Ethical research conducted in Solar and Wind energy towards sustainable development in South Africa

Irene Glorina Setshedi

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Business Administration

Johannesburg, 2014

ABSTRACT

The research aims to determine whether ethics are applied in the research and implementation of renewable energy projects in South Africa. It explores whether researchers involved in the renewable energy environment are transparent about all their findings.

The research also uncovers the sustainability of renewable energy and it explores whether there is holistic communication with respect to renewable energy between all the relevant stakeholders.

.

A qualitative approach was used to conduct the study. Twenty participants who are professionals in the renewable energy environment were interviewed. The participants range from researchers, electricity grid managers and the bulk of the participants were engineers. The recordings from the interviews were transcribed to enable data analysis.

Ethics in renewable energy research were found to be in existence to a large extent. The research community that participated in the research indicated that it is their responsibility to divulge all their findings and communicate all the information to all stakeholders.

Renewable energy was found to be a fossil fuel saver rather than a replacement. The implementation thereof comes at a very high cost which is contrary to the requirements of sustainability. The study found that there were unintended positive and negative consequences associated with renewable energy.

The key message from this study is that government and institutions involved in renewable energy must be forthcoming about the real reasons for implementing renewable energy, the associated advantages and disadvantages and thus making communication transparent and holistic.

DECLARATION

I, Irene Glorina Setshedi, declare that this research is my own, unaided work, except as indicated in the acknowledgements, the text and the references. It is submitted in partial fulfilment of the requirements for the degree of Masters of Business Administration at the University of the Witwatersrand, Johannesburg. It has not been submitted before, either whole or in part, for any degree or examination at this or any other university.

Irene Glorina Setshedi

Signed at ……

On the …….. day of …… 2014

DEDICATION

I dedicate my research to God the almighty who has given me the strength and courage to complete my studies under challenging conditions. I also dedicate this work to my beautiful daughter, Bohlale Phuti Setshedi, who at the tender age of two years had to come to terms with my endless absence in her life for the years of my studies.

ACKNOWLEDGEMENTS

My first acknowledgement goes to my family, which consists of my husband and daughter for their love, support and sacrifice during the duration of my studies.

Thank you to Professor Anthony Stacey for his guidance, expertise and patience in completing this research. Your enthusiasm and commitment in the subject matter has been a constant source of motivation.

The support and motivation from my classmates has been amazing. Your persistence and resilience to continue coming to campus on Saturdays to work on the research has not gone unnoticed. I could not have done it without you.

A special thank you goes out to all the Eskom employees who participated in the research sample. Your passion, dedication, enthusiasm for the subject matter and willingness to assist me is greatly appreciated. Without you, this research was not going to be possible.

My sisters and friends have been instrumental in ensuring the completion of this report through their support. This research could not have been completed without them.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Purpose of the study

The purpose of the research is to determine whether ethics play a role in renewable energy. The sustainability of renewable energy is explored. The research also attempts to identify all the unintended positive and negative consequences of sustainable energy and to identify whether there has been a holistic approach towards the research of the associated technologies. This ultimately informs us about the extent ethical research has been conducted in the renewable energy environment.

To determine the extent to which ethics play a role, interviews were used as the research instrument. The individuals who are actively involved in renewable energy technology development and projects were interviewed. A qualitative approach was used for the research strategy.

1.2 Context of the study

Energy is a fundamental need for the global society (Spalding-Fecher & Matibe, 2003). It is integral in growing economies and thereby reducing poverty. Energy in the form of fossil fuel is exploited in abundance globally for daily consumption of electricity generation and the production of petrochemicals amongst others. The extraction of fossil fuel has been increasing rapidly with the rapid growth of the world population and the world economies (Spalding-Fecher & Matibe, 2003).

South Africa has an abundance of coal resources in the ground. The remaining usable resources have been estimated at hundred and nine years of coal left (Chamber of Mines of South Africa, 2012). South Africa through its power utility, Eskom, has been generating electricity mainly from coal for many years. South Africa's base load energy comes from coal (Eskom, 2014). There are however other sources of energy such as hydro, gas, nuclear and minimal renewable energy.

The continued reliance on coal as the main source of energy in South Africa has been deemed unsustainable. That is due to excessive carbon emissions generated when fossil fuels are converted to usable energy which is said to lead to global warming and the inability of the fossil fuels to be regenerated at a higher rate than currently consumed. That is simply because fossil fuels were generated in environments that do not exist today. They were formed from decomposed plant materials that were compacted over long geological periods (Shaffer & Zim,1989), for that reason, humans cannot replace fossil fuels and need to find new solutions for sources of energy.

Eskom generates the bulk of its electricity mainly from thirteen coal fired power stations. The power utility is ranked in the top five in the list of the highest global carbon emitters (Carbon Monitoring for Action, 2007). In Africa, Eskom is the leading emitter of carbon. It is for this reason that South Africa as country needs to find new ways of generating cleaner electricity.

The country has embarked on various renewable energy projects as guided by the integrated resource plan (IRP) for electricity. The main reason for embarking on these projects was to enable the country to reduce its carbon footprint since the country is among the highest emitters of carbon.

Industry players have introduced renewable energy technologies through various products. These products range from large scale use to domestic use. Industry has been in the forefront in terms of marketing the products. The marketing of these products has highlighted great benefits from sustainable development.

Renewable energy has been found to be a more sustainable solution as opposed to the diminishing fossil fuel resources and as the solution to reduce carbon emissions, thus guaranteeing the continued security of supply of energy (Mundaca, Mansoz, Neij, & Timilsina, 2013).

Various renewable energy sources, such as harnessing solar, biomass, biofuels, hydroelectricity, geothermal energy and others, have been found to be the solution to

the security and continued supply of energy towards sustainable development (Moreno & López, 2008).

Research conducted on renewable energy has managed to indicate the massive benefits of using renewable energy sources (Moreno & López, 2008). They are said to emit less carbon into the atmosphere, they will always be available, and they will increase access to electricity to those without access to clean energy and thereby improve health conditions, ignite and grow economies, amongst others (Moreno & López, 2008).

Renewable energy research is highly focused on the benefits thereof. Little is mentioned on the adverse effects renewables can have on society, the economy and the environment (Miller, 1979). The financial burden on society, the skills required for the massive global roll out and the environmental impact also need to be emphasized as much as the benefits are emphasized.

In order for South Africa as a country to implement renewable energy projects, the decision makers have to ascertain for themselves that research conducted in renewables is ethical. They also need to be clear in their minds that the roll-out of these projects will indeed be sustainable.

The government, private sector, and the public, need to be assured that a holistic research approach has been conducted. That will allow the different stakeholders to make informed decisions and implement the correct policies (Miller, 1979) and thereby instil ethical research approaches. It is thus critical to understand the research ethics applied by scientists and engineers to deem renewable energy technologies sustainable. It is also important to understand the advantages and disadvantages of renewables as well as the unintended positive and negative consequences. It is crucial to ensure that communication relating to renewables is transparent and not skewed in one direction.

1.3 Problem statement

The purpose of the research is to determine if research regarding renewable energy technologies is ethical, that is, to determine if information published with respect to renewable energy is transparent and the reporting of the information is not biased towards a particular agenda.

It also assesses if renewables are indeed sustainable. The research determines if renewables satisfy the definition of sustainable development as it is generally communicated by developers of the technology, government and the green community.

Communication regarding renewables has highlighted massive benefits. However, no technology is without disadvantages. Stakeholders may be misinformed when deciding to implement or purchase the technology. It is for that reason that holistic communication needs to be conducted to ensure that investors, the South African government and the South African public are well informed on the advantages and disadvantages of renewable energy. The research also determines if there are any unintended positive and negative consequences associated with renewable energy.

The research enables governments, private sector, the public and especially the green community to make informed decisions and be aware of the sustainability of renewable energy towards a sustainable future that the world is aspiring towards. Solar (CSP &PV) and wind energy is compared against fossil fuel generated electricity in order to assess the “real” sustainability of these technologies.

1.4 Significance of the study

The study fills the gap in the subject of research ethics among scholars in the science and engineering field but specifically in the renewable energy environment. It brings forward the importance of conducting holistic research with respect to issues

of bringing renewable energy solutions to the world. It thus highlights the importance of conducting holistic research.

Those looking to invest in the renewable energy industry will be able to make informed business decisions by conducting cost-benefit analysis on the projects and building a business case from a profitability point of view.

Governments worldwide have drafted policies whilst some are in the process of drafting policies on renewable energy. The policies need to be well informed and holistic in their content to ensure that they address issues that relate to renewable energy. That is from manufacturing, maintenance, disposal, technology availability, skills availability, financial cost and so forth.

Governments have to ensure that their different ministries, such as those of environment and education, are aligned to ensure that the gains of renewable energy are realised and the adverse effects are managed accordingly.

The South African public needs to be informed about the importance of renewable energy and the benefits thereof. Additionally, they need to be informed about the negative impacts the “new technology” will bring with it. The capital costs in countries such as Germany, in implementing renewable energy were borne by the public. These matters need to be brought forward to the public to render them ethical.

In countries such as South Africa, the coal mining industry supply chain employs thousands of people in the coal industry (Chamber of Mines of South Africa, 2012) versus the 3000 jobs that will be brought about by renewables. It will be crucial for the government to understand the magnitude of the job losses and gains and be able to make ethical decisions from a sustainability perspective.

1.5 Delimitations of the study

The following is included in the research

- The meaning of ethical research
- The meaning and understanding of sustainable development.
- The benefits of renewable energy towards sustainable development.
- The positive and adverse effects of renewable energy from a social, human capital and environmental perspective.
- The identified unintended consequences of renewable energy due to the research conducted.
- The research is conducted in the South African context.

The following is excluded in the research:

- The research does not try to quantify the carbon emissions associated with the renewable energy industry.
- Other renewable energy technologies are excluded.
- The outcomes of renewable energy and their impact on sustainable development.

1.2 Definition of terms

- CAPEX – Capital expenditure
- COP17 – The 17th Conference of parties
- CSP - Concentrated Solar Power
- ECSA – Engineering Council of South Africa

- Ethical Research – in the context of this research, it shall mean a holistic research study that looks at both beneficial and adverse effects of the study and that is without any deliberate omissions.

- Geothermal Energy – it is the energy contained as heat in the Earth's interior which can be used to generate steam and drive turbines to generate electricity by pumping water into the Earth's interior.

- Kyoto Protocol – It is the United Nations framework convention on climate change. It is an international treaty that binds industrialized nations to reduce carbon emissions.

- OPEX – Operational expenditure• PV- Photovoltaic Energy • Renewable Energy – for the purpose of this research, renewable energy will refer only to concentrated solar power, photovoltaic and wind energy.

- SACNASP – South African Council for Natural Scientists.

- SOC – State owned company• Sustainable Development – development that meets the present needs without compromising the ability of future generations to meet their own needs from a social, economic and environmental perspective.

1.6 Assumptions

The following assumptions were made about the study:

- The participants who were interviewed were honest about their conduct with respect to ethical research and research protocols
- There was enough information collected to make reasonable findings.
- The respondents of the target sample had access to electronic mail in terms of requesting interview appointments.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The literature review aims at accessing the extent to which renewable energy (CSP, PV & wind) is considering broader sustainability issues. It aims to determine if all possible positive and negative implications have been considered. That will determine if there are any unintended consequences of these technologies in order to decide if indeed these technologies are sustainable. The study will determine whether research done in the renewable energy sector is ethical (Stacey & Stacey, 2012) in terms of information made known to the public.

2.2. Ethics in research and renewable energy.

Unethical behaviour in the science arena has not gone unnoticed. It is present in a form of plagiarism, whereby scientists are untrue to themselves, that is, by falsifying their own research. Scientist can knowingly falsify research findings or mistakenly report incorrect research findings (Dixon, 1979). The former results in unethical behaviour on the part of the researchers.

Research ethics can be defined in three broad categories, that is falsification, fabrication and plagiarism (FFP); questionable research practices (QRP) and responsible conduct of research (RCR) (Steneck, 2006). The RCR is the most desirable state of research (Steneck, 2006) as it aims at reporting research results as they are without any bias. FFP is one category that must be avoided at all cost. Researchers are self-regulating which could lead to FFP and QRP, however, any published research is peer reviewed (Steneck, 2006), that implies that the likelihood of published research to fall into the first two categories is unlikely (Steneck, 2006).

Steneck undertook a study to determine the extent to which research is genuine by exploring research conduct, research ethics and research integrity. He found that only 0.001 per cent of research under-estimates or over-estimates their research

results and findings. That translates into 20-30 researches over 2.5 million researchers conducted in the United States of America (USA) (Steneck, 2006). These figures have been given by the National Science Foundation (NSF) and the Department of Health and Human Service of the USA (Steneck, 2006).

Further investigations by Steneck indicated that research misconduct (FFP category) is fairly common, with 50% research misconduct in the science and engineering field. This is contrary to the figures given by the NSF and the Department of Health and Human Services.

Earlier research conducted indicates that 36% of research results and reports have been falsified (Kalichman & Friedman, 1992). Research conducted later indicates that 5.7% of respondents they interviewed admitted to falsifying research results and reports (Brown, & Kalichman, 1998; Geggie, 2001).

Category 2 (QRP), which is deemed less detrimental to research is defined as actions that violate traditional values of the research enterprise and that may be detrimental to the research process (Steneck, 2006). Researchers in this category have admitted to publishing the same data in more than two publications, have not given credit to work conducted by other researchers and poor record keeping (Steneck, 2006). This yields to 4.7%, 10% and 27.5% respectively (Steneck, 2006).

Ethical research is also prominent in the medical field where human beings are used for research purposes such as the Milgram experiments and the Gamson, Fireman and Rytina experiments (McArthur, 2009; Marwell, 1985). The Milgram experiments subjected people to psychological harm and deception (McArthur, 2009).

The experiment lacked consent from the participants, lacked or limited freedom for participants to withdraw from the research and used “force” to keep the participants in the research program (McMinn, 2014). Experiments such as the Milgram experiments may lead to incorrect interpretations and conclusions due to the unethical manner in which they are conducted (McArthur, 2009)

Today the Milgram experiments are currently considered unethical based on the Medical Research board and the ethical standards of the Canadian Interagency Advisory Panel on Research Ethics (McArthur, 2009).

The Canadian Interagency Advisory Panel on Research Ethics requires institutions to submit proposed research protocols to the research ethics board (REB). The REB decides on ethical protocols similar to that of America and other countries (McArthur, 2009). Some of the basic research protocols are respect for human dignity, informed consent and minimising harm to the participants (McArthur, 2009).

The Gamson, Fireman and Rytina (Marwell, 1984) experiment is a good example of a research that was conducted ethically. The participants in the research were allowed to discuss amongst themselves and gave consent to release the videos created during the interview. McArthur points out a critical issue of coercion. Where participants are coerced into taking part in the experiments, it is most likely that the findings of the experiments will not give a true reflection (McArthur, 2009).

The issue of ethics is being addressed in a variety of fields of study. In addition to the medical research ethics bodies that have been established , research misconduct has since been given attention from the 1980s to early 1990s (Steneck, 2006) There are other ethics bodies for other fields of study that exist, such as architecture (D'Anjou, 2011), science and engineering and many others (Steneck, 2006).

Renewable Energy, which is the issue in question, falls under the Science and Engineering field. Ethics in this field are not much different to the medical ethical issues discussed above.

There are various committees in South Africa that give guidelines to ethical behaviour and protocol. Science and Engineering in South African are governed by two bodies, that is, the South African Council of Natural Scientific Profession (SACNASP) and Engineering Council of South Africa (ECSA). The former has codes of standard which require registered scientists to conduct themselves according to the codes of conduct stipulated by the professional body. Some of the codes of conduct include but are not limited to the following:

- Have due regard for public safety, public health and public interest generally.
- Have due regard to harmful practices towards the environment.
- Do not, without satisfactory reason, destroy calculations, documentary or any other evidence required for the verification of their work.

The Engineering Council of South African is also a body that manages the engineering profession and it also expects its engineers to behave in an ethical manner. It is governed by the laws of the Republic of South Africa. That is, the Engineering Profession Act, No. 46 of 2000. Some of the codes of conduct expected of registered engineers are as follows (Republic of South Africa, 2000):

- Act with integrity.
- Must at all times have due regard for public safety, public health and interest.
- Avoid adverse impact to the environment and adhere to general principles of sustainable development.

Ethics research committees in South Africa exist mainly within different institutions such as universities, government departments, businesses and mostly in the medical field. There is limited government regulation and legislation that governs how institutions should manage ethical issues except for the medical, engineering and legal field (McAnearney, 2008) which are well regulated and legislated.

The issue of ethical research and responsible writing in the research field has been raised due to a number of high profile scientific research cases (Katavic, 2010). These were the Hwang Woo Suk case and the Jan Hendrik SchÖn case (Katavic, 2010). Woo Suk claimed to have developed a human embryonic stem cell line, which was found to be false and he was given a suspended sentence of two years.

SchÖn was employed by Lucent Technologies at the Bell Laboratories. He claimed to have made a breakthrough in the study of materials and nanotechnology. His work could not be repeated by others and it was scrutinized. He was fired and upon

returning to Germany, his Doctoral degree was stripped off him (Katavic, 2010). These cases give merit to the need for ethical research.

Ultimately, ethical behaviour is purely dependant on the decisions taken by people to act in an ethical manner. Institutions can issue codes of conduct for the different fields of study but it is incumbent upon each professional to act in a manner that will not harm others.

Literature does not indicate any ethical protocols specific to renewable energy on the part of the researchers and the renewable energy industry. Professionals in the renewable energy environment are mostly engineers. Engineers in South Africa will then have to manage their profession in accordance with the Engineering Profession Act No. 46 of 2000 (Republic of South Africa, 2000).

2.3. Sustainable development and renewable energy.

The roots of sustainable development can be traced back to Norway in 1987 (Lafferty, Knudsen, & Larsen, 2007). The then Prime Minister, Gro Harlem Brudtland, who was the chair of the world commission on environment and development, first introduced sustainable development (Lafferty et al., 2007).

Sustainable development has been defined in different ways; that is due to limited regulation or laws on sustainable development (Byrch, Kearins, Milne, & Morgan, 2010). The most widely used definition in the world and in the Republic of South Africa is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Byrch et al., 2010).

The South African government has defined sustainable development as “the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations” (Department of Environmental Affairs and Tourism of South Africa, 2008). The definition has been placed into law in the National

Environmental Management Act (NEMA) No. 107 of 1998 (Republic of South Africa, 1998).

Businesses which are seen as the drivers of development and as a result mostly responsible for sustainable development have different definitions (Byrch et al., 2010) such as “living within ecological limits and fundamentally redesigning how we live” (Byrch et al., 2010) and “to maximise the value to society of the use of scarce resources” (Byrch et al., 2010).

The South African government committed to the Johannesburg Plan of implementation (JPOI) when it hosted the World Summit on sustainable development (WSSD) in September 2002 (Department of Environmental Affairs and Tourism of South Africa, 2008).The JPOI has set targets that are linked to the Millennium Development Goals (MDG’s) with respect to renewable energy.

In light of the South African commitments and the constitution, the country must work towards sustainable development. The energy sector for electrification of both domestic and commercial customers is one of the areas that need to be addressed. That is in light of the depleting coal reserves in 109 years (Chamber of Mines of South Africa, 2012).

Eskom as the main consumer of domestic coal in South Africa is the thirteenth highest emitter of CO2 in the world (Eskom, 2011) with CO2 emissions equating to 230.3 t (Mil) in the 2010 and 2011 financial year (Eskom, 2011). The carbon emissions have a negative impact on the environment and people’s health.

The reliance on the depleting coal resources and the pollution of the atmosphere is deemed unsustainable as it violates the constitution and compromises the right of people to a clean environment. As a result, renewable energy options are being considered by South Africa and in particular, by the power utility, Eskom.

Renewable energy technologies have also been considered due to the commitments made by South Africa at the 17th Conference of Parties (COP17) in terms of reducing carbon emissions and thereby slowing down climate change. Renewable

energy technologies have been developed to ensure that sustainable development is a reality. They are deemed to satisfy the sustainable development requirements. It should be noted that sustainable development also encompasses social and economic well-being. The elements of sustainable development must be balanced carefully if we are to achieve sustainability in the energy sector. There are various renewable energy technologies in the renewable energy industry. These are listed in table 1 below.

Table 1: Renewable Energy Technologies available

RENEWABLE ENERGYTECHNOLOGIES	DESCRIPTION (Marafia & Ashour, 2003
Onshore wind energy	It is the use of wind on-shore to drive the towers (Windmills) which will drive the generators to generate electricity. This technology is highly dependent on wind speed and direction (Marafia & Ashour, 2003).
Offshore wind energy	It is the use of wind off-shore to drive the towers which will drive the generators to generate electricity. This technology is highly dependent on wind speed and direction (Marafia & Ashour, 2003).
Wave Energy	Wave energy converters are placed at predetermined locations where maximum energy will be acquired. The converters will drive the generators which will produce electricity (Silva, Rusu, & Soares, 2013).
Hydro Power	Water pressure from dams turn hydro turbines into mechanical shaft power which drive the generator to produce electricity (Paish, 2002).
Solar Energy	There are different types of solar thermal energy product. CSP is one type of solar energy that concentrates into a receiver where salt will melt and is used to generate steam to power the generator(Eskom, 2014)
Geothermal Energy	It is the injection of water into the earth's hot rock. The injected water will generate steam which will drive the generator to produce electricity (The Chemical Engineer, 2008).
Straw	Straw is used the same as coal with the difference being that it is a product from farming and emits less carbon than coal. It is also co-fired with coal (Wieck-Hansen, Overgaard, & Larsen, 2000).
Wood	Wood from forestry and agricultural waste is co-fired with coal and sometimes with straw to generate electricity in a coal fired power station (Wieck-Hansen et al., 2000).
Waste to Biogas	Bacterial formation of biogas during the biodegradation of organic matter under anaerobic conditions. The biogas produced from waste can be stored in cylinders and used for energy needs (Gakhar, 2013).
Energy crops	It is the use of crop to generate electricity, which is the same as straw and wood (Stankiewicz, 2012).

2.4 Renewable energy and sustainable development in South Africa

Energy in modern society is an integral part of our lives. It drives the economy, impacts on the environment and the societies that live in it. Mankind has been dependent on fossil fuels for electrification and still is to this day. The reliance on the source of energy that cannot be replaced is continuing to rise in price (Dovì, Friedler, Huisingh, & Klemeš, 2009) and the inability to meet the needs of the future generations has been identified by the global community as unsustainable and impacting on climate change (Dovì et al., 2009).

The global community has realised the need to correct the current state of affairs and hence the world has developed different platforms which are integrated to a large extent in addressing sustainable development. These are platforms such as the MGD's, WSSD, the Kyoto Protocol, COP17 and many others to drive the reduction of carbon emissions and the need for sustainable development. This drive is not only meant to intensify the use of renewable energy but to also increase access to electricity to the 2.7 billion people who do not have access to clean energy.

Sustainable development encompasses three areas that are linked and need to be balanced and in harmony with each other as illustrated in figure 1.

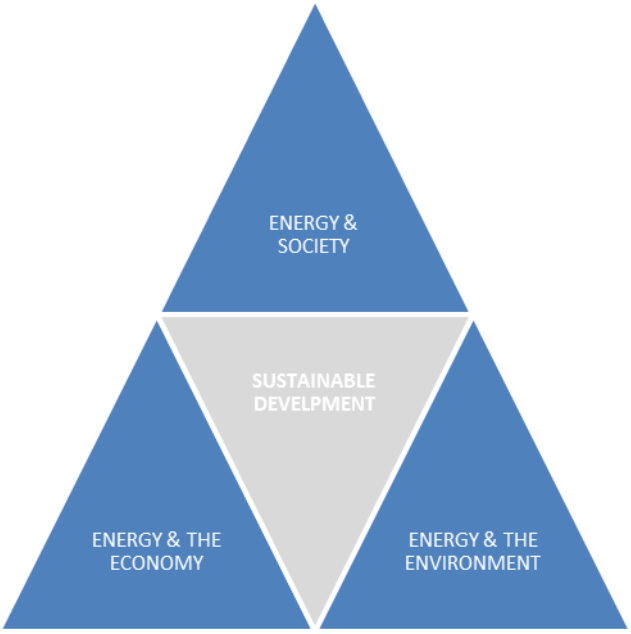

Figure 1: The links and integration of sustainable development element to energy

Energy allows societies to increase productivity and consequently increase employment. It also allows for ease of communication within the society amongst other things. Cleaner energy helps to reduce hunger, improve education and improves living standards in term of cleaner air and thereby drives sustainable development. Sustainable development can be achieved if the needs of society, the environment and the economy are balanced as in figure 1.

South Africa needs to reduce its carbon emissions by 34% and maintain sustainable development (Department of Energy of South Africa, 2011). Increasing the use of renewable energy use in the country will drive the country towards sustainability (Department of Environmental Affairs and Tourism of South Africa, 2008).

2.5 Research Question

- Has there been “ethical” research in the renewable energy sector in reference to sustainable development in South Africa?
- Have the research community in the renewable energy sector conducted an in depth research on all the possible consequences of renewable energy towards a sustainable South Africa given the current socio-economic landscape, unemployment rate and the ease of access to coal resources in South Africa?
- Has the research community and associated stakeholders communicated all the consequences (positive and negative) of renewable energy technologies to all the stakeholders?

2.6 Comparison of the different renewable energy technologies: Concentrated solar, photovoltaic power and wind power.

2.6.1 Concentrated solar power: CSP

Concentrated solar power is one of the solar energy technologies available. They range from parabolic trough, linear Fresnel, tower and parabolic dish system (Aharon, 2013). CSP technology concentrates solar radiation to heat different types of materials to a high temperature. The heat is converted into mechanical energy which will eventually produce electricity (Brown, Muller, & Dobrotkova, 2011). The different CSP technologies are illustrated in figure 2.

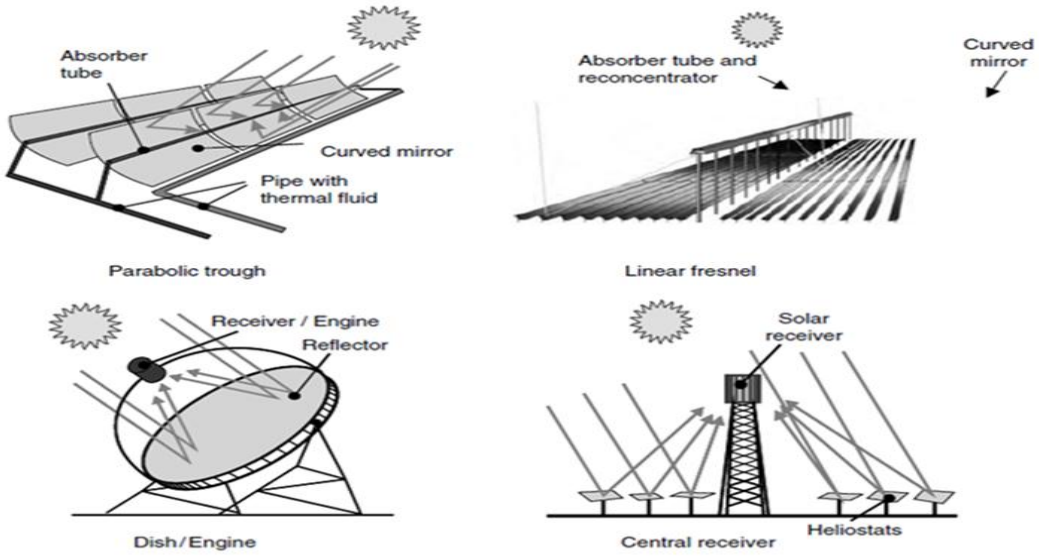

Figure 2: The different CSP technologies (Bischof-Niemz, 2013)

CSP is beneficial as it is able to store energy for a limited period, that is, for hours. The stored energy can later be transformed into electricity at peak times or when it is cloudy (Brown et al, 2011). The most viable locations to set up CSP are in semi-arid to hot regions where water is available as the system requires water for cooling. The amount of water required for a 50 MW plant can range up to 3 700 litre per MW produced depending on the type of the CSP selected. Dry cooling is also available at a higher cost (Brown et al, 2011).

The costs of building a CSP plant are largely dependent on labour costs, land costs and the magnitude of the solar field. The cost per kWh can range from USD 0.18 to USD 0.30. That translates to R1.80 to R3 per kWh for a typical 50 MW CSP plant. Higher capacity CSP plants (100 MW to 200 MW) will reduce the costs by 20% due to economies of scale (Brown et al, 2011).

South Africa has significant amounts of solar radiation available for a CSP. Figure 3 illustrates the South African solar radiation map**.**

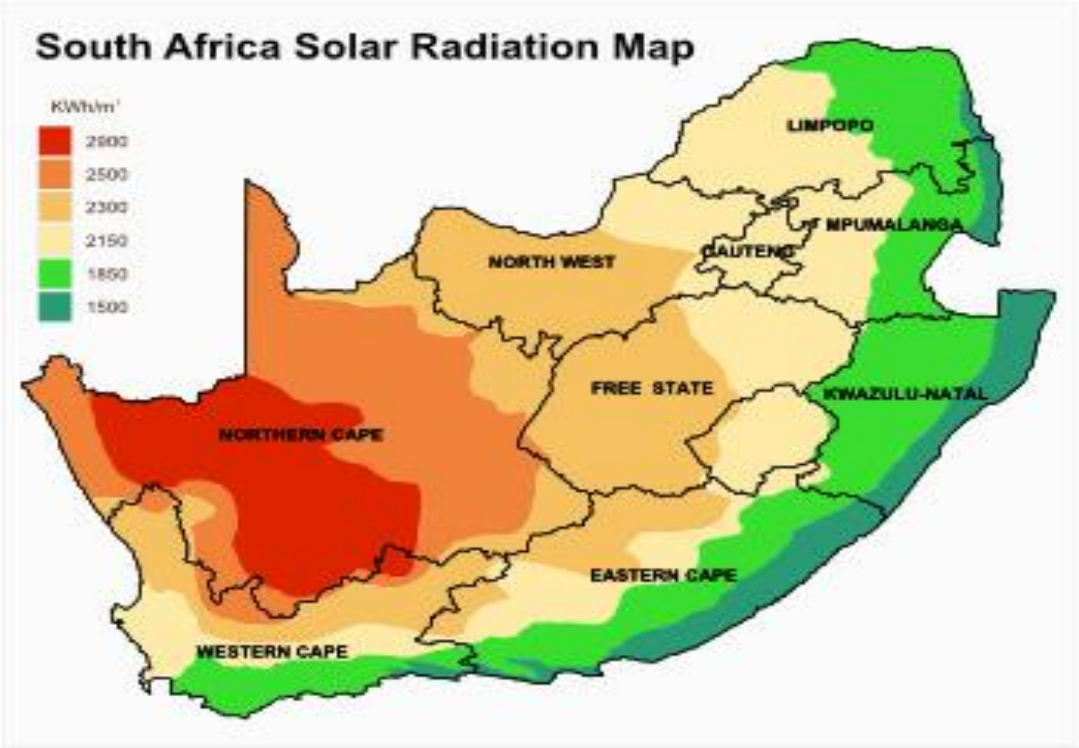

Figure 3: The South African direct normal solar radiation (Sunfin, 2014a)

2.6.2 Photovoltaic power

The IRP has planned to include PV in the energy mix from 300 MW to a peak of 1000 MW by 2030. The widely known silicon based brethren PV is slowly being replaced by thin film Cadmium-telluride (CdTe) which is less expensive than the former (Lesser, 2008). The new technology is not as efficient as the silicon based modules but they come at a lower cost (Brown et al, 2011).

The biggest advantage of solar PV as compared to CSP is its ability to generate electricity even when the sky is not clear. This allows for the technology to be deployed in countries and areas of limited direct sunlight (Brown et al, 2011).

PV is a direct solar energy converter of electricity. The PV cell that functions as a semiconductor makes this energy transformation possible (Brown et al, 2011). Each

PV module which is made up of PV cells from 50 to 200 Watts. The more modules added to the system the more electricity can be generated.

Solar PV technology is very expensive. It will cost the end user USD 11.3/kWh to USD 48.6/kWh for systems mounted on the ground (Brown et al, 2011). The conversion of the costs in South African Rands at the current exchange rate of approximately R10/USD ranges from R113/kWh to R486/kWh. The cost of the roof top solar PV have been estimated at USD 13.8/kWh to USD 68.8/kWh. The conversion to South African Rands will be R138/kWh to R688/kWh. These prices are steep compared to the R1.19/kWh South African consumers are paying from coal generated electricity (Bischof-Niemz, 2013). The pricing of electricity from this technology will need to be carefully thought out and policy making will be vital.

2.6.3 Wind Power

South Africa will be embarking on the production of wind energy. The planned Sere wind farm will be erected in the Northern Cape where wind can reach 6m/s, according to the South African wind Atlas. The wind turbines can be built to have a maximum capacity of 1.5 MW each (Lesser & Puga, 2008).

The costs of wind energy range from USD 0.18/kWh to 0.19/kWh, which translate to R1.80/kWh and R1.90/kWh. These prices are not abnormal relative to the PV costs. They are reasonably within the South African electricity price range.

Figure 4: The South African Wind Atlas (Sunfin, 2014b).

Wind energy potential in South Africa is inconclusive as measurements were taken at a height of 10 metres. The other challenge is the impact of buildings to accurately determine the wind atlas (South African Renewable and Resources Database, 2012). The variable wind speeds and unpredictability of wind makes it impossible to accurately determine the amount of energy that can be added to the grid at any point in time. Wind energy is only expected to contribute 25% of the installed capacity (South African Renewable and Resources Database, 2012). Wind energy in South Africa is also limited to coastal regions as in figure 4. Figure 4 depicts the good areas and fair areas from a wind generation perspective.

2.7 Research Questions

- Does the research community fully understand all the ethical implications of renewable energy technologies towards sustainable development?

2.8 Ethical communication of renewable energy technologies to the South African public.

This section aims to determine whether there is ethical communication to the South African public with respect to renewable energy technologies that is, in terms of the advantages and disadvantages that the technology will bring about and thus informing the ethical behaviour of researchers and other stakeholders.

There are various players in the South African energy sector, that is, Eskom, department of energy, department of education, private sector and non-governmental organizations. These institutions play an active role in policy making, advising government on matters relating to energy in the form of electricity and increasing public knowledge about renewable energy.

The four institutions have been active in educating the South African public about renewable energy through various campaigns. Most of the campaigns were intended to bring awareness to the public with respect to using electricity efficiently. Through these campaigns, renewable energy is also introduced to the public.

Eskom as the power utility in South Africa launched the 49 million campaign on 18 March 2011 (City of Johannesburg, 2011). The campaign is an awareness programme to educate the public on how they can use electricity sparingly. The 49 million campaign also promotes the use of alternative energy technologies such as underground gasification and renewable energy. The campaign reaches the South African public through television commercials.

One of the major South African banks, Standard Bank, has taken it upon itself to educate the public about alternative energy sources such as renewable energy. The bank partnered with the department of education and distributed ten thousand solar lamps to learners in twenty nine schools in the Kwa-Zulu Natal province (Standard Bank, 2010). Some of the names of the schools are listed as follows:

- Sondaba primary School in Zululand
- Inkosentsha Primary School in Zululand
- Lamula Primary School in Pinetown
- Esighingini Primary School in Pinetown

The bank achieves awareness of renewable energy technologies and improves the living conditions of learners.

The department of energy has partnered with the Danish government on increasing awareness of wind energy as an alternative renewable energy source (Endemann, 2011). The name of the campaign was called “Powered by wind” and it was launched in December 2011. The campaign was launched at the COP17 conference and intended to reach the masses of the population to educate them about the importance and benefits of utilising wind energy (Endemann, 2011). The campaign targeted civil servants, business and local communities in the Northern, Eastern and Western Cape as well as NGO’s.

The campaigns have communicated the benefits of utilising renewable energy. None of the campaigns have at any point communicated the disadvantages of renewable energy. The question arises if the implementation of renewable energy and the communication thereof is ethical.

2.9 Known advantages and disadvantages of renewable energy technologies and ethics.

Table 2 below is a list of some of the known advantages and disadvantages of renewable energy technologies. Some advantages and disadvantages are prominent in specific technologies and some are general to all technologies.

Table 2: Some of the known advantages and disadvantages of CSP, PV and wind energy (Masden, 2009 andDepartment of Mineral Resources of South Africa, 2004)

ADVANTAGES	DISADVANTAGES
Job creation	PV generated electricity can only be stored by the use of batteries at an additional cost.
Reduces carbon emissions	Wind turbines impacts on bird movement
Provides cleaner energy	CSP utilises a lot of land
Fossil fuel saver	Renewable energy cannot be used for base load
Allows increased access to electricity to remote areas	Renewable energy cannot be produced in required bulk amounts
The costs are on par with coal produced electricity	Require large capital costs
	Implementation policy is still lacking for some technologies such as PV
	Intermittent technology
	Heavy reliance on weather conditions

The advantages and disadvantage with respect to renewable energy are clearly know by the research community and seem to be communicated to the commercial industry. The fact that the advantages and disadvantages are clearly known indicates that the research community has been ethical in the communication of renewable energy technologies.

The question remains if whether institutions and the commercial industry have been acting ethically when it comes to advocating for renewable energy and selling their

products to the consumers. Have the institutions and industry been ethical in communicating only the advantages of renewable energy to the consumers?

2.10 Conclusion of Literature Review

Ethics in research have proved to be a difficult task to manage when looking at the number of unethical cases discovered in medical research. Unethical research has managed to go through panel reviews without being noticed at times. Unethical research may at times promote a particular agenda and thereby negatively impact the society it claims to be uplifting.

Sustainable development for developing countries might prove to be a challenge. The balancing of society needs, the economy and the environment will be a huge task to fulfil. Given the fact that coal mines in South Africa bring about much needed employment, while the coal extracted from the ground generates high level of carbon emissions, it is a huge task to manage sustainable development in South Africa. The emissions pollute the environment and reduce air quality; which is again contrary to the constitution where everybody has the right to clean energy and contrary to achieving sustainable development.

The ethical nature of the implementation of renewable energy technologies towards sustainable development is highly questionable given the huge capital costs compared to coal fired power stations which have a life span of sixty years as compared to the twenty to twenty five years life of renewable technologies. It is also questionable if renewable energy is implemented ethically when considering the final cost to the customer. Bearing in mind that cost is critical to sustainable development.

CHAPTER 3: RESEARCH METHODOLOGY

In this chapter the research methodology is described in an attempt to address the research questions. The research strategy, research design, population and sample size, research instrument, procedure, data analysis and interpretation, limitations of the study, validity and reliability of the data is discussed in this chapter.

3.1 Research methodology

A qualitative approach is followed to conduct this research. Qualitative research is defined by Bryman (2012) as “research strategy that emphasizes words rather than quantification in the collective and analysis of data. As a research strategy it is broadly inductivist, constructionist and interpretivist” (p. 36)

Qualitative research has also been defined by Merriam as “a method of inquiry that seeks to understand social phenomenon within the context of the participant’s perspectives and experiences” (Merriam, 2002). For the purposes of this study, the Bryman definition is applicable.

This research method is suited for research that is exploratory (Gurtoo, 2011). It is normally beneficial to studies that aim to unearth the character and/or quality of people, processes, relationships, system and situations (Leedy & Ormrod, 2005).

Qualitative research is not without any disadvantages. Qualitative research lacks structure, it is subjective, cannot be quantified and there are no established guidelines (Miles, 1979). The disadvantage of qualitative research is its inability to be replicated, lacks transparency and it is too subjective (Bryman, 2012)

The qualitative research is, however, suitable for this study as it assists in uncovering the issues impacting sustainable development, renewable energy research ethics and ethics in the renewable energy industry in South Africa. This research strategy enabled the researcher to acquire first-hand information.

3.2 Research Design

An un-structured interview was adopted for this research. The interview questions enabled the respondent to voice views and opinions about the matter at hand thus giving the researcher a deeper understanding of the respondent views, and the “true” nature of the dynamics involved with respect to sustainability and renewable energy in South Africa.

The research was guided by the questions in Appendix B. The interview questions were designed so that a level of consistency was maintained from the respondents as well as giving the respondents leeway on how they answered the questions (Bryman, 2012).

Interviews are advantageous as they allow for a certain level of flexibility and afford the interviewer room to manage the interview questioning process (Lundberg, 2003). The disadvantages associated with un-structured interviews are that it can be a challenge for the respondents to respond in a particular way (Bryman, 2012).

3.3 Population and sample

3.3.1 Population

The population under consideration is the Renewable Energy Sector of South Africa. The population targeted professionals in the industry, and included researchers, project managers, sustainability specialists, portfolio managers and the technical staff involved in planning, implementation and execution of the renewable energy projects.

3.3.2 Sample and sampling method

The sample was from the population mentioned above. The sector is mainly driven by Eskom as the power utility of the country.

The sample size includes 20 participants. The respondents were from the Renewable Energy Department, Research Department and the project office of Eskom (SOC) holdings. Convenience sampling was preferred as opposed to random sampling for this research (Creswell, 2009).

3.3.3 Demographic profile of respondents

Table 3: Profile of respondents

SAMPLE TYPE	NO OF PARTICIPANTS	PROFESSION
RESEARCHERS	6	Pure researchers & statisticians
PROJECT MANAGERS	7	Engineers
PROGRAMME MANAGERS	4	Engineers
SENIOR MANAGERS	2	Grid connection manager & Integrated demand manager
RENEWABLE ENERGY EXPERT	1	Electrical engineer
TOTAL	**20**	

Twenty participants who work in the renewable energy environment were interviewed. The participants range from a group of researchers, renewable energy experts, electricity demand managers, grid connection manager, programme manager and project managers. The sample was planned to consist of researchers and project managers. However, through referrals by the initial participants, portfolio managers, a grid connection manager and an integrated demand manager were interviewed. Statisticians in the research field were also interviewed even though they were not considered as part of the planned sample.

Nineteen participants were from various departments from Eskom and only one participant was from a private entity. However, the external participant is an ex-

employee of Eskom. Of the twenty participants, only two participants were female with a researcher being one of them. The bulk of the participants were made up of programme and project managers and the remainder from the research environment.

All the researchers who participated in this study have obtained doctoral degrees from various institutions of higher learning in South Africa. The researchers comprised two statisticians, general manager in research and sustainability and two female researchers in renewable energy. The researchers have significant experience of not less than five years in renewable energy.

The programme and project managers have lengthy experience in managing projects. However, their experience in renewable energy projects is limited as renewables have only recently been implemented in South Africa. The energy demand manager's knowledge in renewable energy was insightful but limited from a costing perspective. The renewable energy expert is a German national with ten years' experience in renewables. Table 3 is a list of the final participants for this research.

3.4 The research instrument

An un-structured interview was utilised and consisted of pre-determined questions which aided the researcher during the interviews. Participants were given leeway when answering questions (Bryman, 2012).

The research instrument is subdivided into three subsections in order to attempt to answer the research questions. The research instrument is attached in appendix B. The first section gave background on the respondents and an indication of their experience in the renewable energy sector and sustainability environment. This assisted the researcher in understanding the depth of knowledge of the respondents.

The second sub section of the instrument drilled deeper into the respondents' knowledge on renewable energy and sustainability. This section established the extent to which ethics play a role in the renewable energy space

The third section was designed to uncover if communication regarding renewable energy is holistic and to uncover if there are any existing unintended positive and negative consequences associated with renewable energy technologies and related products and thereby establishing the role of ethics in renewable energy.

3.5 Procedure for data collection

Participants were requested through electronic mail to be interviewed. The electronic mail indicates the reason for the interview and the intention of the interview. That is, they were informed that it is an MBA research study that intends to determine the extent of ethics and ethical research in the renewable energy sector. The electronic mail request that was sent to participants is attached in appendix A.

Upon acceptance or decline, the potential respondent received a response from the researcher acknowledging their response. The potential respondent was thanked for their participation and for those respondents that declined to be interviewed; they were also thanked for taking their time to respond to the request.

Interview dates, time and venue were arranged with the respondents that accepted the interview request. These respondents were sent an outline of the interview, the intentions and objectives of the interview. The respondents were asked if they wish to receive a final copy of the research document. The final document will be made available electronically to the respondents who are interested.

3.6 Data analysis and interpretation

Qualitative research has various methods that can be used to analyse data. Summative content analysis has been identified as the best analysis method for this study. It was used to analyse the data collected. Content analysis is widely used in the communication field (Manganello & Blake, 2010). It has however penetrated other fields of study including science.

Content analysis is a “systematic and replicable analysis of messages” (Manganello & Blake, 2010).This type of analysis was suitable for this research study in determining the ethical protocols in the renewable energy sector. It enabled the researcher to analyse the manner in which information in the renewable sector is communicated by studying the messages of the respondents from the sample and possibly deriving a phenomenon.

Party manifestos, interest groups and party politics were analysed by Chen using content analysis (Chen, 2011). A study of health care professionals was also conducted using content analysis to determine their standing on risks associated with different treatments.

The similarity in the above mentioned studies to this research in terms of the goal of the research has prompted the use of content analysis to understand research ethics, the sustainability of renewable energy, holistic communication in renewable energy and determining if there are unintended consequences related to renewable energy.

3.7 Limitations of the study

The ability of the respondents to be completely open minded about the renewable energy environment they operate in. The respondents are most likely to be in the same line of thinking on the projects at hand as they are carrying out their duties. If they are not able to detach themselves from their duties and come to terms with the

real nature of the situation, the results of the research may be skewed to one side since the respondents are operating in a particular corporate culture. The study will be limited to the South African societal, economic and environmental dynamics.

3.8 Validity and reliability

Validity and reliability are measures of the quality of how well our instrument is able to gather data (Kimberlin & Winterstein, 2008). Validity is the measure of determining if the instrument is measuring the intended research questions.

It is also defined by Leedy and Ormrod as the ability of the measurement instrument to measure what is intended to be measure (Leedy & Ormrod, 2005). For this research, both definitions will apply as they essentially have the same meaning. Validity as explained by Lincoln and Guba (1985) is based on authenticity and trustworthiness. Validity is split into internal and external validity.

3.8.1 External validity

Leedy and Ormrod have defined external validity as the extent to which the research results can be generalized beyond the scope of the research at hand (Leedy & Ormrod, 2005).

The research findings can be generalized. However, the extent to which the research results can be generalized beyond this research is questionable, since the sample is from one organisation and the sample is already clouded by the culture and strategic objectives of the organization.

3.8.2 Internal validity

It aims to closely match the observation or translate the transcripts in a manner that will match the theories that are developed. For the purpose of this study, transactional validity is considered to determine a level of consensus, experiences and values of the subject matter.

The researcher had to conduct the interviews in a neutral manner without trying to lead the respondents to the desired answer and trying to skew the research in the direction the researcher wanted.

3.8.3 Reliability

Reliability is defined by Riege as the extent to which the research can be replicated (Andreas, 2003). In order to maintain reliability of this research, the researcher kept record of all the steps, audio recording and documents to ensure that the next person can go back in time to understand the findings of the research. It also ensured that the researcher has not falsified information and all the information provided is authentic.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents the results as obtained using the methodology described in Chapter 3. The results attempt to answer the research questions about the ethics in the renewable energy environment, the sustainability of renewable energy, communication to end users relating to renewable energy and the possible positive and negative consequence that will be as a result of renewable energy. The results are presented in that order, together with a summary of results.

4.2 The role of ethics in the renewable energy environment.

The research community indicated that the meaning of ethics is debatable and can hold different meanings depending on one's background. Ethics are a set of rules that are formulated to govern specific processes while values are intrinsic within humans. The general manager in research and sustainability indicated that there are no specific rules in the renewable energy environment; however it is incumbent of individual researchers to apply their minds, exercise a level of caution and divulge all their findings.

The research community indicated that transparency is of vital importance. As researchers it is their duty to ensure that all the positive and negative information is made known to all stakeholders to enable informed decision making. The majority of the researchers indicated that, as researchers, they should hold a holistic view on any study they conduct.

One researcher was aware of the possibility of some researchers holding a single view and channelling their research in one direction. The researcher has indicated that in such cases, the researcher in question has other hidden agendas and is most

likely to be affiliated to the industry selling renewable energy technologies. The researcher in question is most likely interested in financial rewards associated with endorsing a specific technology the industry wants to make available commercially. The researchers have indicated that they personally do not endorse such practices.

The researchers were in agreement in terms of their responsibility pertaining to research and disclosing all the information to the best of their knowledge. They all agreed that they are responsible for any positive or negative consequences that may result due to the studies they have conducted, that is, for as long as stakeholders take into account the requirements and limitations indicated by a particular study. They have however cautioned the researcher of the tendency of some stakeholders to take information out of context. In such instances, the researchers do not hold themselves accountable for any outcome.

The researchers indicated that they have the platform to engage decision makers and ensure that decisions are made in the best interest of all stakeholders and thus enabling an ethical process. The researchers were also comfortable that they have made available all the positive and negative information to stakeholders. Table 4 is a list of some of the information made available by the research community.

Table 4: Positive and negative aspects of renewable energy as communicated by the research community.

POSITIVE	NEGATIVE
Fossil fuel saver	High capital costs
Cleaner environment	The use of
Long term cost saving	Intermittent supply of renewable energy
Lower externality costs	Importation of renewable energy hardware
Creation of specialized skills	

The remainder of the professionals in the renewable energy environment have indicated that there is no room to act unethically within their organization and by themselves. The renewable energy projects embarked on are informed by a detailed

business case. The business case does consider positive and negative consequences of the technology. The information is made known to decision makers before the projects can be implemented, that is, the Sere wind farm project in the western coast and the CSP plant in the Northern Cape.

Professionals have also indicated that a business case does not necessarily imply profitability as it is influenced by factors such as the organizational strategic drivers. Eskom's strategic drivers are influenced by government to create sustainable energy generation and by the financiers of the new build projects (Kusile and Medupi power stations). Government has committed to the global village to reduce carbon emissions, while the financiers of the new build projects have granted Eskom conditional loans; that is, to implement cleaner energy generation in the energy mix.

Professionals themselves are executing their duties as required by their organization and assisting the organization in fulfilling its strategic objectives. They also indicated that they are executing their duties in line with ECSA standards which upholds ethical behaviour and personal values.

One energy demand manager indicated that he has the platform and the ability to point the business in the best direction to ensure ethical conduct. He further mentioned that he has been able to change decisions in the past that were not at the best interest of the organisation and stakeholders.

4.3 The sustainability of renewable energy and ethics

The researchers mentioned that sustainability on its own is a debatable term. However, for simplicity, it shall mean utilising today's resources without compromising the needs of future generations and thus taking into consideration the impact on society, economy and the environment.

The general manager of sustainability indicated that the three elements need to be in balance as illustrated in figure 5.

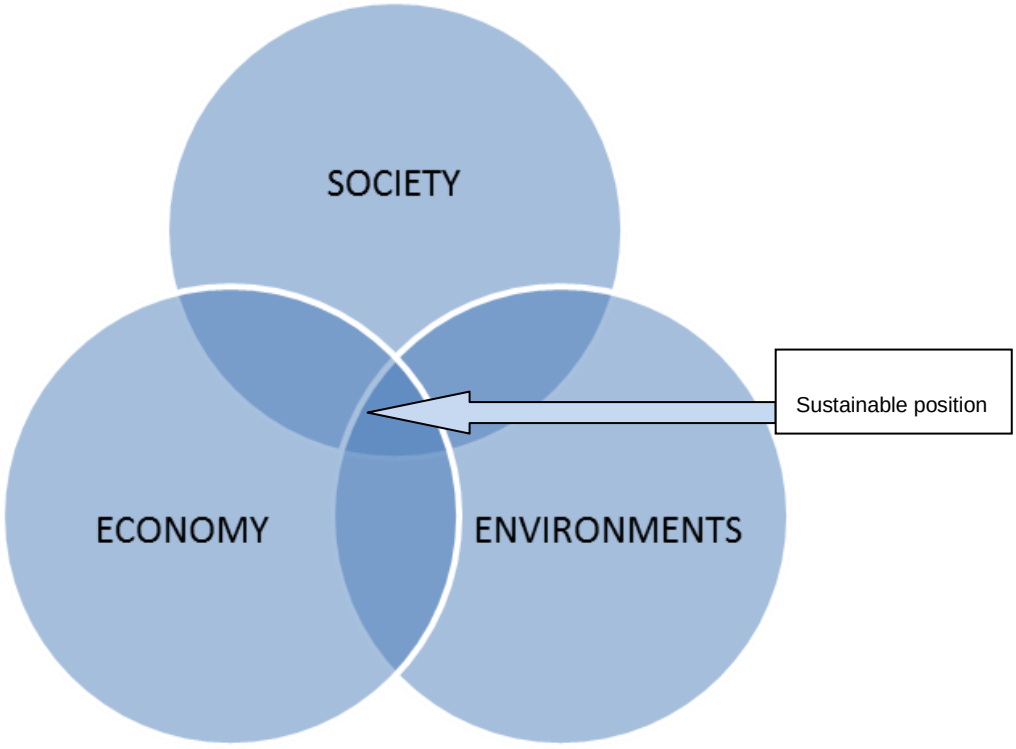

Figure 5: Three elements of sustainability indicating a balanced sustainable position

The three elements should carry the same amount of weight if sustainability is to be reached. Currently the environment carries more weight resulting in the sustainability diagram being skewed towards the environment as illustrated in figure 6.

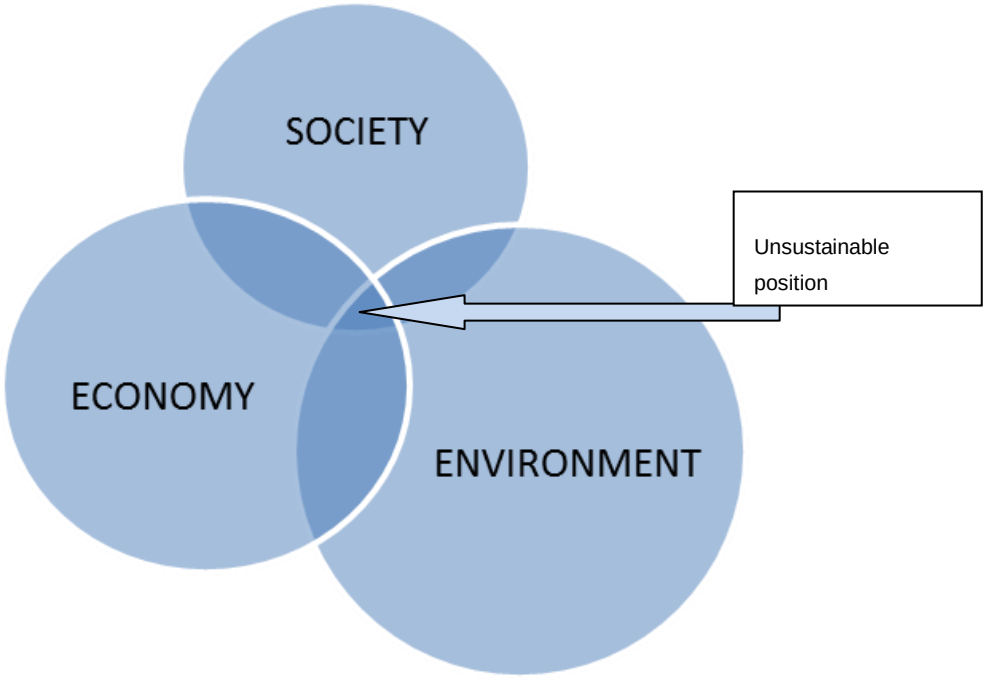

Figure 6: Three elements of sustainability indicating an unbalanced sustainable position.

The current sustainability position is unbalanced for a number of reasons. The main contributor is the extremely high cost of introducing renewable energy into the energy mix.

The cost of generating renewable energy is three times the cost of generating energy by means of fossil fuel currently. The project managers have indicated that the costs will decrease with an increase in demand. Since the inception of the projects, the costs have decreased from R3/kW to R0.88/kW.

The intermittency of the technology also requires additional capital spend to ensure continuous supply of electricity, thus resulting in additional costs. It is evident with the PV technology where batteries are required to store energy. The use of batteries is an additional cost.

The emergence of independent power producers (IPP) in South Africa has a major impact on the sustainability of renewable energy technologies. The IPP's which

mainly constitute renewable energy technology suppliers will be subsidized to feed cleaner energy into the energy mix. The subsidy enables the IPP's to produce clean electricity and still generate a profit. Without the subsidy, their businesses are not viable. The source of the subsidy is of great importance. In South Africa, the public will subsidize the IPP industry through normal electricity purchases.

The impact on the society is twofold as indicated by one of the participants. Renewable energy will impact the health of society in a positive manner. There will be reduced carbon emissions in the air, thereby reducing the externality costs which are borne by the public and thus increasing household disposable income. The reduced carbon emissions will improve the quality of life.

Reduced externality costs will also benefit the government as there will be fewer people reporting to public health institutions as a result of respiratory diseases caused by carbon emissions. Although the government will spend money in subsidizing IPP's, there will be a trade-off in public health care costs.

Renewable energy will also result in the creation of additional jobs. That is because it is an add-on to the energy supply instead of a replacement of fossil fuel generated electricity. The project community has cautioned against the 3000 job creation rhetoric. They have indicated that the 3000 jobs that will be created will be during the construction phase. The number will decrease to approximately 50 for the operation and maintenance of the plants.

The roll-out of solar water geysers at a domestic level is another attempt to improve the living conditions of society towards sustainable development. The South African society would have used dirty energy to heat their water. Dirty energy in this case is the wood fire or coal fire which is harmful to lungs and can cause respiratory diseases in the long term.

This strategy is sustainable as indicated by the energy demand manager, that is because, the power utility together with the department of energy have entered into maintenance contracts to ensure that the installed solar water geysers are maintained. As a result, solar water geysers are installed in households that could

not normally afford to install their own solar water geysers nor to maintain the geysers.

Both the researchers and the project managers are in agreement that renewable energy does have an impact on the environment. The CSP plants and wind farms are sometimes erected in eco-sensitive environments where they tamper with animal habitat. Wind farms are specially known to kill bird life. They however, indicated that the erection of renewable energy plants are subject to environmental impact assessments (EIA). The EIA will ensure minimal impact to the environment.

Some of the researchers have indicated that renewable energy is a fossil fuel saver. It will help reduce carbon emissions while ensuring that future generations will also have access to fossil fuels. It allows the current society to use minimal fossil fuels. They also mention that large scale renewable energy plants are currently not economically viable nor environmentally friendly and that renewable energy production must co-exist with fossil fuel energy generation.

4.4 Holistic communication to users with respect to renewable energy technologies and ethics.

Eighteen participants have indicated that domestic users do not have all the information concerning renewable energy products that they may wish to purchase or have purchased already. The participants are confident that domestic users are aware of the benefits of having renewable energy products such as solar water heaters and solar panels. The majority of the benefits mentioned by the participants are:

- Thirty percent cost savings on energy costs
- Improved air quality
- The possibility of selling back the generated energy into the grid in the future.

The participants recognise the influence of the commercial industry to skew information to their benefit. That has resulted in the negative impacts not being communicated. A typical South African consumer may not be aware that maintenance of the renewable energy products will be required on a periodic basis.

Consumers are not informed on the intermittency of the technology and as a result batteries need to be purchased to store the energy generated from sunlight. This is regarded as hidden costs since the consumer is not aware of the full capability of the equipment and the additional costs that are associated with purchasing such a product.

Given the skewed communication by the commercial industry, their approach can be deemed unethical. However, one project manager indicated that one cannot not expect the sellers to highlight the negative consequences of their products since they are in the business of generating money. If that is expected of the renewable energy industry, the same requirements should be expected of all industries that sell all products in the market place.

One researcher and the energy demand manager were of a different view completely. They were confident that communication to the public is holistic in its nature. It consists of both positive and negative impacts of purchasing the technology for domestic use. The energy demand manager stressed that there are initiatives taking place to educate the public about renewable energy products. The gentleman was adamant that there is education taking place in this regard

4.5 Unintended positive and negative consequences associated with the implementation of renewable energy technologies in South Africa.

There are very few unforeseen positive impacts that the technology will bring about. That was mentioned by one of the researchers. The unintended positive consequences associated with renewable energy as indicated by the participants are

the introduction of specialized skills into the country. The technology will require skills that are currently not available. The investors will bring with them the knowledge to operate and maintain the plants. As part of localisation, the skills will be transferred to South Africans.

The expansion of the renewable energy industry is also anticipated. Over time when the costs of manufacturing are on par with international prices, entrepreneurs will be able to compete in the renewable energy space. That will eliminate the high barriers to entry.

The cost trade-off between public health care and the cost of implementing renewable energy projects was mentioned by one project engineer. Although the cost trade-off has not been quantified, the government will spend less on public health care. Renewable energy will allow the government to provide cleaner living conditions, increased access to electricity and an improvement in living conditions through the roll out of solar water geysers.

The majority of the participants did not identify any unintended negative consequences related to renewable energy. Some participants did, however, mention possible unintended negative consequences. The major issue identified was the limited communication to the public with respect to the real cost of renewable energy.

The acquisition of the products is not limited to the purchase of solar panels. To ensure continued supply of electricity during the night when there is no sunlight, the panels must be accompanied by batteries which are sold separately. The batteries will allow for the storage of energy for later use. The overwhelming number of participants indicated that the majority of the consumers are not informed of the use of batteries and the additional cost involved.

Consumers are also not informed of the associated maintenance costs of the technology. An average South African consumer is of the view that the technology

will cost money initially and no other costs will be incurred during the life of the product. The participants indicated that this is due to a lack of information from different stakeholders in the energy space. The stakeholders include Eskom, Department of Energy, researchers and manufacturers.

There is currently no plan for the disposal of renewable energy products. The main stakeholders responsible for implementing renewable energy have indicated that there is currently no plan on how the products will be disposed of. The products have a life of twenty to twenty five years. The project management community, especially in the CSP environment indicated that there will not be any adverse impact on the environment since the mirrors are made of glass. The only impact to the environment will be an increase in the landfills.

The researchers mentioned that renewable energy products are different from energy saving lights. The energy saving lights contain mercury which is a harmful substance and needs to be disposed of in a controlled environment. They have indicated their concern regarding the disposal of energy saving lights and that there is not much education taking place around the issue.

4.6 Summary of the results

The research community and project management community have indicated that they were confident with the manner in which renewable energy research and project implementation is conducted. Information is presented in a holistic manner taking into consideration the advantages and disadvantages of the technology.

All the participants acknowledged their role in the roll-out of renewables. They indicated that they are liable for any catastrophic events that may occur as a result of the research they conducted and the projects implemented, that is, as long as the users of information do not deviate from the set conditions.

The project community also indicated that they take responsibility for any catastrophic events that may occur as a result of the information that was available at the time the projects were implemented. Should there be new developments in the technology that are introduced post the implementation of renewable technologies, they would not take any responsibility.

The sustainability of renewable energy products is still being debated. The majority of the participants indicated that the sustainability of renewable energy is mostly skewed in one direction, that is, towards the impact on the environment. The implementation of renewable energy is mostly informed by the drive to reduce carbon emissions. The benefits that will be realised towards reducing carbon emission override the social and economic benefits.

Communication by researchers, Eskom, department of energy and other corporate and commercial stakeholders has been sufficient and holistic. The decision makers are well informed of the advantages and disadvantages associated with renewable energy. The domestic consumers of renewable energy products are, however, not well informed of the advantages and disadvantages.

Communication towards domestic users is only limited to the benefits brought about by renewable energy technologies. The potential additional costs associated with purchasing the products are not mentioned. There are however initiatives taking place to educate the broader society on the advantages and disadvantages of renewable energy products.

The participants foresee the introduction of new skills and the emergence of new industries into the country as some of the unintended positive consequences of renewable energy. The disposal of renewable energy products may have an adverse impact on the environment and a disposal plan still needs to be generated. The impact will be unintended and have a negative impact on the environment while trying to reduce carbon emission and creating another environmental challenge.

CHAPTER 5: DISCUSSION OF THE RESULTS

5.1 Introduction

The results of the research are discussed with reference to the research questions and the literature review conducted. Similarities and differences in the data collected and the literature review are discussed.

5.2 The role of ethics in the renewable energy environment.

The extent to which ethics play a role in the renewable energy environment is largely dependent on the individuals involved. That is because ethics is a set of rules that a community has agreed to abide by. In the renewable energy environment there are no specific ethical protocols that researchers and all stakeholders need to adhere to.

The participants agree that their conduct should be ethical. The majority of the research sample agreeing to be ethical is confirmed by an insignificant 0.001 per cent of unethical behaviour (Steneck, 2006). The minimal unethical behaviour was earlier confirmed whereby only 5.7% (Brown & Kalichman, 1998) of unethical research was conducted. Ethical in this instance is to ensure that a holistic approach is taken when embarking on renewable energy research and project implementation. The participants were in agreement that they were responsible for guiding decision makers and ensuring that they make the best possible decision with the information available.

The project managers involved in these projects were all engineers who are registered with ECSA. ECSA requires that engineers act in a manner that will not harm the society when executing their duties (Republic of South Africa., 2000). The engineers were in agreement and recognized their role in decision making and in implementing renewable energy projects as indicated by ECSA (Republic of South Africa., 2000). The fact that the participants agree does not eliminate the existence of unethical behaviour. Some studies have proven that 36% of research is unethical (Kalichman & Friedman, 1992).

The researchers and project managers are also cognisant of the fact that technology evolves with time. What is known today will not be the same with what will be known in 10 years' time. Ethically, they take the view that their responsibility is limited to the information at hand to execute the current projects.

Similarly to medical research (McArthur, 2009) where researchers have to inform participants of any possible benefit and harm, researchers and engineers in the renewable energy space have informed decision makers of the benefits and adverse impacts the technology will introduce. The researchers are being ethical as in the Gamson, Fireman and Rytina experiments (Marwell, 1984)

5.3 The sustainability of renewable energy.

Sustainability encompasses three elements which should be in balance with each other, that is, society, economy and the environment. The main driver for the implementation of renewable energy technologies in South Africa is the commitment by government to the JPOI (Department of Environmental Affairs and Tourism of South Africa, 2008). As a result, the South African community has to reduce its dependence on fossil fuels which emit large quantities of carbon emissions leading to climate change (Dovi et al., 2009).

The global community had since invented renewable energy technologies to slow down climate change by 34% as indicated by the Department of Energy of South Africa (2011). The technology will assist South Africa to consume less fossil fuel to ensure that future generations will also have access to fossil fuels; which is in line with the Byrch, et al. (2010) definition of sustainable development, that is in the South African definition of sustainable development (Department of Environmental Affairs and Tourism of South Africa, 2008).

Firstly, the intermittent nature of renewable energy technologies, as indicated by the participants of the research sample, will require a parallel system that will ensure continued supply of electricity. Secondly, the production limit of 140 MW does not allow for massive roll out such that the current fossil fuel generated electricity is

replaced by renewable energy and hence the need for a parallel system. The parallel system will be fossil fuels, such as coal and gas. The limit of 140 MW will require a lot of power plants to be erected. That is contrary to the intended cost benefits of renewable energy towards sustainable development; considering the high cost of PV of R138/kWh (Brown, et al., 2011) versus the current rate of R1.19kWh (Bischof-Niemz, 2013). Brown, et al. (2011) also highlights the cost of CSP to be R1.8 kWh. The rate is comparable to the South Africa electricity rate. In hindsight, fossil fuels will be required to supplement renewable energy.

Bearing in mind that renewable energy implementation in South Africa is an add-on to the current energy supply and not a replacement and is as a result of the anticipated growth in the economy where additional energy generating capacity will be required. To achieve the implementation of a parallel system, additional capital costs will be required.

The additional capital cost will be financed by the public purse through the levelized cost of electricity. That will be increasing the financial burden on society. This financial burden is currently being felt by the South African public where the power utility was granted eight percent tariff increase (Eskom, 2014). Two percent of the electricity tariff increase is channelled to renewable energy projects.

Contrary to the above, the society will benefit in terms of cleaner air (Department of Environment and Tourism of South Africa, 2008). Cleaner air to breath will reduce some of the respiratory problems the society is struggling with as a result of carbon emissions. The use of public health care to cure these diseases will also be reduced, thereby reduced public health care costs. The question remains if it is ethical for society to fund renewable energy projects. That is in light of the fact that the cost of renewable energy to the end-users has already dropped from R3/kW to R0.88/kW.

Society will benefit greatly during the construction phase of renewable energy projects. A large number of jobs will be created directly and indirectly (Department of Minerals and Energy of South Africa, 2005). The actual construction will create jobs

while indirect jobs will be created through accommodating and feeding the construction workers Minerals and Energy of South Africa, 2005)..

The creation of jobs through renewable energy implementation is misleading. During operation and maintenance, the number of jobs will decline significantly from an estimated three thousand to fifty people (Bischof-Niemz, 2013). A question can be asked if this benefit to society is ethical and sustainable. One can argue that fifty jobs will be created instead of zero jobs in the absence of renewable energy projects.

Renewable energy projects have a negative impact on the environment (Masden, 2009). The process of manufacturing and fabricating renewable energy products is not a clean process from a carbon emissions perspective (Dovi et al., 2009). The process does involve the emission of carbon in its life cycle. The amount of carbon emitted has not been quantified and the participants of the research are not aware of such a study.

Wind energy, which is one of the renewable energy technologies under consideration, has an impact on bird life (Masden, et al., 2009). One participant indicated that the blades of the wind turbines are known to harm bird life; however, EIA's are conducted prior to the erection of wind farms. Masden, et al. (2009) indicated that any bird life that comes across the huge blades ceases to exist.

CSP plants are known to use a lot of water which could possibly be used for human consumption as indicated by Brown, et al. (2011). This fact is debatable depending on the country whereby the CSP will be erected and the benefits mentioned (Brown, et al., 2011). The CSP plant that is currently being erected in South Africa is erected in the Northern Province of the country whereby land is available in abundance. However, the need of land (Masden, et al., 2009) for future generations may require a significant amount of land being used to erect the CSP plant.

CSP plants will also disturb the habitat of plant life due to the land required for their construction. However, environmental impact assessments are conducted prior to erecting any man-made structures to ensure minimal impact on the environment. Having pointed out the issues brought about by these technologies, it can argued

that they are not sustainable. However, if their impact is compared to that of constructing a power station, renewable energy has a lower impact on the environment as mentioned by the research sample.

The research participants further stated that, the creation of jobs and the introduction of renewable energy will impact the macro and micro economy of the country. The assembly of renewable energy products will result in the construction of assembly plant and the emergence of entrepreneurial activity. The growth in “manufacturing” will boost the economy positively.

It should be noted that renewable energy products are manufactured overseas in countries such as China and the technology itself was invented overseas. That implies that jobs are being exported overseas and intellectual property is brought into the country. These have an impact on the ability of the country to generate income and consequently impacts on the economy.

The jobs created will result in an increase in public funds and thereby boost the economy on a macro and micro level. On a micro level, small towns where there is very limited economic activity will start being active. Most of the activity will be brought about by the need for accommodation and related consumer goods that will be required by the construction workers.

Due to the fact that the jobs created in the construction phase of renewable energy projects will decrease substantially (Bischof-Niemz, 2013), economic activity in the small towns will also decrease. This will later result in the loss of jobs that were gained and will impact negatively on the economy. The positive impact on the economy is short lived and is limited in its impact on the long-term economy.

The R138/kW (Brown, et al., 2011) cost indicated by American research of generating PV energy was found to be much less than the cost mentioned by the participant. The one participant, who is an engineer, mentioned a cost of R3/kW. The steep cost of R138/kW will be difficult for South African consumers to afford, given the current electricity cost of approximately R1/kW depending on municipal rates. The opposite is true for CSP and wind plants which cost R1.8/kWh and R1.9/kWh

(Brown, et al., 2011) respectively. The selection criteria of a specific technology will be an ethical dilemma for the South African government.

5.4 Holistic communication to users with respect to renewable energy technologies.

Domestic and commercial users are to a large extent informed about the massive benefits that renewable energy products will bring about. This is evident from the various awareness campaigns and initiatives (City of Johannesburg, 2011) undertaken by various government departments (Endemann, 2011), the power utility, private sector (Standard Bank, 2010) and various NGO's.

The benefits, such as reduction in electricity costs, increased access to electricity for rural household, access to cleaner energy and the reduction in carbon emissions, are clearly articulated by government departments and the renewable energy industry (Department of Energy of South Africa, 2011). The twenty participants that were interviewed for this research were in agreement that the benefits of renewable energy products are well communicated to the public and commercial users.

Literature does not show any evidence that the negative impacts that are brought about by renewable energy are communicated to the end users and potential end users. The awareness campaigns undertaken by government, private sector and NGO's did not communicate the following:

- Renewables are intermittent
- Utilisation of huge land mass by CSP
- Wind turbines pose a threat to bird life
- Jobs created in the construction phase will not be sustained in the long term

- The purchase of renewable energy products require additional capital to enable storage of energy in batteries for use at night when the sun is not available
- There is currently no policy to address the installation of PV on households and commercial buildings
- Any installation of electricity generating product such as PV require a certificate of clearance similarly to the installation of power in any building.
- The installation of PV is currently illegal as it might interfere with existing power lines
- Periodic maintenance will be required for any renewable energy product purchased
- Renewable energy products have a limited life span of twenty to twenty five years
- The implementation and connection of renewable energy to the national grid is subsidized by public funds when they purchase electricity
- The cost of renewable energy from wind is higher than the cost of coal energy.

The above information has been lacking from the awareness campaigns undertaken, which can be deemed unethical. The participants of the research also indicated that users and potential users of renewable energy products such as solar panels and solar water heaters are not well informed of the additional costs associated with these products nor are they aware of the subsidy of implementing national renewable energy projects. The research participants were in agreement that withholding information is unethical.

One participant who is responsible for connecting independent power producers (IPP's) to the national grid indicated that two percent of the electricity price increase

is used to subsidize the IPP industry to enable them to have profit making businesses. The public is not aware that a portion of the money they spend on their electricity is diverted to produce clean energy. It is the view of the researcher that the lack of communication with respect to the subsidy is unethical. The statement is substantiated by the 5.7% of researchers who have admitted to falsifying and withholding research findings Brown et al., 2001). This unethical behaviour is categorized as FFP (Steneck, 2006).

The integrated demand manager who was part of the research sample indicated that commercial users and households that are privileged to afford these products normally take it upon themselves to research and understand the products that they are purchasing. The manager further indicated that these users are able to afford the additional cost of having to purchase a battery and maintenance costs. The interview also revealed that the power utility has undertaken education programmes to educate the public about renewable energy and its associated products.

Although the cost of renewable energy technology is high (Brown et al., 2011) when assessed individually, as indicated by the integrated demand manager, an optimal cost across different technologies is desired. He further indicated that, the cost of electricity is determined from all the different technologies and not from specific technologies. The public will not be paying different rates depending on the source of electricity but they will pay different rates as a result of different municipal rates. The information is however, not shared with the public and thus rendering the conduct unethical by the researcher.

The manager indicated that there is collaboration between the power utility and various municipalities to roll out solar water heaters to under privileged communities. These communities are not able to afford the costs of installing renewable energy products. Contracts are in place to ensure that the solar water heaters are maintained as and when required to ensure that the quality of living is sustained and access to hot water does not revert back to traditional heating mechanisms.

The remainder of the participants indicated that communication to various stakeholders with respect to renewable energy projects and products is mainly focused on the benefits the projects and products will bring about. This admission by the research participants is in agreement with findings by Steneck (2006) of the existence of withholding of information. On the contrary, one researcher was comfortable that the various stakeholders are well informed on the advantages and disadvantages of renewable energy projects and products. The existence of ethical behaviour is again supported by only 0.001 per cent of researchers found to be unethical (Steneck, 2006) resulting in misinterpretation of findings (McArthur, 2009).

Project managers and researchers communicate both advantages and disadvantages to different stakeholders to enable decision making. Project managers had to build a business case for renewable energy projects prior to implementation. The business case did not necessarily have to be based on monetary value but on environmental and social benefits. The prioritization of environmental and social benefits skews sustainable development which requires the economy to be in balance with the later and former economy (Department of Environmental Affairs and Tourism of South Africa, 2008).

Project managers indicated that commercial suppliers of renewable energy product cannot be expected to mention the disadvantages of the products they are selling since their focus is on generating money. It is incumbent on the power utility, Department of Energy and Education to ensure that the public is educated with respect to renewable energy products.

Based on the literature review conducted and the participants' feedback, it is clear that there is no holistic communication with respect to renewable energy projects and products. The government (City of Johannesburg, 2011) and the renewable energy industry are only informing end users on the benefit of renewable energy. The disadvantages associated with renewable energy are not communicated to end users as proven by the various campaigns (Standard Bank, 2010) to communicate and inform the public about renewable energy.

5.5 Unintended positive and negative consequences associated with the implementation of renewable energy technologies.

Literature is very clear on the positive and negative consequences of renewable energy. That is, specific to CSP, PV and wind energy (Masden, et al., 2009). The research community has conducted extensive research in understanding the advantages and disadvantages of renewable energy. This information has been published in various academic journals (Masden, et al., 2009).

Research is silent on the unintended positive and negative consequences of renewable energy that is partially the purpose of this research. The interviews conducted have highlighted unintended positive and negative consequences as a result of renewable energy.

The unintended positive consequences identified by participants who were interviewed were:

- The introduction of new skills into the country
- The creation of new industries
- Cost trade off implementing renewable energy and public health costs as a result of poor air quality

The unintended positive consequences mentioned by the participants are not necessarily unique. Literature has indicated that new skills will be introduced and new industries will be created by the introduction of renewable energy into South Africa.

The cost trade off in introducing renewable energy into the country and the cost of public health is an unintended positive consequence. Government, through the use of public funds, is incurring costs of public health as a result of respiratory diseases caused by poor air quality. The introduction of renewable energy will possibly reduce the costs of public health.

The negative consequences of renewable energy have been researched and made known to various stakeholders such as the Department of Energy of South Africa (2011). These have also been evident from the literature review and from the interviews conducted for this research. The participants indicated that they do not foresee any negative unintended consequences associated with renewable energy.

One research did however indicate that CSP projects may take up land that might be required for human habitation in the future. That is due to the fact that CSP requires large amounts of land, which has been affirmed by the research community (Masden, et al., 2009). An increase in the implementation of CSP plants will require more land which is currently not required for human settlement. The need for land in the future and the need to implement CSP will be in conflict and consequently pose an ethical dilemma for decision makers.

The Grid connection manager also indicated that the lack of policy in relation to the installation of renewable energy for electrification is a safety risk for the occupants of the building where the PV is installed in terms of fire. It is also a risk to the electricity network as it will interfere with the functionality of the electricity network. This is because any electricity generating product requires a certification of clearance and there are currently no processes and procedures for the clearance of PV.

The lack of policy poses a fire risk to consumers who may purchase PV panels with the hope of reducing their electricity costs. It also gives rise to fraudulent activity on the part of manufacturers of these products who have the ability to sell these products to unsuspecting consumers who would not ensure that the products are certified by the South African Bureau of Standards (SABS). Unsuspecting consumers would not request certification of clearance while the installers might produce fake clearances since certificates of clearance are non-existent for PV panels.

On the part of commercial users, the Grid connection manager who is a registered engineer mentioned that there is no cause for concern. That is because commercial users tend to be responsible in the activities they embark on. Commercial users tend

to ensure that a registered engineer is used to install electricity generating products and the commercial users would ensure that the engineer is registered with ECSA. It will then remain the responsibility of the engineer to ensure that all the correct processes are followed when installing any electricity generating units. Literature also affirms this statement as engineers need to conduct themselves in accordance to the Engineering Profession Act, Number 46 (Republic of South Africa, 2000).

5.6 Conclusion

Holistic communication to the various stakeholders is non-existent. Communication to corporate decision makers, policy makers and government is holistic in its nature. These principals are well informed of the advantages and disadvantages of the different renewable energy technologies and products.

Communication to the South African public with respect to renewable energy projects and products has been skewed towards the advantages. This is very clear from the different awareness campaigns conducted by government, the private sector and NGO's. The campaigns highlight the benefits associated with the use of renewable energy and nothing is mentioned about the disadvantages of renewable energy.

Although advantages and disadvantages of renewable energy are well known and are well documented by the energy industry and the research community, positive and negative unintended consequences have not been explored. Cost trade-offs in the cost of public health and the cost of introducing renewable energy has been identified as an unintended positive consequence.

The utilisation of large amounts of land by CSP plants and wind farms may create land shortages should the land be required for human habitation in the future. The ability of renewable energy to create fraudulent activities as a result of lack of policy for PV installation has been identified. These two issues are unintended negative consequences that may result due to the implementation of renewable energy.

CHAPTER 6: .CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The focus of this chapter is to make conclusions based on the literature review and contrast these with the findings from the research conducted by means of interviews. Recommendations are made for key stakeholders such as the South African government, the power utility, private sector and the general public.

6.2 Conclusions of the study

6.2.1 Ethics in Renewable Energy

Ethics in renewable energy research do exist. However, they are not documented as it has been noted with medical research. Researchers in this environment have taken it upon themselves to act in an ethical manner, and is by ensuring that all their findings are communicated to the relevant stakeholders.

Researchers who have been interviewed have ensured that they communicate all the advantages and disadvantages associated with renewable energy. They are also able to communicate any concerns that may arise to their principals with respect to the technology. Although it is not up to them to make the final decision, they utilise the platform they have to communicate their concerns.

Projects managers and other professionals in the renewable energy environment have also identified risks associated with renewable energy technology. The risks can be deemed as the negative consequences of renewable energy technology. The professionals have ensured that the benefits and risks were communicated to their principals.

These professionals, who are mostly engineers registered with ECSA, have also taken it upon themselves to ensure that their projects do not cause harm to humans and to the environment. In cases where there is potential for the projects to cause harm, mitigation plans are put in place.

The researchers and project engineers in this environment are involved in the renewable energy projects as a directive from their organisation. Their organisation, Eskom, is embarking on renewable energy projects as directed by the South African government. The government has made commitments to the global community to reduce its carbon footprint. The government has embarked on these projects regardless of the associated costs and the impact on the society that is currently subsidizing the renewable energy industry.

The government, Department of Energy and Eskom are only driven by the government's commitment and are not informed by the South African unique economy and society. The narrow view of implementing renewable energy projects has potential to cause harm in the future.

The renewable energy industry that manufactures and supplies the technology in the market has communicated the benefits associated with the technology. They have focused the marketing of the products towards the benefits. The industry has not been in the forefront in communicating the disadvantages of renewable energy technology.

It can be concluded that ethics in the renewable energy environment do exist. This is mainly on the part of the academic community. On the part of the industry that manufactures and supplies the technology, it is concluded that there has been selective ethical behaviour since half the truth is communicated.

6.2.2 Renewable Energy and Sustainable Development

Based on the definition of sustainability, renewable energy is supposed to be sustainable. It is able to utilise the world resources without compromising the need of the resource for future generations, that is, by ensuring the security of future supply of energy, ensuring that the environment is clean and impacting positively on the economy through the creation of jobs and the introduction of new industries in the economy.

The main benefit that will be realised by implementing renewable energy technology will be in the reduction of carbon emissions. However, that on its own is questionable since renewable energy cannot be used for base load energy due to its intermittency, and also due to the fact that the technology is not at a stage where it is able to generate the amount of energy required. This implies that base load energy in South Africa will still rely on fossil fuels.

With a projected increase in the demand for energy in South Africa, additional capacity will need to be built. Renewables have been planned as part of the energy mix to supplement the increased demand. However, the intermittency of the technology will require a back-up system which will also need to be constructed. This implies that there will be a need for double capital expenditure. In this case, renewables will simply be fossil fuel savers and will not necessarily replace the need for fossil fuels. They will however, also assist in slowing down the rate of carbon emissions.

The technology is not able to sustain the jobs created during the construction phase. That implies that there will be a temporary “boom” during construction and a decline during operation and maintenance. The benefit to the economy is very limited and short lived considering that these technologies have a life of twenty to twenty five years.

The need for large amounts of land for the erection of CSP plant might be at the detriment of future generations. The future generation might require the land for

agriculture, development or settlement. In this instance, the technology is utilising resources that might be required in future.

It is concluded that renewables are not sustainable as they are not able to satisfy the three element of sustainability equally. In the case of renewables, the environment will benefit greatly while society and the economy will realise minimal benefits. It is also not sustainable since it goes against the definition of sustainability by impacting on resources (land) that will be required by future generations.

6.2.3 Holistic communication on Renewable Energy products to domestic and commercial users

Communication regarding the use of renewable energy products has been conducted by various bodies, such as the Department of Energy, Eskom, private sector and NGO's. These bodies have been instrumental in communicating the need for the introduction and the use of renewable energy.

The various bodies have embarked on awareness campaigns to educate the public about renewable energy and promote the use of renewable energy. The campaigns highlighted the benefits of utilising renewable energy. One of the major benefits communicated is a cleaner environment where the South African population will have clean air to breath and a reduction in electricity costs of thirty percent.

The awareness campaigns conducted were found to be silent with regards to the disadvantages associated with renewable energy. The intermittency of the technology, the additional costs of purchasing a battery, the decline in jobs during the operation and maintenance stages and the lack of policy associated with installing a PV panel are some of the disadvantages associated with renewable energy. It is concluded that there is no holistic communication to domestic and commercial users with respect to renewable energy and renewable energy products.

The South African government, the Department of Energy, Eskom and the associated commercial industry have not made a concerted effort to educate and communicate to all the stakeholders the driving forces behind implementing

renewable energy projects and the negative consequences associated with renewable energy. The public and related stakeholders are only informed of the advantages.

6.2.4 Unintended positive and negative consequences of renewable energy

Unintended positive consequences identified by some of the participants were identified, one of them being the cost trade off in the cost of public health care as compared to the cost of implementing renewable energy projects at a national level in South Africa.

Expenditure will shift from public health care to implementing renewable energy projects. A cost-benefit analysis on the shift in expenditure from public health as a result of carbon emissions by Eskom to providing cleaner breathing air as a result of implementing renewable energy projects still needs to be quantified. The cost-benefit analysis will inform the government and relevant stakeholders if renewable energy projects yield the benefits they were intended to bring about.

Unintended negative consequences have also been identified. One of the unintended negative consequences is the utilisation of land by the erection of wind farms and CSP plants. The land utilised by wind farms and CSP plants might be required by future generations for agriculture or human settlement.

It is concluded that renewable energy is not a perfect solution. It is not without unintended consequences. Although some of the consequences are positive, where the consequences are negative, relevant stakeholders will need to quantify the unintended negative impacts, that is, to ensure that the impact does not outweigh the benefit renewables bring about. Should the negative consequences outweigh the benefits of renewable energy, it would steer the renewable energy scholars and industry in a different direction.

6.3 Recommendations

6.3.1 Investors

It is recommended that corporates wishing to invest in the South African renewable energy industry act in an ethical manner in terms of selling their products in the market. They need to ensure that their customers are well informed of the advantages and disadvantages of their products and not mislead the public with the intention of generating quick money. That will enable them to remain in good standing with the public they wish to serve.

6.3.2 Government bodies

The government must be transparent in the implementation of renewable energy projects, which is mainly from a cost perspective, the objective of implementing the technology and in educating end users about the advantages and disadvantages of renewable energy and in considering policy formulation before implementing projects.

6.3.3 End user of renewable energy products

It is recommended that the end users of renewable energy products educate themselves on the products they purchase. The users need to understand the costs involved in the complete life cycle of the product. They need to be aware of both advantages and disadvantages of the products they purchase.

End users need to familiarise themselves with laws, regulation and policies related to renewable energy products. This is to protect themselves from any possible unsafe living conditions.

6.4 Suggestions for further research

The study has indicated that there will be health benefits to the general public by implementing renewable energy technologies in South Africa. Currently there are externality costs to the general public from a financial and health perspective. The public that is on health insurance spends money on health care induced by carbon emissions. The government spends money on public health for those who do not have health insurance. The health of both sectors of the public is adversely affected by carbon emissions.

A study to quantify the externality cost to the public and government as a result of carbon emissions and the cost benefit of implementing renewable energy would be an interesting one. This will help justify and build a stronger business case of the rhetoric that renewable energy is beneficial to the health of society. Therefore, cost trade-offs between the cost of public health as a result of poor air quality due to carbon emissions and the cost of implementing renewable energy is proposed as a further study.

The IPP's on their own are not able to sell their product in the market. The energy sector is monopolised by Eskom and there are high barriers to entry. As a result, they are not able to sell their product at the same price as Eskom. They are currently being given favourable rates by Eskom to sell their product to Eskom and to connect on the national electricity grid. The favourable rate is making their businesses profitable. Eskom then absorbs the additional cost of the IPP power and charges the public a level cost of energy.

Eskom has managed to afford the favourable prices for the IPP's by allocating 2% of the latest 8% electricity tariff increase in South Africa, which implies that the public is subsidizing the IPP business. Businesses are generating income while the public has to cope with less disposable income. A study is proposed to determine whether it is fair for the IPP's to be funded by all South African electricity consumers while business generates income from poor South Africans.

It is clear from the study that the public is not informed of the disadvantages of renewable energy products. The clearance certificate that is required for households and commercial buildings to install PV, the intermittency of the technology and the costs of maintaining the products are some of the disadvantages associated with renewable energy technologies. The disadvantages beg the question of “who is responsible for educating the public about the disadvantages of renewable energy”. That is proposed for further study.

There has been various campaigns undertaken by government and the private sector to inform the public about renewable energy. It did not seem from this study that the campaigns have reached the majority of the South African public to make them aware and informed of alternative energy and on their advantages and disadvantages. It is for that reason that a question on whether the message is reaching the public is being asked. The following study is thus proposed: Are awareness campaigns on renewable energy reaching the South African public?

The drive by government and the campaigns conducted by government are very clear of the benefits of renewable energy. Some of the benefits mentioned are the creation of jobs, clean energy and access to electricity for remote areas. The interviews conducted have indicated that renewable energy projects are being implemented in South Africa as a result of Eskom’s strategic objectives which are to some extent informed by government.

The campaigns driven by government do not communicate some of the reasons renewable energy is implemented, such as, the loans granted to Eskom for the construction of the new power stations demanding the implementation of renewable energy and the commitment made by government during COP17 to reduce carbon emissions. From the study, it is clear that the public is only told half the truth. The question is asked if the South African government is transparent about the real reason why it is implementing renewable energy projects. The questions asked are proposed as a suggestion for further research.

Renewable energy implementation in South African will only form 9% of the total energy mix by 2030 while coal will form 65% of the energy mix. The huge capital and electricity cost, which is subsidized by the South African public as compared to the cost of coal energy, cannot be justified when comparing to the energy output by the two technologies.

Renewables will be generating 12400 MW as compared to 41074 MW generated by coal fired power stations. To fully understand the issue, it is proposed that the following study be conducted: Will the reduction in carbon emissions due to the introduction of renewable energy be significant considering that renewables cannot be implemented on a large scale?

REFERENCES

Aharon, O. (2013). Profiling solar energy in concentrated solar power systems. *Laser Focus World, 49*(2), 49-51.

Andreas, M. R. (2003). Validity and reliability tests in case study research: a literature review with "hands-on" applications for each research phase. *Qualitative Market Research: An International Journal, 6*(2), 75-86.

Bischof-Niemz, T. (2013). *What role will solar PV play in the future energy mix of Eskom?* Paper presented at the South African-German Chamber of Commerce, Renewable energy. Eskom, Megawatt, Sunninghill, Johannesburg, South Africa.

Brown, A., Muller, S. & Dobrotkova, Z. (2011). *Renewable energy, Markets and prospects by technology* International Energy Agency (pp. 1-66). Paris: International Energy Agency.

Brown, S., & Kalichman, M. (1998). Effects of training in the responsible conduct of research: A survey of graduate students in experimental sciences. *Journal of Science and Engineering Ethics*, 4(4), 487 - 498.

Bryman, A. (2012). *Social Research Methods* (4th ed.). United States: Oxford University Press.

Byrch, C., Kearins, K., Milne, M. J., & Morgan, R. K. (2010). Sustainable Development: What does it really mean? *University of Auckland Business Review, 12*(1), 1-7.

Carbon Monitoring for Action. (2007, 15 October). *Highest carbon dioxide emitting companies in the world*. Retrieved 15 March ,2014, from http://carma.org/company

Chamber of Mines of South Africa. (2012). *2012 Annual Report* (pp. 19). Johannesburg: Chamber of Mines. .

Chen, Y.W. (2011). Quantitative Content Analysis of Chinese Texts?: A Methodological Note. *Journal of Chinese Political Science*, 16(4), 431-443.

City of Johannesburg. (2011). *Power saving campaign launched*. Retrieved 17th March, 2014, from http://www.joburg.org.za/index.php?option=com_content&view=article&id=6381:power-saving-campaign-launched&catid=88&Itemid=266

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches,* (3rd ed.). London: Sage.

Dixon, B. (1979). Cheating in Science. *Sciences*, 19(3), 29.

D'Anjou, P. (2011). An Ethics of Freedom for Architectural Design Practice. *Journal of Architectural Education*, 64(2), 141-148.

Department of Energy of South Africa. (2011). *Integrated Resource Plan for Electricity* (pp. 21-73). Pretoria: Department of Energy.

Department of Environmental Affairs and Tourism of South Africa. (2008*). The National Framework for Sustainable Development in South Africa* (pp. 1-94). Pretoria: Department of Environmental Affairs and Tourism.

Department of Minerals and Energy of South Africa. (2005). *Energy Efficiency Strategy of the Republic of South Africa* (pp. 1-46). Pretoria: Department of Minerals and Energy.

Dovì, V. G., Friedler, F., Huisingh, D., & Klemeš, J. J. (2009). Cleaner energy for sustainable future. *Journal of Cleaner Production*, 17(10), 889-895.

Endemann, S. (2011). *South Africa and Denmark launch the first wind energy campaign focused on maximising awareness and demonstrating the importance of wind.* Retrieved 15th March, 2014, from http://www.energy.gov.za/files/windEnergyAwarenessCampaign.html

Eskom. (2011). *The Eskom Factor report* (pp. 1-89). Sunninghill: Eskom.

Eskom. (2014). *Company Information*. Sunninghill: Eskom.

Facão, J., & Oliveira, A. C. (2010). Simulation of a linear Fresnel solar collector concentrator. *International Journal of Low Carbon Technologies, 5*(3), 125-129.

Fernández-García, A., Zarza, E., Valenzuela, L., & Pérez, M. (2010). Parabolic-trough solar collectors and their applications. *Renewable and Sustainable Energy Reviews, 14*(7), 1695-1721.

Gakhar, S. (2013). An Effective Waste Management System for a Better Future. *Aweshkar Research Journal, 15*(1), 129-136.

Geggie, D. (2001). A survey of newly appointed consultants' attitudes towards research fraud. *Journal of Medical Ethics, 27*(5), 344.

Gurtoo, A. (2011). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. *Current Science (00113891), 101*(5), 683-684.

Hartnady, C. J. H. (2010). South Africa's diminishing coal reserves: review article. *South African Journal of Science, 106*(9/10), 1-5.

Hayhow, R., & Stewart, T. (2006). Introduction to qualitative research and its application to stuttering. *International Journal of Language & Communication Disorders*, 41(5), 475-493.

Higgs-Kleyn, N., & Kapelianis, D. (1999). The Role of Professional Codes in Regulating Ethical Conduct. *Journal of Business Ethics, 19*(4), 363-374.

Kalichman, M. W., and Friedman, P. J. (1992). A pilot study of biomedical trainees perceptions concerning research ethics. *Journal of Academic Medicine*, 67(11), 769-775.

Katavic, V. (2010). Responsible conduct of research: Do we need training in fraud-science? *Croatian Medical Journal*, 20(3), 288-294.

Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and reliability of measurement instruments used in research. *American Journal of Health*, 65(23), 2276-2284.

Lafferty, W. M., Knudsen, J., & Larsen, O. M. (2007). Pursuing sustainable development in Norway: the challenge of living up to Brundtland at home. *European Environment: The Journal of European Environmental Policy (Wiley), 17*(3), 177-188.

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research : planning and design*, (Eighth ed). New Jersey:, Pearson Education.

Lesser, J., & Puga, N. (2008). PV vs. Solar Thermal. *Public Utilities Fortnightly*, 8 July (pp.16-27).

Lund, H. (2007). Renewable energy strategies for sustainable development. *Energy, 32*(6), 912-919.

Lundberg, C. C. (2003). Research Design: Qualitative, Quantitative and Mixed Methods Approaches. *Organizational Research Methods, 6*(3), 404.

Manganello, J., & Blake, N. (2010). A Study of Quantitative Content Analysis of Health Messages in U.S. Media From 1985 to 2005. *Health Communication*, 25(5), 387-396.

Marafia, A. H., & Ashour, H. A. (2003). Economics of off-shore/on-shore wind energy systems in Qatar. Renewable Energy: *An International Journal*, 28(12), 1953.

Marwell, G. (1984). Encounters with Unjust Authority. *Contemporary Sociology*, 13(4), 520-522.

Masden, E., Haydon, D., Fox, R. Furness, R., Bullman, R. & Desholm, M. (2009). Barriers to movement: Impacts of wind farms on migrating birds. *Journal of Marine Science, 66*, 746-753.

McAnearney, T. (2008). The steady erosion of ethics: the law. *Without prejudice: South Africa's corporate legal magazine,* 8(4), 38-40.

McArthur, D. (2009). Good Ethics Can Sometimes Mean Better Science: Research Ethics and the Milgram Experiments. *Science & Engineering Ethics, 15(1)*, 69-79.

McMinn, J. G. (2014). When Heroes Fail: A Re-Framing of Milgram's Shock Experiments. *Journal of Social & Clinical Psychology, 33(3)*, 292-294.

Merriam, S. (2002). *Introduction to Qualitative Research*. San Francisco: Josey Bass Inc.

Miles, M. B. (1979). Qualitative Data as an Attractive Nuisance: The Problem of Analysis. *Administrative Science Quarterly, 24*(4), 590-601.

Miller, A. (1979). Solar Energy : To what end? *Social Alternatives, 1(5)*, 48-50.

Moreno, B., & López, A. J. (2008). The effect of renewable energy on employment. The case of Asturias (Spain). *Renewable & Sustainable Energy Reviews, 12(3)*, 732-751.

Mundaca T, L., Mansoz, M., Neij, L., & Timilsina, G. R. (2013). Transaction costs analysis of low-carbon technologies. *Climate Policy (Earthscan)*, 13(4), 490-513.

Paish, O. (2002). Small hydro power: technology and current status. *Renewable & Sustainable Energy Reviews, 6*(6), 537. ‘

Republic of South Africa. (2000). *The Engineering Profession Act, Number 46. Government Gazette Number 34767*. Pretoria, Government Printer.

Republic of South Africa. (1998). *The National Environmental Management Act, Number 107. Government Gazette Number 33306*. Pretoria, Government Printer.

Shaffer, P., & Zim, H.(1989). *Rocks and Minerals*. Arizona, Golden Guides.

Silva, D., Rusu, E., & Soares, C. G. (2013). Evaluation of Various Technologies for Wave Energy Conversion in the Portuguese Nearshore. *Energies, 6(3)*, 1344-1364.

South African Renewable and Resources Database. (2012). *Renewable Energy Database and the South African Wind Atlas*. Retrieved 1st October, 2014, from http://www.energy.gov.za/files/IEP/presentations/RenewableEnergyDatabase_and_SA_WindAtlas_30March2012.pdf

Solar Thermal Power Generation Technology. (2005). *STP 2005 Solar Thermal Power Generation Technology Solar Thermal Power* (pp. 22-30). London: ABS Energy Research.

Spalding-Fecher, R., & Matibe, D. K. (2003). Electricity and externalities in South Africa. *Energy Policy, 31(8)*, 721

Stacey, A., & Stacey, J. (2012). Integrating Sustainable Development into Research Ethics Protocols. *Electronic Journal of Business Research Methods, 10*(2), 54-63.

Standard Bank. (2010). *Sponsored Schools*. Retrieved 17 March, 2014, from http://movingforward.standardbank.com/Pages/SchoolProfiles.aspx

Stankiewicz, D. (2012). Produkcja rolna na cele energetyczne jako instrument polityki klimatycznej. (Polish). *Energy crops as an instrument of climate policy. (English), 29*(1), 185-208.

Statistics South Africa. (2013). *Quarterly Labour Force Survey Report* (pp. 1-97). Pretoria: Statistics South Africa.

Steneck, N. H. (2006). Fostering Integrity in Research: Definitions, Current Knowledge, and Future Directions. *Science & Engineering Ethics, 12*(1), 53-74..

Sunfin. (2014a). *Keeping our lights on (Vol. 2014). South Africa: Sunfin Solar*. Retrieved 1st October, 2014, from http://sunfinsolar.co.za/Solar-Radiation-Map

Sunfin. (2014b). *Wind Turbines. Wind Turbines*. Retrieved 27th September, 2014, from http://sunfinsolar.co.za/Wind-Map

The Chemical Engineer. (2008). Engineer guilty of Davis-Beese lies. TCE: *The Chemical Engineer(808)*, 13-13.

Wieck-Hansen, K., Overgaard, P., & Larsen, O. H. (2000). Cofiring coal and straw in a 150 MWe power boiler experiences. *Biomass and Bioenergy, 19*(6),395-409.

APPENDIX A: ELECTRONIC MAIL FOR REQUESTING INTERVIEWS

Dear Sir/Madam

I am currently completing the final phase of my MBA programme, the research report component. The purpose of my research is to gain an understanding of the ethical protocols considered when embarking on Renewable energy projects

I will be collecting data by means of a short interview. Please assist me in collecting the data by allocating 20 minutes of your time. On confirmation of the date and time, I will schedule an appointment on Outlook. In addition, could you kindly forward this email to colleagues who would possibly be willing participants?

Be assured that all data collected is confidential and the data will be aggregated before being reported. The responses will be collected on an anonymous basis and as such, no identity related information will be collected nor recorded.

APPENDIX B: RESEARCH INSTRUMENT

Interview Questions

Question 1

What is your role in the renewable energy environment?

Question 2

What has informed the undertaking of renewable energy projects in your organization?

Question 3

Are the any international or local guidelines that are being followed to roll out the projects?

Question 4

Are you aware of studies that have been done to conclusively deem renewable energy sustainable?

Question 5

Do you personally understand and endorse the benefits that have been “claimed” by the research community with respect to renewable energy?

Question 6

Are you aware or for-see any unintended positive and negative consequences based on the research protocols employed?

Question 7

Do you have any influence in your organization to encourage or discourage the implementation of renewable energy projects and what would be your reason?

Question 8

To what extent do scientists and engineers who have researched and invented the renewable energy technologies hold themselves responsible for all the consequences and unintended consequences of these technologies?

Question 9

To what extent do you hold yourself liable for the consequences and unintended consequences?

Question 10

What are the decision making processes that have been followed by your department to embark on renewable energy?