impact, benefits and status of CSPs are analysed in this study, the actual impact of this renewable energy technology cannot be measured extensively as it is not considered to be part of the proposed energy mix in the IRP 2018.

- This study is only based on an analysis from a business perspective i.e. the impact of technical constraints on the relative industry is not considered. This implies that the input from the Renewable Energy Technical Evaluation Committee (RETEC) which reports to NERSA is excluded from the study.

- All other inputs from NERSA, however, are considered in the proposed study as they relate to the analysis of the renewable energy revolution from a business perspective.

- The population group consists of a group of ten experienced individuals who operate in both the public and private sectors. Although considerable efforts and pro-active measures were put in place to ensure objectivity of the data, it is still possible that the interpretations of the data might be somewhat biased towards a certain industry. The outcome of this study therefore may not be the same if a larger population group would have been selected for the empirical research as they might have different opinions on the topic at hand. It is therefore critical to consider the outcome of this study relative to the selected target population.

- The policy uncertainty prevents the researcher to predict a definite outcome for the study which is why the interpretations and conclusions related to this study are presented in the form of probable scenarios.

- Although the current challenges of Eskom are analysed to a certain extent in this study, it is not the main predictor of the outcome of this study. It is for this reason

that the energy industry is considered and analysed from a holistic point of view in order to avoid any internal challenges of the utility dictating the outcome of this study.

1.7 THE CONTRIBUTION OF THE STUDY

The concept of renewable energy has been a critical topic of discussion in the media and amongst various specialists in the energy-generation industry. The reason for this discussion evolved around concerns that were raised regarding the energy crisis which became a reality in the country in recent times. The grid infrastructure in South Africa is reaching a point where it will fail to meet demand and supply requirements unless Eskom and related stakeholders work in collaboration with one another to accelerate and make significant progress in grid rehabilitation and new supply connections. According to Melusi Maposa, managing director of resources at Accenture Management Consulting and also a specialist in the energy sector, the deteriorating national grid infrastructure is placing the economic growth of South Africa at great risk (Nevin, 2017). The application of renewable energy will therefore signifantly stabilise and augment the infrastructure of the grid and as a result enhance the economic growth of the country.

The importance of this study does not lie in the fact that the reader ought to be convinced that renewable energy will have a significant impact on the South Africa, but rather to perform an analyisis of how and why it will have an impact on the country. This study therefore has the following possible benefits:

- It will provide an indication of what strategies ought to be followed to diversify South Africa's energy mix in order to enhance optimal economic growth. A steady transition towards renewable energy at the correct time periods should take place otherwise the coal generation industry will be negatively affected and economic growth will not be a certain outcome. This study will analyse how and when this transition should take place to propose the best possible scenario for the economic development.

- This study will clarify the general concern of the effectivity of renewable energy as a source for electricity generation. A thorough analysis is conducted in this study to compare the financial viability of renewable energy to traditional coal generation. Based on this analysis, the decision-making process can be accelerated to implement renewable energy as a solution to immediate energy needs.

- The outcome of this study will offer a clear indication on when the most suitable time will be for renewable energy strategies to be implemented, taking in account the most recent economic state of the country.

- Apart from economic development, the renewable energy revolution has an impact on several other business aspects and ought to be managed optimally by all stakeholders involved. The benefits of this study are two-tiered because:

    - It provides an in-depth analysis of the energy industry that makes it possible for the related stakholders to derive their own interpretation.

    - Recommendations are provided to all involved stakeholders in terms of how to manage the applicable trends, changes and demands of the evolving energy industry of South Africa.

1.8 ETHICAL CONSIDERATIONS

The following appendices are applicable to the ethical considerations of the study:

- Appendix A – the permission granted from the supervisor to submit this mini-dissertation which states that this document has been checked for plagiarism as well as a solemn declaration by the researcher that the work in this study is his own.

- Appendix B – the ethical clearance letter that serves as proof that the research project has undergone ethical review and fulfils the minimum requirements as set out by the Faculty Research Committee.

- Appendix D – the signed letter of permission from the company in which the research is conducted.

- Appendix E – the informed consent form that was provided to each interviewee prior to the interviews and that granted the researcher permission to conduct the interviews. All informed consent forms were signed by the interviewees. In order to protect the anonymity of the interviewees, the signed consent forms will be made available upon request given that the interviewees provided a second consent after being informed about the request. The names of the interviewees therefore remain confidential.

In addition to the afore-mentioned appendices, the following ethical principles that are applicable to this study were taken into consideration:

- The Eskom standards of professional conduct were adhered to during interview phases. No confidential information ought to be published and therefore only data in the public domain may be disclosed as outcomes of the interviews. This was clearly communicated in the interviews as a principle of integrity.

- Plagiarism with regards to existing studies in the renewable energy fraternity was considered. The outcomes of these studies are not replicated as work done in this study but will only serve as a literature study that can be built on to underpin further research on the topic and are suitably referenced.

- Objectivity is considered to a high extent. Although the researcher performed and constructed a hypothesis on the topic that can be fully supported by literature, a statement that may cause damage or a negative connotation relating to either the coal generation industry or the renewable energy industry is not uttered.

- The probable risk (low-risk) with regards to ethical standards of this study was the historic debate that boomed in the South African energy market regarding Eskom that refused IPP applications to a great extent. This was not be used as a reasoning tool to negatively criticise either the utility or any of its subsidiaries. This barrier was overcome by strictly focussing on the core elements of the research question and only using information obtained through consent from the utility as well as the applicable stakeholders. Any classified or confidential information is and will not be published in this regard but only information in the public domain that is obtained through consent. Lastly, a subjective opinion in

this regards is not formed in this study but merely an objective research approach was followed after the applicable data had been collected in the study.

- Only individuals who provided consent were interviewed.
- In the event that individuals might show resistance to the topic at hand they were not considered for interview purposes – fortunately this type of incident did not occur when the target population was approached for interviews.
- The aspects and objectives of the interviews were clearly defined and explained to the interviewees prior to the interviews.
- Eskom, the employer of the researcher, has a conflict of interest policy in place that the researcher had to adhere to as a general requirement for this study. It is for this reason that consent was requested from Eskom. This consent states that this study will not be used to take advantage of the utility and that the researcher will not get involved in any third party agreements or transaction that may result from this study and that it is purely for research purposes.

1.9 THE LAYOUT OF THE STUDY

The layout of the study is based on four distinct chapters, each chapter comprising the following content:

- Chapter 1 – The nature and scope of the study
  - A brief introduction and industry overview is provided to place the study in context.
  - The problem statement and core research questions are formulated and considered the foundation on which the study is based.
  - From the problem statement and the core research questions, the research objectives are formulated that are in essence milestones that are set to be achieved at the end of the study.
  - The scope of the study is clearly defined and the assumptions made in the study are stated.

- The research methodology followed by the researcher is clearly defined and comprises both a literature review and an empirical study.
- The applicable limitations are described that are related to this study.
- The significant contributions of this study are discussed.
- The ethical considerations taken for this study are discussed.
- A summary is provided of Chapter 1.

- Chapter 2 – The literature review
  - Comprise three constructs which are a coal generation perspective, a renewable energy perspective and a political perspective.
  - Literature on each construct is documented, discussed and referenced providing and objective view of the topic at hand.
  - In essence the literature review for the renewable energy revolution is considered as a continuum where coal generation and renewable energy exist on complete opposite sides of the spectrum and the political intervention, accountability and responsibility is somewhere in the middle.

- Chapter 3 – The empirical study
  - The data obtained from ten interviews with individuals who have a wide variety of experience is analysed and interpreted as per the research methodology.
  - The data obtained from the closed-ended questions are interpreted and causal relationships are identified.
  - The data obtained from the open-ended questions are analysed and utilised to clarify any concerns related to the closed-ended questions.
  - A framework is established and correlated with the core research question.
  - This framework is then utilized to perform a descriptive analysis where recurrent themes are identified.

- The descriptive analysis is then correlated with the findings in the literature review and themes are established
- Conclusions are derived and the initial hypothesis is evaluated.

- Chapter 4 – Conclusions and recommendations
  - The outcome of the study is discussed and correlated with the core research question and research objectives.
  - Recommendations are provided to all applicable stakeholders relating to the study.
  - Recommended further studies relating to the research topic are provided and correlates with the limitations of the study in section 1.6.

An overview of the layout of the study is provided in Table 1.9-1 below.

Table 1.9-1: The layout of the study

Chapter	Content of the chapter
Chapter 1	The nature and scope of the study
Chapter 2	The literature review
Chapter 3	The empirical study
Chapter 4	Conclusions and recommendations

Source: Own compilation

1.10 SUMMARY

This chapter provided a solid foundation for the study of which the first building block is an overview of the industry that described the following:

- The definition of a revolution and why a renewable energy revolution currently exists in South Africa.
- The two industries that exist within the energy industry and the status quo of these two industries.
- The impact that the recent publication of the IRP 2018 has on the revolution.
- The inflection point currently taking place in the industry.

The second building block of this chapter is the definition of the problem statement that describes the paradoxical situation that Eskom is confronted with currently. This made it possible to derive and formulate a core research question as well as specific primary and secondary objectives for the study. The scope of the study was then clearly defined together with the applicable assumptions made.

The third and final building block of this chapter is the research methodology followed to answer the formulated core research question and achieve the applicable objectives. This research methodology comprises both a literature review and an empirical study and is described and discussed in-depth in this chapter. The chapter is concluded by the limitations, contributions and ethical considerations applicable to the study.

CHAPTER 2: LITERATURE REVIEW

2.1 A COAL GENERATION PERSPECTIVE

2.1.1 The paradoxical situation

The supply and demand sides of the electricity industry in South Africa are changing at a rapid pace and Eskom is being confronted with a paradoxical situation (van Staden, 2018). Eskom faces challenges with imminent coal shortages, decommissioning of numerous redundant power stations and probable further interruptions in bringing the Medupi and Kusile power stations on line (Yelland, 2018). These challenges leave South Africa stumbling backwards and contributing to the so-called "supply" phenomenon that Eskom and the country are confronted with. This phenomenon entails that in addition to the afore-mentioned challenges that Eskom is confronted with, the costs of renewable energy technologies are declining at a significant and continuous rate. Eskom, being a state-owned entity, must implement policies and strategies that are in line with that of the government. The Strategic Intent Statement (SIS) includes objectives that are formulated by Eskom shareholders in order to comply with the strategic objectives of the government (Eskom Holdings SOC. LTD., 2018). The SIS comprises seven areas in which the utility intends to focus on intensively for the next five years as depicted in Figure 2.1-1 below.

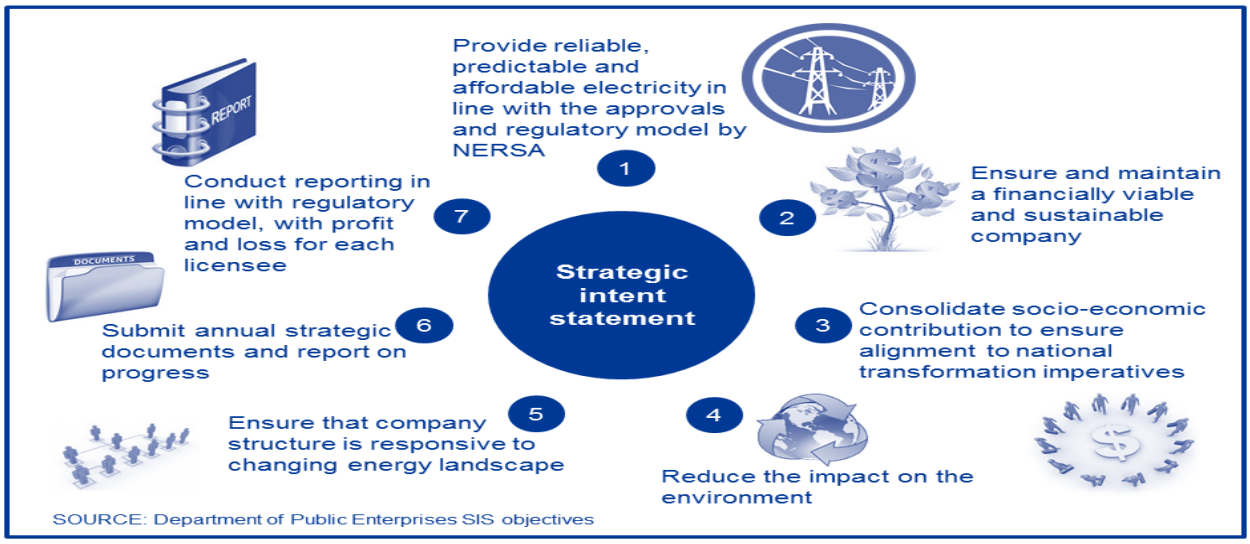


Figure 2.1-1: The seven areas of Eskom's strategy

Source: Adopted from the 2018/19 – 2022/23 Eskom Holdings Corporate Plan (Eskom Holdings SOC. LTD., 2018)

It is therefore clear from the strategic objectives of the utility that they intend to adapt to the changing energy landscape of South Africa (area number 5) although they are still confronted with the fact that they need to completely reinvent their business model. This reinvention requires that the utility needs to transform their operations from being the sole supplier of coal-generated electricity to being the supplier of residual load after renewable energy sources have dispatched their own energy capacity. The expectation is therefore very high for the utility but it cannot be overlooked due to the abundant renewable energy resources that are available. A technical report was published by the Energy Research Centre (ERC) in conjunction with The Council for Scientific and Industrial Research (CSIR) and The International Food Policy Research Institute (IFPRI) (ERC, CSIR and IFPRI, 2017). This report analysed the developing energy landscape in South Africa and the following findings were made:

- The potential for solar photovoltaic (PV) in South Africa is quantified to 220 GW and has already undergone Environmental Impact Assessments (EIA). Additional to this, 72 GW of solar PV rooftop installations have been identified.

- Between 55% and 65% of South Africa's land surface comprises technically recoverable wind capacity that amounts to between 3500 and 4500 GW of capacity.

It is therefore evident that the availability of renewable energy resources (especially PV and wind) is plentiful. It therefore makes sense that Eskom is expected to make a transition from inflexible base-load generation to flexible back-up generation to enhance a least-cost future electricity industry that incorporates renewable energy as a framework. Even though the utility has a strategic objective to align to the energy landscape, extensive transformation in their operations is yet to take place to meet this objective and fully meet the afore-mentioned expectations.

Elaborating on the strategic objectives of the utility they aim to become a sustainable company and intend to reduce their environmental impact (area number 2 and 5). This is predominantly achieved by their focus on improving the efficiency of clean coal technologies and to some extent to drive the implementation of renewable energy projects (Eskom, 2017). The utility's business model is based on coal generation and will therefore focus more on achieving their strategic objectives through improvement of existing technologies instead of pursuing renewable energy markets that is a threat.

The so-called “demand” phenomenon exists on the completely opposite side of the spectrum where substantial structural changes took place in South Africa. The core of this phenomenon lies in the fact that Eskom was mandated by the government in 2007 to build two new coal-fired power stations (Medupi and Kusile) at a time when the demand forecast was high (DoE, 2011). The strategic intent of the additional capacity was that it will be fully utilised once the power stations are online, but the industry was severely affected by the economic meltdown in 2008 (Temin, 2010). In the IRP 2018 it is clearly stated that the expected demand for electricity since this time versus the actual demand for electricity differ significantly and can be attributed to the following factors (DoE, 2018):

- Decreased economic growth.
- The energy efficiency of large power users has increased significantly due to the realities of rising energy tariffs.
- Fuel switching took place to liquefied petroleum gas (LPG) for heating and cooking.
- Fuel switching took place for the heating of water in households.
- Some energy intensive smelters emigrated or completely closed-down.

This provides evident proof that South Africa is currently experiencing a revolution in the entire energy industry and that it impacts the demand for electricity tremendously as depicted in Figure 2.1-2 below.

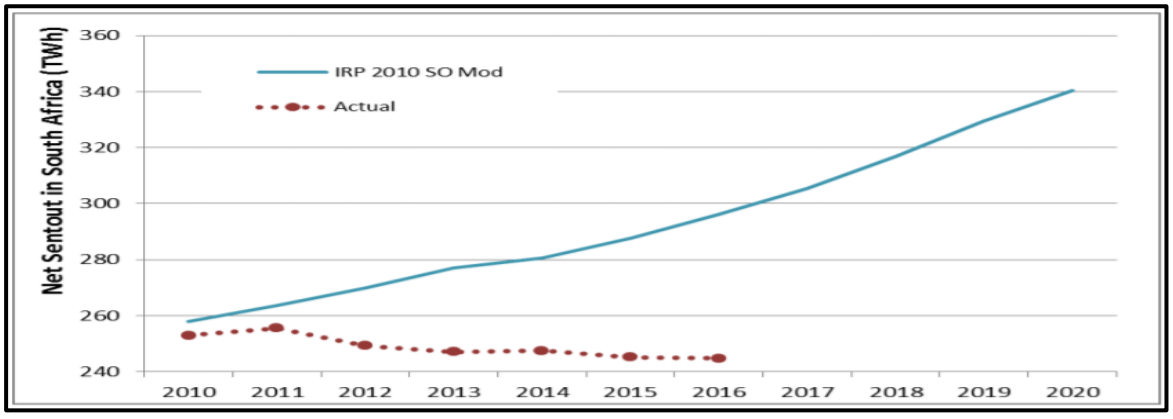


Figure 2.1-2: Comparison of expected vs. actual demand for electricity

Source: Adopted from the IRP 2018 (DoE, 2018)

The expected demand growth therefore did not realise and Eskom is now confronted with the dilemma of recovering their fixed costs from declining sales as the utility did not maintain a sales growth since 2007 according to a report from the Parliamentary Budget Office (Republic of South Africa, 2017:8). This report indicates that the total electricity sales have declined since 2007 subsequent to the following:

- The global financial crisis.
- Load-shedding that occurred across the entire country.
- A continuous decrease in the economic growth rate of the country.
- A decreased demand for electricity of 20.4% for the industrial sector.
- A decreased demand for electricity of 5.5% for the mining sector.
- The industrial and mining sectors accounting for 38 to 42% of direct Eskom sales.

The electricity sales slightly recovered between 2010 and 2012 to the same level as in 2007 but have declined significantly again after 2012 as depicted in Figure 2.1-3 below. There has, however, been an international sales volume growth of 12.1% in 2017 which is attributed to the fact that the utility comprised a surplus capacity (Eskom, 2017:6).

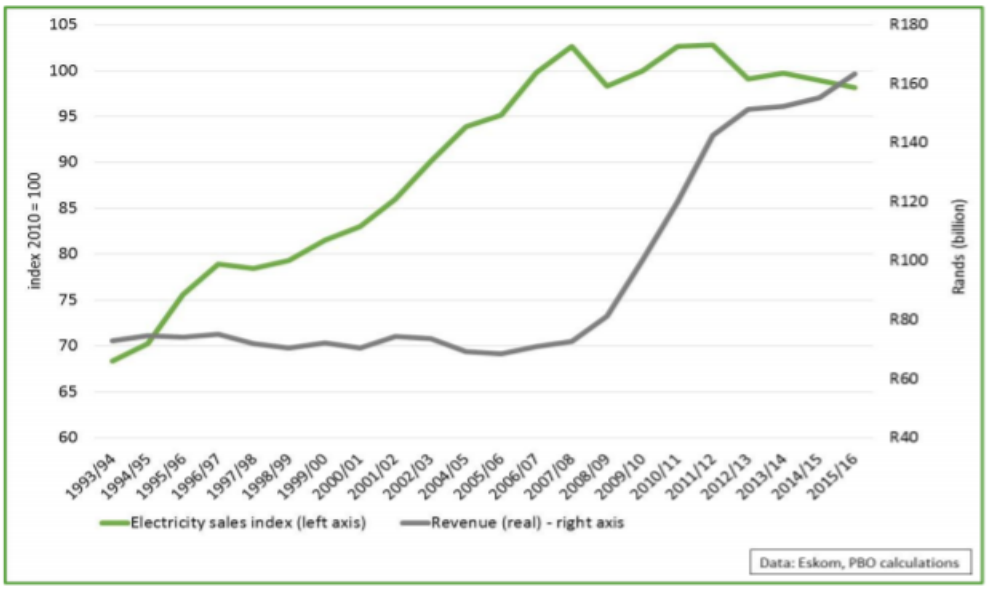


Figure 2.1-3: Eskom's historic sales growth

Source: Adopted from the Parliamentary Budget Office (Republic of South Africa, 2017)

It is therefore clear that the utility is under immense pressure to revolutionise their current business model in order to adapt to both the supply and demand requirements of the industry that places the utility in a paradoxical situation. What makes this paradoxical situation even more complex is the fact that the supply and demand requirements that ought to be met differ extensively. Intensive collaboration between the utility and the DoE should therefore be initiated in order to chart a way forward with a specific and common vision in mind. Unless all-inclusive and intensive collaboration and participation take place between all stakeholders from both the private and public sector, the utility will remain in this paradoxical situation while the growth of the energy industry of South Africa deteriorates over time.

It is important to emphasize the fact that Eskom still comprises a strategic competitive advantage in terms of the grid infrastructure. This implies that even if the demand for renewable energy increases further, the utility still possesses the resources and capabilities to transport the electricity from the renewable energy sources to the customer. Private sector investors of renewable energy projects are therefore still to a great extent dependent on the utility to deliver their product to the customer and cannot operate independently. The opportunity therefore exists for the utility to utilize and the manner in which the utility utilizes this opportunity is greatly dependant on their upcoming strategic moves – this will impact the renewable energy revolution directly.

Apart from the paradoxical situation, the utility is confronted with the following additional challenges as tough decisions are to be made by Eskom in the near future for them to survive and become sustainable (Groenewald, 2018):

- Government guarantees
    - Eskom has a R 350 billion guarantee from the government at the moment.
    - Government exposure is sitting at R 220.8 billion as a result.
    - The Treasury confirmed that Eskom utilised an additional R 18 billion of their guarantee in the previous financial year.
    - The utility is expected to utilise R 17.9 billion annual over the forthcoming medium term.

- An unallocated portion of R96 billion (of the R350 billion guarantee) was extended to 2023.

- Liquidity issues

  - Eskom's profits declined significantly from R 5.1 billion in 2015/16 to R888 million in 2016/17 – this despite an average 8% tariff increase.

  - The declining profits are attributed predominantly to the finance costs being more or less doubled as additional power units became operational – historical interest obligations had to be expensed.

  - Reduced energy demand resulting in decreased growth in revenue.

  - As the new generating capacity is commissioned the utility may have excess supply until such point when economic growth is accelerated and results in an increase of demand.

  - The utility can no longer rely on tariff increases to compensate for their decrease in sales growth.

  - Operating costs ought to be reduced for the utility to become financially sustainable.

  - All the above have resulted in the utility being unable to raise the required funds to maintain practical levels of liquidity.

- Power Purchase Agreements (PPAs)

  - Guarantees are provided to IPPs although this also presents a liability to government due to the utilities' financial complications.

  - The government has committed to procure R220 billion in renewable energy from IPPs.

  - The value of the projects that were signed (representing government's exposure) was R 122.2 billion by March 2018. This exposure is anticipated to decrease to R 97.6 billion in 2020/21.

  - The agreements are classified by Treasury as contingent liabilities.

- The afore-mentioned liabilities can become visible in two distinct ways, viz. Eskom will not have sufficient funds to buy power as specified in the PPAs or the government will have to loan the funds to Eskom to honour the agreements.

It is therefore clear that Eskom needs to make drastic and strategic-wise decisions to deal with the paradoxical challenge as well as the additional challenges in order to remain sustainable and a substantial contributor to the economy of South Africa.

2.1.2 Economic growth

South Africa comprises a diverse economy that accommodates a range of consumers. The contributions of the various sectors to the GDP growth demonstrate this diverse economy of which the majority of these sectors are energy-intensive as depicted in Figure 2.1-4 below.

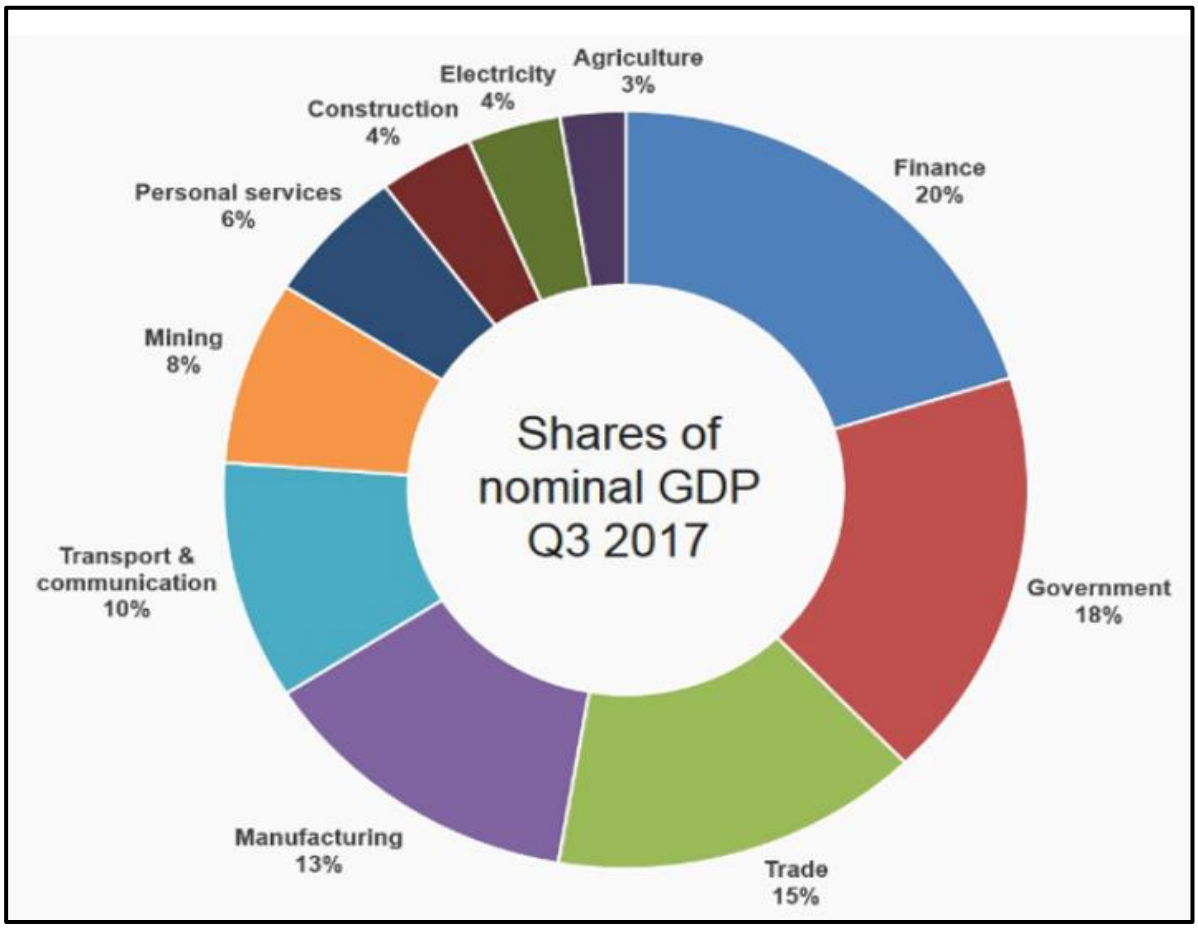


Figure 2.1-4: Contributions to the GDP growth in quarter 3 of 2017

Source: Adopted from Statistics South Africa (StatsSA, 2017)

The interpretation can therefore be made that the energy sector plays a critical role in the economic development of the country as the energy intensive sectors that contribute predominantly to the GDP are directly dependent on the energy sector.

South Africa forms part of a group of 20 countries (also known as G20 countries) that contribute substantially to the world economy and represent 66% of the global population. G20 countries formed an international forum and have a common objective to enhance financial firmness by working especially on concerns that are not necessarily the obligation of a single organisation (Ramachandran, 2015). The PWC Low Carbon Index (Johnson *et al.*, 2016) indicated that South Africa was one of the G20 countries that succeeded in reducing their carbon emission levels while upholding a real GDP growth.

It is surely not a simple task to reduce carbon emmissions while maintaining the GDP growth of a country as the costs of operating coal plants more cleanly are extremely high. Although several delays were incurred on the implementation of carbon tax, the NT remained persistent on the draft bill to be officially executed on 1 January 2017 (James, 2017). This implied that an enterprise such as Eskom would pay an intitial rate of R120 per tonne of Co_2e (carbon dioxide equivalent) and depending on certain pre-determined limits, the actual tax rate may fluctuate between R6 and R48 per tonne.

There is hence no doubt that the increase in costs of operating coal-fired power stations cleaner will cause a significant increase in the costs for electricity which is one of the reasons why renewable energy will be the most economical option from this specific perspective.

The general consensus is that renewable energy will eliminate all environmental concerns. This is not entirely true although the lower level of Greenhouse Gas (GHG) emissions will be a significant benefit. The bottom line is that the renewable energy plant equipment still needs to be transported and manufactured and that once again poses an environmental risk that needs to be addressed as a separate and ongoing concern. The production of some PV cells generates toxic substances that may contaminate water resources. The installation of renewable energy plants can also potentially disrupt land utilisation and wildlife habitat and to a certain extent, some renewable energy technologies consume large quantities of water.

GHG emissions and environmental risks are thus unavoidable when it comes to power generation independent of what sources are utilised (coal or renewable energy). It is just the extent to which these risks impact operations and sustainability that ought to be managed.

Considering the historic GDP growth rate of South Africa, it can be observed that from 1999 to 2003 the growth rate was fairly constant as portrayed in Figure 2.1-5 below. Since 2003, the GDP growth rate increased significantly up until 2007 (from 1.89% to 5.09%). Between 2007 and 2009 the growth rate dropped considerably from 5.09% to -1.79% but it did increase again from 2009 to 2011 to 3.1%. From 2011 onwards a slow and constant decline in the growth rate up until 2017 can be observed to 0, 69%.

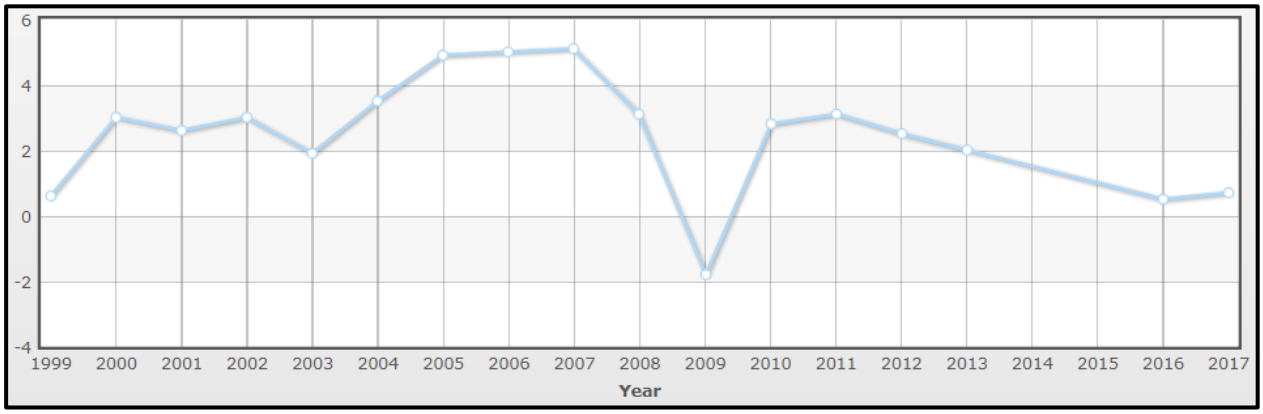


Figure 2.1-5: GDP growth rate of South Africa 1999 to 2017 (% real GDP)

Source: Adopted from IndexMundi (Barrientos & Soria, 2018)

Correlating the GDP growth rate presented in Figure 2.1-5 with the electricity production of South Africa in which is presented in Figure 2.1-6 yields the following:

- During the period of 1999 to 2003 the GDP growth rate and electricity production have both been fairly constant with no deviations from the norm.
- From 2003 to 2007 both the GDP growth rate and electricity production increased significantly.
- The electricity production increased between 2007 and 2008 and remained constant between 2008 and 2009 while the GDP growth rate only decreased during the 2007 to 2009.

- The GDP growth rate increased from 2009 to 2011 while the electricity production decreased between 2009 and 2010 after which it remained constant until 2012.

- While the GDP growth declined slowly but at a constant pace from 2011 to 2017, the electricity production initially increased until 2013, remained constant between 2013 and 2014 and only thereafter decreased as well.

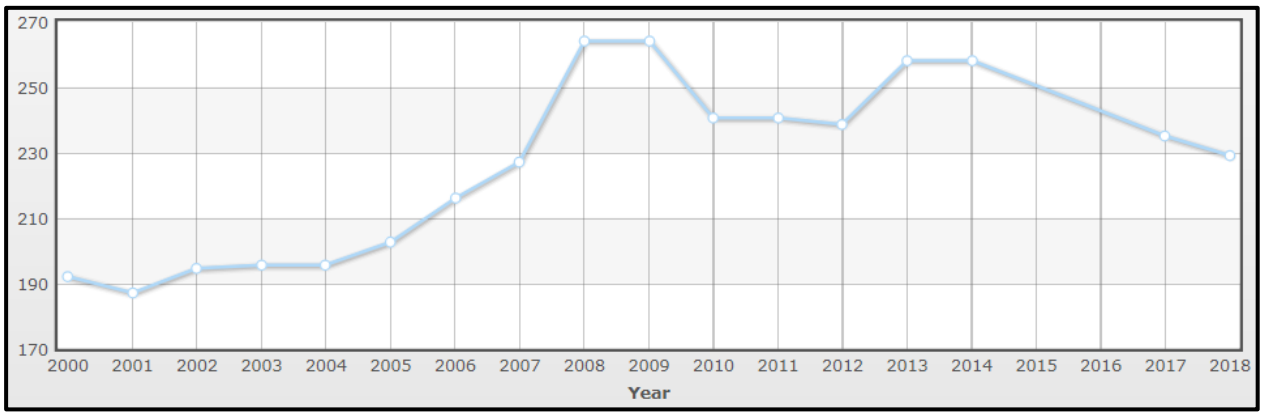


Figure 2.1-6: Electricity production of South Africa (in billion kWh)

Source: Adopted from IndexMundi (Barrientos & Soria, 2018)

Based on the afore-mentioned discussions relating to GDP growth and the production of electricity, it is possible to make an interpretation relating to the demand for specifically renewable energy during the relevant time periods (refer to Figure 2.1-5 and Figure 2.1-6). The interpretations are as follow:

- Between 1999 and 2003 the demand for renewable energy was low as the GDP growth rate and electricity production were both constant and sustainable.

    - This is attributed to the fact that during this time period, the cabinet memo prevented Eskom from investing in new generating capacity (Scholtz *et al.*, 2017:18).

    - An additional attribute to this phenomenon is the fact that no official policies were in place to promote the development of renewable energy in South Africa, i.e. the country was solely dependent on Eskom for the supply of electricity.

- The country was therefore dominated by the coal generation industry that had a direct impact on GDP growth.

- Between 2003 and 2007 the demand for renewable energy remained low while the economic growth was sufficiently high for South Africa.
  - Significant changes in the political landscape took place during this time period.
  - The growth in economy caused a growth in the demand for electricity causing an increase in the production of electricity.
  - The cabinet approved further generating capacity (Scholtz *et al.*, 2017:18).
  - The first integrated energy plan was published in South Africa.
  - The Electricity Regulation Act 4 of 2006 was published (Republic of South Africa, 2006).
- During the time periods 2007 - 2009 and 2011 - 2018 respectively the economic growth of South Africa was low and the demand for renewable energy was high.
  - The country was severely affected by the economic meltdown in 2008 (Temin, 2010).
  - The most noteworthy decline in GDP growth to -2% took place in 2009 which calculated to a loss of approximately R50-billion which is directly attributed to load shedding incidents that took place in 2008 (Hlongwane, 2012). This did not only have an impact on the economic wealth of South Africa but also signicantly changed the impression of the country from the perspectives of international rating agencies.
  - The significant factors that contributed to the change in the GDP growth of the country were the load shedding incidents that took place during 2008 and 2014 that placed immense pressure on the economy of the entire country.
  - What made this drop in GDP growth more substantial was the fact that electricity tariffs also increased during these time periods.

- This is yet another clear indication that the economic wealth of the country is directly dependent on first and foremost the availability of electricity and secondly on how much is paid for the electricity when it is available.

- Figure 2.1-7 below provides a graphic representation of the average price increase per kWh from 2003 to 2017 (Eskom, 2017).

- The demand for renewable energy increased due to the conceptualisation of the REFIT by NERSA (Scholtz *et al.*, 2017:18).

- The afore-mentioned phenomenon was enhanced by the fact that a collective trend by consumers strived to reduce electricity consumption from the utility supply and make a steady transition towards renewable energy as a results of the load-shedding incidents. A need was therefore established at a consumer level to increase the reliability and security of electricity supply.

- The National Energy Act 34 of 2008 was established (Republic of South Africa, 2008).

- In the process of consumers making a transition to renewable energy, political intervention also took place as the REIPPPP was launched in 2011 (DoE, 2018). In that same year, regulation took place in the IRP and the IRP 2010 was promulgated (DoE, 2011).

- In 2013 the IRP 2010 was updated (DoE, 2013).

- In 2016 the draft IRP 2016 was published (DoE, 2016).

- In 2018 the IRP 2018 was published (DoE, 2018).

- The fact that the low economic growth – high renewable energy demand scenario occurred in two separate time periods of which one of the time periods is current emphasises the fact that South Africa is in the midst of a renewable energy revolution. This is based on the fact that a revolution is defined as one complete circular movement of events (Cambridge University, 2018) i.e. a phenomenon where history repeats itself which is exactly what is currently happening in the energy industry of South Africa.

- During the time period 2009 – 2011 both the economic growth and the demand for renewable energy were high.
    - In 2009 the DoE was formed (DoE, 2009).
    - Several mines and large industrial organisations reduced energy consumption.
    - Several load shedding schedules were prepared but never utilized as the demand for electricity decreased and Eskom started to have an excess of supply.
    - The GDP growth during this time period is attributed to the fixed investment spending that occurred during this time period, government expenditure and inventory investment together with changes in the political landscape of South Africa.
    - It is during this time period that the paradoxical situation that escalated and that Eskom is confronted with currently started as the electricity demand declined due to the lack of consumer confidence (historic load-shedding incidents) and the mandate for Eskom to build new power stations remained the status quo.

A summary of the scenarios that exist in terms of economic growth and the demand for renewable energy within specific time periods is presented in Table 2.1-1 below.

Table 2.1-1: Scenario analysis within specific time periods

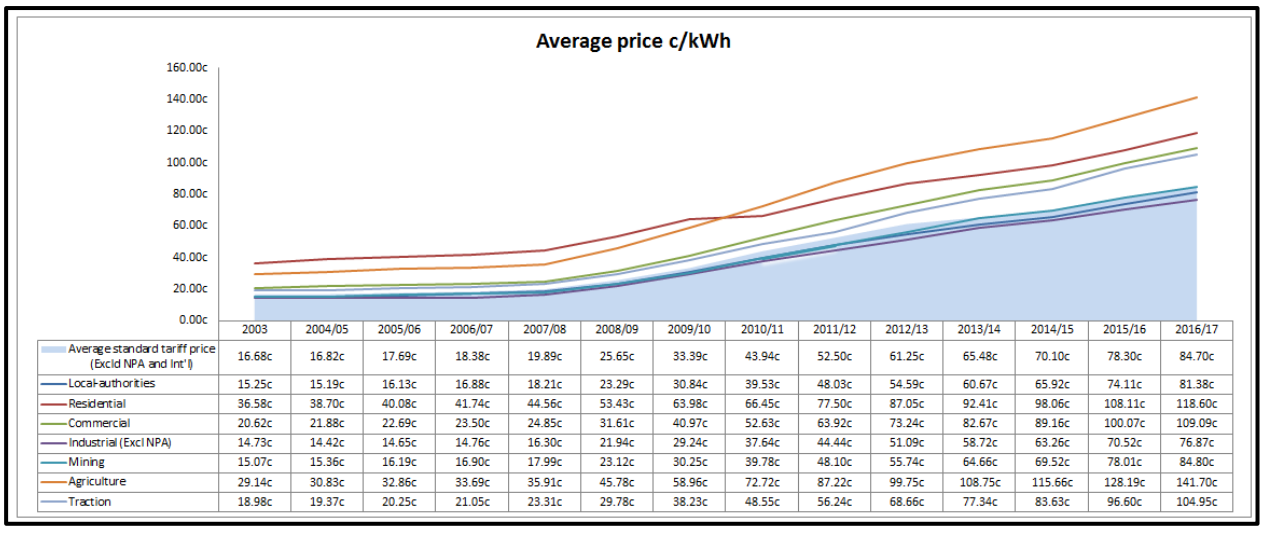
Scenario type	Renewable energy	Economic growth of South Africa	Time period
Scenario 1	High on demand	High	2009 - 2011
Scenario 2	High on demand	Low	2007 - 2009 2011 - 2018
Scenario 3	Low on demand	High	2003 - 2007
Scenario 4	Low on demand	Low	1999 – 2003

Source: Own compilation

There have been ongoing debates and resistance from Eskom to fully support the REIPPPP that was established by the DoE. Eskom claimed the following in numerous media statements (Energyblog, 2018):

- REIPPPP projects will be the cause of higher cost to the utility through tariffs paid by its consumers.
- The programme would cost the average South African more than currently with an increase in 4.9% for electricity tariffs.
- There is no need for this programme as there is already an excess of electricity and lower demand due to a decrease in GDP growth.
- Five coal-fired power stations will have to be closed down due to the programme.

The afore-mentioned scenarios presented in Table 2.1-1 together with the tariff increase presented in Figure 2.1-7 below therefore clarifies the reason why Eskom is not in full support of the REIPPPP and relates to the paradoxical situation the utility is confronted with.



	2003	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Average standard tariff price (Excld NPA and Int'l)	16.68c	16.82c	17.69c	18.38c	19.89c	25.65c	33.39c	43.94c	52.50c	61.25c	65.48c	70.10c	78.30c	84.70c
Local authorities	15.25c	15.19c	16.13c	16.88c	18.21c	23.29c	30.84c	39.53c	48.03c	54.59c	60.67c	65.92c	74.11c	81.38c
Residential	36.58c	38.70c	40.08c	41.74c	44.56c	53.43c	63.98c	66.45c	77.50c	87.05c	92.41c	98.06c	108.11c	118.60c
Commercial	20.62c	21.88c	22.69c	23.50c	24.85c	31.61c	40.97c	52.63c	63.92c	73.24c	82.67c	89.16c	100.07c	109.09c
Industrial (Excl NPA)	14.73c	14.42c	14.65c	14.76c	16.30c	21.94c	29.24c	37.64c	44.44c	51.09c	58.72c	63.26c	70.52c	76.87c
Mining	15.07c	15.36c	16.19c	16.90c	17.99c	23.12c	30.25c	39.78c	48.10c	55.74c	64.66c	69.52c	78.01c	84.80c
Agriculture	29.14c	30.83c	32.86c	33.69c	35.91c	45.78c	58.96c	72.72c	87.22c	99.75c	108.75c	115.66c	128.19c	141.70c
Traction	18.98c	19.37c	20.25c	21.05c	23.31c	29.78c	38.23c	48.55c	56.24c	68.66c	77.34c	83.63c	96.60c	104.95c

Figure 2.1-7: Average unit of electricity price change from 2003 to 2007

Source: Adopted from the Eskom Customer Care website (Eskom, 2017)

In order to put the tariff increases in perspective and relate it to the electricity intensity GDP, Figure 2.1-8 below presents a plot of the two industry trends on a single graph.

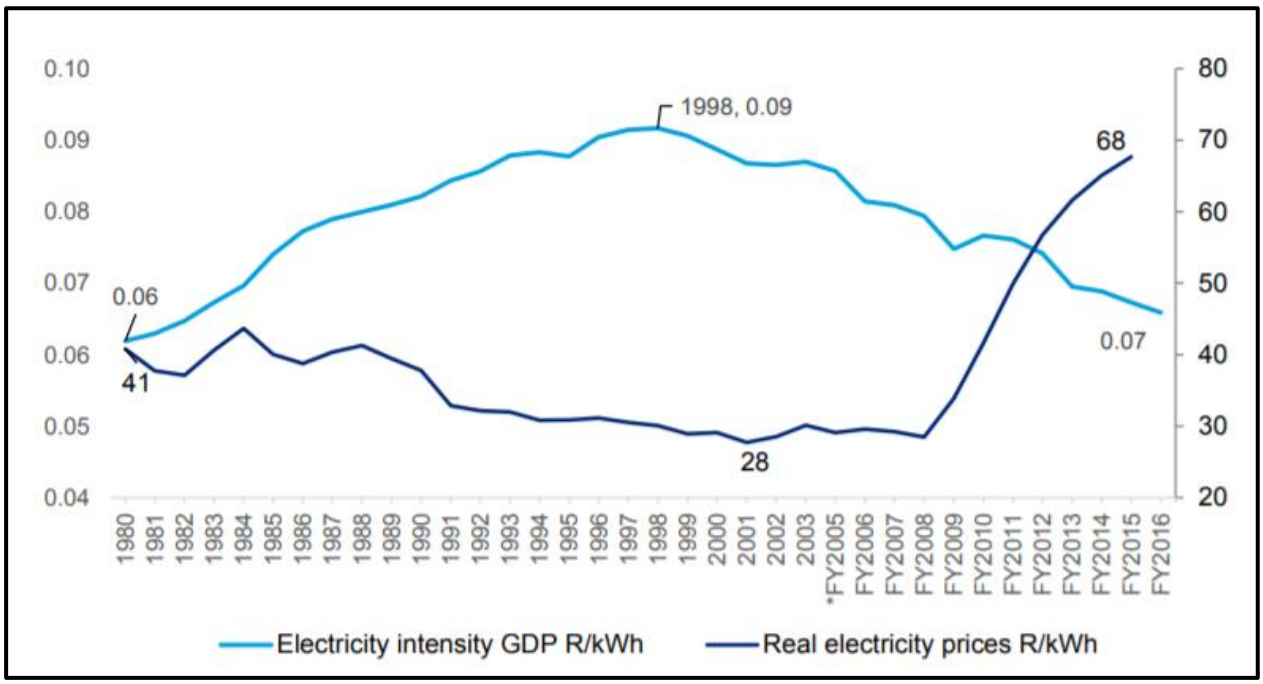


Figure 2.1-8: Electricity intensity trend vs. electricity prices from 1980 to 2016

Source: Adopted from a published report by Deloitte (Deloitte, 2017:29)

It is therefore clear that South Africa's strategic plans for renewable energy are not easily implementable due to the fact that a monopoly market is established for coal generation by the utility. This is not necessarily a negative situation because a well-established electricity grid infrastructure is already in place. The only solution to this situation is to gradually introduce renewable energy solutions to the grid without causing deterioration in the coal energy market.

On the contrary, South Africa has the potential to become an extremely dominant economic competitor in the global energy market for the strategic plans they have in place can ensure that renewable energy is realised while upholding and maintaining the coal energy sector. This potential exists because of abundant coal and renewable energy resources and the manner in which this potential unfolds is to ensure a balanced and mixed energy solution throughout forthcoming years.

Renewable energy technologies and infrastructure are not close to be developed sufficiently so that it can meet the electricity demand of the entire country. According to David Tal (Tal, 2015), a futurist, it could take decades to substitute coal generation with renewable energy generation even if a complete and immediatte transition to renewable energy takes place.

It is therefore clear that the government and Eskom would rather strive to reduce the GHG emmissions at a high cost than to completely close power stations down. It is of critical importance that while the government and the utility attempt to reduce GHG emissions, the slow-but-steady transition to renewable energy sources is established as it will assist in the reduction of costs to reduce the emmissions.

2.1.3 The levelised cost of coal

The Levelised Cost of Energy (LCOE) is a measurement tool that allows comparison of the different methods of electricity generation on a consistent foundation (Branker *et al.*, 2011). In essence, the LCOE is an economic assessment of the average total cost to construct and operate a power-generating asset for its specific lifetime divided by the total energy output of that asset over that lifetime. This economic assessment is thus considered to be the average minimum price at which units of electricity should be sold for the project owner to break even over the project lifetime. According to an article published in the South African Journal of Industrial Engineering (Sklar-Chik *et al.*, 2016:127), the LCOE metric is popular and commonly utilised in conventional electricity generation projects. The LCOE metric is utilised in a variety of conditions that include:

- Utility resource allocation
- Decisions involving dispatching
- The pricing of electricity
- Energy protection programmes
- Research and Development
- Defining and quantifying subsidy schemes
- Environmental planning

The fully-fledged calculation of the LCOE, which is also commonly referred to as the ‘cost of generation’ includes numerous variables. Figure 2.1-9 presents a brief summary of all applicable variables that include plant features, the data relating to the cost of the plant, the financial and general assumptions, fuel costs and tax data.

All the afore-mentioned ought to be available as standard project data or from various industry sources to perform an in-depth LCOE calculation.

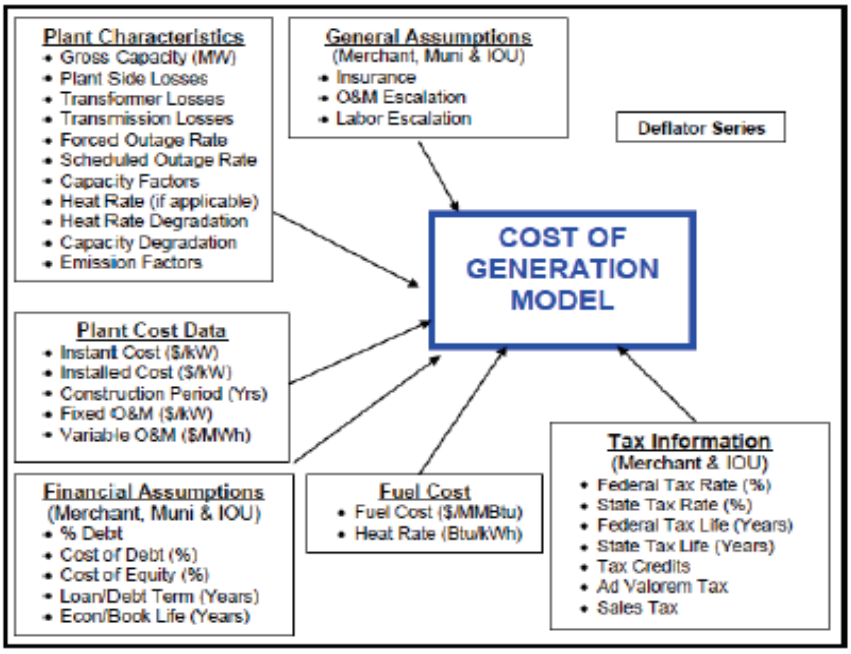


Figure 2.1-9: The 'Cost of Generation' model

Source: Adopted from the Renewable Energy Finance Lecture (Bischof-Niemz, 2015)

Chris Yelland, the managing director of EE Publishers (Pty) Ltd., performed a LCOE calculation and comparison for Medupi, Kusile and IPPs of which the results will be discussed and analysed in the following section (Yelland, 2016). The mathematical model that was utilised to perform this comparison is expressed in Figure 2.1-10 below.

$$LCOE = \frac{sum\ of\ costs\ over\ lifetime}{sum\ of\ electrical\ energy\ produced\ over\ lifetime} = \frac{\sum_{t=0}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{E_t}{(1+r)^t}}$$

where

I_t = investment expenditures in the year t
M_t = operation and maintenance expenditures in the year t
F_t = fuel expenditures in the year t
E_t = electrical energy generated in the year t
r = weighted average cost of capital (WACC)
n = expected economic lifetime of the power plant (years)

Figure 2.1-10: The mathematical model of the LCOE

Source: Adopted from an article in EE Publishers (Yelland, 2016)

The methodology utilised in this LCOE calculation is exactly the same methodology used in the IRP 2010 (DoE, 2011) and the updated IRP 2010 which is also referred to as the 2013 Draft IRP update report (DoE, 2013). In order to perform the LCOE calculation, certain assumptions have to be made regarding the numerous cost factors for Medupi and Kusile which is obtained from Eskom's 2015/16 integrated financial report (Eskom, 2016). A summary of these assumptions is:

- The total cost to completion for Medupi and Kusile, which includes the flue gas desulphurisation plant, interest during construction and contractor claims, have not been processed. The cost of completion is therefore estimated to be R208.7 billion for Medupi and R239.4 billion for Kusile.

- R150 billion for total cost of completion has already been spent for Medupi with a residual R 59 billion to be spent until the final commercial operation date in 2020.

- R 140 billion for total cost of completion has already been spent for Kusile with a residual R 99 billion to be spent until the final commercial operation date in 2022.

- R 9.5 billion had to be written off by Eskom as Medupi was not ready in time to receive coal in terms of the coal supply agreement at the time. This penalty was taken into account for the LCOE calculation as once-off costs occurring in 2015.

- The weighted average cost of capital (WACC) is assumed to be 8% with a plant life of 30 years.

- The load factor as well as the fixed and variable operating and maintenance costs are obtained from the updated IRP 2010 (DoE, 2013:62) and adjusted with inflation up until May 2016.

- The coal costs for the two relevant power stations are assumed to be the average coal costs across Eskom's entire fleet as per the Eskom 2015/16 integrated financial report (Eskom, 2016).

With the afore-mentioned assumptions taken into consideration, the values for the various LCOE variables are presented in Figure 2.1-11 below.

	Medupi	Kusile
Total CAPEX	R193-billion	R213-billion
Lifetime of the plant	30 years	30 years
WACC (real)	8%	8%
Plant nameplate capacity (gross)	6 x 794 MW	6 x 800 MW
Plant net capacity (net of parasitic houseloads)	6 x 722 MW	6 x 723 MW
Average annual load factor	85%	85%
Fuel cost per electricity unit	R0,26/kWh	R0,26/kWh
Fixed O & M costs	R704/kW/annum	R704/kW/annum
Variable O & M costs	R65,30/MWh	R65,30/MWh

Figure 2.1-11: Assumptions and variables for the LCOE calculations

Source: Adopted from an article in EE Publishers (Yelland, 2016)

Based on the values depicted in Figure 2.1-11, the LCOE is calculated to be R 1.05/kWh for Medupi and R 1.16/kWh for Kusile (with the flue gas desulphurisation plant taken into consideration). The LCOE for new pulverised coal-fired plants in South Africa is calculated to be R 0.74/kWh also taking the flue gas desulphurisation plant into consideration.

For the afore-mentioned calculation results the following should be noted:

- No tax effects have been accounted for.
- The current environmental levy of R 0.035/kWh on coal-fired generation was not taken into account.
- The proposed carbon tax of R120/tonne of emitted Co_2e which would have resulted in a R 0.1 kWh/h increase is not taken into account.
- The externality costs have not been taken into account but would be useful when coal-fired power plants are compared to renewable energy technologies.

In contrast to the LCOE calculated for Medupi and Kusile, the fully indexed average price per kWh that is in essence being paid by Eskom for renewable energy during the procurement of IPPs was presented by the IPP Office of the DoE on 16 April 2015 as shown in Figure 2.1-12 below.

It should be noted that the fully indexed average price per kWh that was paid by Eskom at that specific time period is used and not the recent price per kWh because this was the time period during which the LCOE study was done. The intention is therefore to make a comparison between the indexed average price per kWh for IPPs and the LCOE for new coal as at 21 July 2016 (Yelland, 2016).

Average price paid by Eskom	Bid Window 1	Bid Window 2	Bid Window 3	Bid Window 4
Wind	R1,52/kWh	R1,19/kWh	R0,87/kWh	R0,69/kWh
Solar PV	R3,66/kWh	R2,18/kWh	R1,17/kWh	R0,87/kWh
CSP	R3,56/kWh	R3,33/kWh	R3,31/kWh[1]	R3,09/kWh[1, 2]

Figure 2.1-12: The fully indexed average price per kWh for IPPs on 16 April 2015

Source: Adopted from an article in EE Publishers (Yelland, 2016)

It is apparent that the cost of primary energy from coal per kWh generated cannot be compared to the LCOE of electricity for a specific renewable energy technology. The additional variables in the LCOE model make this comparison irrelevant; however, this is exactly what is often done by utilities in promoting the fact that electricity procured from IPPs are way more expensive than the utility's cost of coal (Hodges, 2018). Applying a similar analogy, the cost of electricity from an ageing fleet of power plants (of which Eskom has a few) cannot be compared with the LCOE of a planned new power plant. Once again, this often takes place and in the process the uninformed is misled. Finally, the LCOE of variable sources of electricity (such as renewables) cannot be compared with the LCOE of baseload generation.

The most challenging element that relates to LCOE in South Africa is that it is merely a planning tool and investments decisions are based on the planned value. Eskom has already made the major investment decisions regarding the capital expansion programme of constructing the two new coal-fired power stations.

The LCOE have for a number of reasons increased during the construction and operating phases and the utility simply asks for additional funds from the regulator. Whatever the case may be, the risk is always on the consumer of electricity or the taxpayer which is either in the form of increased electricity tariffs or increased taxes.

On the other hand, if an IPP constructs a power plant, the LCOE is utilised as a forecasting tool to submit a bid price for electricity to feed into the national grid for the period stipulated in the PPA. Should things not go according to plan, the IPP bear the costs, or go bankrupt or sell the plant to the next IPP as per the requirements in the PPA. The consumer or taxpayer therefore bears no risk of cost overruns. This is the major difference between the electricity provided by the public and private sector respectively.

Due to the fact that the LCOE fails to account for all costs of a generating plant, the LCOE calculation should be well-understood, modelled and predicted. This will provide great assistance for the policy-makers of South Africa regarding the decisions that ought to be made for new projects (specifically renewable energy projects) as well as understanding the subsequent costs for the relevant network operator. This is very relevant to the recent publication for consultation with stakeholders of the IRP 2018 (DoE, 2018). Although the LCOE cannot be used as a comparison tool for the various generation technologies, a recent study suggested that adjacent factors that are independent of the LCOE cause new renewable energy technologies to considerably cheaper than new Eskom coal-fired power stations (Moyo, 2018).

2.2 A RENEWABLE ENERGY PERSPECTIVE

2.2.1 The viability of technologies

2.2.1.1 The innovation of technologies

2.2.1.1.1 Micro-grids

The Journal of Energy South Africa published the following statistics in an attempt to analyse various options for a supply in rural areas (J. energy SA, 2015):

- Approximately 31% of South Africans are residing in rural areas.

- More than 60% of households in the afore-mentioned areas have no access to electricity.

These statistics were published in in 2015. Out of the total population of 55,291,225 in 2015, 62.7% included the urban population and out of the total population of 57,398,421 in 2018, 62.1% included the urban population (Worldometers, 2018).

The population in rural areas have therefore increased by 3.26% in the 2015 – 2018 time period (from 20,628,472 to 21,289,254 respectively), whereas the urban population has decreased by 0.6% during the same time period. Figure 2.2-1 below graphically indicates the total population growth of South Africa for the past 68 years.

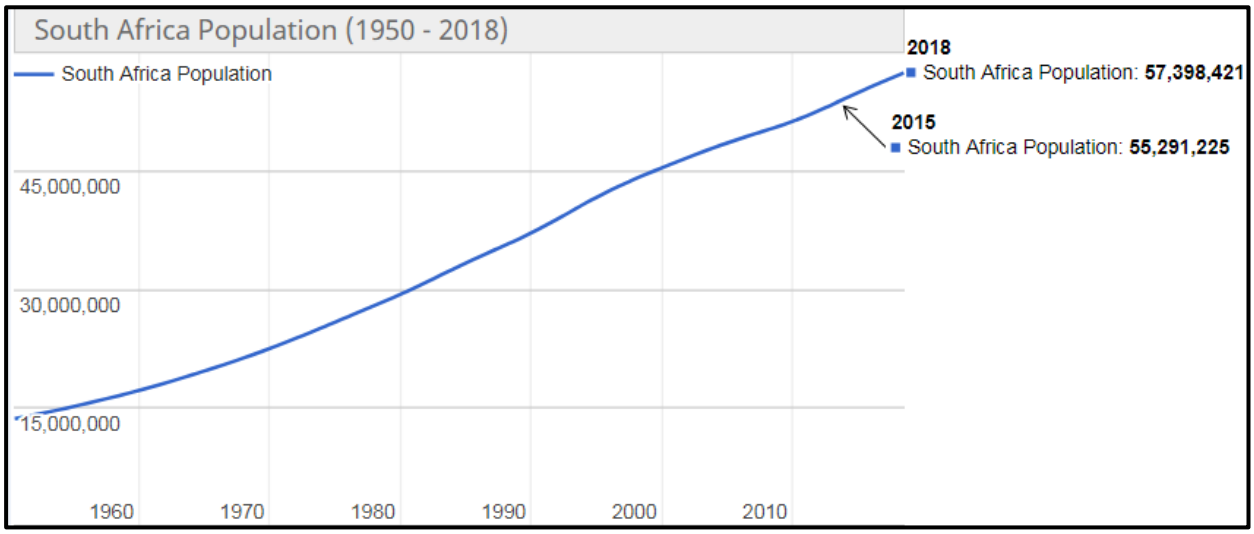


Figure 2.2-1: Graphic representation of the population growth of South Africa

Source: Adopted from Dadax (Worldometers, 2018)

Because the rural population in South Africa has enlarged considerably while the urban population has declined, the country is confronted by an immense challenge – the access to electricity in rural areas. In 2015, 60% of rural households did not have access to electricity; this has increased to 87% of rural citizens who did not have access to electricity in 2018 (Alfreds, 2018). This is because the rural population increased during the same time period. Dr Fatih Birol, executive director of the International Energy Agency (IEA, 2018) states that there is a persistent need for technologies that encourage energy to be efficient and for renewable energy in the aim to address the following three critical goals:

- Access to energy

- Mitigation of climate conditions
- A decrease in air Pollution

In order to fulfil the afore-mentioned need and inevitably obtaining the pre-set goals, renewable energy companies that focus on solar PV, hydro and wind need to collaborate intensively to construct micro-grids in strategically selected rural areas. A micro-grid is a localised energy infrastructure that comprises intelligent controlling capability which means it can disconnect from the utility grid and operate autonomously (Lantero, 2014). The diversified energy sources of the micro-grid can be a mixture of various renewable energy technologies that are incorporated with one another and automated to balance supply and demand at any given time. Given the discussion on the afore-mentioned paradoxical situation Eskom is confronted in section 2.1.1, micro-grids can perhaps be a partial solution to their problem.

The World Bank report has recently published a report (Creamer, 2018) stating that the evolution of electricity systems in sub-Saharan Africa has to integrate more than one national grid. This suggests that the way to universal electrification will allow for the integration of interconnected stand-alone micro-grids. The backing from the World Bank and supplementary development partners to increase the amount of private micro-grid investments is exceptionally valuable in highlighting the benefits they can provide and costs incurred to place them in operation.

A well-known weakness for micro-grids is that it is primarily focused on using wind and solar PV for primary operations. Slight consideration is thus given to the utilization of waste-to-energy meaning that the consideration for biogas as a renewable fuel for generators is minimal. This gap can be filled by private sector investors by entering the micro-grid market of South Africa. An overview of a micro-grid system is depicted in Figure 2.2-2 below.

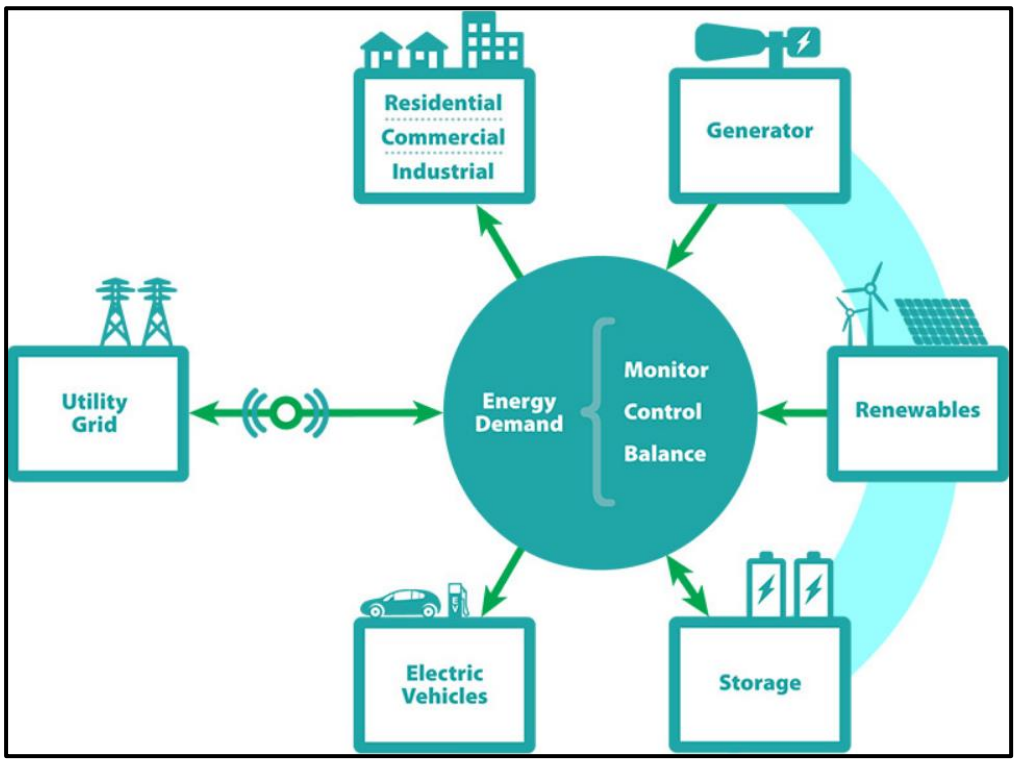


Figure 2.2-2: Overview of a generic micro-grid system

Source: Adopted from the Centre for Sustainable Energy (CSE, 2018)

From a utility point of view, a private-sector micro-grid establishment will be supported as the costs incurred by the utility to expand the network infrastructure to a rural community will be extremely high. Private sector investors are therefore incentivized to propose their business model to major stakeholders and become part of the micro-grid industry that is also still in the development phase.

2.2.1.1.2 IPPs

A new dawn for renewable energy in South Africa is therefore becoming apparent in the country as the doubt that private sector investments had in the energy sector has now been addressed to a large extent. Direction and support are provided by the government to enhance policy certainty as far as possible. It is, however, crucial that the informed and well-researched strategic decisions are made by private sector investors to ensure long-term growth and sustainability. It is not only important that these decisions are actually made, but even more important that these strategic decisions are made as soon as possible. Due to the renewable energy revolution, the renewable energy market may soon be flooded with industry competitors.

This is therefore considered an important time for private investors to take strategic action and make use of the support of the public sector to safeguard growth in the private sector by investing in IPPs.

The Energy Minister Jeff Radebe disclosed on Friday 01 June 2018 in a media statement that a new bidding window for the following phase of IPPs will be launched in November 2018 (Khumalo, 2018). This implies that approximately 1800 MW of electricity would be added to the national grid. The minister elaborated on this statement by stating that it is the intention of the government in collaboration with the DoE to direct the socio-economic and enterprise development spend of the IPP programme to the applicable communities where the projects are located.

It is forecasted that over the next three years, a minimum of 61,000 jobs (6% of the government's target of one million jobs) will be created as a result of the signing of the IPP contracts (Wills, 2018). The strong signal from the government to the renewable energy industry will therefore assist South Africa in recovering its former positions as the leader in independent power production after a two-year delay. Individuals and companies in the private sector will now be enabled to invest in electricity generation assets that can deliver revenue streams of up to 20 years. This will allow increased participation in the economy of South Africa and increased competition will be established to ensure the optimal value for the IPP consumer. According to Chris Yelland in a media statement published on 14 March 2018 (Lechela & Cronjé, 2018), the court bid to refuse the signing of the 27 IPP contracts is only a delaying tactic as the transitions towards renewable energy is a global trend that will not leave South Africa behind. The trend towards renewable energy can thus not be fought – a slow transition is required though.

2.2.1.2 The benefits offered by technologies

There is no doubt that renewable energy will benefit the country in many ways, given that the strategic plans for implementing renewable energy technologies are managed effectively. These strategic plans have been established to fulfil the vision of the DoE which is to have a 30% clean energy mix by the year 2025 (DoE, 2014). The only manner in which this vision will become a reality is to gradually shift to renewable energy sources.

In the short-term, South Africa will not be able to rely only on renewable energy as the primary source of energy but rather to rely on mixed technologies with coal generation as the primary source of energy.

2.2.1.2.1 Impact on the economic growth

A publication by IRENA in 2014 provided a theoretical structure to assist with the analysis of socio-economic effects and proposed benefits introduced through the deployment renewable energy on a large-scale (IRENA, 2016). The aspects of this structure contained economic benefits that go beyond only a direct impact on the GDP growth as other economic benefits include the enhancement of new employment opportunities as well as the increase in trade activities of the country. These trade activities include trading with new and innovative energy products that have the potential to disrupt the energy market in a positive manner as well as the domestic production of renewable energy equipment. The establishment of a large-scale renewable energy plant will also have an effect on energy consumers and taxpayers which results in an inevitable impact on the local economy structure of those consumers. Lastly, the application of a large-scale renewable energy plant will stimulate economic activity because of generation and balancing costs of the plant as well as additional energy transaction costs on the grid. It is therefore evident that renewable energy generation creates a completely new and innovative space for economic activity and if managed optimally can enhance economic growth.

The main goal of renewable energy is not necessarily to increase South Africa's generation capacity (although it is still a benefit) as previous mentions in the literature suggested that the demand for and production of electricity have declined in recent years (refer to Figure 2.1-2 and Figure 2.1-6 respectively). The implementation of renewable energy technologies holds several other potential benefits that can have a direct or indirect impact on economic growth among others. According to an article published in the Renewable and Sustainable Energy Reviews journal (O'Connel, 2014) these benefits include:

- Decrease in the overall electricity price and stabilisation of energy tariffs.
- Utilisation of peak plants.
- Decrease or delay in infrastructure capacity requirements.

- A decrease in the congestion of transmission and distribution congestion.
- An environmental benefit in the sense that Co_2e emissions are reduced.
- The afore-mentioned benefit is considered an indirect impact on the economy as the carbon tax related to the relative renewable energy plant will be reduced as a result.
- An improvement on the general economic efficiency

2.2.1.2.2 Socio-economic impact

From a socio-economic point of view, the following benefits are identified when a renewable energy plant is constructed within a specific community according to an article published in the journal of Procedia Engineering (Shoaib & Ariaratnam, 2016:997):

- Social
  - Social bonds are created.
  - The links among various communities are strengthened.
  - A sense of ownership is fostered.
  - A collective response to common problems and challenges among communities is established.
  - Job creation where the impact on direct employment is modest and the impact on indirect employment is large compared to the community size. Solar PV projects create the lowest number of jobs, whereas biomass projects create the largest number of both direct and indirect jobs.
  - Although job creation is a benefit, it is still limited.
  - Renewable energy projects lead to diversification of employment as well as income sources and also create temporary employment opportunities.

- Economic
    - Local labour, businesses and raw material are utilised and they stimulate local economic activity within the community.
    - Dividends are paid to local shareholders.
    - Local banks are serviced.
    - Community resilience is enhanced as most often a trust fund is established that invests money that is earned through electricity sales in the local economy.
    - Communities are enabled to invest in key economic priorities of their own choice.

2.2.1.2.3 Impact on the coal generation industry

According to an article published in the Journal of Energy in Southern Africa (Sparks *et al.*, 2014) it is of critical important to account for all possible aspects of the energy life cycle to allow separation of stages where substantial amounts of water are utilised. This article confirmed that conventional fuels such as coal utilise major quantities of water over the life-cycle producing energy (specifically plants that operate on a wet-cooling system). The quality of water is also unfavourably affected during some of the stages in the energy production process. Contradicting the afore-mentioned, solar PV as well as wind energy have the lowest demand for water, and could possibly be considered the most feasible renewable options in terms of water extraction and consumption.

During the past number of years there has been a collapse in the global demand for coal of which the major disrupter for the industry has been the gradual transition towards renewable energy resources – especially in South Africa (Jansen van Vuuren, 2018). The afore-mentioned phenomenon together with the reduction in demand for conventional sources of electricity (DoE, 2018:17) has exhibited the severe impact that renewable energy has on the coal generation industry.

A complete transition towards renewable energy (especially the sustainable commissioning of IPPs) will have the following two impacts (Jeffrey, 2018):

- The coal and mining sector could shrink by 46% due to direct and indirect impact which will reduce the GDP growth of South Africa by at least 2.5%.
- Wind merely produces 35% and solar 26% which implies that renewable energy will always require back-up from the coal generation sector.

2.2.1.2.4 Benefits offered by micro-grids

According to a recently published report by the World Bank micro-grids offer benefits that include job creation, social upliftment and stimulating of economic activities in the local identified rural communities (Creamer, 2018). This report elaborates on further benefits that will have a positive impact even outside the boundaries of the local rural communities:

- Streamlined electricity pricing and elevated economic efficiency.
- Provision of an encouraging investment environment.
- Expansion of private-sector involvement.
- Increase in public confidence – public interest is served.
- Provision of electricity to rural/remote areas which is not financially viable for traditional coal generation utilities.

Considering electric vehicles that are integrated with flexible demand resources proves to have the potential to provide additional benefits to the energy grid if sufficiently economical (ERC, CSIR and IFPRI, 2017).

In-line with micro-grids, the South African Local Government Association (SALGA) aim to strategically align the energy needs and challenges of municipalities with the following seven scenarios that offer substantial benefits to numerous stakeholders (SALGA, 2018):

- Procuring electricity from a small-scale embedded generator (SSEG).

- Securing electricity from an IPP.
- Generating renewable energy for own use.
- Generating renewable energy for sale.
- Wheeling of private sector electricity.
- Increase energy access and reducing energy poverty.
- Operating a storage facility.

2.2.1.3 The impact of the technologies

Based on the afore-mentioned literature pertaining to the renewable energy revolution, it is not driven as much by the tax on Co_2e or subsidies relating to green energy as it is driven by the overall economy efficiency to generate electricity from renewable energy sources instead of being dependent on traditional utility supply.

The obvious observation that can be made with regards to renewable energy is that the price of the raw materials used for the generation of electricity (the sun, wind, biogas and water) is free of charge. What makes renewable energy expensive are the plant initiation costs but these costs can be recovered over time as a return on investment (ROI) figure because of the fact that the raw material price is negligible. Comparing this significant benefit with coal generation, the raw material price (coal price) steadily increases over time (World Bank, 2017).

2.2.1.3.1 Solar PV and wind

Solar PV and wind renewable energy are the two most dominant technologies in the renewable energy sector. Hydro and biogas are not as developed as yet but are making steady progress that can be attributed to the REIPPPP. In May 2014, 37 companies have installed rooftop PV all over the country which was at a time when a high degree of policy uncertainty existed regarding the IRP 2010 update (Tuson, 2014). Figure 2.2-3 below illustrates the steady growth of solar PV and wind technologies where projects in excess of 30 were commissioned and connected to the national grid in 2014.

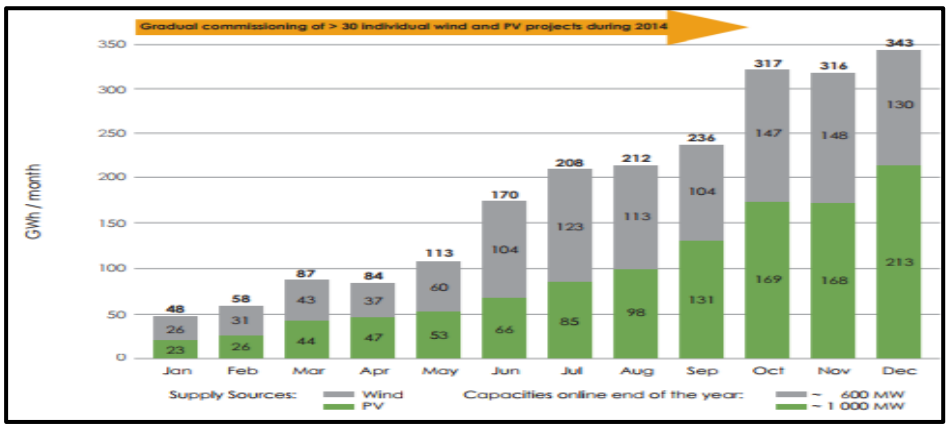


Figure 2.2-3: REIPP growth in energy production for solar PV and wind in 2014

Source: Adopted from the DoE (DoE, 2015:4)

The number of installed small-scale PV systems, however, has significantly increased from 2014 to an astonishing 138 352 in 2017 (Rycroft, 2017). The capacities of these installations range from smaller than 1kWp to greater than 5MWp. It is, however, important to note that 128 622 out of the 138 352 installations are smaller than 1kWp that consist of the majority of the installations. The drive towards solar PV is also attributed to space constraints of buildings, thus a large number of solar PV installations occur on the rooftops of buildings. Table 2.2-1 below is a summary of 4 selected case studies that present the cost savings obtained due to these PV rooftop installations. These case studies indicate that solar PV is influencing the commercial and corporate environment to a large extent which stimulates local economic activity surrounding that specific market.

Table 2.2-1: Case studies for solar PV rooftop installations

Customer	Location	Capacity	Annual cost savings	Annual carbon footprint reduction
Wembley Square	Cape Town	549.9 kWdc	R 969 841.79	12%
Goldrich Toyota	Bronkhorstspruit	80.64 kWp	R 195 258.00	35%
Hout Bay	Cape Town	10.23 kWp	R 30 000.00	384 tons carbon offset
PPE Technologies	Nelspruit	52.9 kW	R 68 900.00	30%

Source: Adopted from SAPVIA (SAPVIA, 2018)

A practical example of a recently commissioned rooftop solar PV is that of Mall of Africa where the world's 10th biggest solar roof is installed (de Villiers, 2018). This solar PV system will save 8,034 tonnes of Co_2e on an annual basis which calculates to 1000 more than the average annual Co_2e production of a typical household. The capacity of this system is 4,7555kWp and created 50 temporary jobs and only two permanent jobs.

The authorised body responsible for ensuring compliance with policies regarding wind the energy technology and to promote sustainable wind energy for South Africa is SAWEA. SAWEA was registered as a non-profit organisation in 2004 under the Department of Social development (SAWEA, 2018).

Ever since the initial bidding window for IPPs in 2011, the energy tariffs of wind energy have declined at a significant rate. This proves that wind energy is a technology that becomes more economical as time progresses due to the ROI contribution from the initial plant costs which makes wind energy a financial viable solution. Figure 2.2-4 indicates how the tariffs for wind energy have declined by 59% over a 5-year period.

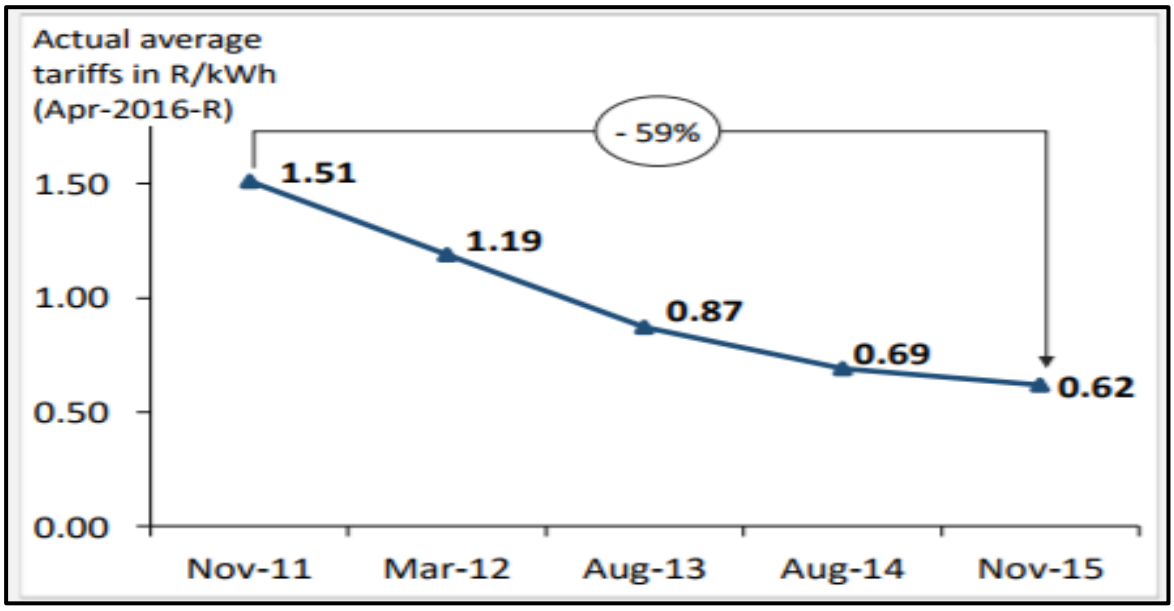


Figure 2.2-4: Tariffs for wind energy from November 2011 to November 2015

Source: Adopted from CSIR Statistics (CSIR, 2017)

The reason for this drastic decrease in tariffs can be attributed to the decrease in the technological component prices, the progressions made in wind harvesting technology and the increased market competiveness for low costs of wind energy.

In a market overview analysis that was conducted by SAWEA (SAWEA, 2018), the following statistics for the wind energy in South Africa were published:

- By the end of 2015, 3366 MW of wind power was successfully procured from 36 projects through four bid windows under the REIPPPP.
- 22 wind power plants that comprise an installed capacity of 2020 MW have accomplished commercial operations to date.
- The wind power plants currently in operation contribute 52% of South Africa's renewable power.
- PPAs for 12 utility scale wind projects from the 4th bid window were concluded in quarter 1 of 2018.
- The bid price for wind power has decreased to R 0.79/kwh which translates to a 50% annual drop.
- The price of wind in South Africa is now directly comparable with the per kWh price of new coal-based power generation.

It is therefore clear from the above that wind energy is a renewable energy technology that is making financial breakthroughs on an ongoing basis in the country. The contributions made to these significant breakthroughs is attributed to the energy triangle of the REIPPPP of wind technology which is based on the following three objectives: Economic growth and development, energy access and security and environmental sustainability (DoE, 2015).

2.2.1.3.2 Biogas and hydro

Biogas plants focus on waste-to-energy technology that is still in the early phases of development in South Africa and is yet to make a significant impact on the energy market compared to solar PV and wind energy. This technology is based on the extraction of methane gas from either landfill sites or agricultural establishments such as a feeding lot. This methane gas is then used as the source of energy for generation plants that are constructed by self-build customer applications as part of the REIPPPP.

The challenges that prohibit this type of technology to dominate the renewable energy market are low capacity installations compared to other renewable energy sources, high capital costs and the lack of financial and regulatory incentives (Munganga, 2013).

The first commercially operating biogas plant in South Africa, the Bronkhorstspruit Biogas Plant (Pty) Ltd. (BBP) is owned and operated by Bio2Watt (Pty) Ltd. (Bio2Watt, 2016). Power was provided by this plant to the national electricity grid on 10 October 2015 for the first time and is established as an autonomous commercial enterprise with a lifecycle of roundabout 20 years. BBP is positioned on the premises of Beefcor which is one of South Africa's major feedlots. The reason for BBP being located at the feedlot is attributed to the fact that the biogas it utilises for generating electricity is extracted from cattle manure.

It only made sense to construct this plant at the feedlot as Beefcor market over 70 000 heads of cattle on an annual basis (Beefcor, 2015). This plant contributes to the diversified energy mix of South Africa with an installed capacity of 4.6 MW and although this is considered a small contribution to the electricity grid, it has the potential revolutionise the renewable energy industry in the near future.

BMW, located in Rosslyn Pretoria, is the off-taker of electricity that is produced by the plant and is governed by a wheeling agreement (BMW Group, 2018). Wheeling is defined as the transport of energy between two parties (the seller and the buyer) using the national electricity grid as the mutual medium (SALGA, 2013). A wheeling agreement therefore deals with the utilisation of the network as well as the cost incurred in delivering the energy. This was the first private deal of its kind in South Africa – an IPP selling electricity directly to a consumer instead of selling it to Eskom. The wheeling agreement aids in BMW's attempt to ultimately source all their electricity utilised in their production processes from renewable energy sources (Donnelly, 2015). The factory in Rosslyn currently fulfils between 25% and 30% of their energy needs from the plant and has signed a PPA with the IPP owner for the next ten years. The core of the wheeling agreement is attributed to BMW South Africa's drive for environmental sustainability and is thus not driven solely by the cost of energy as they are willing to pay a premium for Green Electricity (Thomas, 2015).

The Cape Dairy Biogas Plant (Pty) Ltd. which is situated in Malmesbury, Western Cape is a follow-up on the success of the BBP. Construction of this plant at one of South Africa's largest dairy farms, Vyvlei Dairy farm, started in April 2016 and comprises an installed capacity of 4.8 MW. The plant generates electricity on the same principles as the BBP – utilising cattle manure to produce biogas fuel. This plant, however, does not comprise a wheeling agreement i.e. the off-taker is the Single Buyer Office (SBO) of the REIPPPP Programme. Both the BBP and the Cape Dairy Biogas Plant (Pty) Ltd. are therefore considered IPPs with different PPAs and that form part of the Renewable Energy Independent Power Producer (REIPPP) unit.

It is therefore clear that biogas technologies currently offer unique opportunities for investors in the private sector in the form of wheeling agreements. The value offered by the biogas technology is therefore not the same as offered by solar PV or wind but comprise additional benefits in the wheeling that corporate companies can thrive on. The wheeling agreement is unique in the sense that it benefits both the off-taker of electricity as well as the applicable owner of the IPP plant.

Unlike all the other renewable energy technologies, hydro power is mainly enhanced by the utility instead of external customers. Hydro power, specifically pumped storage schemes, is used in Eskom to support peak load time periods when required where water is stored in two separate reservoirs of which one is higher in altitude than the other. Reversible pump-turbines are used to pump water from the low-altitude dam to the higher one during times when the demand for electricity is its minimum. When the demand is high, water is then allowed to flow downstream converting potential energy to kinetic energy through pump-turbines which are switched to generating mode. Water is therefore re-used to generate power (Eskom, 2015). Hydro plants are thus useful in assisting utilities in terms of stabilising the electricity grid in peak demand time periods of which an example is the Ingula Pumped Storage Scheme (Eskom, 2018). Other peaking stations include Drakensberg and Palmiet (both pumped storage schemes) and Gariep and Vanderkloof both of which are hydro-electric stations (DoE, 2018:59). There is therefore not a substantial drive from the private sector for this specific technology; however, the IRP 2018 (DoE, 2018:39) published that 2500 MW of hydro power is included in the plan for 2030 to align with the commitments of the National Development Plan (NDP).

The high-growth scenario of the IRP 2018 there sees the full import of hydro capacity of 2500 MW coming in line during the strategic planning period of 2021-2030. The IRP 2018 elaborates by stating that higher gas prices and stringent Co_2e emission limits could be the reason for full hydro capacity. The main risks, however, associated with the import of hydro options are the possible delays in the construction of the required grid extension and the power plants themselves as indicated in the IRP 2018.

2.2.2 The processes that enhance development

2.2.2.1 The REIPPPP

The REIPPPP unit was established by the DoE, NT and the DBSA with the sole purpose of delivering on IPP procurement objectives (IPPPP, 2016). The REIPPPP added significant value to communities that previously did not have access basic services such as electricity. The great benefit of this programme is that it provides a vast amount of opportunities to rural communities with access to electricity as they do not need to be connected to the national electricity grid to be a consumer. An example of a community that benefited from the REIPPPP was the Duineveld Township in Kheis Municipality in Northern Cape where 300 households were electrified (Spanjaard, 2015).

The DoE published a report in 2015 that provides an in-depth analysis of the state of renewable energy in South Africa (DoE, 2015). This report indicated that the REIPPPP attracted substantial foreign investments into the country that amounted to R53.2 billion and comprised 28% of the total investment share of which the remaining 72% was attributed to domestic investment. According to the University of Cape Town (UCT, 2015), the REIPPPP is the most rapidly developing renewable energy programme globally as steadfast private sector investment for renewable energy generation reached R193 billion. Comparing these investment figures with other countries shows that South Africa was competing in the top ten renewable energy investing countries on a global scale in 2014 according to a report from the United Nations Environmental Programme (UNEP, 2015). A leading investor in the renewable energy fraternity across Africa is the Old Mutual Alternative Investments because they have identified noteworthy potential for these investments (Moodley, 2016). They believe it will have a sustained impact on the economy of the country and continent.

They consider renewable energy as a source of steady, reliable and low-cost power which at the same time ensures both long-terms investments and job opportunities. These investments provides a solid foundation for grid infrastructure, but need to be maintained and managed by all stakeholders in a pro-active manner in order to achieve the desired ROI.

Community trusts have been the core of local shareholding in IPPs of which there will be numerous benefits for local economy infrastructure. The DoE predicted an annual net income of R1.46 billion and that the cash flows to the investment societies will be restricted until their debt has been fully cleared (South African Government, 2017). Figure 2.2-5 below indicates the community trusts' cash flow projection until 2037.

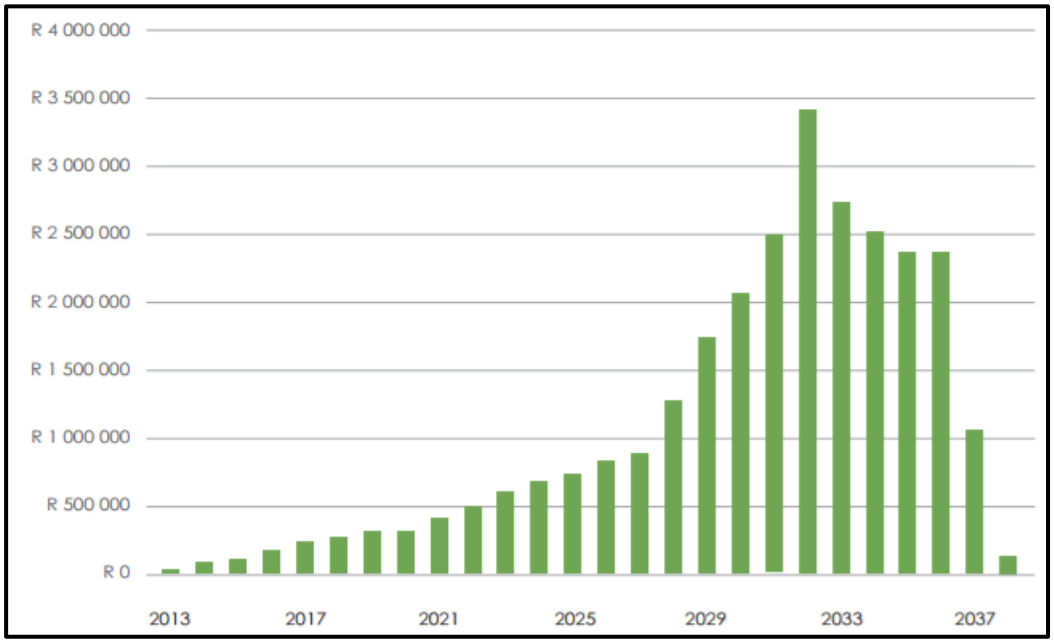


Figure 2.2-5: Community trusts cash flow projection

Source: Adopted from the State of Renewable Energy report in South Africa (DoE, 2015)

Contradicting the REIPPPP and the benefits it holds, is the need to cap renewable energy source as depicted in the IRP 2010 developed by the DoE. During the one-day discussion event hosted by SANEA at the Sandton Convention Centre, Mike Rossouw, an independent consultant, queried the fact that this cap is placed on renewable energy (Rossouw, 2017). This was queried because if the country utilised more renewable energy sources, it would not be necessary to reserve a vast amount of funds for Co_2e reduction.

Figure 2.2-6 below shows the investments made across major renewable technologies that are secured in four completed bidding windows of the REIPPPP.

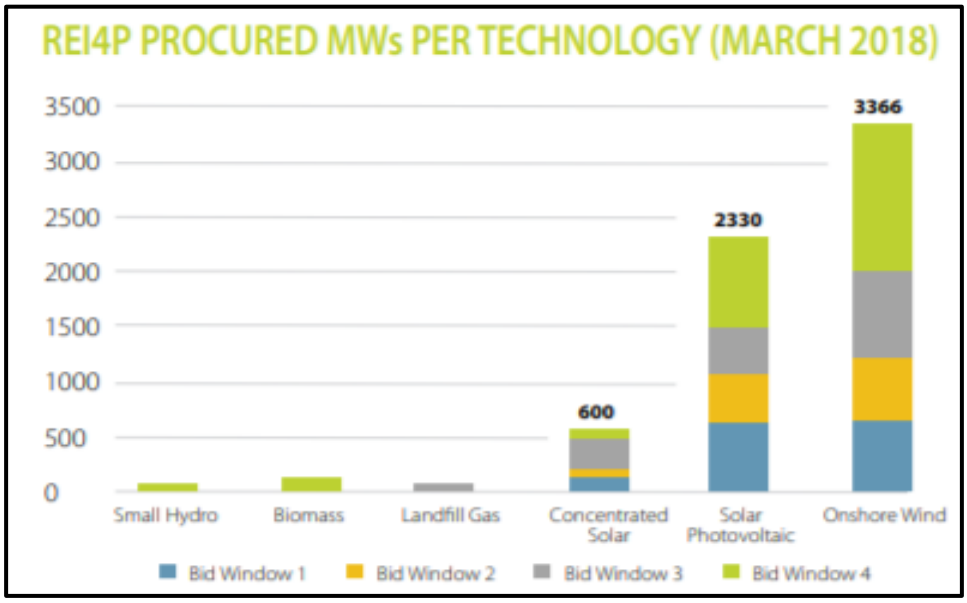


Figure 2.2-6: REIPPPP procured MWs per renewable energy technology

Source: Adopted from a market overview analysis by SAWEA (SAWEA, 2018)

2.2.2.2 The REFIT

NERSA has established the study of the REFIT in June 2007 in order to make sufficient provision for renewable energy usage in South Africa which concluded with the endorsement of the REFIT recommendations on 26 March 2009 (NERSA, 2009). The purpose of the REFIT is to standardise electricity tariffs in South Africa utilising the LCOE as a fundamental basemodel. Renewable energy is purchased from qualifying generators (predominantly in the private sector) at pre-determined prices to serve as an incentive for renewable energy investors and developers. A threat, however, exists for the afore-mentioned developers and investors as the policy uncertainty plays a significant role in the sense that the REFIT might be removed in future if not optimally rolled-out by all involved stakeholders (Boyd, 2010). Without the established REFIT which is currently suitable and favourable for existing and potential investors in the private sector, the viability of any renewable energy is significantly compromised. It is therefore of critical importance that potential investors of all renewable energy technologies establish PPAs while this framework exists in South Africa and while no rapid policy changes in this regard takes place.

Based on the LCOE model, the REFIT has established tariffs for each renewable energy technology as depicted in Table 2.2-2 below:

Table 2.2-2: REFIT Phase I tariffs

Renewable energy technology	Unit	REFIT
Wind	R/kWh	1.25
Small hydro	R/kWh	0.94
Landfill gas	R/kWh	0.9
CSP	R/kWh	2.10
All inclusive renewable energy technology (average rate)	R/kWh	1.3

Source: Adopted from NERSA as per the establishment of the REFIT (NERSA, 2009:9)

The tariffs in Table 2.2-2 above is therefore based on renewable energy generation in the case whereby it is required that Eskom's SBO purchase the energy from qualifying producers at the pre-determined rates. On the other hand, the tariffs published by Eskom on 23 February 2017 increased by 2.2% for direct customers and 0.31 % for municipalities (Eskom, 2017). These tariffs are presented in Table 2.2-3 below of which value-added tax (VAT) are included in the tariffs.

Table 2.2-3: Approved Eskom average tariffs for 2017/2018

Tariff type	Unit (VAT included)	Tariff
Home power (0-600 kWh)	R/kWh	1.27
Home power (> 600 kWh)	R/kWh	2.05
Home power bulk (NMD dependent)	R/kWh	1.47
Home light 60 A	R/kWh	1.2
Home light 20 A (0-350 kWh)	R/kWh	1.07
Home light 20 A (> 350 kWh)	R/kWh	1.21

Source: Adopted from the Eskom Customer Care website (Eskom, 2017)

An observation made with regards to the tariffs presented in Table 2.2-3 is that the tariff is mostly dependent on the consumption of the customer - which is not the case for the renewable energy tariffs presented in Table 2.2-2. Comparing the two groups of tariffs with one another, it can be observed that the tariffs for renewable energy are in general lower than that of traditional coal generation (except for CSP which is in general the most expensive renewable energy technology per kWh). This implies that renewable energy will impact consumer behaviour in the near future as it holds an economic benefit. This phenomenon will have a severe impact on local economic structures and communities and will inevitably impact the entire energy market of the country.

Two main scenarios can be derived from this phenomenon: consumers will either make a complete transition to renewable energy sources, disconnecting themselves from the national electricity grid or consumers will utilise renewable energy technologies in conjunction with the national electricity grid with the objective to save on energy usage. The first mentioned scenario will result in Eskom collecting less revenue which will in essence imply that a critical portion of the economy of the country will stagnate. The second scenario, however, will benefit the economy as Eskom still generates revenue, but consumers pay less for the electricity they use. In both cases, however, renewable energy will ensure economic and trade activity as well as job creation which will enhance the local economy.

2.2.2.3 The Green star rating system

According to the Global Africa Network (GlobalAfrica, 2017), the drive for sustainability has increased enormously over the past few years and several sectors, particularly the corporate sector, are striving to become greener, cleaner and more efficient. Supplementing to the drive for corporate sustainability is the fact that companies being listed on the Johannesburg Stock Exchange (JSE) are now obligated to integrate sustainability reporting with their financial reporting (JSE, 2018). Should these companies fail to do so, significant consequences are to be faced and they need to explain their reasons for not complying. Corporate companies and investors of these companies are thus sensitised to not be ignorant regarding sustainability elements and are encouraged to make sustainability form part of their value proposition. This is a strong indication that the emphasis should be far beyond only the triple bottom line concept which implies that more challenging features of sustainability should be considered. A deliberate transition from weak sustainability to strong sustainability is thus in progress in the corporate environment.

Based on the need and drive for corporate sustainability several companies are attempting to acquire a Green Star rating. This rating is considered an internationally acknowledged and trustworthy stamp of quality for buildings that rewards environmental leadership within the property industry. This rating is provided by the Green Building Council of South Africa (GBCSA) and forms part of an international body named the World Green Building Council that consists of 74 additional members (GBCSA, 2017).

The Green star rating for South Africa is also known as the PV Greencard as promoted by SAPVIA (SAPVIA, 2018). The benefits for companies obtaining a Green Star rating include (GBCA, 2012):

- Sound corporate images with regards to climate change and sustainability that will attract investors.
- Competitive advantages for a new sustainable marketplace.
- Improved awareness and media attention.
- Case study availability for researchers.
- Prompting change in the property industry.
- Reduction in operating costs.
- Increase productivity.
- Safety and health in the workplace.
- Demonstration of corporate social responsibility.
- Enhancement of future proofing.

The sector that contributed the most to this growth is the commerce and industry sector which can be ascribed to the need for energy and cost savings as well as energy security. The rapid growth in solar PV installations exhibits a decisive trend for major corporates to become sustainable in obtaining the Green star rating. This established programme therefore serves as an incentive for companies to make a transition towards renewable energy (specifically rooftop solar PV installations) and contributes significantly towards the renewable energy revolution.

2.3 A POLITICAL PERSPECTIVE

2.3.1 Policies established

As observed in the afore-mentioned literature several policies and legislation are established and key events took place that have shaped and enabled the development of renewable energy in South Africa. A timeline is exhibited in Figure 2.3-1 below indicating the chronological order of these developments.

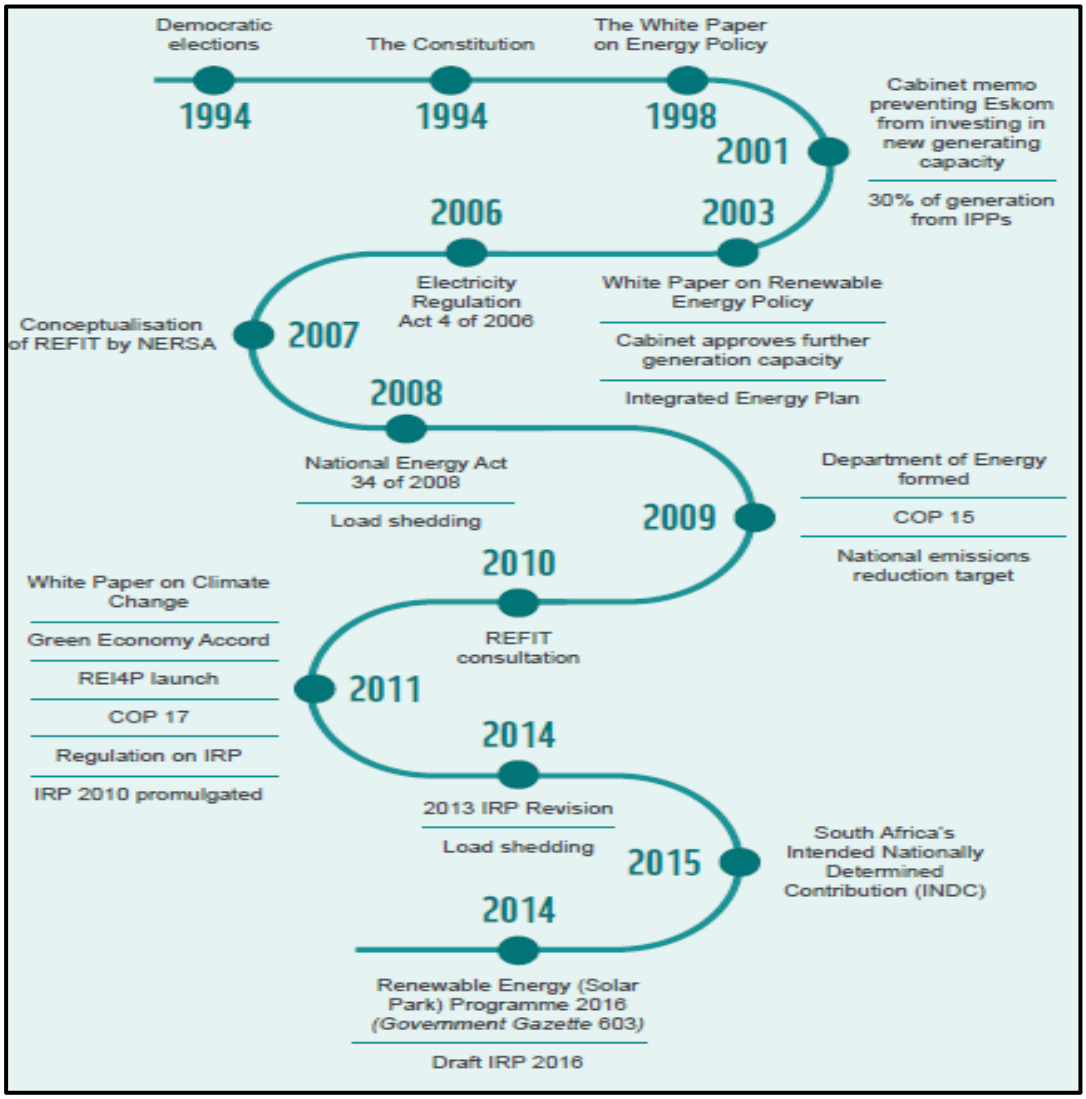


Figure 2.3-1: Timeline of key energy policies, legislations and events

Source: Adopted from the World Wide Fund (Scholtz *et al.*, 2017:18)

After 2014, the most significant and recent policy is the IRP 2018 that was published on Monday 27 August 2018 (DoE, 2018). Due to the fact this is the most recent policy that has been published in terms of the government's strategic plans to manage electricity demand in the country, most of the analysis and interpretations of this study evolved around this document. It is, however, important to be acquainted with the preceding policies that built-up to the IRP 2018, which is why the following section will be based on the analysis of the initial IRP 2010 (DoE, 2011), after which the key trends in the IRP 2018 will be discussed. It is important to take note that the executive summary of the IRP 2010 (DoE, 2010) was published prior to the final IRP 2010 report (DoE, 2011) – 22 October 2010 and 25 March 2011 respectively. The time period between the two reports was while the report was being published for public comment.

The objective of the IRP 2010 was to offer an indication of the country's electricity demand, the manner in which it will be supplied and how costs are incurred in doing so from 2010 up until 2030 (DoE, 2011). The core of this plan, which was in the promulgation process at the time, contained a study that incorporated three scenarios which are in actual fact three future possibilities for the country's diversified energy mix by 2030. The three possibilities as per the executive summary of the IRP 2010 are (DoE, 2010):

- The Low Cost scenario – the baseload will be predominantly coal-fired power stations. This is a low-cost scenario due to lower coal costs and the high local availability of the coal.

- The Low Carbon scenario – coal-fired power stations are reduced significantly and renewable energy dominates the market to a great extent.

- The Balanced scenario – coal-fired power stations are still predominant in the electricity supply but continuous developing and increasingly renewable energy generation supports the energy infrastructure of the country to a larger extent compared to current infrastructure.

The first two scenarios above are extreme cases for both sides of the spectrum i.e. the absence of renewable energy growth or the abundance thereof. Figure 2.3-2 below provides a visual representation of what the energy mix ought to consist of at the time as a forecast for 2030 with the aforementioned scenarios taken into account.

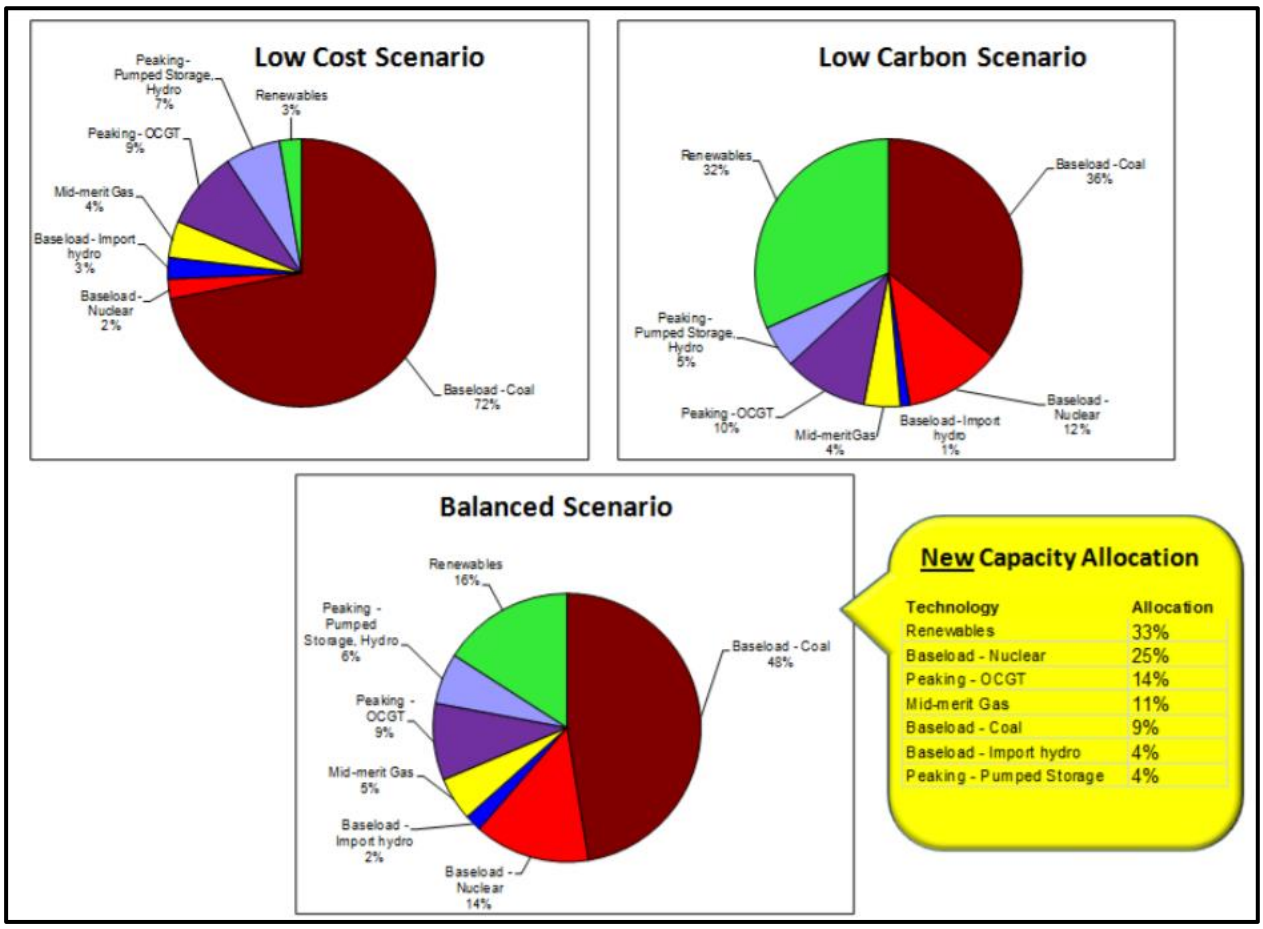


Figure 2.3-2: Diversified energy mix of South Africa by 2030 - IRP 2010

Source: Adopted from the executive summary of the IRP 2010 (DoE, 2010:24)

The IRP 2010 took into account that if the balanced scenario realised in the forthcoming years at the time, a steady transition would take place away from coal in the direction of renewable energy. This is still the status quo approximately seven years later although this transition has speeded up slightly as observed in the afore-mentioned literature. The reality is that the likelihood of the drive for clean coal technologies in the future cannot be ignored due to environmental legislation to enhance sustainability. The IRP 2010 therefore predicted that the withdrawal of approximately 25% of the existing Eskom generating fleet would cause a clear shift towards renewable energy. The focus of the plan was also clear, viz. that a definite transition towards renewable energy in the country would take place.

Taking the aforementioned scenario analysis into consideration, an interesting observation can be made with regards to the affordability of electricity of the future as this will have a severe impact on the economy of the country.

This affordability study forms a crucial part of this study as it will provide an accurate indication of the feasibility of renewable energy that is used as an instrument to answer the core research objectives. The indication that the DoE provided in the IRP 2010 is therefore utilised in conjunction with the IRP 2018 to perform an affordability study i.e. a comparison is made between the two policies and similarities and differences are noted.

Firstly, a complete and extreme transition to renewable energy with a significant decrease in coal generation will increase the energy tariffs to a great extent (close to 1.7 R/kWh in 2020 as per the IRP 2010). Comparing this tariff to the REFIT tariffs provided in Table 2.2-2, it can be seen that the tariff will increase by 0.4 R/kWh which is a 31% increase. This is the crucial impact coal generation has on the affordability of electricity which once again demonstrates the importance of having a diversified and balanced energy mix in the country. It also illustrates that the REFIT tariffs were established at a time (2009) when coal generation was the prime source of energy and that renewable energy was not as popular as in 2018. Renewable energy was also not forming an integral part of strategic development for South Africa in 2010.

Secondly, the balanced energy scenario will also cause an increase in energy tariffs but it won't be as high as when renewable energy was used as the country's predominant source of energy. The tariff increase will be 0.1 R/kWh which is a 10% increase. These tariffs will also significantly decrease over time and as the energy mix is diversified even further due to less emission costs with the benefit of having a secure and reliable supply from numerous energy sources. This phenomenon will cause the balanced energy scenario to follow a similar trend as the low-cost scenario making renewable energy affordable given that it is established in conjunction with coal generation. Figure 2.3-3 below illustrates the price paths of the three scenarios and provides an indication of the impact on affordability of energy should a diversified energy mix exist for the future.

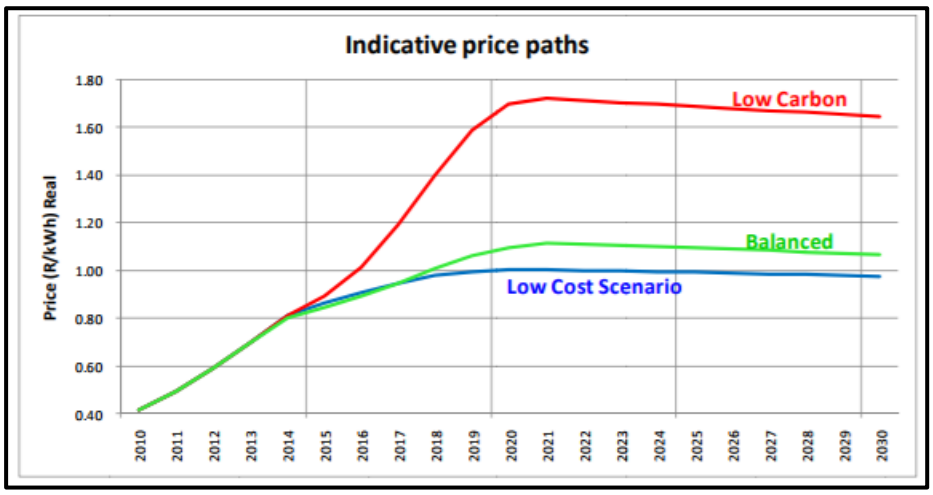


Figure 2.3-3: Indicative price paths for the energy mix scenarios - IRP 2010

Source: Adopted from the executive summary of the IRP 2010 (DoE, 2010:25)

The IRP 2010 emphasised that in order to ensure evolution to a stage-4 economy (where the manufacturing of finished consumer and capital goods forms part of the country's operations) the higher cost of electricity still needs be directed towards local beneficiation. Should this be achieved, employment opportunities will be increased with increased energy efficiency compared to previous time periods. This will significantly enhance local economic activity and growth as a result. With the recent publication of the IRP 2018 (DoE, 2018), the afore-mentioned seems like a realistic probability for the near future.

Comparing the IRP 2010 with the IRP 2018 that was recently published for commenting and input from key stakeholders, yields the following significant changes that affect decision-making of the applicable stakeholders to a great extent (DoE, 2018):

- Detailed analysis and engagements between industry key role players will take place to make forecasts of the energy mix even after 2030 (up until 2050). These engagements will guarantee a transition towards a diversified energy mix will therefore be inclusive according to the Energy Minister Jeff Radebe.

- The demand for electricity is declining annually compared to the assumptions made in the IRP2010 (as observed in Figure 2.1-2). The current demand is very similar to what was observed in 2007 – yet another indication of a revolution as per its definition. For the financial year ending March 2018, the actual demand was approximately 30% less than had been projected in the IRP2010.

Corresponding to this phenomenon is the fact that the performance of Eskom's current fleet is not at expected levels as the plant availability of the assumptions made in the IRP 210 which was above 80%. The IRP 2018 therefore accounts for the decline in demand for electricity to propose the new energy mix.

- Four energy scenarios are tested in the IRP 2018 (as opposed to only three in the IRP 2010) of which their impact on the future energy mix of the country is analysed. These scenarios are the following:

  - The electricity demand scenario
  - A gas scenario
  - A renewables energy scenario
  - An emission constraint scenario

  The DoE determined that the pace and scale at which the new capacity developments would take place need to be limited to what was projected in the IRP 2010. The least cost plan includes only three main renewable energy technologies which are:

  - Solar PV energy
  - Wind energy
  - Gas

  This implies that some new technologies will not be deployed as per the projections in the IRP 2010 which causes both uncertainty and disruption in the private sector among key stakeholders and investors.

  Annual build limits on renewable energy technologies ought not to impact the total installed capacity and development thereof in the renewable energy fraternity up until 2030. The proposed energy mix takes into account the decommissioning of some of Eskom's redundant coal power plants that have reached the end of their lifecycle.

- The IRP 2018 is prepared specifically taking into account the impact of a steady and slow-progressing transition towards renewable energy will have on stakeholders in the coal sector as the decommissioning of Eskom's redundant coal plants influence jobs in the sector. A socio-impact analysis is conducted to determine the actual impact of the decommissioning of the coal-fired plants. The DoE and the Minister of Energy left Eskom with the accountability to explain how this decommissioning process will take place and to minimise the impact as far as possible. The IRP 2018 states that coal will account for 46% (34 000 MW) in the energy mix up until 2030 and even though coal will be lower than the current installed base, it will contribute in excess of 65% of the energy volumes.

- The IRP 2018 states that the costs of new generation technologies have decreased – especially solar PV and wind projects. The respective renewable energy technologies will comprise the following total capacities:

    - 5670 MW obtained from solar PV (10% of installed capacity).

    - 8100 MW from wind (15% of installed capacity).

    - 8100 MW from gas (16% of installed capacity).

- The importance of gas is emphasised in the energy mix. In terms of where the gas will be sourced from, the Minister of Energy stated that the Southern African Development Community (SADC) has established a committee to compile a so-called gas master plan to deal with the challenge. Bilateral contracts are also established with Mozambique and the key stakeholders of South Africa will meet with Mozambique to finalise the contracts pertaining to this. In addition to this, the MPRDA bill will deal with fracking in the Karoo although the minister of Mineral Resources, Gwede Mantashe, is considering withdrawing the bill (Omarjee, 2018).

- The IRP 2018 does not forecast an increase in the utilisation of nuclear energy up until 2030 and it will only contribute to 4% of the energy volumes for the specified time period of 2018 to 2030. There is, however, an analysis conducted in the plan to determine the amount of nuclear energy that may be required after 2030 but up until the year 2030 no increase is required.

2.3.2 The challenges and scenarios

2.3.2.1 Policy uncertainty

2.3.2.1.1 CSP relating to the IRP 2018

From the four scenarios tested in the IRP 2018, the lowest cost plant favours solar PV, wind and gas and not CSP (DoE, 2018). STASA has made several comments on the IRP 2018 in order to request the DoE to consider the contribution of CSP in the proposed energy mix (Govender, 2018). According to STASA, the assumptions made in the LCOE modelling of the learning curves of CSP were omitted in the IRP 2018 but procurement was constrained. Several CSP projects are already operational and some still under construction (Govender, 2018:16):

- Bokpoort – 50 MW
- Kathu Solar Parl – 100 MW
- KaXu Solar One – 100 MW
- Khi Solar One – 50 MW
- Xina Solar One – 100 MW
- Ilanga – 100 MW (construction stage)
- Redstone Solar Thermal Power Plant – 100 MW (construction stage)

CSP has an economic life and the potential to allow PPAs of a 30 year time period and should be considered as the most competitive generator if it is allowed to dispatch 200 MW or more with capacity factors in excess of 70% (Govender, 2018:22). Figure 2.3-4 below presents the current range of CSP tariffs (R 0.80 to R 1.50 /kWh depending on uncapped procurement and PPAs) according to the assumptions made in all previous IRPs versus the actual bid tariffs in the REIPPPP.

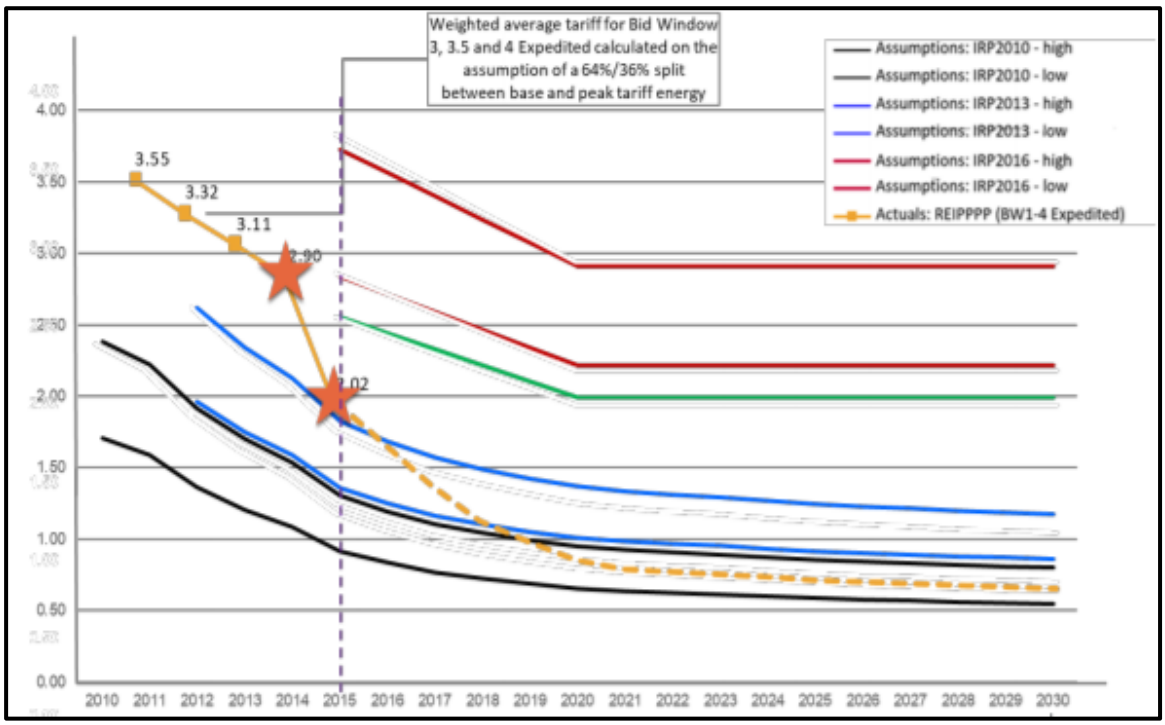


Figure 2.3-4: CSP tariff range for the previous IRP assumptions vs. actual

Source: Adopted from STASA's comments on the IRP 2018 (Govender, 2018:23)

A significant decrease in the tariffs for CSP is forecast for the near future. Final comments on the IRP 2018 regarding CSP are thus (Govender, 2018:24):

- The IRP should not limit CSP investments in South Africa as the development of projects is long lead and expensive and results in equity investments.
- Procurement for CSP technologies should be allowed that are uncapped so that larger plants can be planned for. This implies that CSP (as hydro) can serve as peak-demand stations on a competitive base and procurement can take place as and when energy are required (PPAs to match these requirements).
- CSPs have the potential to stabilise the network and avoid intermittent interruptions of supply.

2.3.2.1.2 Solar PV and wind relating to the IRP 2018

SAWEA has submitted a response to the IRP 2018 whereby they question the basis for investment decisions that were made in the plan, especially regarding the employment as well as the investment and manufacturing sector growth effects (SAWEA, 2018).

The organisation therefore calls for reconsideration of key assumptions made in the report pertaining to the coal and entire energy transition context. Specific reference is made to the planned sequence of wind energy procurement as a three-year gap is identified between 2022 and 2024. SAWEA suggest that there is evidence for the probable socio-economic and environmental benefits. The financial viability of the plan is thus questioned as the least cost plan in IRP 2018 does not cater for several known and anticipated market actualities. These include large-scale technology trends, the effects of the carbon tax as well as the LCOE of coal power investments together with the data on Eskom's fleet efficiency. SAWEA states that completely different investment decisions would have been made if this was taken into account effectively.

The following concluding concerns are therefore raised by SAWEA in terms of the IRP 2018 that takes the afore-mentioned into account (SAWEA, 2018):

- A critical opportunity for the government lies in the demonstration of climate change commitments by bringing forward greater investment in renewable energy.

- Costs pertaining to the continued maintenance and investments in coal power stations should be avoided.

- The REIPPPP is a strategically sound plan that can assist in the government's objective to attract R1 trillion worth of new investments to South Africa while stimulating growth of employment.

- The substantial number of jobs, direct rural social and economic advantages pertaining to the Wind industry in South Africa has shown that it has the potential to provide.

- The wind energy industry made a noteworthy contribution to the South African economy in terms of GDP output as the CSIR analysis indicated that the wind energy sector during the IRP period will result in R 63.7 billion in earnings, R 360 billion in total economic output and R 122 billion in GDP contribution (2019 to 2030).

The IRP 2018 should therefore ensure improved and optimal policy alignment so that it establishes an enabling environment for localisation as the projected procurement gap in the plan threatens to undermine this critical and highly valued policy.

SAPVIA on the other hand welcomed the long-awaited IRP 2019 as they stated that it provides a solid foundation for a sustainable future (SAPVIA, 2018). The organisation is therefore grateful to observe the least cost plan being a crucial component of the IRP 2018 as they agree that solar PV is among the most cost-effective and financially viable renewable energy technologies in the country. The following comments were, however, made pertaining to the IRP 2018 by SAPVIA (SAPVIA, 2018):

- The steady transition to changing electricity landscapes should be holistic in nature i.e. accurate summation of jobs pertaining to the solar industry should be made.

- No specific mention is made in the IRP 2018 regarding round 5 of the bid window in the REIPPPP, yet the Minister of Energy through the DoE promulgated this round of procurement through an official determination.

- No specific mention is made of small programmes and this should be clarified by the DoE.

- Rooftop PV deserves specific mention and quantification in the plan and this is important as this sector has spiked substantially over the past few years. SAPVIA believes that the allocated 200 MW is insufficient to address the growing needs of this specific market segment.

- A lag period between 2022 and 2025 exists in the plan whereby committed solar PV ends and consistent growth is required for the industry to augment job creation.

- The plan is decisive on the separation of the decommissioning of Eskom’s redundant coal power plants and this provides a clear indication of the impact on energy demand.

SAPVIA therefore supports the efforts by the government to test and consider annual bid limits in terms of renewable energy given that the total installed capacity building up to 2030 is not impacted. SAPVIA will engage with the key stakeholders to provide further commenting on the IRP 2018 to the DoE.

2.3.2.2 Collaboration of the public and private sectors

Although the 27 IPP projects were recently signed, it cannot be overlooked that there were clear signs that Eskom showed great resistance to the signing of these contracts that contributed to the two-year delay in the procurement process. The refusal by Eskom to sign the PPAs of the respective IPP contracts took place in 2016 stating that cost implication and overcapacity in South Africa were the reasons for their decision (ERC, CSIR and IFPRI, 2017). This decision effectively stumped the REIPPPP and in the process South Africa has since been overtaken by numerous countries in continuous delivery of considerable cost related benefits for wind and solar PV. This is a clear indication that the utility hinders the development of renewable energy and supports the original problem statement. Brenda Martin, the chairperson of the South African Renewable Energy Council (SAREC), stated during a press conference in 2017 (Meier, 2017) that South Africa could not afford to refuse the creation of construction jobs in excess of 13 000 that would result from the IPP procurement process. Fortunately, IPP contracts were signed after an extensive delay but the status quo will remain unless Eskom makes strategic transitions to cater for both the coal-fired energy and the renewable energy market.

The bottom-line of the research is therefore that the economic growth of South Africa is to a large extent dependent on the development of renewable energy and if renewable energy strategies are not managed optimally, the economy may be affected in an undesirable manner. The paradoxical phenomenon demonstrates that Eskom is the key stakeholder that ought to strategically develop renewable energy technologies in collaboration with the DoE and other industry role-players (including the private sector).

In order for the proposed diversified energy mix suggested in the IRP 2018 to become a reality, it is of critical importance that all stakeholders within the energy industry of South Africa collaborate intensively. If this collaboration does not take place, the defined renewable energy revolution might yield undesired results for the country that may negatively affect stakeholders in both the public and private sector.

The following collaboration of key role players should therefore take place to yield the desired potential outcome of the renewable energy revolution in the build-up to a sustainable green economy:

- Collaboration between Eskom and the DoE to deal with the mentioned paradoxical situation - a balance between a diversified energy mix that will benefit both Eskom and private sector stakeholders therefore needs to be established.

- Collaboration between Eskom and NERSA to create a pathway towards to stabilisation of energy tariffs – the utility has recently asked for a 15% increase in tariff per year for the next three years but NERSA only recently approved a 4.1% increase which is effective in April 2019 (NERSA, 2018). NERSA provided Eskom with the opportunity to recover R 32.69 billion although the original application was to allow revenue of R 219 billion for 2019/20, R 252 billion for 2020/21 and R 291 billion for 2021/22. Eskom can therefore not rely on NERSA anymore to recover their fixed cost through tariff increases to increase revenue growth. The only way for Eskom to recover the fixed costs is therefore to collaborate with NERSA and to start offering renewable energy solutions together with their main product – coal supply electricity. The stabilisation of energy tariffs will then become a reality. This implies that their business model should be transformed to increase revenue.

- The DoE, NT and the DBSA should collaborate intensively with one another to enhance the development of newly procured IPPs in order for the proposed energy mix to become a reality. Additional to this collaboration, the DTI, DPE, DEA, SANEA should collaborate with one another as well as the private sector to fulfil the requirements and objectives of the IRP 2018.

2.4 SUMMARY

This chapter provided an in-depth insight on three main constructs pertaining to the literature available for the renewable energy revolution. These constructs are the coal generation perspective, the renewable energy perspective and the political perspective of the defined revolution. The coal generation perspective describes the paradoxical situation that Eskom is confronted with, the manner in which economic growth correlates with coal generation and provides insight on the LCOE model for coal. The renewable energy perspective provides insight on the viability of innovative renewable energy technologies, presents the benefits that these technologies offer and investigates the impact that these technologies have on the energy industry. The processes established to enhance the development of renewable energy in South Africa were also investigated. The chapter is concluded with a political perspective that provides insight on the established policies for the energy industry and the challenges and scenarios pertaining to these policies. The impact, benefits, challenges and scenarios pertaining to the revolution were therefore critically analysed to obtain sufficient data to be compared to the findings in the forthcoming empirical study.

CHAPTER 3: EMPIRICAL STUDY

3.1 OVERVIEW

The purpose of the data collection instruments (Appendix F) is to observe phenomena and scenarios of various elements of the renewable energy fraternity and then experiment with the findings by comparing the views of different experts with one another. The closed-ended questions are used to guide the participants in a certain direction but also to predict a specific outcome of certain elements of the study. The open-ended questions on the other hand are utilised to obtain rich, thick and holistic data that explain and support the findings of the closed-ended questions. The results for the closed-ended questions are presented in Appendix G and the transcribed interview results appear in Appendix F.

For each construct established in the literature review, selective data collection instruments were established to correlate with the literature review. It is important to note that the exact same data collection instruments are used for all members of the target population group. Therefore, selective findings on specific scenarios, topics, trends, events or policies from the literature were posed to the interview participants under each construct and a discussion was held with them. The literature is therefore tested in this empirical study. From these discussions, themes under each construct are derived that are in essence trends, similarities and common findings or opinions among the interview participants that revolves around a certain concept. These themes are then tested against the findings in the literature, interpreted and discussed to make definite conclusions about certain concepts.

It is important to emphasise the fact that the findings in this empirical study is qualitative in nature and that the open-ended questions developed into a discussion with the interviewees. The closed-ended questions are therefore only utilised to determine specific trends to enhance the qualitative nature of the study and to make substantial conclusions from the discussions with population group during interviews. Similarly, the open-ended discussions are utilised as data collection instruments to describe the trends identified in the closed-ended discussions. Both the findings from the closed-ended and open-ended questions are discussed and analysed in the forthcoming section 3.3.

3.2 DESCRIBING THE SPECIFIC STUDY POPULATION

Out of the target population group of ten experienced individuals, seven are employed within the organization (public sector) and operate in diverse business divisions. This ensures that the interpretation of the contributing factors to the renewable energy revolution from a utility perspective is objective and wide-spread i.e. it does not relate to the opinions of only a specific division of the utility.

The other three individuals who represent experience within the renewable energy fraternity are employed outside the organization in the private sector, further ensuring diverse and objective data collection.

Identifying a study population within the organisation will on its own not be sufficient as the views and opinions of the experts may be biased and the data collected may not be a true reflection of the impact renewable energy revolution. The core purpose of selecting a diverse target population group is to obtain a holistic view of the renewable energy impact and not only from a utility perspective (although this side of the spectrum forms a crucial part of the empirical research). It is for this reason that the decision was made to extend the study population outside the boundaries of the utility. The approach taken in the selection of the target population is to progressively increase the boundaries of the research population circle.

The further segmentation of the target population is as follows:

- Three individuals employed in Eskom Distribution, Asset Creation – Network Engineering and Design (NED) responsible for the design and execution of projects of which IPP projects form part of. These individuals have the following job descriptions:
    - Asset Creation – NED, Control Plant Middle Manager (more than 15 years of experience)
    - Asset Creation – NED, Control Plant Senior Advisor (more than 15 years of experience)
    - Asset Creation – NED, Control Plant Senior Engineer (between 10 and 15 years of experience)

- An individual employed in Eskom Distribution, Asset Creation – NED responsible for medium- to long-term planning of projects specifically focussing on the control plant infrastructure. Part of this planning entails feasibility studies for providing rural communities with access to electricity. This individual has the following job description:

    - Asset Creation – NED, Control Plant, Smart Grid and Telecoms Senior Advisor (more than 15 years of experience)

- An individual employed in the Operation and Maintenance (O&M) division in a department called Network Operations and Support (NOS) and specifically appointed in the Protection Coordination and Configuration (PC&C) section. This individual is responsible for calculating settings that are applied on protection relays to operate correctly in the event of a fault on the network. Extensive work was done by this individual on the first commercially viable biogas plant in South Africa. The job description of this individual is:

    - Protection Coordination and Configuration Engineer (between 5 and 10 years of experience)

- Two individuals employed in Eskom Group Technology (GT) which is a division established within the organisation responsible for research, development and execution of technologically feasible solutions relating to grid infrastructure. The job descriptions of these two individuals are:

    - Centre of Excellence, Control and Instrumentation (C&I) Senior Engineer (between five and ten years of experience and completed a PhD in renewable energy)

    - Design Base Operating Unit Support (DBOUS), Standards and Implementation (S&I) Senior Technologist (more than 15 years of experience and specialises in electrical engineering substation protection)

- An individual who is a graduate in training at a renewable energy company that specialises in solar and wind energy technologies with the following job description:

    - Graduate in training (less than one year experience and currently studying Electrical Power Engineering and thus has extensive theoretical knowledge of the most recent renewable energy technologies and its benefits)

- An individual who is on the board of directors of a privately owned biogas plant in Gauteng with the following job description:

    - Major shareholder of a biogas plant and overseeing operations of the plant (more than 15 years of experience and former Eskom employee)

- An individual who is employed at a private, limited liability company of which the core activities are to publish printed and electronic media with specific focus on electrical and renewable energy trends relating to specific energy intensive sectors of South Africa. The job description of the employee is as follow:

    - Strategic Energy Planner (more than 15 years of experience in electrical engineering and specialises in journalism with the aim to promote thorough understanding of energy and the impact it has on sustaining human endeavours)

The target population therefore consists of ten individuals comprising a diverse set of skills and expertise in energy development and the impact it has on both the public and the private sector of South Africa. The description of the target population and the sample sizes of each target population are depicted in Table 3.2-1 below.

Table 3.2-1: Sample size for each target population

Industry	Specific sector	Field of expertise	Sample size
Coal generation	Eskom Distribution	Asset Creation - NED (Projects)	5
Coal generation	Eskom Distribution	Asset Creation - NED (Projects)	
Coal generation	Eskom Distribution	Asset Creation - NED (Projects)	
Coal generation	Eskom Distribution	Asset Creation - NED (Planning)	
Coal generation	Eskom Distribution	O&M – NOS (PC&C)	
Coal generation	Eskom GT	Centre of Excellence (C&I)	1
Coal generation	Eskom GT	DBOUS (S&I)	1
Renewable Energy	Solar and Wind	Electrical Power Engineering	2
Renewable Energy	Biogas	Privatised Energy Solutions	
Media Technology	Energy Planning	Strategic Energy Planning	1

Source: Own compilation

The alternative unit of analysis that was considered for this study is the following:

- Experts purely operating in the financial and economic sector. The problem with this unit of analysis is the lack of knowledge and experience in the renewable energy industry. Consultation with the chosen unit of analysis during the interview stages did, however, take place to investigate possible additional experience that relates to the financial and economic sector. From the interviews it has emerged that three individuals out of the population group of ten did indeed have experience relating to this industry. These individuals were responsible for cost forecasting and feasibility studies of several renewable energy projects. The additional data obtained as a result of seeking and alternative unit of analysis proved to be extremely valuable with respect to the data collection for this study. The additional data gathered were therefore utilized to further quantify the impact of the renewable energy revolution.

- The communities affected by the implementation of renewable energy were definitely an option to retrieve sampling data. The reason why the decision was dismissed to utilize this unit of analysis is purely because the data that would have been collected would be very shallow. The socio-economic impact of the renewable energy projects had on these communities is thus purely based on the literature review and the relevant stakeholders that were involved with the projects in these communities.

An alternative unit of analysis would not be appropriate to answer the research question as the intention was to gather accurate and reliable information from professionals and experts in the respective fields. The unit of analysis is therefore considered to be an all-inclusive and wide variety of experts with different experiences, views and opinions.

3.3 ESTABLISHMENT OF THEMES

3.3.1 Coal generation industry

3.3.1.1 Coal generation to remain the predominant energy source

Eskom is a monopoly and has expensive capital investment to repay while also paying premium cost for renewables. A clear trend was observed during the interviews in the sense that Eskom should have considered renewables or curtailing the current coal fired power station units. However, older units can possibly be shut down. The cost for the two new power stations did, however, escalate massively due to excessive political interference.

A definite trend observed during the interviews is the fact that the majority of the population group favours the renewable energy revolution, although they feel that the coal generation industry will be sustainable. The interviewees therefore support the fact that the contribution of coal generation should be decreased with an increase in renewable energy initiatives. This is why the results from data collection instrument B.1 indicate that 60% of the population group indicated that they don't agree that South Africa is completely dependent on coal generation for economic growth. Furthermore, it can be observed from the same data collection instrument that the remaining 40% of the population group slightly agreed that South Africa is completely dependent on coal generation for economic growth. This implies that the expectation from the entire population group is that the renewable energy revolution holds the potential to stimulate economic growth should it be implemented in collaboration with the coal generation industry. A conclusion is thus derived that the population group is not entirely convinced that the coal generation industry alone will ensure economic growth and that renewable energy is required to enhance this growth.

There is therefore no doubt from the empirical study that coal should still form part of the diverse energy mix and that it is just the size of the contribution in the mix that will differ in the future.

The majority of the population group (80%) agree that the optimal energy solution for South Africa should in fact consist of coal generation (data collection instrument B.2). This is emphasized by the fact that 70% of the population group are of the opinion that the coal generation industry is not threatened by renewable energy initiatives (data collection instrument B.3). It became clear during the interviews that this can be mainly attributed to the fact that Eskom comprise a strategic competitive advantage which is their grid infrastructure. This correlates with the findings in the literature review.

Considering the cost of coal, a decisive conclusion can be derived from the results of data collection instrument B.5 whereby 70% of the population group agree that coal should remain the primary energy source of the country due to the relative low cost of coal and the abundancy of the commodity. The fact that the remaining 30% do not agree with this phenomenon can be attributed to the fact that the costs of renewable energy technologies are decreasing at a significant rate and are therefore considered intense competition for the coal generation industry.

Although it is clear from the empirical study that coal generation is here to stay with a decrease in contribution to the energy mix of the country, the decision between investments in clean coal technologies and renewable energy technologies is still a balanced decision. This evident from data collection instrument B.7 as 60% of the population group states that the investment should be in renewable energy technologies and the other 40% believe the investment should be in clean coal technologies. Proving the validity of the fact that investment should slightly more in renewable energy than clean coal technologies (as in data collection instrument B.7) are the results from data collection instrument B.11. These results indicate that 90% of the population group disagreed that the investment in clean coal technologies should be the primary focus instead of renewable energy. The results from data collection instrument E.13 support this statement by the population group.

The conclusion therefore regarding the investment decision between these two technologies is that a strategic balance ought to be maintained. The literature also supports this outcome as the government succeeded in reducing their carbon emission levels while upholding a real GDP growth. The costs of operating coal plants more cleanly are high, which is why the investments in clean coal technologies should be a careful and strategic decisions by the government and should be balanced with the investments in renewable energy.

To emphasize this balance, the results from data collection instrument B.9 indicate that 70% of the population group agreed that the required R 400 billion to extend the life of Eskom's redundant power stations should rather be utilised for investment in renewable energy.

3.3.1.2 Eskom to revolutionise their business model

3.3.1.2.1 The Eskom death spiral

A significant correlation with the literature exists with regards to the paradoxical situation that Eskom is confronted with currently which is also commonly referred to as the Eskom "death spiral" in numerous mentions during the interviews. Although the coal industry is not threatened by renewable energy technologies, there are still high expectations from industry key role players (especially Eskom) to promote research and development in renewable energy. Contributing to this "death spiral" is the fact that the availability of Eskom plant is lower than initially anticipated in the IRP 2010 – 70% of the population group believed that this negatively impacted South Africa's economic growth (data collection instrument B.10). The entire population group fully support the fact that Eskom should promote research and development in renewable energy (data collection instrument B.4). Whether the grid infrastructure is sufficient to support and sustain upcoming IPP connections is, however, questionable as observed in the results from data collection instrument C.14. This is questionable due to the fact that the experts in the energy industry is not entirely convinced that Eskom will in the near future be changing their business model to cater for renewable energy technologies. In addition to this uncertainty is the fact that political interference in the past caused the utility to be mandated for the construction of two new power stations and as a result increased their capital investments that they have to repay. The problem with Eskom is therefore much deeper than just governance issues in the organisation - they are pressurized and confronted with this renewable energy revolution.

The results from data collection instrument D.5 indicate that that seven out of the ten interviewees believe that renewable energy has the potential to help Eskom out of its difficulties. This is opposed to the results from data collection instrument D.6 that indicates high uncertainty among the population group regarding the possibility of this actually happening.

Renewable energy is therefore a definite solution to Eskom's paradoxical situation but the utility's current strategic planning and business model is so out of sync with the energy market that it requires more than just a sudden change in the utility's structure (data collection instrument E.18). It is therefore indeed a complete revolution that is required to amend their current situation. High uncertainty exists, however, whether Eskom is abusing its position as a dictator of a monopoly market to favour its own investment in new power plants as indicated by the results from data collection instrument D.8. This uncertainty is attributed to the fact that Eskom previously refused to sign-off the recent 27 IPP contracts for procurement but still shows some intention to support green energy. The only manner in which this uncertainty is removed is to adapt their business model to deliberately cater for renewable energy technologies (data collection instrument E.14). The fact that the utility did not adapt their business model already (while the renewable energy revolution is at its peak) is considered a major barrier that ought to be overcome for the country to flourish in the renewable energy fraternity (data collection instrument E.1). The factors that need to be considered for the utility's business model to be revolutionised are:

- The capability to absorb generated electricity from IPPs.
- Cater specifically for customers who need electricity and sell the generated electricity to them (generated from IPPs).
- Maintain a strict balance between supply and demand.

Eskom should therefore position them in such a way that they are considered the transport-medium for all types of generated electricity that connects "sellers" and "buyers" of electricity. This is, according to the majority of the population group, the only that Eskom will save themselves from the so-called "death spiral" as they have expensive capital investments to repay while currently paying a premium cost for renewable energy. In addition to entering the renewable energy market, the utility should consider limiting the output of current power stations that incur high maintenance costs or even completely shutting down these power stations (already part of the IRP 2018). The results from data collection instruments E.7 and E.8 confirmed that the major threat to Eskom is indeed the so-called "death spiral" that ought to be managed by the utility.

The results from data collection instrument E.20 indicate that for the renewable energy revolution to have a positive impact on the country, the first step will be indeed for Eskom to adapt their business model to cater for renewable energy.

3.3.1.2.2 The cost structure to be adapted

A substantial need exists that is specifically related to the stabilisation of tariffs as the cost structure is not clearly defined and controlled by the relevant stakeholders. There is already a challenge regarding the current cost structure for electricity generated from coal i.e. adding renewable energy to this existing cost structure creates additional challenges in the industry. A need therefore exists (as observed during the interviews) for the gird and its maintenance costs to be separated to reveal a true reflection of the tariffs offered by the utility should they enter the renewable energy market (data collection instrument E.16). NERSA should then decide the realistic cost of this by taking into account grid costs, maintenance, ageing plant and several other factors that may have an impact on tariff stabilisation. The cost of energy must then be standardized across the board for all different renewable and non-renewable energy sources i.e. determining the rate that the energy generator must be paid, irrespective of size and location. Over time, the non-renewable and renewable energy tariffs have to be carefully managed and cross-subsidized to control the IPPs being introduced and to work towards the governments' end state vision for energy in South Africa.

The afore-mentioned requirement is validated as the results from the data collection instrument C.15 indicate that the population group is in clear disagreement as to whether the pricing investment decisions for IPPs are efficient. It became clear from the discussions during the interviews that the pricing investment decisions for IPPs are not solely dependent on the stakeholders in the private sector and that Eskom and NERSA also need to become pro-actively involved in the process. This involvement, however, is limited to a great extent according to the majority of the population group. This also contributes to findings from the results of data collection instrument C.16 as the population group are not able to comfortably state that the investment in an IPP project is low risk, stable and predictable. According to the PPA and application to NERSA, power generated through IPPs are pass through cost, i.e. Eskom does not pay for this electricity as it is directly passed on to the consumer. The tariff increases is attributed to the fact that Eskom attempts to cover their debt and operating expenses.

Taking off power from IPPs does, however, negatively affect Eskom as they lose out on the sales they could have made instead. A definite conclusion in this regard can therefore made i.e. unless Eskom and NERSA collaborate to deal with the so-called “death spiral” the electricity tariffs will remain unstable and the taxpayer and consumer will have to bear severe consequences.

A noteworthy correlation exists between the empirical study and the literature study regarding the LCOE as exactly half of the population group agreed that the LCOE of new coal is among the most expensive technologies per kWh of electricity delivered and the other half did not agree with the statement (data collection instrument B.8). The reason for these divided opinions of the population group can be attributed to the fact that the literature states in section 2.1.3:

- The LCOE from coal per kWh generated cannot be compared with the LCOE of renewable energy.
- The LCOE of ageing power plants cannot be compared with the LCOE of new coal.
- The LCOE of variable sources of energy such as renewable energy cannot be compared with the LCOE of baseload generation such as Eskom.

The results from the empirical study prove that although the above-mentioned comparisons cannot and should not be made, this often takes place and in the process the uninformed is misled. This is exactly why the population group was not able to predict a specific outcome of the LCOE for new coal because they attempted to make the comparison which is not possible. The conclusion is therefore that the costs for renewable energy, new coal generation and coal generation from ageing fleet should be treated as completely different entities. The costs of the various generation technologies should therefore not be considered the deciding factor of the impact it has on the country. A barrier identified in data collection instrument E.1, however, is the fact that the upfront capital costs for renewable energy technologies are very high. The additional impacts discussed in the literature review and empirical study should therefore carry more weight when the generation technologies are compared with one another.

3.3.2 Renewable energy industry

3.3.2.1 A need for a transition

Analysing the results of data collection instrument C.1 indicate that the entire population group believe that an urgent need exists for South Africa to make a transition towards renewable energy, keeping in mind that 70% of the target population are employed in the coal generation sector. Furthermore, 90% of the target population (data collection instrument C.2) agrees that this transition should be gradual and not instant which correlates with the literature in section 2.2.1.2.3 that states if the renewable energy transition in South Africa is not gradual, the impact on the coal sector would be immense. This is yet another indicator as to why it is crucial that Eskom revolutionise their business model to cater for renewable energy as the demand for coal-generated electricity declines while a gradual transition in renewable energy takes place. Eskom therefore needs to find a way to generate revenue through other means with the trading of renewable energy becoming a bigger reality for their business model.

Contributing to the need for a transition is the fact that the entire population group stated that it is indeed feasible to increase and promote renewable energy generation in South Africa (data collection instrument C.5). In addition to this, the population group stated that South Africa is privileged to be a country where the majority of renewable energy variations can be implemented (data collection instrument E.1). The challenge, however is to create opportunities to utilise these technologies optimally. From the interviews it became clear that the feasibility of renewable energy is attributed to the fact the ROI is achieved over an extensive period of time – depending on the technology type and capacity size of the plant. The technology is thus considered a long-term investment.

It also became clear during the interviews that although the demand for electricity (especially from Eskom) has decreased in recent years, that the need for renewable energy still exists. The results from data collection instrument C.8 prove this as nine out of the ten interviewees indicated that the need still exists. This correlates with the literature review (section 2.2.1.2.1) that states the need for renewable energy predominantly is not because an increase in capacity is required and that several other factors exist that defines this need.

Further proof from the literature relating to this phenomenon is the fact that the demand for electricity is still decreasing (Figure 2.1-2 and Figure 2.1-6) but the need for renewable energy is increasing as depicted in the IRP 2018.

The need for this transition is mainly attributed to the fact that consumers of electricity strive to reduce their cost of current use of energy (data collection instrument C.17). This is due to the fact that renewable energy seems like a very attractive option for all consumers of the energy industry indicating once again that South Africa is currently experiencing a renewable energy revolution. The reason for renewable energy being an attractive option is due to the perception that is created in the industry that the costs of renewable energy technologies are declining at a significant rate (section 2.2.1.3). The factor that attributes the least to the need for a transition is the shortage of traditional energy sources as there are still abundant coal supplies left in South Africa (evident during the interview discussions). The remaining attributes to the need for a transition are as follow (in descending order of significance):

- Economic growth
- Reliability and security of supply
- Balancing demand and supply during peak periods
- Reduction of the carbon footprint

It is important to note that only a perception is created in the industry regarding the costs of renewable energy and that this might differ substantially from actual costs. This is proven by the results from data collection instrument D.2 as diverse opinions among the population group exist regarding whether the upfront investment costs for renewable energy can be justified by a reduction in energy tariffs. The results do indicated that the renewable energy tariffs are reduced in recent years but the following factors still play a significant role:

- Great uncertainty still exists regarding the sustainability of the REFIT.
- Great uncertainty still exists pertaining to the level of collaboration between Eskom and NERSA.

- Great uncertainty still exist as to whether Eskom will be able to and in actual fact will decide to revolutionise their business model.

- The upfront investment cost of renewable energy are currently so high that the reduction in energy tariffs are just not enough to justify the investment and the ROI might not be feasible.

The afore-mentioned factors are evident from the discussion during interviews and are considered barriers that ought to be overcome if a steady transition is made to renewable energy. These factors play a significant role in the perception that is created among private sector stakeholders and if not managed a so-called “false market” may be established for renewable energy and will contribute also substantially to the paradoxical situation that Eskom is confronted with. The private sector is a competitive environment (especially for renewable energy in 2018) but should be managed by all stakeholders in the industry to spiral out of control. Should this not be managed the transition to renewable energy in South Africa will have numerous unnecessary challenges and extensive delays.

3.3.2.2 An indication of a transition

Data collection instrument E.17 provides substantial evidence that the transition towards renewable energy should be a gradual transition as stated by the entire population group. Furthermore, 70% of the population group indicated that from a holistic point of view, the impact of a transition towards a renewable energy revolution in South Africa will be positive (data collection instrument E.19). When South Africa is benchmarked against other countries regarding the implementation of renewable technologies, the results from data collection instrument C.6 indicate that nine out of the ten interviewees agree that the country is lagging behind with the implementation. This is largely attributed to the fact that the energy sector of South Africa is dictated by a monopoly market and is another clear indication that Eskom need to adapt their business model to compete in the global energy market. The possibility of this realising within the next decade is tested with the results from data collection instrument C.7 and indicates that this is not a high possibility. The results indicate that 70% of the population group indicated that they do not think South Africa will overtake other countries in the implementation of renewable energy within a decade.

It became clear during the interviews with the remaining 30% who believe that it is indeed a possibility, that it is attributed to the following factors:

- The recent publication of the IRP 2018 as it provides an indication that the government in collaboration with the DoE have clear intensions to promote renewable energy in the country – it is therefore a step in the right direction.
- The availability of renewable energy is abundant – especially for solar PV and wind energy.
- The significant growth of renewable energy technologies in recent years – especially solar PV and wind energy.
- A significant transition of major corporates towards the installation of rooftop solar PV.

From the afore-mentioned factors, the results from data collection instrument C.20 indicate that this transition has the potential to benefit a number of sectors and stakeholders that are related to the renewable energy fraternity. The corporate sector will benefit the most from the transition to renewable energy which is attributed to the Green star rating system a described in section 2.2.2.3 of the literature review. There is a clear indication from the population group that Eskom will benefit the least from the transition to renewable energy. This is attributed to the fact that the utility's business is yet to be revolutionised as this will be the only manner in which the utility will benefit from the transition. The remaining sectors and stakeholders that will benefit from the transition are as follow (in descending order of significance):

- Private households
- Agriculture
- Rural communities
- Municipalities

3.3.2.3 The downside of renewable energy projects

Although several positive indicators of the renewable energy revolution were identified in this study, several downsides exist with regards to the implementation of renewable energy technologies. The results from data collection instrument E.6 provides evident proof of this as follow:

- Job losses in the coal sector should the revolution be sustainable. This downside only exists if a complete revolution takes place and is not applicable to the commissioning of single IPP projects.
- Renewable energy technologies still require high upfront capital costs.
- The reliability of renewable energy projects are yet to be proven.
- A high probability exists whereby the rich become richer and the poor get poorer especially with the implementation of solar PV technologies. The increase in tariffs will be the result of this phenomenon should further development of renewable energy technologies take place (especially solar PV).
- A sustainable renewable energy revolution will decrease the demand for coal-generated electricity and cause Eskom to have a surplus energy which will affect the utility's sustainability. This will negatively affect the economy of the country if not managed pro-actively as Eskom is a substantial driver of the economy.
- If renewable energy is not implemented together with a specific form of energy storage, the Eskom "death spiral" might escalate out of control.
    - Eskom assets being over-utilised in some instances and under-utilised in other.
    - The afore-mentioned will lead to increased maintenance costs incurred by the utility.
    - The electricity tariffs will as a result be unstable and increase significantly.
    - More IPPs will be commissioned due to attractive investments in the private sector which will reduce the demand for coal-generated electricity even further.

- A so-called “false” market for renewable energy is established that will result in uneducated decisions in the private sector.

- Should the renewable energy revolution be sustained, major adjustments will be required in the workforce of the utility which may cause instability in the utility workforce for an extensive period of time.

3.3.2.4 Several indicators of the revolution

A decisive interpretation is made regarding the indicators that are used to quantify the impact of the revolution. Out of the ten interviewees, nine stated that GDP growth is not an accurate indicator of the renewable energy revolution and that other factors should be considered as indicators that include (data collection instruments E.2 and E.3):

- Reduction on electricity demand from Eskom.
- The price of coal as a commodity.
- Skills level and understanding how renewables should integrate with the grid.
- Reduction in day time peak demand. It is perceived that minimal storage exists with the majority of renewable IPPs being solar PV and wind only contributing a small portion in the end-state energy mix.
- The reduction of water scarcity and improvement in the pollution of the environment.
- Eskom being allowed to participate in the REIPPP and submit their bids.
- A diverse combination of job creation, energy consumption and energy tariffs.
- Local economic activity.
- The effect wheeling agreements have on the corporate environment - the drive for corporate sustainability is huge. JSE listed companies should even now report on their sustainability.
- The LCOE model provides sufficient indications of how this can affect the tariffs for new coal technologies as well as renewable energy technologies.

The afore-mentioned indicators tie up with the findings in the literature as all the mentioned indicators in the empirical study were mentioned during stages of the literature study. The data collection instruments E.2 and E.3 yielded the results pertaining to the afore-mentioned indicators which were evident from the open discussions during the interviews. These data collection instruments, however, did not prioritise the indicators of the renewable energy revolution and in addition to this gap; the indicators are fairly vague in terms of the actual contribution to the revolution. This gap is closed utilising data collection instrument C.18 that guided the interviewees in a specific direction pertaining to factors that contribute to the revolution. The results from this data collection instrument indicate that the factor that contributes the most to the impact of the renewable energy revolution is the stabilisation of energy tariffs. Once again, this shifts a great responsibility to Eskom to collaborate with NERSA and in actual fact all other industry stakeholders to path a way to a steady transition to renewable energy as mentioned in section 3.3.1.2.2. The factor that has the least contribution to the impact of the renewable energy revolution is the decrease in the demand for coal. This correlates to both the literature and the empirical study section 3.3.1.1. The remaining factors that contribute to the impact of the renewable energy revolution are as follow (in descending order of significance):

- GDP growth
- Reduction of carbon-tax costs
- Job creation
- Water-usage cost-saving

A significant observation made from the above is that although GDP growth is not considered an accurate measurement for the impact, it is still considered an important indicator. The fact that the stabilisation of energy tariffs has such a substantial impact therefore makes the GDP growth irrelative to some extent. This once again indicates that the impact is not easily quantifiable.

Although the impact is not quantifiable, a definite impact will be observed especially in rural areas where great potential exist for micro-grid implementation as analysed in the results from data collection instrument E.8. This correlates with the findings in sections 2.2.1.1.1 and 2.2.1.2.4 of the literature review.

The results from the data collection instrument C.19 indicated that solar PV energy will contribute the most to the impact of the renewable energy revolution with wind energy contributing the second-most. This correlates with the literature review (section 2.2.1.3.1) to a great extent that states solar PV and wind energy have displayed the highest development in recent years as far as renewable energy technologies are concerned. The reason for the population group indicating that solar PV will contribute the most to the revolution is attributed to the fact that rooftop solar PV specifically has made significant progress in the corporate environment. This is yet another identified gap in the IRP 2018 as discussed in section 3.3.3.1 below. The remaining renewable energy technologies that will contribute to the impact of the renewable energy revolution are as follow (in descending order of significance):

- Hydro power
- Biogas
- Hydrogen and fuel cell technology
- Geothermal

The population group provided practical examples of how renewable energy projects made a significant impact on the local community and grid infrastructure that yielded the following results (data collection instrument E.11):

- Solar PV as well as gravity power technology proved to be cheaper for a rural community instead of applying for a utility connection point (correlating with literature review section 2.2.1.1.1 and 2.2.1.2.4).
- The impact on the local agricultural community of a biogas plant was substantial as the local economic growth was established; however, the constraint was the fact that the level of technical understanding of the workforce relating to the industry was not sufficient.
- International funding was possible through the implementation of a rooftop solar PV project that made it possible for the investor to reinvest the funds into related projects.
- The ROI is long-term but feasible for biogas plants.

3.3.2.5 Technologies or not independent

From the ten respondents that were interviewed, eight agreed that renewable energy cannot operate independently due to unreliability and that back-up coal generation will always be required (data collection instrument C.4). Confirming that Eskom's grid infrastructure is a significant competitive advantage for the utility, the interviewees added that this competitive advantage for the utility is enhanced by the fact that the potential IPPs are not threatened by this advantage. On the contrary, IPP stakeholders consider Eskom's grid infrastructure as capital costs they do not have to cater for and can utilise the grid to transport the energy they generate through a PPA.

The stakeholders of IPPs realise that the grid infrastructure took the utility years to establish and that they cannot compete with that. It will cost the private investors of IPP projects way too much to establish infrastructure to transport the energy to the consumer which is why they prefer utilising the national grid for this purpose. The private sector investors are dependent on the grid infrastructure to such an extent that in actual fact it would not at all be feasible for them to generate and transport energy to the off-taker of electricity without the grid infrastructure. It is therefore obvious that the transmission and distribution grid of Eskom should still be managed by the utility and local municipalities as it will be too expensive for IPP stakeholders to establish their own network (data collection instrument E.7).

3.3.2.6 Scenarios are decisive

Yet again, a major correlation between the empirical study and the literature study is made with regards to the various scenarios. The following outcomes therefore exist regarding the results obtained from data collection instruments C.21, C.22 and C.23:

- Prior to the revolution, economic growth was low and the demand for renewable energy was also low.
- Currently (in the midst of the revolution), economic growth is low and the demand for renewable energy is at an all-time high.
- The future scenario is that both the economic growth and the demand for renewable energy will be high.

No clear time periods were provided were provided to the population group in prompting them to favour certain scenarios pertaining to the economic growth of South Africa and the demand for renewable energy. The reason for not providing time periods is because the intensions was to discuss this during the interviews with the population group as well as the fact that it ensured that the data obtained from the closed-ended questions ought to be a true reflection of the interpretations of the interviewees. Correlating Table 2.1-1 presented in the literature review with the results from the data collection instruments yield the following final outcome of the scenario analysis as presented in

Table 3.3-1: Correlated scenario analysis results

Scenario type	Renewable energy	Economic growth of South Africa	Time period
Scenario 1	High on demand	High	2009 - 2011 2018 – 2030 (post-revolution)
Scenario 2	High on demand	Low	2007 - 2009 2011 - 2018 (midst of revolution)
Scenario 3	Low on demand	High	2003 - 2007
Scenario 4	Low on demand	Low	1999 - 2003 (pre-revolution)

Source: Own compilation

From Table 3.3-1 it is therefore confirmed that the pre-revolution time period is defined as 1999 to 2003 as expected from the literature review. It is also confirmed that South Africa is currently experiencing a renewable energy revolution and that it is indeed a revolution as per the definition due to a the recurrence of a previous duplicate scenario during 2007 and 2009. The results from data collection instrument D.11 proves this as the majority of the population group confirmed that South Africa is at the verge of a renewable energy revolution as per the definition of a revolution. The future scenario pertaining to the renewable energy revolution is therefore identified to be scenario 1 as in Table 3.3-1 which is also a duplicate and recurring scenario from the time period 2009 to 2011.

This scenario is considered to be applicable from 2018 to 2030 as depicted in the IRP 2019 that is defined as a period of medium- to high certainty of the energy mix of South Africa. Scenario 3 in Table 3.3-1 is thus not catered for from the results of the closed-ended questions.

From the interview discussions with the experts in the energy industry, however, it became clear that this scenario will be the most probable one beyond the year 2030. This is most-likely attributed to the fact that renewable most energy consumers have made major transitions towards the technology that will inevitably stimulate the economic growth of South Africa. The interviewees also indicated in data collection instrument E.1 that the barriers that need to be overcome relating to this future scenario is the fact that the economy of South Africa should be developed to such an extent that the maximum demand for energy is shifted to midday. This opposed to the current maximum demand that is taking place in the evenings – integration with renewable energy technologies will thus ensure that this demand period is shifted.

From the seven scenarios offered by SALGA, the most favourable scenario for municipalities is to generate electricity for own use (data collection instrument D.17). This is attributed to the fact the reliability and security of supply from municipalities are very low in general. By generating electricity for own use from renewable energy sources will increase the reliability and security of supply offered by the municipalities. The least favourable scenario is operating a storage facility which is attributed to the fact that storage technology in South Africa is not yet fully developed. The storing capability of renewable energy (especially for thermal) is considered a barrier that ought to be overcome in South Africa to flourish in renewable energy. The remaining scenarios are presented as follow (in descending order of favourability from the population group):

- Generating renewable energy for sale.
- The wheeling of private sector electricity.
- Securing electricity from an IPP.
- Procuring electricity from small-scale embedded generation.
- Increase energy access and reduce energy poverty.

3.3.2.7 The socio-economic impact on the coal sector

Analysing the results from data collection instrument C.3 shows that 90% of the population group believe that the recent signing of the IRP by the Minister of Energy will not lead to a significant decline in the coal mining sector.

This correlates with the findings in the literature review (section 2.2.1.3.1) that indicated that the job creation for IPPs occurs predominantly during the construction phase of the projects whereby a steady decline occurs thereafter. With respect to job creation, the coal mining sector is therefore not impacted by the commissioning of IPPs.

The results from data collection instrument C.11 indicate that the population group is not able to predict that there will be a definite impact on the coal industry with respect to job creation. These results indicate that the opinions regarding whether IPPs will lead to sustainable employment in the economy are extremely diverse and therefore no definite conclusion can be derived with respect to this possibility. Furthermore, a definite prediction cannot be made as to whether IPPs will cause a reduction in permanent ongoing jobs elsewhere in the economy due to diverse opinions from the population group in data collection instrument C.13. A definite conclusion can, however, be derived pertaining to whether IPPs will ensure employment during the construction phase only with limited ongoing jobs thereafter. Data collection instrument C.12 proves that this will be the case as eight out of the ten interviewees confirmed this which also correlates to the literature review section 2.2.1.2.3.

A genuine concern from the population group (data collection instrument E.1) is the fact that job losses may occur due to the commissioning of IPPs. The results from data collection instrument D.10 indicates, however, that seven out of the ten interviewees believe that South Africa has the potential to generate far more jobs in the renewable energy fraternity than the amount of jobs that will be lost from the coal mining sector. This is given that a steady transition towards renewable energy takes place and does not refer to only the commissioning of IPPs but as a matter of fact refers to a complete shift towards renewable energy. It is therefore concluded that IPPs operating independently will not have a severe and sustainable impact on job creation but a complete revolution of renewable energy will have. A complete revolution toward renewable energy will cause a reduction in electricity tariffs that will encourage economic growth and inevitably enhance job creation.

According to the population group assurance must, however, be given by Eskom that staff from power stations will be employed somewhere else in the energy sector should this renewable energy revolution be sustainable (data collection instrument E.4). The socio-economic impact will therefore be localised to the area of the coal fired power station.

The initial impact will be attributed to the construction phase development of renewable energy technologies but will be a limited impact. An additional concern from the population group is that the skill level and capabilities of the workforce that are present at the power stations are most probably not sufficient to function at a renewable energy plant. This will create a vicious circle of which the socio-economic impact will escalate over an extensive period of time. The population group elaborated that it is not only the responsibility of Eskom only to ensure that no job losses occur due to the commissioning IPPs, but that this responsibility is shared with the government (data collection instrument E.9).

3.3.3 Political environment

3.3.3.1 Energy mix is questionable

The section on policy uncertainty in the literature study is the most prevalent factor that is correlated with the empirical study. The fact that no consideration is made in including CSP in the energy of the IRP 2018 creates immense policy uncertainty among key stakeholders in the energy industry. The interviewees therefore believe and the literature confirms that this technology is extremely viable, holds significant benefits for the energy industry of South Africa and its tariffs are decreasing immensely.

The interviewees in general feel that the IRP 2018 comprises a good energy mix although the slow growth in the economy will place a constraint on the achievable timelines. They believe that the energy mix and forecasts are realistic, but will only be reached with good planning, hard work and focus on the goal. It has the potential to be favourable to South Africa's energy needs. Contributing to policy uncertainty is the fact that experts in the energy industry questions the DoE’s statements regarding the forecasts they make as seven out of the ten experts that were interviewed did not agree with a statement made by the DoE (data collection instrument B.6). The DoE stated that 77% of South Africa’s energy needs are provided by coal and that it is unlikely to change within the next two decades as there is a lack of suitable alternatives to coal.

The fact that the majority of the target population disagrees with this statement is correlated with the observations in the literature review whereby especially SAPVIA and SAWEA are convinced that wind and solar PV can be considered suitable alternatives to coal.

The fact that SAPVIA and SAWEA questions the IRP 2018 that was also published by the DoE provides a clear outcome to this study – insufficient assumptions and forecasts are made by the DoE which causes uncertainty among all stakeholders in the entire energy industry.

Diverse opinions exist among the population group as five out of the ten interviewees slightly disagree with the fact that the IRP 2018 favours wind, solar PV and gas technologies and that it is realistic and suitable for South Africa's energy mix (data collection instruments C.9 and E.10). Three out of the ten interviewees slightly agreed that the proposed energy mix is suitable whereas one agreed that is suitable and the remaining one strongly disagree on the proposed energy mix. This proves the findings in the literature review (section 2.3.2.1) that mentions the following:

- CSP should have been included in the proposed energy mix.
- Wind energy should have a higher contribution.
- Rooftop solar PV should have been included in the proposed energy mix.

The majority of the population group agreed that the fact that gas accounts for 16% of the installed capacity mix in the year 2030 as per the IRP 2018 sufficiently favours a future diversified mix for South Africa (data collection instrument D.13). One member of the population group, however, did state that importing gas makes no sense when the current energy needs of South Africa are considered (data collection instrument E.10). The results from data collection instrument D.4 indicate that the majority of the population group believe that South Africa will have at least 30% clean energy as part of the energy mix by 2025. It is therefore just the contributions of the various renewable energy technologies that are questioned (primarily CSP solar PV and wind) and not the fact that the energy mix sufficiently caters for renewable energy. Due to the fact that the energy mix is questioned, several uncertainties exist regarding whether the IRP 2018 will lead to political and social instability as observed in the results from data collection instrument D.15.

From the four scenarios depicted in the IRP 2018 the electricity demand scenario is favoured by the population group as being the most suitable for the country's electricity needs (data collection instrument D.16). The least favoured scenario is the emissions constrain scenario.

This proves that the need to make a transition towards renewable energy is more driven by taking in account the declining demand for electricity than any other factors investigated in this study. This also proves that a strict balance ought to be maintained between coal generation and renewable energy technologies to address the current energy transition challenges of South Africa. A concern from the study population indicate that the renewable energy for the various scenarios need to be correctly modelled as the strategies from the DoE are not catered for sufficiently in these models (data collection instrument E.1). This concern is supported by the fact that the population group believes that although the energy mix is viable to a certain extent, the slow economy growth will place a constraint on the achievable timelines set out in the IRP 2018 (data collection instrument E.10).

Limited investigation was done on the impact of nuclear energy for two reasons:

- There is no plan to increase the utilisation of nuclear energy up until at least the year 2030 as per the IRP 2018.
- Nuclear is not considered a renewable energy source and therefore does not form part of the original scope of the study.

The afore-mentioned reasons for not including nuclear energy in the scope of the study proved to be viable. The majority of the population group indicated that the fact that there is no plan to increase the use of nuclear energy up until 2030 will not negatively impact the economic growth of South Africa nor will it negatively affect investments opportunities for the country (data collection instrument D.14). The shift of especially the DoE and all other involved stakeholders is towards purely renewable energy technologies and away from nuclear energy that will impact several business aspects in the country.

3.3.3.2 Political uncertainty

The results from data collection instrument D.1 indicate that the experts in the energy fraternity are not sure whether enough is done by the government to promote and implement renewable energy technologies. The population group comprise diverse opinions in this regard and is attributed to the fact that several IRPs have been published in recent years but the results do not match the initial desired objectives.

The most recent IRP 2018 is thus also questioned by the majority of the population group as they predict the outcome of the IRP by comparing it with historic experiences. The only way to ensure policy certainty among all stakeholders in the energy industry is to allow ongoing engagements on energy transition as observed in the results from data collection instrument D.12. The results indicate that eight out of the ten interviewees agree that this is the solution to policy certainty especially on the IRP 2018. Eight out of the ten interviewees stated that the IRP 2018 is directly opposed by the fact that Eskom is not sufficiently promoting renewable energy initiatives (data collection instrument D.9). This proves that it is not only the DoE and government's responsibility to ensure policy certainty among industry stakeholders, but that Eskom has a significant contribution to the manner in which policies set by the DoE is implemented.

It is not only the fact that uncertainty exists regarding whether the government is doing enough to promote and implement renewable energy technologies but also the fact that the strategic plan of the DoE for 2015 -2020 is questioned. The results from data collection instrument D.3 indicate that eight out of the ten interviewees disagree that South Africa is moving forward toward an energy secure future as stated by the DoE. Contributing to this phenomenon is the fact that no incentives are established for end-users to utilize rooftop solar PV as well as electric vehicles as per the results from data collection instrument E.9. The verdict therefore from the entire population group is therefore that the government is not doing enough to promote and execute renewable energy technologies. There is thus a lack of policy certainty in South Africa to truly align the relative energy policies with the current status of the ever-changing energy industry.

Contributing to the lack of policy uncertainty is the fact that the recent signing of the IPP contracts is a political decision instead of a strategic decision by the government (data collection instrument E.15). The population group therefore agrees that the signing of the IPP contracts can benefits the country in numerous ways, although the strategic intention of the relative stakeholders were not clear in this regard. The IPP contracts are thus only a starting point of the renewable energy revolution and are not sustainable if the buy-in from all industry stakeholders does not take place.

3.3.3.3 Intervention and collaboration are required

A major trend in the empirical study indicates that intervention and collaboration among all the stakeholders in the energy industry (including the coal industry, the private sector and the government key role players) are required. This requirement exists due to the fact that the revolution will not be sustainable unless collaboration takes place on a continuous basis. The entire population group stated that mixed technology generation is required to ensure energy sustainability in South Africa (data collection instrument E.12). This provides a clear indication that intensive collaboration and intervention is required by all industry stakeholders.

The private sector is adopting renewable technologies to be environmentally friendly in order to comply with municipal drives to reduce, but also to attract private investments from overseas and to reduce monthly costs. Government liabilities have been reduced by proposed IPP frameworks, but the success of this is still unknown to a great extent and requires further study. The results from data collection instrument C.10 supports the afore-mentioned as diverse opinions among the population group exist as to whether the commissioning of several IPPs is a strategic wise decision for the country. The same findings are identified for the results obtained from data collection instrument C.11 whereby no clear indication is provided by the population group as to whether IPPs will lead to sustainable employment in the economy. There is therefore no clear indication that this was indeed a strategic wise decision and the conclusion in this regard from the entire population group is that only time will tell. The literature proved that the REIPPPP comprise both benefits and drawbacks and that it all depends all on the manner the involved industry stakeholders manages this programme.

The results from data collection instrument D.7 indicate that insufficient private and public sector coordination takes place so that the cost of renewable energy generation is optimised according to seven out of the ten interviewees. A need therefore exists that not only Eskom should collaborate with the applicable stakeholders in the energy industry but all-inclusive participation from all relevant industry stakeholders is required to ensure a positive outcome of the renewable energy revolution.

The data from data collection instrument E.1 indicate that public sector involvement in the REIPPPP is of critical importance for the renewable energy revolution to be sustainable.

Analysing the data obtained from data collection instrument E.5 indicates that the majority of the population group indicated that the accountability and risk of IPP projects are shifted towards the private sector. However, the public sector involvement is not denied in these projects and is in most cases even considered as a barrier to entry for private sector investors. The barriers that are established by the public sector are listed as follow:

- No clear future direction for private investors that results in negative financial implications.
- Uncertainty regarding tariff stabilisation – this makes it difficult for private investors to determine if an IPP project is viable.
- The lack of a balance between favouring the consumer and favouring the IPP investor as observed in historic IPP bids.

There is thus no doubt that the private sector stakeholders contribute immensely to the success of IPP projects; however, intensive intervention and collaboration are still required from the public sector to ensure the sustainability of the IPP projects. Without the intervention of the public sector, Eskom would remain in the paradoxical situation as the demand and supply phenomena will not be addressed pro-actively. The government liabilities have, however, been reduced by proposed IPP frameworks in the past, but the success of this is still unknown.

3.4 SUMMARY

This chapter provided an in-depth analysis and interpretation of the data obtained from a qualitative study that was performed by interviewing 10 experts employed in the energy industry of South Africa. These individuals comprise a diverse experience in various sectors within the energy industry. The analysis of the qualitative data made it possible to establish specific themes related to the defined constructs in the literature review. These themes are in essence trends relating to a specific topic or event. The themes were established by grouping specific findings that have similar outcomes as per the results from the data collection instruments presented in Appendix F.

The first established themes that were critically analysed and discussed pertaining to the coal generation industry is that coal generation will remain the predominant energy source for South Africa. The second established theme, however, states that for Eskom to remain sustainable in the energy industry, a substantial change in their current business model is required.

The established themes for the renewable energy industry indicate that a need for a transition to renewable energy exists in South Africa with a follow-up theme providing evidence that indicates that an existing transition already exists. Another theme that is established indicates that although several positive indications were identified for the renewable energy revolution, although evidence from the empirical study suggested that numerous downsides pertaining to renewable energy projects also exist. Furthermore, the empirical study indicates that several indicators of a renewable energy revolution can be identified and utilised to measure the impact of the revolution to some extent. It was also found that the scenarios that describe the relationship between economic growth and renewable energy demand correlates with what was expected in the literature review. These scenarios are also decisive in terms of historic events, the current status of the energy industry as well as where the industry is heading the future. The final theme pertaining to the second construct indicate that renewable energy has a substantial socio-economic impact on the coal sector – this impact was described and critically analysed.

This chapter was concluded by establishing themes that relate to the political environment. The first established theme is that the proposed energy mix in the IRP 2018 is questionable by numerous stakeholders in the energy industry of South Africa.

The second established theme indicates that political uncertainty exists in the energy fraternity – the reasons for this uncertainty were discussed. The final established theme indicates that for renewable energy projects and programmes to be sustainable, intervention and collaboration is required by all industry stakeholders.

CHAPTER 4: CONCLUSION AND RECOMMENDATIONS

4.1 ANSWERING THE CORE RESEARCH QUESTION

In section 1.2, the following core research question was established:

Will the impact of the renewable energy revolution be positive or negative considering the growth of the energy industry of South Africa from a holistic perspective?

It is evident from both the literature review in Chapter 2 and the empirical study in Chapter 3 that the impact of the renewable energy revolution cannot be quantified. Furthermore, the impact of the renewable energy revolution is directly dependent on the collaboration between the public and private sector. The level of collaboration between the afore-mentioned sectors therefore determines whether the impact of this revolution is positive or negative. A conclusive verdict on the core research question is therefore the impact of the renewable energy revolution will be positive because:

- An inflection point occurred in the energy industry of South Africa which considered a major turning point for the industry as drastic political intervention took place from the DoE by publishing the IRP 2018. This cleared policy uncertainty to a great extent and allowed private investors to enhance the development of renewable energy technologies. It also opened up potential opportunities for Eskom to enter the renewable energy market that will stimulate the economic growth of the country extensively if the utility adapt their business model accordingly.

- During historic periods of policy uncertainty, renewable energy technologies have developed rapidly. Now that policy uncertainty is clarified to a large extent, the development of these technologies from the private sector will escalate immensely that will constitute a green economy in South Africa.

- South Africa is in the midst of the revolution where the demand for renewable energy is at an all-time high and economic growth is fairly low. It is clear from this study that this scenario is predicted to change very soon and very quickly to such an extent that the demand for renewable energy will remain high for an extensive period of time (2018 - 2030). This will ensure substantial economic growth for the country in the forthcoming period of certainty as per the IRP 2018.

4.2 VALIDATION OF THE RESEARCH OBJECTIVES

4.2.1 Primary research objectives validation

The primary research objectives of this study were derived in section 1.3.1 from the core research question stated in section 1.2. The primary research objectives that were established for this study are validated as follow:

- To determine the most suitable scenario for South Africa that will enhance sustainable energy development with regards to electricity generation i.e. coal generation, renewable energy or mixed technology generation.
    - *Validation* – The study clearly indicated that mixed technology generation is the only suitable scenario for the country to enhance the sustainability of energy development.
- To craft out a transition plan that will benefit and incorporate both the public and private sector stakeholders during the renewable energy revolution.
    - *Validation* – The transition plan is based on the re-invention of Eskom's business model. This plan requires the utility to position themselves in such a way that they are able to offer renewable energy as an additional product to private sector stakeholders (whether it be the consumer or the investor).
- To determine the extent to which the accountability and risk of renewable energy projects belong to public and private sector stakeholders respectively.
    - *Validation* – The predominant accountability and risk belongs to the private sector, although intervention from the public sector is of critical importance to provide opportunities for renewable energy projects.
- To determine the extent to which the energy mix forecast defined in the IRP 2018 is realistic, attainable and favourable for South Africa's energy needs.
    - *Validation* – The energy mix in the IRP is highly questionable (especially for solar PV energy, wind energy and CSP energy) and is thus not favourable for all industry stakeholders. It does, however, cater for the energy needs of the country to a large extent as it is realistic if intensive collaboration takes place.

- To identify the major barriers that ought to be overcome for South Africa to flourish in the renewable energy fraternity and provide strategic recommendations on how these barriers can be overcome.

    - *Validation* – The predominant barrier that ought to be overcome is for Eskom to re-invent their current business model. This will ensure that the electricity generated from IPPs is absorbed, the utility is able to sell renewable energy to consumers and a strict balance is maintained between the supply and demand of electricity. The barriers identified in this study that relates specifically to the renewable energy fraternity are the high upfront capital costs of renewable energy technologies and the fact that job losses may occur due to the commissioning of IPPs. From a political perspective, the identified barriers are the fact that the DoE does not cater sufficiently for renewable energy models in the assumptions made in the IRP 2018 and that there is a lack of public sector involvement in the REIPPPP. The strategic recommendations on how these barriers can be overcome are provided in section 4.3 below.

4.2.2 Secondary research objectives validation

The secondary research objectives of this study are considered to be supplementary to the primary research objectives. These objectives are therefore structured in such a manner that the primary research objectives are fulfilled when the secondary objectives are met. The secondary research objectives that were established for this study in section 1.3.2 are validated as follow:

- To establish if a direct relationship exists between the GDP growth of South Africa and the application of renewable energy sources to feed into the national electricity grid.

    - *Validation* – This study proved that the impact of the renewable energy revolution is not quantifiable and that the closest and most accurate tool to attempt to quantify it is through the LCOE model. There is thus not a direct relationship between the GDP growth and the development of renewable energy technologies. The GDP growth may increase should sufficient

collaboration and intervention take place by all industry stakeholders and is therefore merely considered and indicator of the revolution.

- To establish the various indicators that result from the renewable energy revolution and to rank these indicators according to importance.

  - *Validation* – The indicators that result from the renewable energy revolution in descending order of priority are the stabilisation of energy tariffs, GDP growth, reducing carbon-tax costs, job creation, water-usage cost-saving and the decrease in the demand for coal.

- To perform a feasibility study and comparison between coal generation and renewable energy generation with the aim of determining which method of generation holds the greatest return on investment.

  - *Validation* – From both the literature review and the empirical study it was evident that the LCOE model indicates that a direct comparison cannot be made between renewable energy and coal generation. Each generation type offers its own unique benefits as well as disadvantages and should be considered as separate entities. It is therefore also not possible and realistic to compare the ROI figures of the two generation technologies with one another.

- To determine if the electricity tariff per unit changes significantly if the renewable energy industry becomes revolutionised.

  - *Validation* – The study proved that the per unit electricity tariffs will be stabilised as a result of the renewable energy revolution if Eskom enters and dominate the renewable energy market as the utility will no longer be confronted with the paradoxical situation they are confronted with currently.

- To determine the extent to which the coal generation industry will be affected from a financial point of view should there be substantial progression in the renewable energy industry.

  - *Validation* – The coal generation industry will only be severely affected if Eskom does not re-invent their business model to cater for renewable energy technologies.

- To determine the effect of carbon tax and how it will influence the various renewable energy strategies set out by the DoE as well as the coal generation industry.
    - *Validation* – Carbon tax is a major driver for the strategies set out by the DoE as depicted in the IRP 2018 and places the coal generation industry under immense pressure to make a drastic transition towards renewable energy.

4.3 RECOMMENDATIONS

The following recommendations are made with regards to the findings in the afore-mentioned chapters:

- The issues Eskom face regarding poor and unethical governance, state capture and corruption are only superficial. The structural problem of the coal-fired utility not being able to adapt quickly enough or at all to the evolving energy market is what compromises the overall financial viability of the utility. Until this is fixed, the status quo remains. Reference is therefore made to the research problem and it is recommended that Eskom revolutionise their strategy.

- Real intervention is required to get the energy industry back on course. This intervention needs to take place from all stakeholders in both the public and private sectors.

- The DoE and Eskom need to collaborate intensively to discuss a way forward in order to find a balance between a diversified energy mix that will benefit both Eskom and private sector stakeholders.

- Eskom still has the sustainable competitive advantage – grid infrastructure. This will not be sustainable if Eskom does not make a transition. Decarbonising the grid without breaking it is the key objective that Eskom have to maintain in their forthcoming strategic plans.

- Business, government, labour, DoE and Eskom need to get together to chart a way forward with a specific and common vision in mind.

- Eskom should stimulate demand growth in order to increase sales and in parallel with this manage a gradual but steady transition towards renewable energy projects.

- Eskom should consider a complete restructuring process for the long-term i.e. the utility should consider getting private equity into the organisation (not necessarily total privatisation) but private participation and partial privatisation. Eskom should thus revolutionise their current business model to get in sync with revolutionised energy market. The core of Eskom's so-called "death spiral" is the political intervention that dictates decision-making within the organisation. This causes the utility to not be managed as a business which is not sustainable with the ever-changing energy industry.

- Elaborating on the afore-mentioned, the utility should be able to offer a customer with a range of products that include renewable energy technologies. A customer will be much more comfortable when the product as well as the service is offered by Eskom.

- In the process of Eskom revolutionising their business model, it critical that the utility pro-actively improve specifically their distribution infrastructure to prepare for upcoming IPP connections. This will position the utility to cater for new smart-grid and micro-grid systems that forms part of the renewable energy revolution.

- In addition to smart-grids and micro-grids, Eskom should consider establishing an infrastructure to cater for virtual power plants which are integrated cloud-based distribution plants. The intention of virtual power plants is to enhance power generation and to establish a platform for the trading and selling of power in the open market. South Africa should therefore observe and adapt virtual power plant technologies from other countries where the technologies are already operational (Europe, United States and Australia).

- Energy storage should be considered by all stakeholders in the energy industry.

- Eskom should therefore craft out a transition plan i.e. the utility should start on a clean slate – determine where they are and state where they need to be to recover from their current situation. The pathway to get there is still very unclear

but should be mapped out in the utility's strategic plans for the forthcoming period.

- A long term transition plan should be established by the DoE as coal will still form part of the energy mix. Long term milestones need to be broken down into short-term and medium term milestones that do not only set objectives for renewable energy technologies but also for Eskom to adjust their infrastructure. The IRP 2018 encapsulates this transition plan but it contains high uncertainties and incorrect assumptions that need to be addressed and critically analysed.

- In order to reduce the socio-economic impact on the coal sector, redundant power stations should be repurposed to be utilised as a storage facility for renewable energy. In this way, the infrastructure can still be useful even though it is not utilised for its primary purpose. Minimal job losses will thus occur in the entire industry as the existing workforce in the coal sector can be appointed at the storage facilities. This should form part of the requirement for Eskom to establish and implement a fully-fledged decommissioning strategy for their redundant coal-fired power stations. This will create a major influx in the economy through additional job creation in South Africa.

- It is recommended that the government pro-actively seek solutions to enhance the skills and capabilities of the coal generation workforce in an attempt to ease the transition towards renewable energy. This will limit the socio-economic impact on the coal generation sector and should take place in collaboration with Eskom.

- It is recommended that all industry stakeholders become more pro-actively involved in improving the energy policies of South Africa i.e. to build on the existing IRP 2018. The DoE has a great responsibility, however, to ensure that this involvement is optimally managed.

- The government should actively focus on making renewable energy technologies and specific projects more attractive in order to obtain international funding for the projects.

- The government should strive to increase the education relating to renewable energy technologies to avoid a misperception among the public. Awareness should therefore be raised in order to portray the genuine benefits that these technologies offer in terms of tariff stabilisation.

4.4 FURTHER STUDIES

The following should be considered for further studies as it shows great potential relating to the topic and was defined as limitations to this particular study:

- The impact that CSP could have on the renewable energy revolution if it contributes significantly to the proposed energy mix of South Africa.
- The future impact that nuclear energy might have on the energy mix of South Africa.
- The influence technical skills, capabilities and resources will have on the commissioning and development of IPPs.
- The effect that the removal of REFIT will have on the energy industry of South Africa.
- Quantifying the socio-economic impact of micro-grids in rural communities to a larger extent than this study was able to. This would imply that a more quantitative study approach should be taken.
- Validating if the predicted scenarios of this study actually realised in the near future (before 2030 when policy certainty regarding the IRP 2018 will decrease).
- Performing a post-renewable energy revolution analysis to determine the state of the Eskom business model in the near future.

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APPENDICES

APPENDIX A: PERMISSION TO SUBMIT

Higher Degrees Administration

SOLEMN DECLARATION AND PERMISSION TO SUBMIT

1. Solemn declaration by student

I, Daniël Roux van Niekerk

declare herewith that the thesis/dissertation/mini-dissertation/article entitled (**exactly as registered/approved title**),

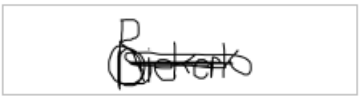
Analysing the impact of the renewable energy revolution in South-Africa

which I herewith submit to the North-West University is in compliance/partial compliance with the requirements set for the degree:

Master of Business Administration

is my own work, has been text-edited in accordance with the requirements and has not already been submitted to any other university.

LATE SUBMISSION: If a thesis/dissertation/mini-dissertation/article of a student is submitted after the deadline for submission, the period available for examination is limited. No guarantee can therefore be given that (should the examiner reports be positive) the degree will be conferred at the next applicable graduation ceremony. It may also imply that the student would have to re-register for the following academic year.

Signature of Student  University Number 21210047

Signed on this 15th day of November of 20 18

2. Permission to submit and solemn declaration by supervisor/promoter

The undersigned declares that the thesis/dissertation/mini-dissertation complies with the specifications set out by the NWU and that:

- the student is hereby granted permission to submit his/her mini-dissertation/ dissertation/thesis:
  (•) Yes ( ) No
- that the student's work has been checked by me for plagiarism (by making use of TurnItIn software for example) and a satisfactory report has been obtained:
  (•) Yes ( ) No

Signature of Supervisor/Promoter

Theo Venter

Digitally signed by Theo Venter
Date: 2018.11.19 09:10:51 +02'00'

Date 21/11/2018

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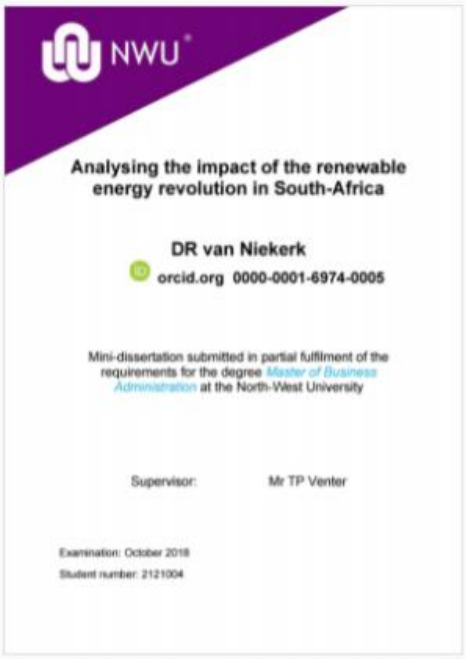

NWU

Analysing the impact of the renewable energy revolution in South-Africa

DR van Niekerk

orcid.org 0000-0001-6974-0005

Mini-dissertation submitted in partial fulfilment of the requirements for the degree *Master of Business Administration* at the North-West University

Supervisor: Mr TP Venter

Examination: October 2018

Student number: 21210047

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APPENDIX B: ETHICAL CLEARANCE

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Economic and Management Sciences Research
Ethics Committee (EMS-REC)
Tel: 018 299-1427
Email: Bennie.Linde@nwu.ac.za

31 October 2018

Mr T Venter
Per e-mail

Dear mr Venter,

FEEDBACK – ETHICS APPLICATION: DR VAN NIEKERK (21210047) - MBA

Your application for ethical clearance – *Analysing the impact of the renewable energy revolution in South Africa* – has been evaluated on the 26th of October 2018.

Outcome:

The application is approved as a low-risk study.

Ethics number (A): NWU00751-18-S4

Yours sincerely,

Prof B Linde
Chairperson: Economic and Management Sciences Research Ethics Committee (EMS-REC)

Original details: (11153431) C:\Fakulteit\Bestuur\Kwaliteitsbestuur\Etiek\26 October 2018DR van Niekerk\26 October 2018

File reference: 9.1.5.3

NWU APPLICATION FOR ECONOMIC AND MANAGEMENT SCIENCES RESEARCH ETHICS COMMITTEE (EMS-REC)

Application for ethics approval for commerce related research

Instructions and recommended path for the completion of the application	**Checklist** *(please complete)*
a. Ensure that a research proposal has been approved by an appropriate scientific (research proposal) committee and attach the proof of its approval. **Date of approval:**	☒ 17/10/2018 *(click here to select date)*
b. The final research proposal, as approved by the scientific committee (research proposal committee), forms the base document that is evaluated in conjunction with this application form. The research proposal is mainly used for proof of ethical procedures, while the application form provides contextual detail and other applicable and necessary information (e.g. informed consent letter). Therefore, this application offers the researcher the opportunity to expand on specific ethical issues required for approval.	☒
c. Any questionnaires or interview schedules that will be used in the completion of the study have to be attached if it is not part of the approved research proposal.	☒
d. Where applicable, attach any permission letters received from governing bodies.	☒
e. Where applicable, attach any contracts with collaborators/sponsors.	☒
f. Should this study already received ethical clearance from another institution, attach questionnaire and ethical clearance.	☒

Applicant details	
Initial(s) and surname	DR van Niekerk
University number	21210047
Title of study/project	Analysing the impact of the renewable energy revolution in South-Africa
Research programme/entity	TRADE
School	NWU School of Business and Governance

1.1 Scope of research

The following form part of the scope and are included in the proposed study:

- The economic growth of South-Africa only (not globally) attributed by renewable energy
- GDP growth is used as the main measurement for economic growth
- The impact that is caused by renewable energy is not always expressed in monetary terms but also in job creation, environmental sustainability and community empowerment. These impacts will have an indirect influence on the economic growth of the country and will be analysed in the proposed study.

	Yes	No
Health-related research (as defined in the National Health Act [61 of 2003]), includes any research that contributes to the knowledge of: o The biological, clinical psychological or social processes in human beings; o Improved methods for the provision of health services; o Human pathology; o The causes of diseases; o The effects of the environment on the human body; o The development or new application of pharmaceuticals, medicines and related substances; and/or o The development of new applications of health technology.	☐	☒
Research will make use of tests/instruments that are classified by the HPCSA or other legislative bodies.	☐	☒
Educational research (refers to a variety of methods, in which individuals evaluate different aspects of education, including student learning, teaching methods, and teacher training and classroom dynamics).	☐	☒
Affiliated study under a larger study with ethical clearance.	☐	☒
Not applicable		
Making use of previously collected data with human participants.	☐	☒
Not applicable		

1.2 Type of research with human participants

Description of contact with human participants		
Qualitative with interviews (pre-setup structured questionnaires as provided in Research Proposal document – Appendix A Data collection instruments)		
Description of participants		
	Yes	**No**
Minors (<18)	☐	☒
Adults with incapacities	☐	☒
Persons in dependent relationships (e.g. prisoners)	☐	☒

Students	☐	☒
Persons with physical disabilities	☐	☒
Collectives (individuals who are considered in the research as a whole group, e.g. a trade union's members)	☐	☒
Research-naïve communities (e.g. participants in townships)	☐	☒

1.3 Phased research

Ethical clearance can be given for phases of research (e.g. where a qualitative study is first necessary before a measuring instrument can be developed and evaluated).

A literature study on the topic is already conducted. Interviews will be conducted at the end of April 2018 (qualitative study) of which the data will be used to confirm the literature.

1.4 Privacy, confidentiality and informed consent

Permission letter from company as well as the informed consent form attached in application.

Please attach, if not already available in the research proposal, the applicable documentation that will be used for these purposes (e.g. cover letter of questionnaire and consent form), including details of data management, storage and destruction.

1.5 Competence of researchers/student/supervisor

Both the supervisor and the researcher have sufficient knowledge on the topic and are legally competent to perform research on the topic. Researcher already employed in the industry in which research will be conducted.

1.6 Announcement of study results to participants

Results of the study and final dissertation will be made available to interviewees as not confidential information will be included in the study. The results will have the potential to assist the company in future endeavours and will therefore only be beneficial in the publication or availability of the research results.

2. DECLARATIONS

I, the undersigned, hereby apply for approval of the research as described in the preceding application and declare that:

2.1 The information in this application is, to the best of my knowledge, correct and that no ethical codes will be violated with the study;

2.2 In the case of human participants;

- 2.2.1 I will put it clearly to all participants that participation (including assent) in any research study is absolutely voluntary and that no pressure, of whatever nature, will be placed on any potential participant to take part;
- 2.2.2 I will put it clearly to all participants that any participant may withdraw from the study at any time and may ask that his/her data no longer be used in the study, without stating reasons and without fear of any form of prejudice;
- 2.2.3 every participant who takes part in the study will receive the indicated form for informed consent and it will be ensured that every participant understands the information (including the process and risks) fully;
- 2.2.4 every participant will provide informed consent before the study commences, or a witness will stand in on behalf of the participant when the participant cannot provide permission, but agrees to it;
- 2.2.5 any foreseeable risk is restricted to the minimum, any permanent damage is avoided as far as possible and appropriate precautions and safety measures are in place;
- 2.2.6 confidentiality of all the information of all participants will be respected and ensured;

2.3 I and all co-workers/assistants/fieldworkers are appropriately qualified, capable and legally competent to implement the proposed studies/procedures/interventions;

2.4 I will not deviate from the approved proposal and I understand approval for the study will be cancelled if I deviate from the proposal without the approval of the Ethics in Commerce Research Committee;

2.5 the study is scientifically justifiable;

2.6 where necessary, all contracts, permits and the applicable documents of relevance will be obtained before the research commences;

2.7 I will ensure that all data are stored safely and remain in the possession of the North-West University;

2.8 I will report in writing any incidents or adverse events that occur during the study without delay to the Ethics in Commerce Research Committee;

2.9 I undertake to respect the intellectual property rights of the North-West University throughout and undertake to avoid any form of plagiarism and academic dishonesty;

2.10 I will notify the Ethics in Commerce Research Committee should the study be terminated.

Signature of applicant — Date: 26/03/18

Signature of supervisor — Date: 20/11/18

APPENDIX C: LETTER FROM LANGUAGE EDITOR

Declaration

This is to declare that I, Annette L Combrink, accredited language editor and translator of the South African Translators' Institute, have language-edited the dissertation by

DR van Niekerk

With the title

Analysing the impact of the renewable energy revolution in South-Africa

Prof Annette L Combrink
Accredited translator and language editor
South African Translators' Institute
Membership No. 1000356
Date: 15 November 2018

APPENDIX D: LETTER OF PERMISSION FROM COMPANY

Eskom

Mr. DR van Niekerk
Protection Coordination & Configuration Engineer (NOS)
Eskom Distribution Division
PO Box 1091
Johannesburg
2000

Dear Mr. Mottian

REQUEST FOR PERMISSION TO CONDUCT RESEARCH FOR MBA DISSERTATION

As partial fulfilment of the requirements for obtaining my degree in Master's in Business Administration (MBA) I need to submit a mini-dissertation on a topic of my choice. My current career as an electrical engineer, employed by Eskom, provides me with an opportunity to perform research in the field of electricity distribution and delivery. There have been numerous applications for Independent Power Producers (IPP's) to obtain generation licenses and connect to the Eskom National electrical grid. Trends in these applications have increased immensely and to such an extent that the electrical supply industry are revolutionised by renewable energy. During this revolution, several business aspects with regards to the electricity delivery industry can be identified, analysed and predicted to a certain extent. These business aspects include electricity tariffs and how it affects stakeholders, the impact of the renewable energy revolution on the economic growth of South-Africa and the influence of political trends and policy uncertainty on this revolution. It is for this reason that I as a final-year MBA student have decided to choose my mini-dissertation topic as follow: "Analysing the impact of the renewable energy revolution in South-Africa".

Eskom, being the only licensed electricity provider in South-Africa, has appointed several knowledgeable, qualified and experienced experts over the years in order to maintain and optimize its operations. I hereby therefore request permission to interview the relevant subject experts and use the interview data for the purpose of my research as explained above and to publish it in my mini-dissertation at the end of 2018.

In order to ensure that the data I will be collecting are holistic and objective, I intend to interview consultants and customers of IPP plants that are already in service. I have acquainted myself with these consultants on previous projects of which I was a stakeholder and declare that I have no interest as an Eskom employee to engage these individuals on an unethical manner. These engagements will therefore purely be conducted by me representing the NWU Business School as a MBA student for research purposes only.

I confirm that no confidential information pertaining to the Eskom Holdings SOC Ltd will be published in the mini-dissertation. Fictitious names will be utilized in the dissertation documentation when quoting statements made during the interviews.

Yours sincerely

Daniël Roux van Niekerk
Network Operations & Support – Protection Coordination & Configuration Engineer
Date: 15/03/2018 Signature: [signature]

I hereby grant Daniël Roux van Niekerk permission to conduct research on the afore-mentioned topic based on the explanation of the requirements contained in the permission letter above:

Name & Surname:	**Designation:**	**Signature:**	**Date:**
Mervin Mottian	NOS Manager (M18)	[signature]	19/3/18

Head office
Megawatt Park Maxwell Drive Sunninghill Sandton
PO Box 1091 Johannesburg 2000 SA
Tel +27 11 800 4585 www.eskom.co.za
Eskom Holdings SOC Ltd Reg No 2002/015527/30

APPENDIX E: INFORMED CONSENT FORM

Informed consent form

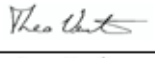
MBA-STUDY: Analysing the impact of the renewable energy revolution in South-Africa
SOUTH-AFRICA
FIELD OF STUDY: BUSSINESS AND COMMERCE (ENERGY INDUSTRY)
NORTH-WEST UNIVERSITY
RESEARCHER: MR. D R VAN NIEKERK
CELL: 076 500 1969
Email: 21210047@nwu.g.ac.za

Dear Interviewee

This **Informed Consent Statement** serves to confirm the following information as it relates to the MBA mini-dissertation titled: "Analysing the impact of the renewable energy revolution in the South-Africa":

1. The sole purpose of this study is to obtain information from experts (such as yourself) employed and/or operating in the energy industry in an attempt to determine the nature of your everyday experience related to the research topic.
2. The procedure to be followed is a mixture between qualitative and quantitative research design, which includes structured, controlled and prescriptive questions but also open-ended questions where you will have the opportunity to communicate your views on the relevant topic during a face-to-face in-depth interview. Basic background information related will be asked e.g. your name, academic qualifications and related experience to the topic.
3. The duration of the interview will take no longer than a maximum of 2 hours.
4. If at any point during the interview you should feel uncomfortable, you will be provided with the opportunity to make your discomfort known or immediately have the option to end your participation.
5. This interview takes place on a voluntary basis.
6. The confidentiality of the interview data is guaranteed. Fictitious names will be utilised when quoting statements in the dissertation.
7. Any confidential information that prohibits the researcher to publish it in the final dissertation should be communicated during the interview.
8. A list of questions to be asked in the interview will be made available to the interviewee prior to the interview. This is done to ensure a mutual understanding of what will be asked to avoid confusion during the interview.
9. A summarised copy of the final dissertation will be made available to the interviewee upon request.
10. The data gathered from the interview will only be used for research purposes.
11. No confidential information (only publically available information) relating to Eskom will be published in the final mini-dissertation.

I, _____ (name and surname), hereby declare that I have read and understand the contents of the Informed Consent Statement, and give my full consent to Mr. DR van Niekerk to progress with the interview on _____ (date) and use the information communicated by myself to him in his MBA dissertation.

Name and designation	Signature	Date
Mr. T P Venter *Supervisor*		21/8/2018
Mr. D R van Niekerk *Researcher*		14/09/2018
Interviewee		

APPENDIX F: DATA COLLECTION INSTRUMENTS

INTERVIEWER: DR van Niekerk
NORTH-WEST UNIVERSITY
CELL: 076 500 1969
EMAIL: 21210047@student.g.nwu.ac.za
MBA-STUDY: Analysing the impact of the renewable energy revolution in South Africa
FIELD OF STUDY: Business and Commerce (Energy Industry)

Dear participant

Thank you for offering your precious time to participate in this interview and voluntarily completing this questionnaire.

Section A: Biographical and demographic Information

The following information is required in order to perform a meaningful data analysis that can be contextualised.

Biographical and demographic categories		Please mark the appropriate box with an X											
A.1	**Age Category:**	Between 18 and 25		Between 25 and 30		Between 30 and 40		Between 40 and 50		Between 50 and 63		Older than 63	
A.2	**Which gender do you identify with?**	Male				Female				Other			
A.3	**Highest qualification:**	No matric		Matric		Diploma/ Certificate		Degree		Post graduate degree			
A.4	**Are you employed by Eskom SOC. LTD?**	Yes				No							
If answered Yes in A.4, please answer A.5 - A.8 in Section A. If answered No in A.4, please answer A.9 - A.11 in Section A. Sections B, C, D and E is however applicable and need to be answered, independent of the answer to question A.4													
A.5	**In what division are you appointed?**	Generation		Transmission		Distribution		Other					
A.6	**In what department are you appointed?**												
A.7	**Level of employment:**	Junior		Middle		Senior		Specialist					
A.8	**Years of experience:**	Less than 1year		1-5 years		5-10 years		10-15 years		More than 15 years			
A.9	**In what sector are you employed?**												
A.10	**Job title:**												
A.11	**Years of experience:**	Less than 1year		1-5 years		5-10 years		10-15 years		More than 15 years			

Section B: A Coal Generation Perspective

		Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
		1	2	3	4	5	6
B.1	South Africa is completely dependent on coal generation for economic growth.						
B.2	The optimal energy mix solution for South Africa should primarily consist out of coal generation.						
B.3	The coal generation business is pressurised and threatened by renewable energy initiatives.						
B.4	Eskom should promote research and development in renewable energy technologies.						
B.5	The coal generation industry in South Africa should remain the major energy source due to relative low cost of coal and abundant reserves of coal.						
B.6	According to the DoE, 77% of South Africa's primary energy needs are provided by coal. This is unlikely to change significantly in the next two decades due to the lack of suitable alternatives to coal as energy source according to the DoE – to what extent do you agree?						
B.7	According to the DoE, there should be more than 50 years of coal supply left at the current production rate. This is sufficient motivation for the government to invest more in clean coal technologies compared to the amount invested in renewable energy technologies.						
B.8	The levelised costs of electricity from new coal are among the most expensive technologies per kWh of electricity delivered.						
B.9	Eskom confirmed in a recent media briefing that it would require some R400-billion to extend the life of its old coal-fired power stations. Given Eskom's current financial situation, it would be wise for the government to rather invest this type of funds in renewable energy.						
B.10	The fact that the existing availability of Eskom plant is significantly lower than initially anticipated in IRP 2010-2013 (assumed to be 86%) negatively impacts the country's economic growth.						
B.11	Investment in low-carbon technologies i.e. cleaner coal should be the primary focus for energy transition instead of renewable energy technologies.						

Section C: A Renewable Energy Perspective

		Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
		1	2	3	4	5	6
C.1	An urgent need exists in South Africa to make a transition renewable energy.						
C.2	If a transition towards renewable energy takes place, it should be gradual and not instant.						
C.3	The recent signing of the IPP agreements will lead to a significant decline in the coal mining sector.						
C.4	Renewable energy is still unreliable to a great extent i.e. back-up coal generation will always be required.						
C.5	It is feasible to increase and promote renewable energy generation in South Africa.						
C.6	South Africa lags behind other countries with respect to renewable energy implementation.						
C.7	South Africa will overtake numerous other countries in the implementation of renewable energy within a decade.						
C.8	The need for renewable energy still exists although the demand for electricity has decreased in recent years.						
C.9	The least cost plan established by the government that favours wind, PV and gas technologies is a realistic and suitable plan for the country's energy mix given the current state of electrical infrastructure.						
C.10	Given the fact that South Africa currently has an electricity supply surplus and a low economic growth rate, the commissioning of several new IPP's may not be a strategic wise decision for the country.						
C.11	IPP's will lead to sustainable employment in the economy.						
C.12	IPP's will ensure employment during the construction phase of the projects and only few ongoing jobs.						
C.13	IPP's will cause a reduction in permanent ongoing jobs elsewhere in the economy.						
C.14	South Africa's grid infrastructure is sufficient to support and sustain IPP upcoming IPP connections.						
C.15	The pricing and investment decisions for IPP's are efficient.						
C.16	An investment in a typical IPP project is low risk, stable and predictable.						

Rate the elements in the following questions (C.17 – C.20) according to significance. Key - 1 = highest significance and 6 = lowest significance.

		Reliability and security of supply	Reduction of the carbon footprint	Balancing demand and supply in peak periods	Economic growth	Cost of energy	Shortage of traditional energy sources
C.17	The need for a transition towards renewable energy is attributed to the following factors:						
		Job creation	GDP growth	Water-usage cost-saving	Reduction of carbon-tax costs	Stabilisation of energy tariffs	Decrease in the demand for coal
C.18	Should a renewable energy revolution persist in South Africa, what factors will contribute the most to the impact of this revolution?						
		Solar	Wind	Biogas	Hydro	Geothermal	Hydrogen and fuel cells
C.19	The renewable energy technologies that will contribute to the impact of the revolution are:						
		Agriculture	Corporate	Rural communities	Utility	Municipalities	Private Households
C.20	The sectors/stakeholders that will benefit from renewable energy are:						

Rate the elements in the following questions according to significance where 1 = highest significance and 4 = lowest significance:

		Scenario 1: Renewable Energy - High on Demand Economic Growth - High	Scenario 2: Renewable Energy - High on Demand Economic Growth - Low	Scenario 3: Renewable Energy - Low on Demand Economic Growth - High	Scenario 4: Renewable Energy - Low on Demand Economic Growth - Low
C.21	Considering a scenario-based approach, rate the following scenarios according to significance. A relationship between the demand for renewable energy and the economic growth of South Africa is the basis for this approach. Consider the *historic* situation of South Africa i.e. pre-renewable revolution.				
C.22	Considering a scenario-based approach, rate the following scenarios according to significance. A relationship between the demand for renewable energy and the economic growth of South Africa is the basis for this approach. Consider the *current* situation of South Africa.				
C.23	Considering a scenario-based approach, rate the following scenarios according to significance. A relationship between the demand for renewable energy and the economic growth of South Africa is the basis for this approach. Consider the *future* situation of South Africa.				

Section D: Economical, Political and Adjacent factors

		Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
		1	2	3	4	5	6
D.1	The government is doing enough to promote and implement renewable energy technologies.						
D.2	The upfront investment costs for renewable energy can be justified due to the reduction in energy tariffs.						
D.3	In the Strategic Plan 2015-2020 set out by the DoE the following statement was made: "The five years is about moving South Africa forward toward an energy secure future". This statement will be fulfilled by the end of 2020.						
D.4	The vision for 2025 according to the Strategic Plan 2015-2020 set out by the DoE is to improve South Africa's energy mix by having 30% clean energy by 2025. This is a realistic vision and is an inevitable phenomenon.						
D.5	Renewable energy has the potential to help Eskom out of its difficulties.						
D.6	It is inevitable that renewable energy will help Eskom out of its difficulties.						
D.7	Sufficient private and public sector coordination is taking place in order to optimise the cost of renewable energy generation.						
D.8	Eskom is abusing its position to favour its own investment in new power plants.						
D.9	The government's energy policy is opposed through the resistance of Eskom not promoting renewable energy initiatives.						
D.10	South Africa has the potential to generate far more jobs in the renewable energy fraternity than the amount of jobs that will be lost from coal mining and related activities should a steady transition towards renewable energy take place.						
D.11	A revolution is defined as an overthrow and thorough replacement of an established government or political system by the people governed. South Africa is currently at the verge of a renewable energy revolution.						
D.12	Energy Minister, Jeff Radebe stated that policy certainty regarding the IRP 2018 will be ensured by allowing engagements on energy transition. To what extent do you agree?						

		Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree
		1	2	3	4	5	6
D.13	The fact that gas will account for 16% of the installed capacity mix in the year 2030 sufficiently favours a future diversified energy mix for the country.						
D.14	The fact that there is no plan to increase the use of nuclear energy up until the year 2030 will negatively impact economic growth and investment opportunities for the country.						
D.15	The revised strategy (IRP 2018) for a diversified energy for the country may lead to political and social instability.						

Rate the elements in the following questions according to significance where 1 = highest significance and 4 = lowest significance:

		Scenario 1: Electricity Demand	Scenario 2: Gas	Scenario 3: Renewable Energy	Scenario 4: Emissions Constrain
D.16	According to the IRP 2018, four scenarios are depicted in which government intend to manage electricity demand in South Africa. Rate the significance of the four scenarios according to the suitability for the country's electricity demand at the moment.				

Rate the elements in the following questions according to significance where 1 = highest significance and 7 = lowest significance:

		Scenario 1: Procuring Electricity from a SSEG	Scenario 2: Securing Electricity from an IPP	Scenario 3: Generating Renewable Energy for Own use	Scenario 4: Generating Renewable Energy for Sale	Scenario 5: Wheeling of Private Sector Electricity	Scenario 6: Increase Energy Access and Reducing Energy Poverty	Scenario 7: Operating a Storage Facility
D.17	According to the South African Local Government Association (SALGA), municipalities face seven different scenarios pertaining to renewable energy trends. Rate these scenarios according to the suitability and practicality of implementation that can serve as a solution to current challenges that consumers are experiencing with electricity supply from municipalities.							

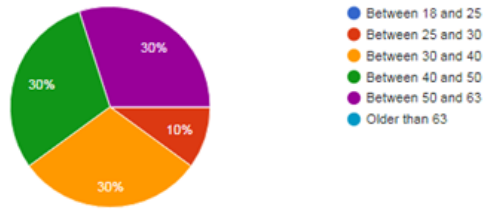
Section E: Open-ended questions

E.1	What is biggest barrier that need to be overcome for South Africa to flourish in the renewable energy fraternity?
E.2	Would you say GDP growth is the most accurate measurement indication of the impact of a renewable energy revolution in South Africa?
E.3	What other indicators can you identify to quantify the impact of a renewable energy revolution?
E.4	Describe the socio-economic impact you think the decommissioning of old coal-fired power stations will have and how this will affect job loss or creation?
E.5	In your opinion, has the accountability and risk of IPP project shifted towards the private sector or did it increase government liabilities? Please elaborate.
E.6	Do you think a downside exist in execution of renewable energy projects? Please elaborate.
E.7	Do you think Eskom, the solely licensed electricity provider of South Africa, is threatened/will be threatened by renewable energy technologies? Please elaborate.
E.8	What impact do you think an increase in renewable energy will have on the economic growth of the country (keeping in mind that Eskom is a monopolistic SOC that drives the economy and coal generation industry)?
E.9	Do you think the government is doing enough to promote and execute renewable energy technologies in order to manage energy demand in South Africa? Please elaborate.
E.10	What is your view on the publication of the recent IRP as set out by the DoE i.e. is the energy mix and forecast realistic, attainable and favourable for South Africa's energy needs?
E.11	Please provide a practical example of a renewable energy project where you have perhaps been part of and demonstrate the impact it had on the local community or grid infrastructure.
E.12	What do you think will be a sustainable solution to electricity generation in terms of financial sustainability? Specifically refer to Coal-fired only or Renewable energy only or mixed technology generation.
E.13	Do think Eskom should invest in renewable energy technologies or clean coal technologies?
E.14	How do you think Eskom will benefit from renewable energy projects i.e. IPP's and micro-grids?
E.15	Would you consider the recent signing of IPP bidders a strategic wise decision by the government i.e. job creation mainly during construction phase vs. possible job losses in the coal sector?
E.16	Please share your view regarding the fact that renewable energy tariffs decreased over the past few years vs. the application by Eskom to NERSA for tariff increases? Please elaborate and propose how you think NERSA should manage this in the future.
E.17	Do you think a transition towards renewable energy, if required, should be a gradual process that span over decades or it should be considered an immediate event? Please elaborate by defining whether coal generation should still be considered an option in the future.
E.18	Do you think renewable energy can be utilised as a strategy by Eskom to amend their current financial situation?
E.19	From a holistic point of view, do you think the impact of a renewable energy revolution in South Africa will be positive or negative? Please state why.
E.20	Are there any additional input, view or opinion you would like to share regarding this research topic than can add significant value to the results of the study?

APPENDIX G: EMPIRICAL STUDY RESULTS-CLOSED-ENDED QUESTIONS

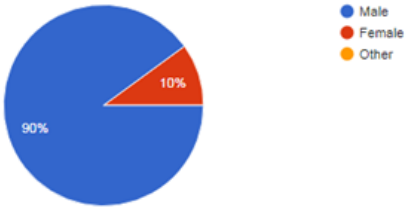
A.1 Age Category:

10 responses



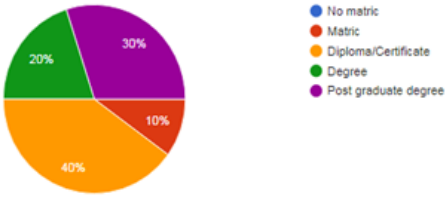
A.2 Which gender do you identify with?

10 responses



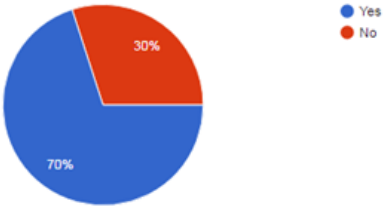
A.3 Highest qualification:

10 responses



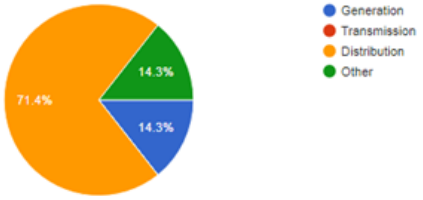
A.4 Are you employed by Eskom SOC. LTD?

10 responses



A.5 In what division are you appointed?

7 responses



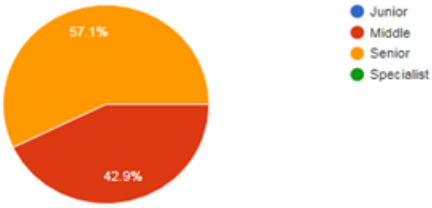
A.6 In what department are you appointed?

7 responses

Network Engineering and design
Asset Creation
Asset creation - NED
Network Engineering and Design
Group Technology, DBOUS, SI GOU & NWOU
Group Technology - C&I CoE
O&M - NOS (PC&C)

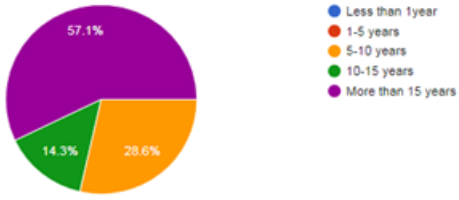
A.7 Level of employment:

7 responses



A.8 Years of experience:

7 responses



A.9 In what sector are you employed?

6 responses

Distribution
Network Planning
Electrical Engineering Substation Protection
Currently studying Electrical Power Engineering
Biogas
Energy Planning (Journalism)

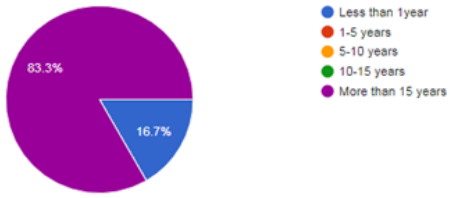
A.10 Job title:

6 responses

Senior Technician
Smart Grid and Telecoms Senior Advisor
Senior Technologist
Graduate in Training
Managing Director
Strategic Energy Planner

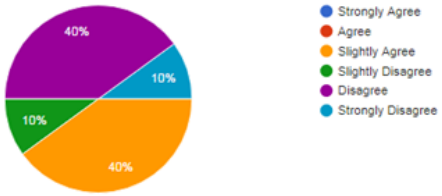
A.11 Years of experience:

6 responses



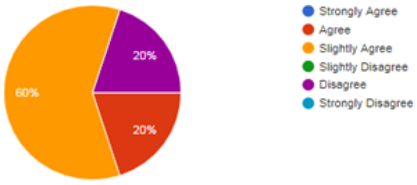
B.1 South Africa is completely dependent on coal generation for economic growth.

10 responses



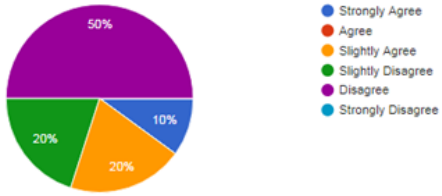
B.2 The optimal energy mix solution for South Africa should primarily consist out of coal generation.

10 responses



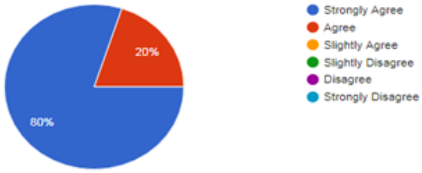
B.3 The coal generation business is pressurised and threatened by renewable energy initiatives.

10 responses



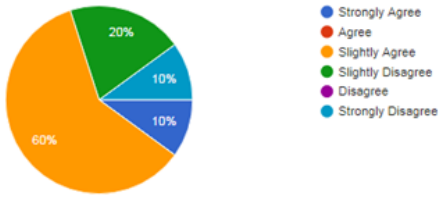
B.4 Eskom should promote research and development in renewable energy technologies.

10 responses



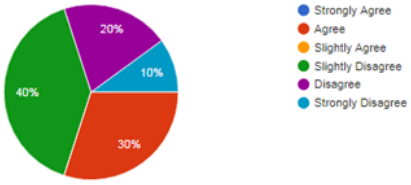
B.5 The coal generation industry in South Africa should remain the major energy source due to relative low cost of coal and abundant reserves of coal.

10 responses



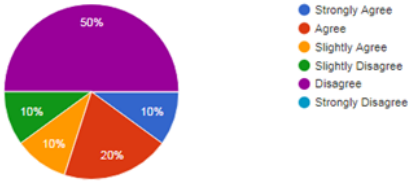
B.6 According to the DoE, 77% of South Africa's primary energy needs are provided by coal. This is unlikely to change significantly in the next two decades due to the lack of suitable alternatives to coal as energy source according to the DoE – to what extent do you agree?

10 responses



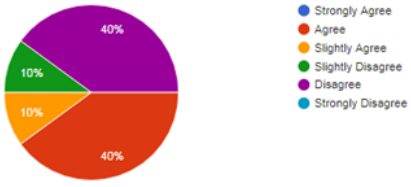
B.7 According to the DoE, there should be more than 50 years of coal supply left at the current production rate. This is sufficient motivation for the government to invest more in clean coal technologies compared to the amount invested in renewable energy technologies.

10 responses



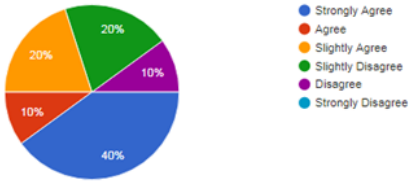
B.8 The levelised costs of electricity from new coal are among the most expensive technologies per kWh of electricity delivered.

10 responses



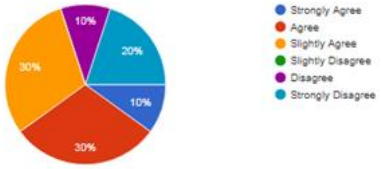
B.9 Eskom confirmed in a recent media briefing that it would require some R400-billion to extend the life of its old coal-fired power stations. Given Eskom's current financial situation, it would be wise for the government to rather invest this type of funds in renewable energy.

10 responses



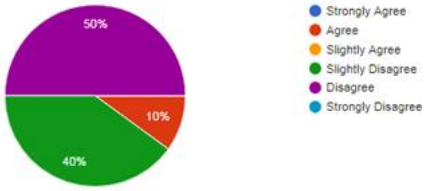
B.10 The fact that the existing availability of Eskom plant is significantly lower than initially anticipated in IRP 2010-2013 (assumed to be 86%) negatively impacts the country's economic growth.

10 responses



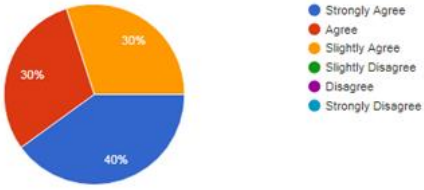
B.11 Investment in low-carbon technologies i.e. cleaner coal should be the primary focus for energy transition instead of renewable energy technologies.

10 responses



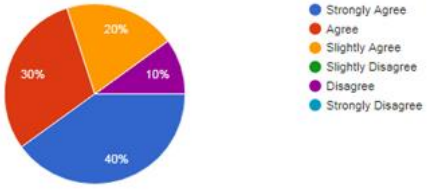
C.1 An urgent need exists in South Africa to make a transition renewable energy.

10 responses



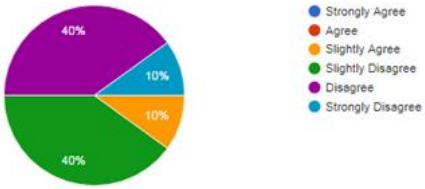
C.2 If a transition towards renewable energy takes place, it should be gradual and not instant.

10 responses



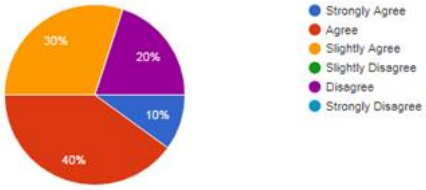
C.3 The recent signing of the IPP agreements will lead to a significant decline in the coal mining sector.

10 responses



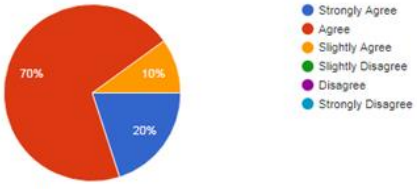
C.4 Renewable energy is still unreliable to a great extent i.e. back-up coal generation will always be required.

10 responses



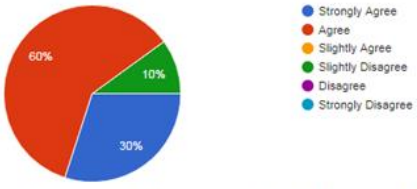
C.5 It is feasible to increase and promote renewable energy generation in South Africa.

10 responses



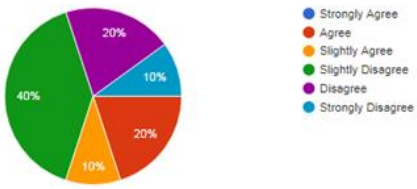
C.6 South Africa lags behind other countries with respect to renewable energy implementation.

10 responses



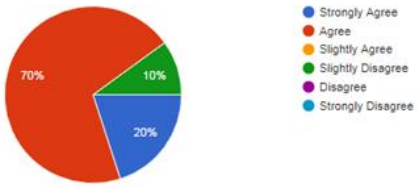
C.7 South Africa will overtake numerous other countries in the implementation of renewable energy within a decade.

10 responses



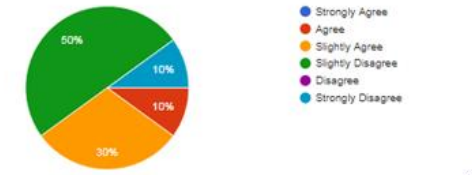
C.8 The need for renewable energy still exists although the demand for electricity has decreased in recent years.

10 responses



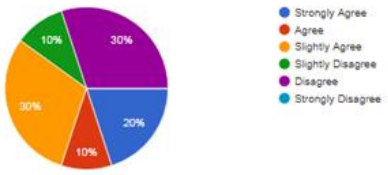
C.9 The least cost plan established by the government that favours wind, PV and gas technologies is a realistic and suitable plan for the country's energy mix given the current state of electrical infrastructure.

10 responses



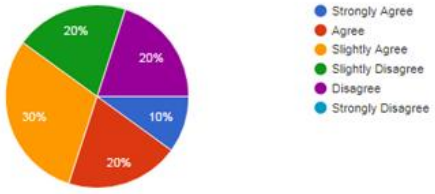
C.10 Given the fact that South Africa currently has an electricity supply surplus and a low economic growth rate, the commissioning of several new IPP's may not be a strategic wise decision for the country.

10 responses



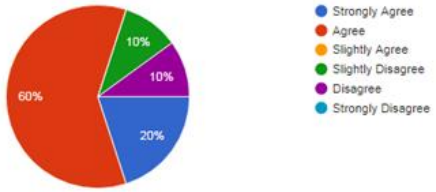
C.11 IPP's will lead to sustainable employment in the economy.

10 responses



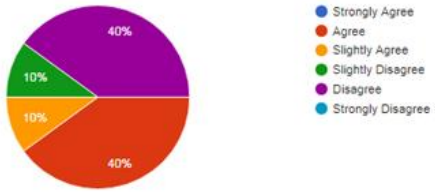
C.12 IPP's will ensure employment during the construction phase of the projects and only few ongoing jobs.

10 responses



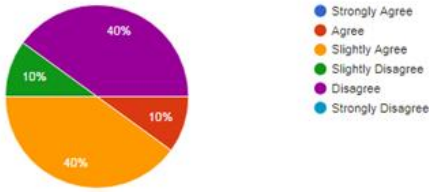
C.13 IPP's will cause a reduction in permanent ongoing jobs elsewhere in the economy.

10 responses



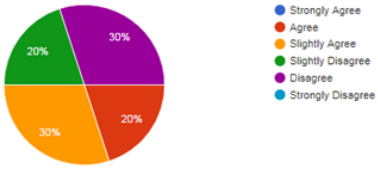
C.14 South Africa's grid infrastructure is sufficient to support and sustain IPP upcoming IPP connections.

10 responses



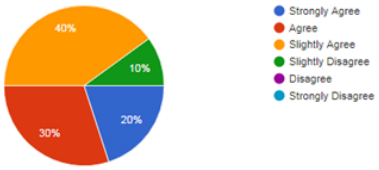
C.15 The pricing and investment decisions for IPP's are efficient.

10 responses



C.16 An investment in a typical IPP project is low risk, stable and predictable.

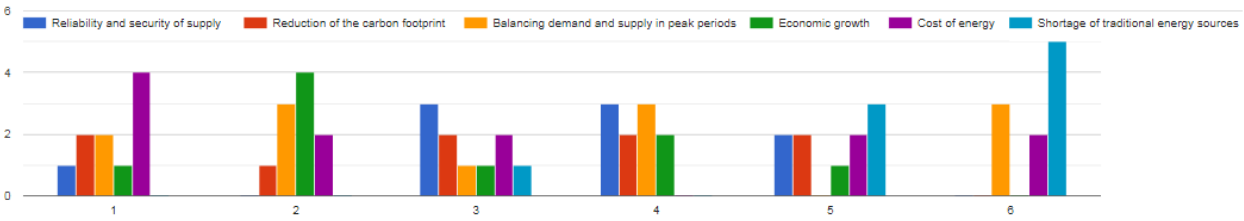
10 responses



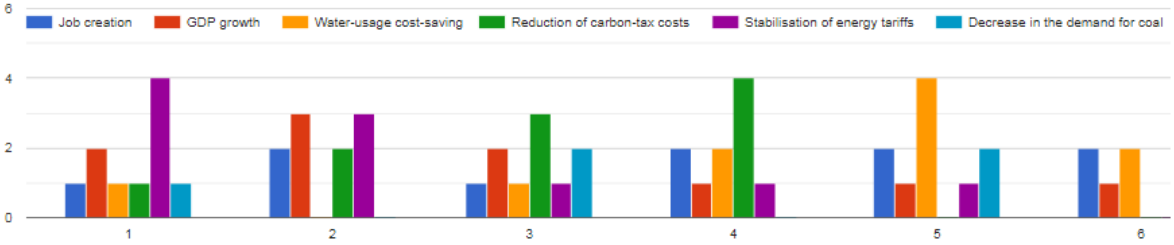
Rate the elements in the following questions (C.17 – C.20) according to significance.

Key - 1 = highest significance and 6 = lowest significance.

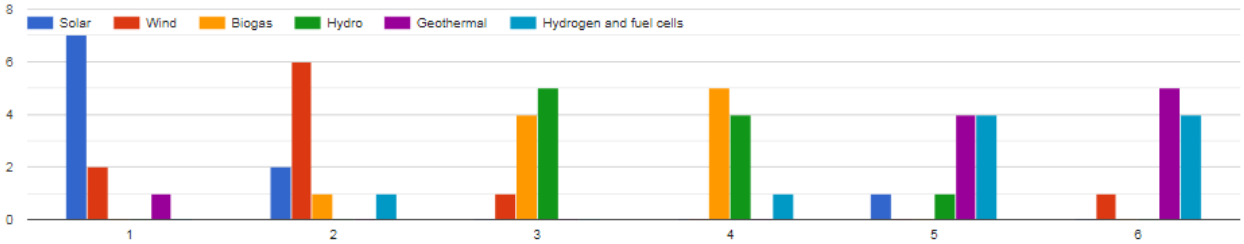
C.17 The need for a transition towards renewable energy is attributed to the following factors:



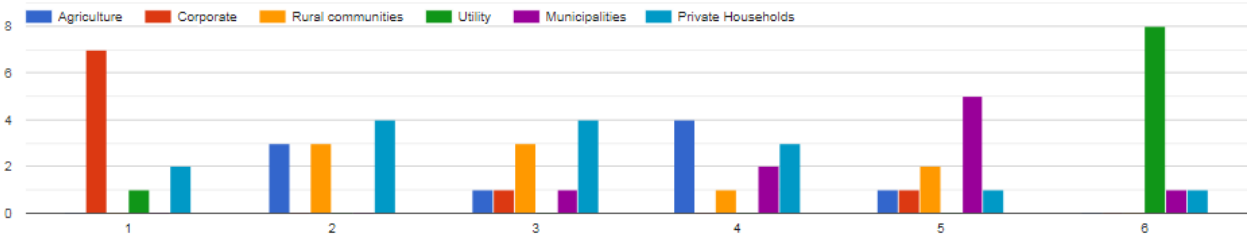
C.18 Should a renewable energy revolution persist in South Africa, what factors will contribute the most to the impact of this revolution?



C.19 The renewable energy technologies that will contribute to the impact of the revolution are:



C.20 The sectors/stakeholders that will benefit from renewable energy are:

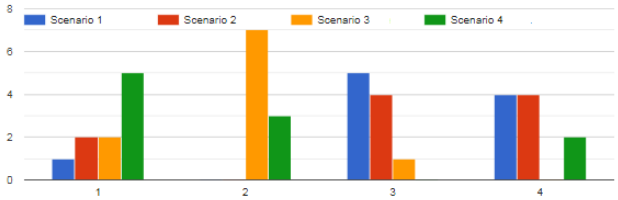


Rate the elements in the following questions (C.21 – C.23) according to

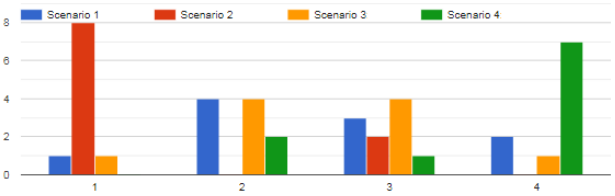
Key - 1 = highest significance and 4 = lowest significance.

Scenario 1: Renewable Energy - High on Demand, Economic Growth - High
Scenario 2: Renewable Energy - High on Demand, Economic Growth - Low
Scenario 3: Renewable Energy - Low on Demand, Economic Growth - High
Scenario 4: Renewable Energy - Low on Demand, Economic Growth - Low

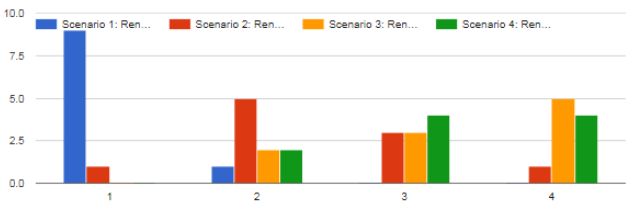
C.21 Considering a scenario-based approach, rate the following scenarios according to significance. A relationship between the demand for renewable energy and the economic growth of South Africa is the basis for this approach. Consider the historic situation of South Africa i.e. pre-renewable revolution.



C.22 Considering a scenario-based approach, rate the following scenarios according to significance. A relationship between the demand for renewable energy and the economic growth of South Africa is the basis for this approach. Consider the current situation of South Africa.

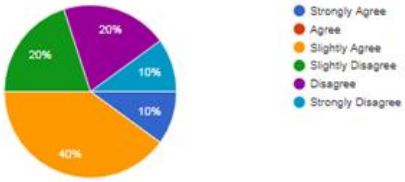


C.23 Considering a scenario-based approach, rate the following scenarios according to significance. A relationship between the demand for renewable energy and the economic growth of South Africa is the basis for this approach. Consider the future situation of South Africa.



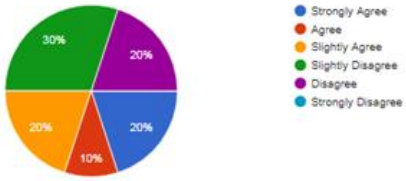
D.1 The government is doing enough to promote and implement renewable energy technologies.

10 responses



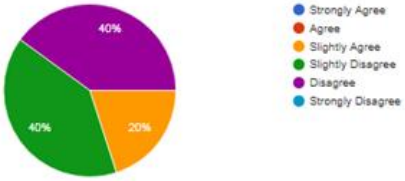
D.2 The upfront investment costs for renewable energy can be justified due to the reduction in energy tariffs.

10 responses



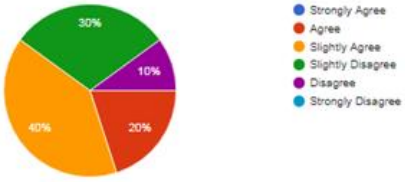
D.3 In the Strategic Plan 2015-2020 set out by the DoE the following statement was made: "The five years is about moving South Africa forward toward an energy secure future". This statement will be fulfilled by the end of 2020.

10 responses



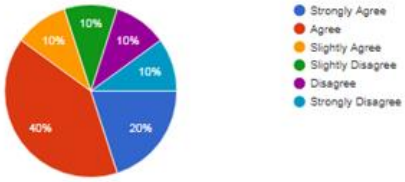
D.4 The vision for 2025 according to the Strategic Plan 2015-2020 set out by the DoE is to improve South Africa's energy mix by having 30% clean energy by 2025. This is a realistic vision and is an inevitable phenomenon.

10 responses



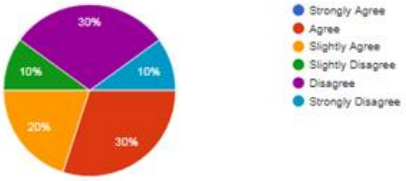
D.5 Renewable energy has the potential to help Eskom out of its difficulties.

10 responses



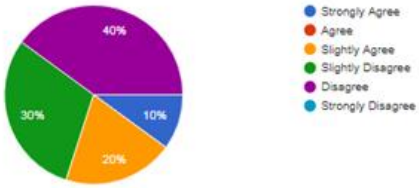
D.6 It is inevitable that renewable energy will help Eskom out of its difficulties.

10 responses



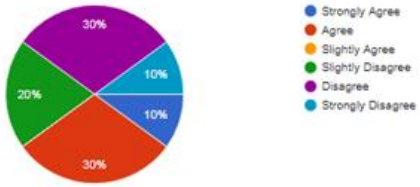
D.7 Sufficient private and public sector coordination is taking place in order to optimise the cost of renewable energy generation.

10 responses



D.8 Eskom is abusing its position to favour its own investment in new power plants.

10 responses

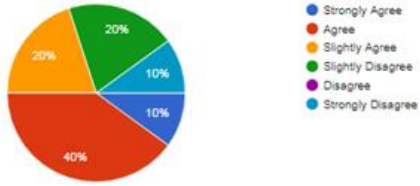


D.9 The government's energy policy is opposed through the resistance of Eskom not promoting renewable energy initiatives.

10 responses

D.10 South Africa has the potential to generate far more jobs in the renewable energy fraternity than the amount of jobs that will be lost from coal mining and related activities should a steady transition towards renewable energy take place.

10 responses

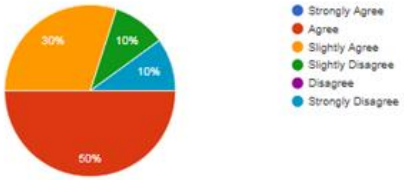


D.11 A revolution is defined as an overthrow and thorough replacement of an established government or political system by the people governed. South Africa is currently at the verge of a renewable energy revolution.

10 responses

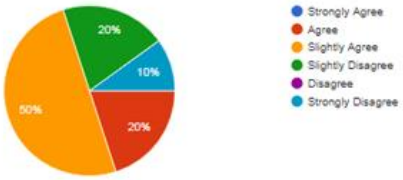
D.12 Energy Minister, Jeff Radebe stated that policy certainty regarding the IRP 2018 will be ensured by allowing engagements on energy transition. To what extent do you agree?

10 responses



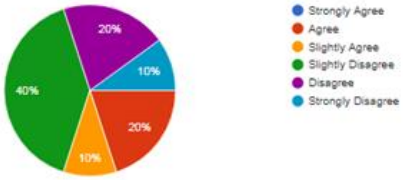
D.13 The fact that gas will account for 16% of the installed capacity mix in the year 2030 sufficiently favours a future diversified energy mix for the country.

10 responses



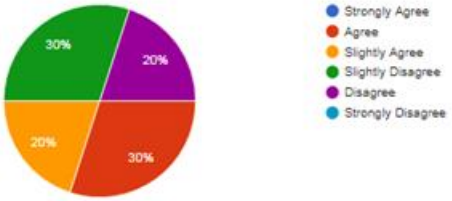
D.14 The fact that there is no plan to increase the use of nuclear energy up until the year 2030 will negatively impact economic growth and investment opportunities for the country.

10 responses



D.15 The revised strategy (IRP 2018) for a diversified energy mix for the country may lead to political and social instability.

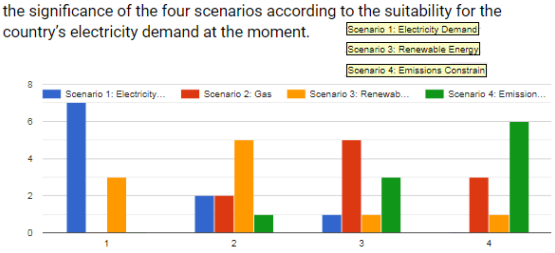
10 responses



Rate the elements in the following question (D.16) according to significance.

Key - 1 = highest significance and 4 = lowest significance.

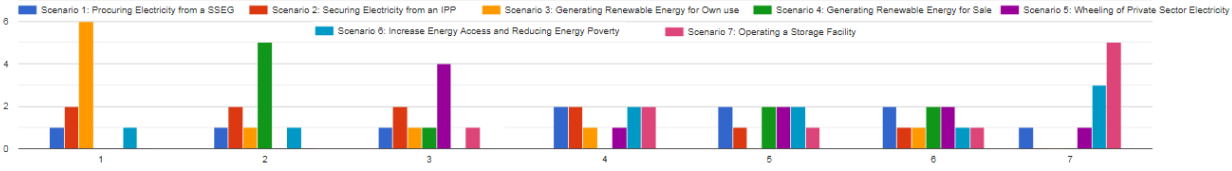
D.16 According to the IRP 2018, four scenarios are depicted in which government intend to manage electricity demand in South Africa. Rate the significance of the four scenarios according to the suitability for the country's electricity demand at the moment.



Rate the elements in the following question (D.17) according to significance.

Key - 1 = highest significance and 7 = lowest significance.

D.17 According to the South African Local Government Association (SALGA), municipalities face seven different scenarios pertaining to renewable energy trends. Rate these scenarios according to the suitability and practicality of implementation that can serve as a solution to current challenges that consumers are experiencing with electricity supply from municipalities.



APPENDIX H: EMPIRICAL STUDY RESULTS-TRANSCRIBED INTERVIEWS

E.1: What is biggest barrier that need to be overcome for South Africa to flourish in the renewable energy fraternity?

Respondent 1: Ensure that no job losses will occur due to IPPs

Respondent 2: Economic growth to the stage where maximum is shifted to midday

Respondent 3: The cost of renewable energy is still a factor that needs to be overcome

Respondent 4: Eskom needs to accept Renewable energy and place itself in a position to 1.) Absorb IPP generated electricity, 2.) Sell to customers who need electricity, 3.) Manage the supply and demand challenge. Eskom needs to become the 'Uber' or 'Broker' that connects 'sellers' and 'buyers' to save Eskom and ensure South Africa moves forward in terms of renewable energy.

Respondent 5: The Utility is a monopoly and has expensive capital investment to repay while also paying premium cost for renewables. Possibly should have considered renewables or curtailing the current coal fired Power Station units. However, older units can possibly be shut down. The cost for the two new Power Stations escalated massively due to excessive political interference.

Respondent 6: The storing capability of renewable energy (thermal/electrical) is a factor. Correct modelling of renewable energy for various scenarios. Renewable energy operating strategies are not catered for correctly in these models.

Respondent 7: South Africa is privileged to be a country where the majority of renewable energy variations can be implemented (wind, hydro, solar, etc.). South Africa's biggest barrier is creating the correct and efficient enough opportunities in order to use all the available resources to their best potential.

Respondent 8: Eskom needs to offer renewable energy solutions to avoid the so-called death spiral.

Respondent 9: Public sector involvement in the REIPPPP

Respondent 10: Eskom needs to re-invent their business model to cater for renewable energy solutions. The problem with Eskom is much deeper than just governance issues in the organisation - they are pressurized and confronted with this renewable energy revolution. If the firm does not strategically align their business model with the rapid changes in the energy industry, the taxpayer and the consumer will keep on paying for their poor decision making regarding the investments in energy.

E.2: Would you say GDP growth is the most accurate measurement indication of the impact of a renewable energy revolution in South Africa?

Respondent 1: No

Respondent 2: No, not enough information available to make accurate assessments

Respondent 3: No, GDP growth is not solely dependent on renewable energy implementation; political stability towards investment is the main driver

Respondent 4: No

Respondent 5: Yes

Respondent 6: Need economy to grow in order to create demand. With demand increase, renewable energy can contribute as Eskom has oversupply (Ingula, Medupi, Kusile)

Respondent 7: No, as there are several other elements of the GDP that can affect the growth rate directly, that has nothing to do with the renewable energy revolution in South Africa.

Respondent 8: No

Respondent 9: No

Respondent 10: No

E.3: What other indicators can you identify to quantify the impact of a renewable energy revolution?

Respondent 1: Reduction on electricity demand from Eskom.

Respondent 2: The price of coal as a commodity

Respondent 3: Skill level, understanding how renewables should integrate with the grid.

Respondent 4: Reduction in day time peak demand. It is perceived that minimal storage exist, and the majority of renewable IPPs being Solar, and Wind only contributing a small portion in the end-state energy mix.

Respondent 5: The reduction of water scarcity and improvement in the pollution of the environment.

Respondent 6: Allow Eskom to participate in the REIPPP and submit their bids

Respondent 7: There are several aspects to be analysed, but job creation, energy consumption and rates will give a good indicator.

Respondent 8: Job creation and local economic activity

Respondent 9: The effect wheeling agreements have on the corporate environment - the drive for corporate sustainability is huge. JSE listed companies should even now report on their sustainability

Respondent 10: The LCOE model provides sufficient indication of how this can affect the tariffs for both new coal technologies as well as renewable energy technologies.

E.4: Describe the socio-economic impact you think the decommissioning of old coal-fired power stations will have and how this will affect job loss or creation?

Respondent 1: Assurance must be given that staff from power stations will be employed somewhere else in the energy sector. IPPs should not contribute to job losses.

Respondent 2: Socio-economic impact will be localised to the area of the coal fired power station.

Respondent 3: Initial job creation and capital influx due to decommissioning but this is short term and long term job loss. Are the work force laid off at the power stations equipped to function at the renewable energy sites?

Respondent 4: Little to none. For the immediate future these coal fired stations are still required. 50 Years is a life time, and probably most staff would retire with the plant. In addition, the plant can be repurposed to serve as a 'spinning reserve'/'battery', so the plant can still be useful, even if coal runs out. (So minimal job loss impact at the coal fired stations, with a big increase in jobs in the renewable IPP section; thus it is good for the economy in terms of jobs.)

Respondent 5: This is hard to say, however, the older PS are inefficient and lack emissions reduction of equipment. It is hard to quantify if people employed here will immediately find new challenges. Should electricity become low in cost and become abundant this could stimulate new industrial growth.

Respondent 6: Decommissioning of old coal-fired power stations is inevitable. And yes, there will be job losses. But as a consumer, lower electricity tariffs will encourage economic growth which will create additional jobs

Respondent 7: Decommissioning the old coal-fired power stations will increase job loss statistics dramatically. It is therefore Eskom's responsibility to develop the renewable energy sector to such an extent that more jobs can be created than lost.

Respondent 8: Should a gradual transition take place (which is probable) the impact won't be severe as jobs will be created in the RE fraternity.

Respondent 9: A big impact which is why renewables should fill this gap

Respondent 10: A major impact which is why it is crucial that Eskom need to step-up and take accountability in proposing a fully-fledged decommissioning strategy for their redundant coal-fired power stations.

E.5: In your opinion has the accountability and risk of IPP project shifted towards the private sector or did it increase government liabilities? Please elaborate.

Respondent 1: Private sector. There will be initial financial implications as well as no clear future direction.

Respondent 2: It has shifted towards the private sector.

Respondent 3: Private sector, these stakeholders should determine if it is viable for them depending on the kWh costs associated with the project.

Respondent 4: Yes/No. Private Sector is adopting renewable technologies to be 'green', to comply with municipal drives to reduce, but also to attract private investments from overseas, and to reduce monthly costs. Government liabilities have been reduced by proposed IPP frameworks, but the success of this is still unknown?

Respondent 5: The early IPP bids favoured the IPP investor; however it appears to be improving where the end user may start getting some benefit.

Respondent 6: Private sector. Government has some accountability with regards to policy formulation. But the risk of the project is private and should not be the accountability of the government. They can intervene when for instance Eskom doesn't want to sign IPPs

Respondent 7: I think that there will definitely be an increase in the government liabilities, but it will surely be a mixture between the private sector and government.

Respondent 8: Both, the private sector should strive to sign PPAs to contribute to the revolution and the public sector should manage the demand and supply impact of the revolution. Collaboration is therefore required between the two sectors.

Respondent 9: Private sector to setup wheeling agreements with investors and establish sustainable PPAs with private investors that are interested. The intervention of the public sector is still required though.

Respondent 10: Both - intensive collaboration needs to take place between the two sectors to collectively build and develop a green economy.

E.6: Do you think a downside exist in execution of renewable energy projects? Please elaborate.

Respondent 1: Yes, if it contributes to job losses. Renewable energy is still expensive and its reliability not proven,

Respondent 2: Yes, the trend I believe is the rich will benefit to the detriment of the poor. The rich can afford to install PV's which means less sales/demand but the base load needs to be sustained as renewable energy fluctuates. Therefore the price for electricity will rise.

Respondent 3: Yes, Eskom sits with surplus energy which will affect its sustainability.

Respondent 4: Yes, if not implemented with some form of energy storage. Then this will create havoc on the supply and demand of the grid, which will lead to (mostly) Eskom assets being over and under stretched, leading to additional maintenance costs, leading to further price increases, leading to more IPPs (As the investment is now more attractive).... - A death spiral.

Respondent 5: People working in the traditional utility model would probably have to make major adjustments. However, in the longer term all South Africans should benefit.

Respondent 6: No

Respondent 7: Generally I think that the renewable energy projects are mostly good, but the environmental affects that could be created should definitely be considered.

Respondent 8: Yes, a false market can be established as the public is not informed of the actual costs of renewable energy technologies. This may cause uneducated

decisions in the private sector instead of collaboration between both the public and the private sector.

Respondent 9: No, the IRP provides great period of certainty of which currently this certainty is at its peak and it is clear that renewable energy will have a significant impact on the economy if it is managed properly in during this revolution the country find themselves in.

Respondent 10: Not on paper as the principles on which renewables are based hold significant benefits. The downside, however, may be if Eskom does not support the development of renewable energy technologies.

E.7: Do you think Eskom, the solely licensed electricity provider of South Africa, is threatened/will be threatened by renewable energy technologies? Please elaborate.

Respondent 1: No. Transmission and distribution should remain with Eskom/ Municipalities. It would be very expensive for IPPs to create its own distribution network.

Respondent 2: No, as the infrastructure that Eskom has in place is needed to transport the energy can be the balancing factor in keeping Eskom sustainable. This would, however, have to be a fine balance.

Respondent 3: Yes, middle class clients, corporates will move over to RE. The same middle class are the clients paying; Electricity theft is increasing which will lead the utility in a downward income spiral

Respondent 4: Only because of current decisions made within Eskom. See E.1 above for clarity.

Respondent 5: This depends largely on how the utility positions itself. If the utility does not become a player in the renewable field and scale operations to suite a renewable power model it can have implications. I envisage a future where smaller localized energy suppliers will rule the roost. An integrated network would probably always be needed to shift power between regions due to weather and climate related events. New technologies such as battery storage, transport systems with battery storage capability

can, however, alleviate this. It is not inconceivable that other technologies will complement the energy mix - Fusion reactors.

Respondent 6: Yes and No. I see no reason why Eskom can't participate in the REIPPP? Therefore, they won't be threatened. If they are excluded, the sales will go down and debt won't be repaid

Respondent 7: No, I think that Eskom should embrace the renewable energy technologies and branch out the energy generation in to more than coal-fired power stations.

Respondent 8: No - their strategic competitive advantage is the grid infrastructure.

Respondent 9: No, in fact this is an opportunity for them to recover from past failed decision by entering into the renewable energy market as they have a competitive advantage over the private sector which is grid infrastructure.

Respondent 10: They are to a certain extent as they find themselves in a predicament - on the supply side the cost of renewable energy is dropping at a significant rate and Eskom's strategic intentions does not cater for this situation. On the demand side, there have also been several changes that caused a significant drop in the demand for electricity and the utility need to recover fixed costs (Medupi and Kusile) from declining revue streams. Should the utility not act on these two changes in the energy industry the threat will enlarge to such an extent that the revolution negatively affects the country, economy and its people.

E.8: What impact do you think an increase in renewable energy will have on the economic growth of the country (keeping in mind that Eskom is a monopolistic SOC that drives the economy and coal generation industry)?

Respondent 1: At this stage minimal unless renewable energy becomes much cheaper that tradition elegy from fuel sources.

Respondent 2: Renewable energy can create a surplus of energy and as the sun in South Africa will have the greatest impact growing an economy to utilise that can lead to economic growth.

Respondent 3: It will have a positive impact but unable to quantify the exact percentage on economic growth.

Respondent 4: It would contribute, if implemented in a sustainable planned manner.

Respondent 5: Currently Eskom is driving up electricity prices due to inefficient operation, over staffing and more or less keeping to the status quo of the last 20 years or more. Eskom needs a new vision to move along with renewables and other energy sources.

Respondent 6: None. A market for renewable energy needs to be established for economic growth in the sector. We have a surplus of power; therefore, tariff increases are more likely to happen as Eskom need to cover its debt

Respondent 7: It would definitely increase the economic growth of the country, especially if electricity is supplied in rural areas for examples. People who would not have been able to do business without electricity would then have the opportunity to grow their own business for example and create jobs.

Respondent 8: Positive if it is optimally managed by all relevant stakeholders.

Respondent 9: A positive impact - Eskom need to embrace the opportunity.

Respondent 10: Positive impact based on the IRP 2018.

E.9: Do you think the government is doing enough to promote and execute renewable energy technologies in order to manage energy demand in South Africa? Please elaborate.

Respondent 1: Yes. Signing of IPP contracts proves this. Government also has a responsibility towards Eskom and mines to ensure no job losses as a result of increased IPPs.

Respondent 2: Yes, I believe renewable energy should grow at a steady pace over a number of years to ensure economic stability.

Respondent 3: If you refer to government as Eskom then the lack of capital is surely affecting the availability of renewable energy

Respondent 4: No, as its semi-government Eskom seems to be in odds with government drives.

Respondent 5: No. There is no incentive for end users to utilize roof top solar, no incentive to utilize electric cars and hybrids.

Respondent 6: The REIPPP is great initiative, but policy formulation needs to be revisited and be updated.

Respondent 7: No, there is a large gap between the renewable energy development in South Africa and other leading countries. There is still a lot to learn and develop.

Respondent 8: Yes the recent publication of the IRP 2018 suggests this although some assumptions made in the plan are questionable.

Respondent 9: Yes (recent publication of the IRP 2018) although a few assumptions should be clarified to the private sector.

Respondent 10: Yes but a few concerns are raised specifically with regards to the inaccurate assumptions made that affect the Wind, Solar PV and most definitely the CSP industry. The government (DoE) should therefore investigate this to rectify these assumptions and align it with the reality of the current status of the energy industry.

E.10: What is your view on the publication of the recent IRP as set out by the DoE i.e. is the energy mix and forecast realistic, attainable and favourable for South Africa's energy needs?

Respondent 1: Yes and No. If we can stimulate the economy there will be load growth and thus a need for additional energy. If not, we will always have surplus energy from Eskom.

Respondent 2: I have not read the publication and therefore I cannot comment.

Respondent 3: It comprises a good energy mix although the slow growth in the economy will place a constraint on the achievable timelines.

Respondent 4: Did not see forecast therefore I cannot comment.

Respondent 5: I have not studied this.

Respondent 6: Not in favour. No CSP with thermal storage included. Importing Gas makes no sense. Will probably change after the elections and include nuclear again.

Respondent 7: My view is that the energy mix and forecast is realistic, but will only be reached with good planning, hard work and focus on the goal. It has the potential to be favourable to South Africa's energy needs.

Respondent 8: Rooftop PV and CSP should be have been considered as well.

Respondent 9: Good Energy mix that favours the private sector.

Respondent 10: Good Energy Mix but policy uncertainty might be a probability

E.11: Please provide a practical example of a renewable energy project where you have perhaps been part of and demonstrate the impact it had on the local community or grid infrastructure.

Respondent 1: Involved in all the IPP projects in Gauteng Operating unit. No real impact on local community or grid.

Respondent 2: I am aware of a farm community that has benefited from renewable energy where it was cheaper to install PV with battery back-up compared to building a line to supply the community.

Respondent 3: Bio2Watt is a 6MVA biogas plant generating electricity from manure. The major constraint was the technical understanding of industry to understand/comply to the technical interconnection requirements posed by the utility.

Respondent 4: Mall of Africa - Demand was reduced by more or less 4MVA in the day. Night time demand the same, but in any case little for a mall. The Mall could source

funding from overseas as they are 'green'. Thus, they could reinvest this into other projects related to the same developer that built the mall.

Respondent 5: I have not had such an opportunity.

Respondent 6: My projects didn't realise to execution phase

Respondent 7: I myself was not part of the project, but did come across a project where a gravity powered energy source was supplied to rural areas where grid and renewable energy development is not feasible. It had a tremendous effect on the community (in a good way).

Respondent 8: Mall of Africa: Biggest rooftop PV in South Africa. This attracted foreign investments.

Respondent 9: I am the owner of a privately owned biogas plant in Gauteng and this holds benefits to the agricultural community. Local economic activity takes place and the investor of the project is also the off-taker of electricity supplied by the plant. This investor comprise a massive ROI due to the project. This is only a few mentioned benefits.

Respondent 10: I am a strategic planner focusing on the entire energy industry i.e. both the renewable fraternity and the coal generation sector and to some extent nuclear. The common finding in my experience is that the drive for renewable energy is now bigger as ever in South Africa and this is the first time the country is confronted with this type of scenario. This implies that it is now the crucial time period whereby all stakeholders should collaborate to make the proposed energy mix viable and a reality.

E.12: What do you think will be a sustainable solution to electricity generation in terms of financial sustainability? Specifically refer to Coal-fired only or Renewable energy only or mixed technology generation.

Respondent 1: A combination of both with a sound partnership between Eskom (coal) and private sector (renewables)

Respondent 2: Mixed technology generation would be more financial sustainable.

Respondent 3: Coal fired financial sustainability is heavily dependent on reliable and cheap coal supply from cost plus coal mines or fixed price coal supply.

Respondent 4: Mixed technology.

Respondent 5: I believe coal is still going to be around for the next decade but should start declining should renewables take off in a big way. However, in countries such as Germany it has been shown renewables is the future. In economies where utilities are not a monopoly and government pushes renewables this happens relatively quickly. (Germany) Even China is pushing for renewables possibly driven by severely polluted cities.

Respondent 6: Mix technology generation in favour - a balanced system

Respondent 7: Mixed technology generation

Respondent 8: Mixed. Eskom needs to collaborate and find a pathway to offer renewable energy solutions.

Respondent 9: Mixed - Eskom needs to re-invent operations and the private sector needs to partner with the utility to stabilize energy tariffs.

Respondent 10: Mixed technology definitely and the only sustainable solution is for Eskom to enter, surprise and disrupt the renewable energy market by offering products directly to consumers.

E.13: Do think Eskom should invest in renewable energy technologies or clean coal technologies?

Respondent 1: Renewable energy technologies.

Respondent 2: I believe they should invest in both as mixed technology generation in my view is the best solution for South Africa.

Respondent 3: I believe a mix between the two must be considered.

Respondent 4: Renewable Energy technologies.

Respondent 5: Renewable energy technologies.

Respondent 6: Renewable energy technologies.

Respondent 7: Most definitely invest in renewable energy technologies

Respondent 8: Renewable energy technologies definitely – Eskom's business model should be adjusted to cater for the evolving energy market.

Respondent 9: Renewable energy technologies.

Respondent 10: Renewable energy technologies.

E.14: How do you think Eskom will benefit from renewable energy projects i.e. IPPs and micro-grids?

Respondent 1: Only if they have a financial partnership/supply agreement with the private IPPs.

Respondent 2: Renewable energy can benefit Eskom from it in rural areas where the cost benefit would be cheaper than build a line or supporting long lines with supply problems. Not much benefit can be realised in a province like Gauteng

Respondent 3: If the present cost of generating is less than the agreed kWh tariff paid to renewable energy then financially there will not be a benefit.

Respondent 4: Tremendously, but need to make a shift change to this technology first.

Respondent 5: It can benefit possibly by allowing the shutting down of old power stations but would also have to relook at operations. The future role may be to regulate and stabilise power flow between the renewable power centres. New technologies may also develop (fusion reactors have been touted as an abundant, clean energy source low in cost). Currently as far as I know there is no promise of commercial fusion reactors imminent.) Natural gas is seemingly abundant and relatively cheap to transport. Cost effective battery storage solutions can be the catalyst ultimately needed.

Respondent 6: It affects Eskom negatively, as the cost in the PPA is a pass through cost. Eskom need to take the power generated, meaning that the coal fired power stations need to be curtailed

Respondent 7: There will not be a point in the near future where there will be a low demand of coal-fired generation. South Africa's infrastructure doesn't support IPPs on a large scale yet, but it will benefit from the lightening of the load in situations where load-shedding would have been the only other option without IPPs.

Respondent 8: They will only benefit if they offer the product

Respondent 9: Eskom can recover fixed if they re-invent and offer renewable energy as a product.

Respondent 10: No real benefit if they do not collaborate.

E.15: Would you consider the recent signing of IPP bidders a strategic wise decision by the government i.e. job creation mainly during construction phase vs. possible job losses in the coal sector?

Respondent 1: Seeing that the IPP contribution towards the greater energy demand is still small I do not think it will have a huge impact on the coal industry.

Respondent 2: The demand for coal will remain, if not in South Africa then world-wide.

Respondent 3: The coal sector is thriving due to the high international cost of coal; I don't foresee job losses only based on RE introduction at coal mines.

Respondent 4: It is a start, but not a sustainable solution. Large numbers of jobs created over a short period - that is it. Also, the IPP bidders are signed at a tariff rate higher than what Eskom gets paid for the same energy, so Eskom loses 'forever' while the country gains job over a short period - Not sustainable.

Respondent 5: If it were up to me IPPs would have to beat the cost of coal based electricity tariffs, this would make sense. The coal sector may still flourish in the short to mid-term by means of exports. The coal sector also appears to be very volatile also risking coal based power generation.

Respondent 6: Signing of the recent IPPs was not strategic but political. I do not see a correlation between the two with regards to job loss vs job creation. These plants are very small in comparison to a coal fired power station where 1x unit output about 600 MW

Respondent 7: I believe it is a good opportunity that was created by the recent signing of IPP bidders. It creates the potential of more job creations and possibilities in the future and not only during the construction phase.

Respondent 8: Yes, although the job creation plays a role. This will be normalised after a period of time though.

Respondent 9: Yes, the job creation is still sustainable specifically for biogas plants as the lifetime of the plant is 20 years and numerous job creation opportunities exist around the plant i.e. delivery of raw materials, plant operation and maintenance, wheeling of power etc.

Respondent 10: Yes, job losses in the coal sector will not be severely affected. The construction phase job creation of IPPs will surely stimulate the local economic activity in close vicinity of the plant which will have a positive impact on the local economy.

E.16: Please share your view regarding the fact that renewable energy tariffs decreased over the past few years vs. the application by Eskom to NERSA for tariff increases? Please elaborate and propose how you think NERSA should manage this in the future.

Respondent 1: Infrastructure development and maintenance would still require an increase for Eskom. You cannot purely look at production cost of energy. Distribution cost must be taken into account as well.

Respondent 2: I believe NERSA has a difficult job to manage this because at some stage renewable energy and Eskom energy will match and at that stage NERSA needs to ensure that the tariffs for both stay on par with each other.

Respondent 3: NERSA should take in account that an IPP project is initially very expensive and only after the commissioning phase the costs decline yielding a ROI.

Respondent 4: The two cannot really be compared. IPPs only generate energy, will Eskom generated and distributed. - Thus, who must pay for the use of the grid? Should it be IPP/Eskom selling the energy or the end user that buys the energy?

Respondent 5: Basically, the 'grid' and its maintenance cost must be separated, and NERSA should decide the realistic cost of this, taking into account grid costs, maintenance, aging plant, etc. The cost of energy must then be standardized across the board for all different renewable and non-renewable energy sources. That is the rate the energy generator must be paid, irrespective of size and location. Over time, the non-renewable and renewable energy tariffs have to be carefully managed (and cross subsidized) to control the IPPs being introduced, and to work towards the government's end state vision for energy in South Africa. (Currently the price is not controlled correctly, thus why it is spiralling out of control.)

Respondent 6: Eskom has to deal with the inefficient operational model and start massively reducing the cost of electricity. This can only be achieved by scaling down staff and a severely top heavy management structure. Eskom would have to re-invent itself. The problem is how to do this while keeping a deflated economy going and providing reduced electricity cost to get the economy going again. An ailing Eskom also by and large results in a poor Electrical Engineering economy.

Respondent 7: If there is no renewable energy industry in South Africa, the LCOE for these technologies will not come down. Also, if the industry is not established, the financial cost (interest rates) will be higher due to risk. According to the PPA and application to NERSA, power generated through IPPs is pass through cost, i.e. Eskom does not pay for this electricity it is directly passed on to the consumer. The tariff increases is due to cover Eskom’s debt and operating expenses. Taking off power from IPPs does, however, negatively affect Eskom as they lose out on the sales they could have made instead (seeing as we have excess capacity)

Respondent 8: The tariff increases requested by Eskom is based more than just the implementation of renewable energy and the renewable energy tariffs. NERSA should consider all the aspects when managing this in the future.

Respondent 9: A false market is established as renewable energy tariffs are not as low as advertised. Coal is still cheaper.

Respondent 10: Once again, the LCOE provides a comparison mechanism between these two tariff structures and the only way for these tariffs to be stabilized is if Eskom and private sector stakeholder intensively collaborate.

E.17: Do you think a transition towards renewable energy, if required, should be a gradual process that span over decades or it should be considered an immediate event? Please elaborate by defining whether coal generation should still be considered an option in the future.

Respondent 1: It must be a gradual transition with coal being part of the energy mix.

Respondent 2: In South Africa I believe it should be gradual but not more than two decades. In South Africa the best form of renewable energy is solar and therefore we will always need either coal or nuclear power to sustain the base load.

Respondent 3: The introduction of renewable energy should be a gradual process phased together with the decommissioning of aging generation plant. Coal generation should always be available to cover the base load demand.

Respondent 4: Gradual, for technology, grid reasons and sustainable job creation. Coal will form part of the mix, until it runs out, in which case we should be ready for this and have alternatives in place.

Respondent 5: I don't see a need for an overnight revolution but definitely a planned scaling down of coal based generation with new technology which reduces energy cost to all of South Africa. Coal pollutes and promotes water scarcity in a country that is water scarce.

Respondent 6: 5-10 year plan give sufficient planning, with all relevant stakeholders. Upgrading of grid infrastructure also need to be considered. So it should be gradual. Furthermore, the creation of a renewable energy industry in South Africa will aid to job creation

Respondent 7: The transition towards renewable energy cannot be considered as an immediate event as Eskom's infrastructure does not support a major change like that, but can most definitely be implemented gradually.

Respondent 8: Gradual, Eskom and the government is not ready for the change.

Respondent 9: Gradual although the pace of transition should be increased now with the publication of the IRP 2018.

Respondent 10: Gradual, Rome was not built in a day and Eskom was not either. It will take time for the renewable energy market and the coal generation market merge - this will be a second much bigger energy revolution this country have seen and will ever see.

E.18: Do you think renewable energy can be utilised as a strategy by Eskom to amend their current financial situation?

Respondent 1: No. Renewable energy is still too expensive in my opinion.

Respondent 2: Yes, I do believe that Eskom can use it as it is the aim to provide electricity to everybody in SA and in certain situations renewable energy will be more cost effective.

Respondent 3: Yes, Eskom should be in the position to offer a customer a renewable energy solution.

Respondent 4: Yes. But various previous decisions have to be changed.

Respondent 5: Possibly if Eskom makes a dramatic shift in staffing and phasing out old technology power stations. Engineers and operational engineering staff should be absorbed partly by the renewable movement. Other skills can again become available should the economy recover. It will, however, cause hardships for many people.

Respondent 6: If Eskom is allowed to participate in the REIPPP

Respondent 7: It can make a difference.

Respondent 8: Yes - adjusting and revolutionizing their business model should take place though.

Respondent 9: Definitely

Respondent 10: Definitely, in my opinion it is Eskom's only way out.

E.19: From a holistic point of view, do you think the impact of a renewable energy revolution in South Africa will be positive or negative? Please state why.

Respondent 1: Can be either or. Depending on how it is implemented and managed.

Respondent 2: In the long run I believe it will be positive as it will reduce carbon emissions.

Respondent 3: I think holistically it will have a positive impact if

Respondent 4: Positive if controlled. We are securing our future energy requirements while creating jobs at the same time.

Respondent 5: This really depends on the Leadership of the country. Can the necessary investment be stimulated to occur in South Africa? South Africa has serious skills issues with poor schooling and tertiary education also seemingly struggling to keep up good standards. Without good skills the economy won't grow. Low cost energy, however, can be a catalyst and possibly South Africa needs less government and more privatisation.

Respondent 6: Negative. You can't change overnight, but the current plan (IRP) on the table should be revised including CSP with storage

Respondent 7: Positive. As stated earlier, South Africa has more than one renewable energy source available in its country and can be used to its advantage when managed correctly.

Respondent 8: Positive if managed well by all stakeholders.

Respondent 9: Positive the IRP states it as well with numerous benefits.

Respondent 10: Positive - stabilization of energy tariffs and stimulation of local economic activities.

E.20: Are there any additional input, view or opinion you would like to share regarding this research topic than can add significant value to the results of the study?

Respondent 1: Renewable energy is a definite but must not be seen as the answer to all of South Africa's energy challenges.

Respondent 2: All I can say renewable energy is here to stay, we can only embrace the change.

Respondent 3: The industry and Eskom's drive to enhance IPP development is going nowhere slowly. Initially there were a lot of applications for IPPs but now these applications have stagnated. The rate of new applications is slowing down because Eskom is not ready on a technical level. Eskom is protecting its own turf.

Respondent 4: Unfortunately people are mostly driven by finances. A combined finance / business plan is required for all stakeholders (Government, Eskom, Private, etc.) to see what role they can play to enable renewable energy. (Who puts in what, who gets what slice of the cake, etc.) While everyone is on their own 'mission', it will continue to cause more problems for all, leading to more regulation and control, and ultimately lead to undesirable outcomes which cannot be foreseen now.

Respondent 5: In Eskom very few people are exposed to renewables and the impact of the technology has on networks in terms of design and operation. A small grouping get exposed and operational staff planning and building networks and integrating networks are left to sort out the nuts and bolts as the 'revolution' moves along. There should be more workshops and renewable training to all staff.

Respondent 6: Perhaps to look at the Government Policies regarding the IPP process and PPA and also perform an analysis on the job creation/losses. Some of these resources can be used in the renewable energy industry. Construction create a lot of jobs, but operations and maintenance have a few people involved at site

Respondent 7: An in depth analysis can be done on what steps other countries have taken that was in a similar position as South African and chose to implement renewable energy on a large enough scale to be profitable to their country. Similar steps can be taken by South Africa to implement a much needed infrastructure for renewable energy.

Respondent 8: The solution is simple - Eskom should adapt to the ever-changing energy landscape and adjust their business model to deal with both the supply and demand side of the so-called death-spiral.

Respondent 9: The role of the public sector is important but it is critical from us in the private sector to also support the utility and key stakeholders to make a steady transition towards green energy.

Respondent 10: I think it is important to consider the IRP as a guiding mechanism by all stakeholders in order to establish a common objective among them. This is the first step towards a stabilized and developed energy infrastructure that comprise both renewable energy and coal-fired energy.