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Factors Influencing Adoption of Renewable Energy Technology by High Energy Intensive Firms in South Africa

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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

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ABSTRACT

This report presents results of a research that investigated factors that influence adoption of renewable energy technology (RET) by energy intensive firms in South Africa.

The analysis considered external environment factors, internal environment factors and technological attributes as three types of factors that are likely to be important. External environment factors are those external to the adopting organisation, which include public policy and stakeholders influence. Internal environment factors involve firm-level decision making, namely cost and benefit analysis, organisational capabilities and leadership values. Technology attributes are factors related to characteristics of the technology being adopted, which include compatibility, perceived benefits and relative advantage.

The research design involved administering a questionnaire to all 36 members of the energy intensive user group of South Africa (EIUG), which is a professional association of industrial firms that accounts for a very high proportion of energy use in the country. The response rate was high (50%), with complete responses being received from representatives of 18 EIUG members.

The key findings of this research are as follows: among EIUG members there is high level of awareness of RETs and firms viewed RET as credible technology to reduce their greenhouse gas (GHG) emissions. These firms are actively and continuously monitoring their own GHG emissions and majority have taken steps to adopt RETs but the momentum towards active and intensive adoption and deployment of RETs has simply not been reached. Internal environment factors and technological attributes are the two major concerns for firms wanting to adopt RET. The firms consider themselves to have strong leadership and organisational support for RET, but this is not reflected in sustained, well-resourced RET deployment strategies at firm-level.

The most important finding of this research is that it starkly demonstrates the limited value of technology promotion and adoption strategies if they do not take firm-level decision making into account. The firms in this study reported that external environment factors such as public policy play only a limited role in influencing their adoption decisions. Importantly, these large industrial firms characterise the much vaunted renewable energy policy strategy (i.e. REFIT and Carbon Tax) as one that would only achieve minimum compliance.

DECLARATION

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

(Tshifhiwa Bernard Magoro)

Signed at …….

On the …….. day of …… 2013

DEDICATION

To my mom, Sophie Khakhu Magoro

ACKNOWLEDGEMENTS

I would like to thank the following people for their invaluable contribution towards the completion of this research report:

- My family (my wife Tshinyi, and our sons Mufhiwa and Mukoni) for their support, encouragement and allowing me so much time away from home.
- Professor Gillian Marcelle for her guidance throughout this seemingly daunting task.
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CHAPTER 1: INTRODUCTION

1.1 Introduction

The purpose of this research is to explore factors influencing adoption of renewable energy technology by energy intensive firms in South Africa. The study employed qualitative research methodology and surveyed the 36 industrial firms belonging to the energy intensive user group of South Africa.

1.2 Context of the study

This section introduces the reader to the challenges facing South African (SA) energy system in the context of the changing global environment and then rationalises the reason for choosing this area of research.

The SA energy system is characterised by high level of carbon lock-in (Unruh 2000), with electricity as the main source of energy for industrial firms. The electricity industry is currently faced with two major challenges:– (1) an urgent need to invest in additional capacity to support much needed economic growth as well as the national drive to increase access to electricity particularly by the previously disadvantaged rural poor communities, and (2) the international pressure to reduce the country's greenhouse gas (GHG) emissions associated with, *inter alia*, coal-based power generation (Winkler 2007; Surridge and Cloete 2009; Pegels 2010; Tyler 2010; Menyah and Wolde-Rufael 2010). In response to these challenges, government has over the years attempted to introduce policies aimed at facilitating introduction of renewable energy technology (RET) in the energy production mix (for example, DME 1998; DME 2003; National Treasury 2010 and South Africa 2011b).

Renewable energy is defined as energy source that is continuously renewed (Krey and Clarke 2011), as opposed to fossil based energy

sources that have limited supply. RET innovation is relatively novel in SA and their deployment brings about a number of issues to the fore, which must be taken into context when analysing factors influencing the adoption of renewable energy technology in SA.

Firstly, the country's energy system is characterised by a history of high dependence on cheap, reliable coal-based electricity generation technologies. This has resulted in an economy which is highly energy intensive by world standards, particularly the industrial sector (Sebitosi 2008; DEAT 2004 and DME 1998). However, in an increasingly carbon constrained world South Africa has to reduce its greenhouse gas emissions intensity (Pegels, 2010).

The second issue relates to electricity supply and demand dynamics. Electricity supply structure remains highly monopolistic with the national utility, Eskom, supplying about 95% of electricity demand in the country. Customers have neither a choice regarding the electricity supplier nor a primary source of energy they consume. The main technology utilised in electricity production remains large coal based power stations accounting for about 90% of the total production. As a result electricity policy has always been targeted at regulating the supply sector with very little attention given to alternative technology adoption by energy users (DME 1998, DME 2003 and South Africa 2011b). The demand sector is also characterised by a small number of highly energy intensive firms (hereafter referred to as industrial firms). The 36 industrial firms surveyed in this study accounts for over 40% of total electricity usage (Eskom 2011 and EIUG 2011) and therefore are also responsible for a significant amount of the country's GHG emissions. The challenge faced by these firms is therefore finding ways to successfully adopt alternative energy technologies, such as RET, in their energy mix in order to reduce their carbon footprint with minimum impact to their business operations.

Finally, although SA has abundance availability of RET resources, particularly wind and solar, they are significantly under-utilised at present

(Fluri 2009; Sebitosi and Pillay 2008). While they provide social and environmental benefit, RETs are well known for having too many barriers limiting their large scale deployment (Painuly 2001; Pegels 2010 and Montalvo 2008), and as a result remain highly uncompetitive to traditional fossil based incumbent technologies.

Empirical evidence shows a slow adoption of RET in SA at present (Eskom 2011 and South Africa 2011b). According to Montalvo (2008) there are two major issues associated with slow adoption of clean energy technology as a means of providing environmental sustainability. First is the little acceptance in the society of the link between the use of the current energy technologies and negative environmental problems they cause. The second relates to the actual process of adoption and diffusion of new technologies, particularly by the users. The aim of this research was to understand both these issues from industrial firms' perspective by analysing factors that would influence adoption of RET by these firms.

1.3 Focus of the study

The study aimed to understand factors that influence the adoption of RET by energy intensive industrial firms in South Africa. Factors influencing adoption of RET were identified from published literature. Senior managers responsible for energy sourcing, planning and strategies in energy intensive firms were surveyed in order to answer the research question. Targeted firms are members of the energy intensive user group of South Africa (EIUG).

1.4 Significance of the study

This study contributes to understanding factors that influence adoption of renewable technologies that are important for SA's development.

The role of corporate industrial firms in shaping RET adoption remains largely unassessed and this is problematic because these primary production sectors are very energy intensive. Much of the past research on the adoption and diffusion of RET focused on government policy options and economic instruments to promote RET deployment (Jacobsson and Johnson 2000; Painuly 2001; Winkler 2005; Rao and Kishore 2009; Pegels 2010). In other words the focus of these authors has largely been on promoting the "supply-side" of the equation. In a country characterised by energy intensive industries, historical reliant on cheap coal based electricity supply (and still having an abundance of untapped coal reserves), and a dominant monopolistic utility supplier; it was important to also understand those "demand-side" factors that will ensure successful adoption of new alternative technology by the users (Montalvo 2008; Mani and Dhingra 2011).

Policy makers, regulators and professionals from the advocacy community needing a vision of the current as well as future prospects for RET deployment in SA will also appreciate the implications of current policies and respond accordingly in future policy directions.

The targeted sector is the largest consumer group of total energy produced in the country and forms the backbone of the country's economy. Any significant changes in the energy sector will affect this sector and ultimately the overall economy. It was, therefore, important to understand their perspective and attitude towards RET as the level of adoption and diffusion to be achieved largely depends on the response of this stakeholder. Individual firms will also be able to appreciate the sector level perspective of RET adoption within the industry.

The study will also provide guidance to technology original equipment manufacturers and RE developers with regard to market appetite for RETs in SA as well as market forces driving potential demand for RETs.

1.5 Delimitations of the study

Current IRP2010 as published by the Department of Energy (DoE) and the potential introduction of carbon tax are assumed to be the base plan to kick-start a shift towards a low carbon future for SA. Any significant changes to these policies regarding RET adoption may affect the significance of this study.

Electricity consumers are generally segmented into 6 sectors, namely: industrial, mining, commercial, transport (i.e. rail), agriculture, and rural and domestic urban sectors (Eskom, 2011). The research was limited to the industrial and mining sectors to the total exclusion of all other consumer segments.

1.6 Definition of terms

The following terms are used in this research:

Term	***Definition***	***Reference***
Energy intensive user group (EIUG) (for the purpose of this research, also referred to as "industrial firms")	Firms that, at the time of writing, were members of the EIUG of SA. These are firms whose individual annual energy consumption exceed 100GWh.	EIUG 2011
Feed-in-Tariff (FIT)	Regulated prices for renewable energy fed into the grid, set by law for certain of time, and typically set higher than achievable market prices.	Madlener and Stagl 2005
Integrated resource plan (IRP)	Co-ordinated schedule for generation expansion and demand-side intervention programmes, taking into consideration multiple criteria to meet electricity demand.	South Africa 2011b
Preventative Innovation	Innovations that require an action at one point in time in order to avoid unwanted future condition.	Rogers 2002
Renewable energy (RE)	Energy sources derived from natural processes that are continually renewed through conversion of natural resources such as solar, biomass, wind and hydro into useful forms of energy.	Krey and Clarke 2011 Rao and Kishore 2010
Renewable energy technology (RET)	Technology that converts RE sources into useful energy form.	Author
RE developer	An entity that build, own and operate a renewable energy production facility	
Renewable portfolio standard (RPS)	An RET support scheme where each electricity utility or consumer is required to have a portion of its overall electricity supplied or consumed to come from RET	(Walsh 2001, Madlener and Stagl 2005 Carley 2009).
Technology learning rates	The extent to which technology gets cheaper over time	Winkler et al. 2009

The following acronyms are used in this research:

Acronym	***Stands For***
DoE	Department of Energy
EIUG	Energy Intensive Users Group of South Africa
FIT	Feed-in-Tariff
IEA	International Energy Agency
IRP	Integrated Resource Plan
IPP	Independent Power Producer
RET	Renewable Energy Technology
REBID	Renewable Energy Bid Programme
REC	Renewable Energy Certificate
REFIT	Renewable Energy Feed-in-Tariffs
RPS	Renewable Portfolio Standard
SA	South Africa

1.7 Assumptions

The following assumptions could influence the outcome of the research:

- That the respondents were aware of RET attributes and how these compare to conventional energy technologies. This was a reasonable assumption given that the targeted respondents were senior managers responsible for energy strategies within their firms.

- That government will spearhead the effort to change the current energy technology mix through the various policy initiatives, including the adoption of RET. This is qualified by the published IRP 2010 and the recent government renewable energy bidding programmes (REBID) to procure renewable energy from private developers.

- That the current electricity supply industry structure reform will not proceed beyond the proposed single-buyer model. Under this proposed model the cost of renewable energy will be socialised among all consumers through the feed-in-tariffs (FIT) scheme. Any reform proposal beyond this model (for example, wholesale market model) will affect the results of this study.

1.8 Conclusions

Current energy challenges, as presented in this chapter, also present an opportunity for SA to invest into renewable energy technologies. Understanding, embracing and adequately addressing issues of renewable energy technology adoption within the South African context will aid the country and companies to redefine their role in reducing greenhouse gas emission and ensuring sustainable energy supply and this research was aimed to contribute to that outcome. It particularly aimed to do so through understanding factors that would influence adoption of RET by energy intensive industrial firms.

The next chapter reviews the relevant literature in developing a theoretical framework from which this research was explored.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of academic and policy literature that is relevant for this research enquiry. It starts by providing background information on the technological, institutional, and policy context that characterise the SA energy industry. RETs are then introduced as novel technology in the SA context. This is followed by a discussion of technology adoption models. Factors influencing adoption of RET were also developed from published literature. Each of the factors is explained and discussed in order to arrive at core issues that will be addressed in the research.

2.2 South African Energy Landscape

Before addressing the RET adoption decision making process by energy intensive firms, it is important to understand the context of energy supply and usage in South Africa.

“The South African energy system is characterized by a high path dependency, having its roots in the apartheid period when independence from external energy supplies was a political necessity” (Pegels 2010, pp.4948). This quote from Pegels (2010) emphasises the importance of the history of SA in shaping the current state of the energy supply system. According to Pegels (2010) political isolation and abundance of coal reserves resulted in an energy technology research centred on fossil fuel technologies driven mainly by the state owned companies, Eskom (for electricity) and Sasol (for fuels). It is in this context that SA energy supply technologies and potential adoption of alternatives must be understood.

2.2.1 Energy Supply Patterns

The country's energy system is characterised by a high level of carbon lock-in (Unruh 2000), in which the traditional sources of energy production are entrenched and actively slow down the rate at which there is transition to alternatives. This lock-in effect exerted by mature technologies has led to relatively slow rate of uptake for RET and is influenced by a combination of factors. Empirical studies have also shown a unidirectional causal flow from economic growth to carbon emissions in SA (Odhiambo 2011, and Menyah and Wolde-Rufael 2010). This is the case despite growing awareness of the social and environmental benefits associated with RET, a policy landscape which has a stated intention to encourage RET deployment and a relatively organised, vocal environmental civil society.

SA consumes about 1.1% of total energy output in the world and in 2009, 88% of total energy used in all forms (i.e. electricity and fuel) was produced from fossil fuels based technologies (IEA, 2012). Electricity is the main source of energy accounting for 43% of total energy consumed in the country. According to Eskom (2011) about 90% of electricity generated in 2010, was generated from coal-based power generation technologies. Figure 1 shows the current electricity generation mix and it is evident that RET were almost non-existent, at less than 0.1%.

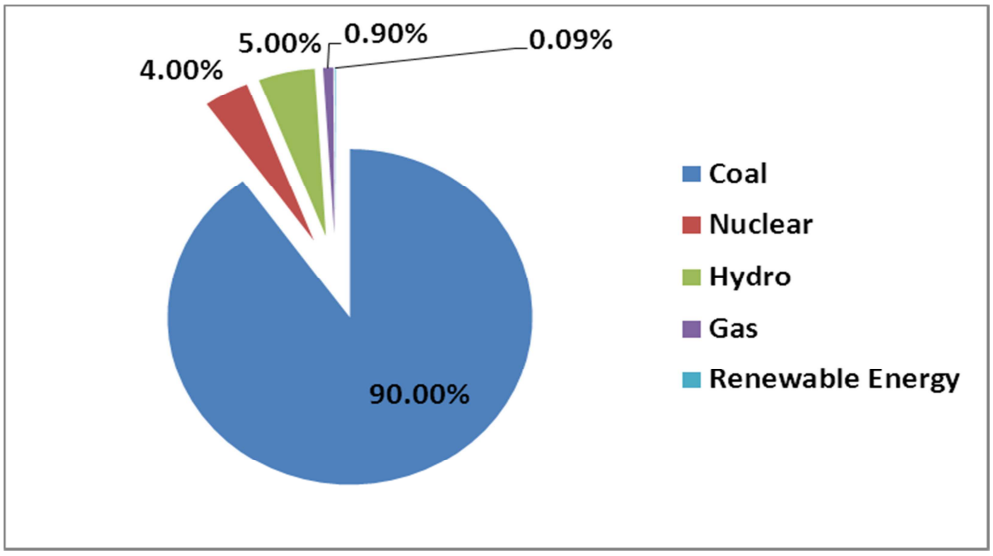


Figure 1: *Electricity generation technology mix (Source:* South Africa *2011b)*

As a result the country is among the highest GHG emitting nations in the world, and from electricity alone this amounted to 230Mt of $C0_2$ in 2010 (Eskom. 2011). Unlike in other countries where RET adoption was also driven by energy security requirements, the main reason for RET adoption in SA appears to be the need to reduce the country's carbon footprint (Surridge and Cloete 2009; Pegels 2010; and Tyler 2010) since SA still has an abundant untapped coal reserves. However, steering South Africa's economy towards low-carbon future was described as an extremely complex task (Pegels, 2010).

The nature of SA's electricity supply structure remains highly monopolistic. Approximately 95% of the power is generated by the national utility, Eskom. The remainder consists of imports from neighbouring countries, as well as municipalities' and industrial consumers' own generation facilities (Eskom, 2011). According to current policy indications, SA is in transition from a regulated monopoly to a hybrid single-buyer model (South Africa, 2011a). Under this model a designated buyer will purchase energy from all generators, including utilities and renewable IPPs, and in turn sell the energy to all consumers.

RET would be supported through a feed-in-tariff (FIT) scheme, which is essentially a premium levy on electricity unit sold to each consumer. Under a FIT scheme costs of RET are therefore socialised among all electricity consumers in proportion to their consumption.

2.2.2 Energy Usage Patterns

Figure 2 shows electricity consumption by the different sectors of the economy for the year 2010 (Eskom, 2011). Industrial firms are the largest consumer of electricity[1]. According to (Battle, 2011) allowing all consumers to pay for the costs of RE promotion programmes in proportion to their energy consumed has been empirically found to be the most optimal cost allocation method. Therefore, in the SA context, success or failure of the RET adoption and diffusion largely depends on RET uptake by corporate industry.

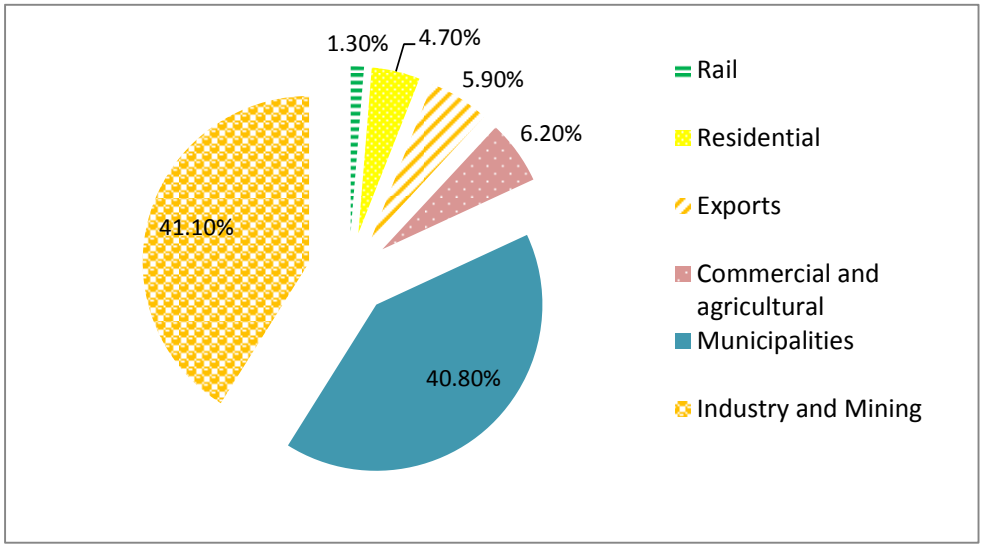


Figure 2: *Electricity consumption by sector (Source: Eskom 2011)*

[1] Total industrial load for the purpose of this research includes industrial and mining sectors. This load is much higher than this estimate as some industrial and mining loads are embedded within municipal networks and their consumption is therefore accounted for within the municipalities sector

EIUG is a voluntary non-profit association of large scale high intensity electrical energy consumers. It represents the interest of the majority of industrial firms is South Africa whose individual electricity consumption exceed 100GWh per year. At the time of writing the association had 36 member companies which together consume approximately 44% of total electricity produced in South Africa (EIUG, 2011). According to EIUG (2011) the organisation's main aim is to ensure "the continued availability of low cost, high quality electricity supply on a reliable basis through critical interventions with stakeholders to ensure a sustainable and viable outcome of the national electricity discourse". Empirical studies have shown that renewable energy, in contrary, is characterized by high upfront costs and low reliability (Sorensen 1991 and Turner 1999). The association's concern over energy costs was evident in an article challenging the regulator's decision to grant Eskom a 25% electricity tariff increases for the three years in succession, claiming that SA electricity prices are approaching tipping point and high energy cost posed a threat to their international competitiveness (Engineering News Online, 2011). As a result of pressure from industry price increase for the last year of the three-year price determination period was reduced from 25.9% to 16% (Mining Weekly, 2012). Wang (2006) also found that in Sweden large energy users were initially nervous of new technology deployment fearing the possible negative impact that new technology will have on the electricity tariff and ultimately industry international competitiveness.

2.2.3 Policy Context

Since political transition of 1994 SA has, at least at policy level, always aspired to introduce renewable energy onto electricity generation mix (DME 1998, DME 2003). Winkler (2005) and Tyler (2010) provide a comprehensive chronological summary of SA energy policy choices, and the planning processes, dating back to the times before the dawn of democracy. Prior to the political transition of 1994, the individual national and local utilities of electricity, coal, liquid fuels and nuclear, largely

acting independently, dominated the policy development and implementation processes with little interference from the state or industry stakeholders. Cheap locally available coal was the dominant energy source with no consideration for energy efficiency or alternatives such as renewable energy (Tyler, 2010). Post the democratic transition several legislations, regulations and policies were enacted to set the stage for the introduction of renewable energy. The key ones will be discussed briefly below.

The 1998 White Paper on Energy Policy set the stage for the introduction of the renewable energy for the purposes of, *inter alia*, electricity generation (DME, 1998). The 1998 White Paper identified five policy objectives: (1) increasing access to affordable energy services, (2) improving energy governance, (3) stimulating economic development, (4) managing energy-related environmental and health impacts, and (5) securing supply through diversity. Through the White Paper government sought to tap into renewable energy to address challenges such as energy sustainability and job creation, and in addition RET was viewed as a viable solution to the energy source for the disadvantaged and rural communities (DME 1998). The policy also aimed to encourage the development of renewable and environmentally sound energy technologies by allowing multiple players in non-utility generation, i.e. introduction of independent power producers (IPPs).

In 2003 government published the White Paper on Renewable Energy. The purpose of the 2003 White Paper was to set out government's principles, goals and objectives for renewable energy adoption (DME, 2003). It furthermore committed government to a number of enabling actions aimed at ensuring that RET becomes a significant part of the country's energy portfolio over the following ten years by setting an ambitious target of 10GWh of energy to be produced from RE by 2013.

Finally, in May 2011 government's first independent integrated resource plan for 2010 to 2030 (IRP2010) was gazetted by the DoE (South Africa 2011b).

Figure ***3*** below shows the current and projected future electricity generation technology mix according to the IRP2010. While RET currently constitutes less that 1% of the annual electricity generated (excluding large hydro power plants), it is estimated that by 2030 about 22% of total annual electricity supplied will be produced from renewable energy. According to the IRP2010, during the same period percentage of electricity generated from coal will reduce from current 90% to 45% while nuclear contribution will increase from 5% to 13% (South Africa, 2011b).

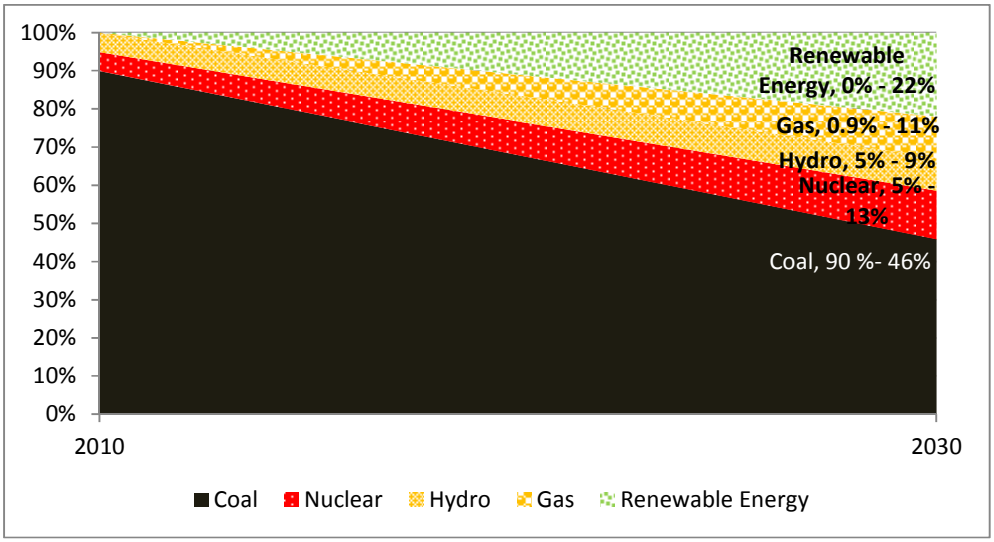


Figure 3: *Change in electricity generation technology mix (Source:* South Africa *2011b)*

South Africa has decided to implement the Feed-in-Tariffs as a financial instrument to support RETs deployment (Tyler, 2010). Under this programme RET developers will be paid a guaranteed tariff over an agreed period for all the energy produced from RET and fed into the grid, from revenue collected as a premium charge to energy unit sold.

Options for carbon taxation on energy produced from fossil fuel based technologies are currently being considered by SA government (National

Treasury, 2010). However, there is no clarity as to whether revenue collected from this tax will be ploughed back into promoting RET diffusion (Sebitosi and Pillay, 2008). It is anticipated that taxes on carbon emissions will afford firms the flexibility to undertake GHG emission reductions according to their specific processes (National Treasury, 2010).

The next section gives a brief overview of renewable energy technology. It covers the definition and historical background, advantages and disadvantages and lastly the economics of RET.

2.3 Renewable Energy Technology

"During most of human history renewable energy has been the only energy option available. Only during the last few centuries has fossil fuel and lately nuclear energy sources been used in a non-renewable way. They took over because they seemed much cheaper than renewable sources" (Sorensen 1991, pp.8).

Krey and Clarke (2011) define renewable energy (RE) as energy sources derived from natural processes that are continually renewed. The process involves conversion of natural resources such as solar, biomass, wind and hydro into useful forms of energy (Rao and Kishore, 2010). Like all energy sources, RE is produced from the heating of the earth by the sun. Renewable energy technology (RET) can therefore be defined as technology that converts RE sources into their useful energy form. RET encompasses a wide range of energy sources and technologies; including solar power and heat, wind power, geothermal energy, bioenergy, hydroelectric power and ocean-based energy (Turner, 1999).

A key distinguishing factor for RET is the grid-connected versus non-grid-connected technologies. Whereas non-grid connected technologies are small scale standalone units such as solar PVs and solar water geysers connected directly to the applications for example individual households,

grid-connected RETs are connected to the bulk electricity supply networks. For the purpose of this research both grid-connected and non-grid connected renewable energy technologies were considered.

In the SA context, several RETs have been identified for support through the government initiated REBID programme, and these are:

- Wind,
- Solar CSP (Concentrated Solar Power),
- Solar PV (Photovoltaic),
- Small hydro,
- Landfill,
- Biomass and
- Biogas (South Africa, 2011b).

Renewable energy technologies first became popular during the oil crisis of the 1970s, however their popularity was then short lived as fossil fuel supplies once again met energy demand at much lower cost, while RET costs remained highly uncompetitive (Wang 2006, Jacobsson and Johnson 2000; Turner 1999; and Sorensen 1991).

However, since the 1990s renewable energy, mainly grid-connected technologies, started re-emerging all across the globe. This time their main drivers were to combat the impact of GHG emissions from fossil fuel based energy sources as well as the need for sustainable security of energy supply (Madlener and Stagl 2005, Sebitosi and Pillay 2008; Turner 1999).

Since then several countries, especially in the developed and lately some developing nations, gradually introduced RET into their electricity generation mix. However, these early adopters regarded RET innovation not only as a solution to environmental degradation but also as a source of competitive advantage of their national economies (Montalvo, 2008). South Africa was left behind partly due to over-investment in the coal based electricity generation technologies in the 1980s, which until

recently, prevented a need to invest in new electricity generation capacity.

Although much of the research focus on the benefit of RET, it must be recognised that RET delivers both desirable and undesirable consequences; both will be briefly discussed below.

"The need to mitigate the adverse environmental impacts of fossil fuel usage, the volatility of fuel prices and enhancement of national energy security, have largely driven a phenomenal growth in grid-connected renewable energy generation around the world over the past two decades" (Sebitosi and Pillay 2008, pp. 3312). According to Schimmoller (2004) the convergence of attitudes regarding climate change, fuels diversity, energy security and sustainable development was main driver for their resurgence and this is expected to intensify in the future. As these authors indicate environmental considerations, energy security and sustainability are the commonly cited reasons for RE promotion.

Montalvo (2008) on the other hand highlighted two additional reasons for the recent popularity of cleaner technologies: (1) the fact that cleaner technologies have recently received much attention in diverse media and policy agendas; and (2) their potential to contribute to economic growth and competitiveness (Montalvo, 2008).

Ellis (1996) further raises four main factors influencing RE uptake by countries that are appropriate in the context of this research, and these are:

- domestic availability and cost of non-renewable energy sources;
- rate of growth of demand for electricity;
- the national policy framework for renewable energy; and
- the physical, economic and market potential for renewable energy.

The main disadvantages of RET are their high capital costs and low reliability as compared to conventional electricity generation technologies (Winkler 2005 and Pegels 2010). According to Pegels (2010) the main

barriers to RET adoption in South African are to be found in the energy technology innovation system and in the economics of renewable energy technologies. However, literature indicates that economic barriers are expected to change in the near future. Whereas costs of fossil fuels are expected to continue to increase as they become scarce and risk of running out increases (Sorensen 1991), the cost of RE technologies is expected to decrease on the basis of technology learning rates, driven largely by technology improvements and economies of scale (Turner 1999; Winkler et al. 2009).

Another major drawback to most forms of RET is their intermittency or variability of their energy production, which negatively affect their reliability (Sorensen 1991; and Turner 1999). As a result other forms of energy, such as conventional fossil fuels, large hydro or nuclear generators must always be available as backup to cater for times when RE is not being produced (for example, solar RET during night time). A potential future solution to this challenge is the development of more efficient and economic energy storage technologies.

2.3.1 Economics of Renewable Energy

Renewable energy for bulk electricity generation is constrained primarily by their high upfront costs, which makes it difficult to compete with other conventional electricity generating technologies (Ellis 1996; Schimmoller 2004 and Winkler 2005). There is a general consensus among researchers that this can only be overcome through RET cost reduction from technological learning rates, and by taking into consideration the costs of externalities associated with societal impact of fossil based energy technologies in electricity pricing (Sorensen 1991, Ellis 1996, Owen 2004, Burer 2007, and Sebitosi 2007).

The high cost of harnessing RE sources have prompted governments' intervention to promote RET policies. A range of instruments (economic and fiscal incentives) are available for policy makers to support RET

policy implementation, either by (1) making RET economics more favourable for investors, or (2) encouraging consumers to buy RET, or (3) keeping RET price low (Ellis 1996; Madlener and Stagl 2005). These instruments are mainly charges and taxes levied on electricity users and paid to RE developers (Montalvo 2008).

According to Ellis (1996) these policy instruments can also be categorised as (1) financial incentives, (2) market guarantees and (3) green pricing schemes. Each of the 3 categories will be briefly explained below, for more detailed discussion of RET policy economic instrument, see Madlener and Stagl (2005).

Financial incentives are aimed at providing incentives for RET developers by guaranteeing a preferential price for electricity from renewables with the cost being spread to all consumers through a levy on electricity unit sold (Diaz-Rainey and Ashton 2008). This is most popular in Europe through what is commonly known as renewable energy feed-in tariffs (FIT) scheme (Madlener and Stagl, 2005). Other financial incentives are carbon taxing on fossil based technologies and tax incentives for RE developers (National Treasury, 2010). Ellis (1996) concluded that any form of premium prices with guaranteed return has proven effective in increasing the interest of RET developers (Ellis, 1996). According to Madlener and Stagl (2005) one of the drawbacks with financial incentive schemes such as FIT is that they do not provide incentives for consumers to adopt RET beyond government targets.

Market guarantees are most prevalent in the USA and Australia through the systems called renewable portfolio standards (RPS) and renewable energy certificates (RECs). Under RPS or RECs each electricity utility or consumer is required to have a portion of its overall electricity supplied or used to come from RET (Walsh 2001, Sebitosi and Pillay 2008, Carley 2009). The underlying electricity must be generated by accredited renewable generators and there is always a penalty for non-compliance. Because consumers are in full control of this process there is potential for

continuous innovation to take place which may lead to RET adoption beyond minimum targets.

Green pricing schemes allows consumers to pay more for RET at their own volition. This is usually the case where the firm's image or social standing is affected by the type of energy used in the manufacturing of their product (Truffer et al., 2001). The key challenge with electricity is that as a product is not differentiable on the basis of the primary source of the energy production process, which limits development of green pricing scheme (Truffer et al., 2001).

The next section introduces technology adoption models.

2.4 Technology Adoption Models

This section reviews technology adoption literature and summarises some common models. In South Africa RET can be regarded as new and novel technology.

Utterback (1974) defines innovation as a technology being used or applied for the first time. Rogers on the other hand defines an innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption (Rogers, 2002). In the South African context, where there is relatively no history of renewable energy utilisation at large scale, the introduction of renewable energy technologies can therefore be regarded as new technology.

Rogers (2002) also described an innovation in terms of its purpose. He defined preventative innovation as a "new ideas that require an action at one point in time in order to avoid unwanted consequences at some future time" (Rogers 2002, pp. 989). RET aims to reduce carbon emissions, ensure sustainable energy security and combat the unwanted consequences of climate change. Accordingly, RET can also be described as a preventative innovation.

Technology adoption process is the mental process through which an individual (or other decision-making unit) passes (1) from first knowledge of an innovation, (2) to forming an attitude toward the innovation, (3) to a decision to adopt or reject, (4) to implementation of the new idea, and to (5) confirmation of this decision (Rogers 2002).

Whereas technology adoption relates to a decision to take up a new technology by individual users (Montalvo, 2008), the process by which an innovation is communicated among members within a society through certain channels over time is called diffusion of innovation (Rogers, 2002). Innovation diffusion aims to convey a new idea, reduce uncertainty, provide information, and promote social change at sectorial macro level. The diffusion effect is therefore the cumulatively increasing degree of influence on an individual to adopt or reject an innovation (Rogers 1983). Diffusion models relate the rate of new product adoption over time to product characteristics (price, features, etc.), population characteristics (size, income) and penetration level (number of previous adopters - the word of mouth effect) (Kalish and Lilien, 1983).

Most researchers appreciate the difficulty of generating a dynamic diffusion model that includes all the relevant variables, especially at aggregated policy levels (Montalvo 2008; Nan et. al. 2008). It is important to understand relevant adoption variables (stimuli, facilitating factors and barriers) and changes in the adoption environment that will induce firms to adopt an innovation at a particular moment in time (Montalvo 2008).

Most common technology adoption models are technology adoption model (TAM) and innovation diffusion theory (IDT) (Nan and Gouging, 2008). TAM argues that the individual user adoption decision is based on two factors, namely perceived usefulness and perceived ease of use, whereas IDT added perceived characteristics of the innovation as the third factor influencing the individual decision to adopt a new technology.

Waarts, van Everdingen and van Hillegerbrg (2002) developed the framework for explaining the likelihood of early and late adoption of information systems. The framework states that adoption of information systems depends on perceived innovation characteristics, adopter characteristics, internal environment characteristics and external environment characteristics. This framework is shown in Figure 4 below.

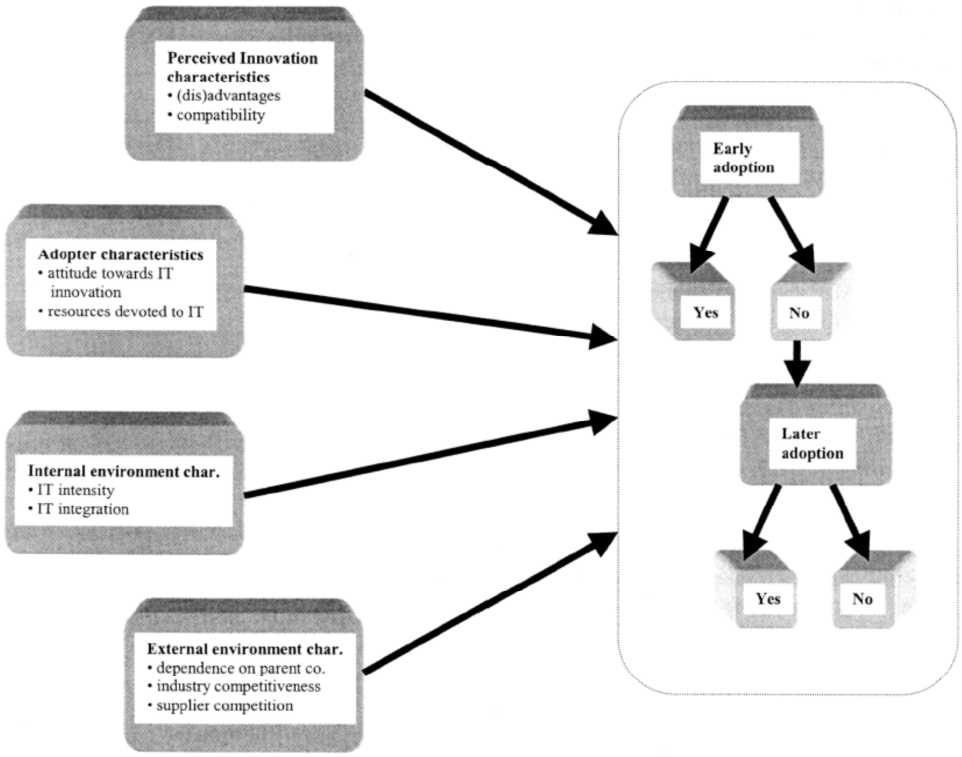


Figure 4: *Framework explaining the likelihood of early and late adoption of information systems (source: Waarts et al. 2002)*

The above models and framework were incorporated in formulating research instrument for the current study.

2.5 RET Adoption

Although RETs have distinct advantages such as energy security, environmental and social considerations, their adoption is largely driven by policies and incentives due to their inherent characteristics such as high upfront costs (Rao and Kishore, 2009). The bulk of literature on RET

adoption and diffusion are therefore limited to government policies aimed at promoting RET deployment, what Mani and Dhingra (2011) refer to as the “push” strategy from government. Montalvo (2008), Wang (2006), and Mani and Dhingra (2011) focused on the role of users in the adoption and diffusion of new technology. Mani and Dhingra (2011) refer to this as the “pull” strategy of facilitating technology adoption.

Montalvo (2008), after analysing literature published between 1990 and 2007 on the topic of the adoption of cleaner technologies, identified 7 factors affecting adoption of cleaner technologies at the adopting industry level, and these are:

- Public policy;
- Economics;
- Markets;
- Communities and social pressure;
- Attitudes and social values;
- Technological opportunities and technological capabilities; and
- Organisational capabilities.

These factors formed the basis of this research enquiry and will be the focus of the discussion that follows. According to Montalvo (2008) these factors are also interrelated and need not be mutually exclusive and can be used in combination. Montalvo (2008) further concluded that these factors are also dynamic and may also be drivers or barriers to adoption decision depending on the circumstances, time and context in which they are considered. It was the aim of this research to analyse and understand how these factors influence the decision to adopt RET by energy intensive firms in SA.

2.5.1 Public Policy

Intervention of public policy in the form of environmental policy and enforcement of regulations has been recognised as one of the major drivers of environmentally responsible behaviour in industry (Montalvo

2008). Government policies have ranged from direct command-and-control to voluntary programmes to economic instruments. Ellis (1996) warned that creating policies that can improve the environmental performance for the energy sector while at the same time maintaining a low-cost and reliable energy supply remain a challenge for most governments (Ellis, 1996).

IEA (2008), after assessing the effectiveness and efficiencies of the energy policies of the 35 member countries from OECD and developing countries (mainly members of the BRICS communities) came up with the five fundamental principles that any renewable energy policy design should reflect in order to be successful and this is shown in Table 1.

Table 1: Five fundamental principles a RE policy design should reflect

1. the removal of non-economic barriers, such as administrative hurdles, obstacles to grid access, poor electricity market design, lack of information and training, and the tackling of social acceptance issues – with a view to overcome them – in order to improve market and policy functioning;
2. the need for a predictable and transparent support framework to attract investments;
3. the introduction of transitional incentives, decreasing over time, to foster and monitor technological innovation and move technologies quickly towards market competitiveness;
4. the development and implementation of appropriate incentives guaranteeing a specific level of support to different technologies based on their degree of technology maturity, in order to exploit the significant potential of the large basket of renewable energy technologies over time; and
5. the due consideration of the impact of large-scale penetration of renewable energy technologies on the overall energy system, especially in liberalised energy markets, with regard to overall cost efficiency and system reliability.

Source: IEA (2008)

According to IEA (2008) to ensure overall success, RE policy support schemes should be designed to foster transition towards mass integration. National circumstances (RET potential, existing policy framework, existence of non-economic barriers, degree of market

liberalisation and energy system infrastructure) must also be taken into account.

Tyler (2010) stressed the need to be consultative in policy development in order to ensure successful implementation. This participatory policy design approach would allow an explicit consideration for stakeholder preferences (Madlener and Stagl 2005). Policy implementation should be regarded as a continuously evolving process wherein existing decisions must be adapted and modified (Sebitosi and Pillay 2008, and Tyler 2010). This coordination and planning should not be limited to the energy sector, but must be inclusive of the rest of society, recognising the importance of all stakeholders in shaping energy policy direction (Sebitosi and Pillay 2008; Tyler 2010).

Jacobsson and Bergek (2004) emphasised the need for policy to be clear and coordinated as inconsistent and changing policy measures increase the level of uncertainty and resulting in erratic demand for other technologies, guiding firms away from RET. According to Jacobsson and Bergek (2004) policy has to overcome two challenges. The first policy challenge is to create an understanding of the functional pattern of each relevant system to ensure that weak functions are strengthened. The second policy challenge is that of coordination between the different actors in the industry.

The current SA renewable energy policy can be classified as a combination of command-and-control and economic instruments focusing mainly on the energy supply side, wherein government decides on RET targets and economic instruments to facilitate meeting those targets (i.e. REFIT tariffs and taxation on non-renewable electricity). (Montalvo (2008) warned of the danger of these policies as they only promote minimum compliance. Accordingly, Montalvo (2008) concluded that government interventions should rather only be limited to providing the right conditions and stimuli for firms to take lead in the adoption of cleaner technologies. Policy implementation by government has also

been found to be a daunting challenge in SA (Sebitosi and Pillay 2008; and Pegels 2010).

2.5.2 Economic benefits

Economic factors relate to the many benefits that innovation in cleaner technologies is supposed to bring to the adopting organisation. An industry will adopt a cleaner technology if there is perceived economic consequences derived from the innovative activities (Montalvo, 2008).

According to Rogers (2003) RETs seen as “preventive innovations” will diffuse rather slowly, in part due to delayed rewards from their adoption. RETs remain highly uncompetitive and currently do not provide any direct economic benefits to the adopting organisation. However, indirect economic benefits may still accrue as a result of market related factors discussed in the next subsection, for example market competitiveness.

Most authors, however, remain optimistic that RET will become competitive to conventional fossil fuel technologies over time. Although costs of RET were expected to remain high in the short term (Winkler 2005), these are expected to decline over time (Turner 1999, Winkler et al. 2009). At the same time the costs of fossil based technologies are expected to increase as they become scares (Sorensen 1991; Winkler et al. 2009) and as a result of removal of subsidies for the damage fossil fuels cause to the environment and human health (Sorensen 1991, Ellis 1996, Owen 2004, Burer 2007, and Sebitosi 2007).

2.5.3 Markets

Market related factors refer to the pressure from consumers and suppliers of products of the adopting industry, who might have heightened environmental awareness. Customers demand for green energy may be an important driving factor for supporting environmental sustainability (Truffer et al., 2001). According to Montalvo (2008) there is

a positive relationship between the perceived environmental orientated market pressures and their level of diffusion within an industrial sector.

According to Lim (2004) companies adopting renewable energy technologies will also benefit from competitiveness and market positioning, improved reputation management, improved ability to attract and build effective and efficient supply chain relationships. Thus, government policy with regard to electricity market model, for example, voluntary green pricing schemes or allowing industry to purchase RET directly from RE developers have the potential to speed up RE adoption by industrial firms.

2.5.4 Communities and social pressure

This factor refers to pressure from all of company's stakeholders (e.g. local communities, employees, financing communities and investors) who are aware of environmental and sustainability issues and are active in pushing for change in industrial environmental behavioural trends (Montlavo, 2008). The stronger the social demand for clean production, the higher the diffusion of renewable energy will be.

Lim (2004) argues that as citizens; regulators, shareholders, management, employees and other stakeholders are becoming more environmental cautious and as a result companies that integrate environmental considerations in their business strategies have potential benefits such as improved reputation management and a more robust ''social licence'' to operate in the community.

Wustenhagen et. al. (2007) warned that although general social acceptance for RET may be easy to obtain at broader or global level, obtaining social acceptance at local level is always difficult, and may even be a constraining factor in achieving RET targets, especially if those community stakeholders are to be impacted by investment and sitting decisions (for example, visual impacts and costs of RET). However,

Wang (2006) found that social pressure from non-governmental organisations (NGOs) played a critical role in the adoption of RET by industrial firms in Sweden.

2.5.5 Leadership attitudes and social values

According to Montalvo (2008) the conduct and commitment of top management to cleaner production are of great relevance to the diffusion of cleaner technologies. Montalvo defines “people’s attitudes” as the predisposition to act based on the assessment of possible outcomes; and “social values” as the criteria against which people justify their actions

Since RETs are “preventative innovation”, top management’s attitude will also be shaped by their level of awareness of RE technology attributes (Rogers, 2002). Rogers (2002) suggested the following 5 strategies to facilitate diffusion of “preventative innovation”. These strategies are:

- Changing the perceived attributes of preventive innovations by stressing relative advantage of a preventive innovation needs;
- Utilizing champions to promote preventive innovations. A champion is an individual who devotes his/her personal influence to encourage adoption of an innovation;
- Change the norms of the system regarding preventive innovations through peer support;
- Use of entertainment–education to promote preventive innovations. Entertainment–education is the process of placing educational ideas (such as on prevention) in entertainment messages; and
- Activate peer networks to diffuse preventive innovations (Rogers, 2002).

2.5.6 Perceived technology attributes

Technology attributes refer to the trade-off between old and new technologies. Innovations that are perceived by individuals as having greater relative advantage, compatibility, trialability, observability, and less complexity are adopted more rapidly than other innovations (Rogers 2002). This is largely dependent on the following factors:

- Dominance of specific technology paradigm;
- Level of awareness of technological opportunities provided by new technology;
- Organisation's capability to adapt to new technology;
- Technological risks associated with the new technology's benefits that are yet to be realised.

The historical dominance of cheap coal-based electricity generation, lack of awareness of RETs by industry and the high costs of RE all present a possible threat to RET adoption by industrial firms.

2.5.7 Organisational capabilities

Organisational capabilities refer to the firm's endowments and capabilities to carry out innovation (Montalvo 2008). According to Montalvo (2008), the high levels of technological opportunities and organisational capabilities in firms, increases the degree of cleaner technology adoption in firms and diffusion at sector level.

2.6 Conclusion of Literature Review

This chapter reviewed published literature in relation to RET adoption in order to understand what it means in the SA context and how RET could be adopted by local industrial firms. After a brief overview of the SA energy system and its characteristics, RET was then introduced. Literature on technology adoption models was also presented in an

attempt to develop a model for RET adoption. Finally, factors that may affect RET adoption decision were discussed. The overall findings of literature presented in this chapter are summarised below.

In SA the energy supply system remains carbon lock-in despite the huge potential for renewable energy sources. Industrial firms, as the largest energy consumer, provides an opportunity for RET adoption beyond government targets.

Concerns over environmental sustainability, energy security, scarcity of fossil fuels, potential technology learning rates and new sources competitiveness have all driven RET adoption in other countries. However, adoption of RETs by energy intensive industrial firms is not well studied. The bulk of literature on the adoption of RET has largely been limited to policy considerations to drive RET adoption from energy producers perspective.

Table 2 below summarises the eight factors that were found to be likely to influence adoption of RETs by industrial firms. For the purpose of this research inquiry it was possible to group these factors into three domain levels in line with the framework for technology adoption models. The eight identified factors were grouped into external environment characteristics, internal environment characteristics and perceived technology attributes. External environment characteristic are factors external to the adopting organisation, which include public policy and stakeholders influence. Internal environment characteristic are factors which involve firm-level decision making, which include cost and benefit analysis, organisational capabilities and leadership values. Perceived technology attributes are those factors related to the actual technology being adopted, and factors investigated were compatibility, relative advantage and perceived benefits. Table 2 also show the criteria developed from literature to assess influence of each of the factors.

2.6.1 Research Question

In order to address the purpose and objectives of this research, the following research question was developed guided by the literature review presented in this chapter.

- What are the factors that influence RET adoption by industrial firms in South Africa?

Table 2: Factors influencing RET Adoption relevant for the current study

Domain	Factor	Criteria	References
External Environment characteristics	Public Policy	Participation / Consultation	Ellis 1996; Jacobsson and Bergek 2004; Sebitosi and Pillay 2008; Montalvo 2008; IEA 2008; Tyler 2010
		Policy Clarity	
		Policy Instruments	
	Stakeholder Influence	Change in stakeholder awareness	Lim 2004; Wang 2006; Wustenhagen et al. 2007; Montalvo 2008
		Community pressure and public sentiment	
		Financiers	
		Customers	
		Suppliers	
Internal Environment Characteristic	Cost and Benefits	Cost of Energy	Sorensen 1991; Turner 1999; Rogers 2003; Winkler 2003; Owen 2004; Wang 2006; Burer 2007; Sebitosi 2007; Montalvo 2008; Winkler et al. 2009
		Competitiveness	
		Learning Rates / Early Adopter Advantage	
	Leadership Values	Leadership Commitment	Rogers 2002; Montalvo 2008
		RET Implementation	
		Communication	
	Organisational Capabilities	RET Champion	Rogers 2002; Montalvo 2008
		RET Strategies	
		RET Awareness	
		Investment decision making	
Perceived Technology Attributes	Compatibility	Technology fit	Rogers 2002; Montalvo 2008
	Relative Advantage	Relative advantage	
	Perceived Benefits	Sustainability	Rogers 2002; Montalvo 2008; Winkler et al. 2009
		Learning rates	

Source: Author, 2012

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This section describes the methodology that was followed to address the proposed research question. It was critical that the appropriate method of research be used to understand the relevant factors influencing the adoption of RET by energy intensive firms in SA. It was also important to utilise an approach that allowed value laden opinions, experience and objectivity to come through in the research process as it was this expertise and experience of the respondents that provided the depth of this research.

The chapter begins by describing the methodology approach that was used in the study and explain its relevance in addressing key research question. This is followed by an in-depth description of the research method, including understanding the population, unit of analysis, sampling method, size of the sample, data gathering and data analysis. Reliability and validity of data collection process will be discussed thereafter. Respondents' profiles are also presented in this chapter

3.2 Research paradigm

This exploratory study sought to understand the factors influencing the adoption of renewable energy technology by industrial firms, given the SA context. By understanding these factors the study developed a framework of analysing adoption of renewable energy by these firms as well as the guiding principles that could assist policy makers while formulating new policies.

The study was qualitative in nature. Qualitative research is characterised by the quest for understanding and in-depth enquiry (Henning 2004). The

exploratory method that will be used will be experience survey which is defined by Zikmund (2003) as an opinion of knowledgeable people.

Due to the nature of the research, qualitative approach was favoured as it allowed expert views on key issues to come out. It also allowed the researcher an opportunity to ask questions with few constraints by allowing respondents to expand on their responses. This was essential in understanding and addressing the research question in depth.

3.3 Research Design

Zikmund (2003) states that the design of the research is determined by the four key constraints and these are, objective of the research, availability of data sources, urgency of the decision, cost of obtaining the data. All these factors were taken into account when this study was conducted.

The research design involved administering a questionnaire consisting of open and closed questions to investigate the perception of respondents regarding factors influencing RET adoption by their firms. The primary data collection was supplemented by consulting secondary data in the form of published literature.

3.4 Population and sample

3.4.1 Population

A population comprises of any complete group that shares similar characteristics (Zikmund, 2003). This research population consisted of the 36 members of energy intensive users group of South Africa (EIUG). These firms are the largest electricity consumer sector in South Africa, each consuming in access of 100GWh per annum and in total 44% of total electricity produced in the country.

3.4.2 Sample and sampling method

No sampling was done in this research as the whole population of EIUG members was targeted. Since the population is quite small, that is there are only 36 energy intensive industrial users in South Africa, the intention was to carry out a census targeting the whole group. Therefore, the sample was the whole population.

The response rate was very high (50%) and the quality of responses was good, and all the returned questionnaires contained answers to all questions. Therefore, the sample of firms for which the data is reported consists of eighteen members of the EIUG. All of the respondents occupy senior management positions within their respective firms and are involved in energy strategic matters at decision making level.

3.5 The Research Instrument

A questionnaire was designed based on the findings from literature review (see Table 2 above) to serve as a research instrument to collect the data. The final questionnaire is attached in Appendix A. The questionnaire was structured in two parts. The first part (i.e. question 1) consists of general questions designed to understand industrial firms' current energy sources as well as RET adoption trends. Question 2 was organised to include both structured and unstructured components to elicit perceptions of respondents regarding factors influencing adoption of RETs. The structured questions ensured that responses were consistent and focused to the key issues being investigated. This allowed the respondents to provide precise information in the Likert scale. Open-ended questions allowed the respondents to add comments, perceptions and opinions, to supplement their selection, for example with regard to technological capabilities needed for adoption of RETs.

For the main structured questions, a Likert scale was used and this allowed for presentation of the variation across the sample in an easy to

interpret format. Responses to open ended questions were coded and transformed using content analysis. This data was then used to supplement the results of the main study. All data was ultimately used in the analysis and discussion in chapter five.

3.6 Procedure for data collection

The questionnaire was sent to all members of the EIUG by email with a request to resend the completed questionnaire to the researcher. Several follow-up emails were sent to the respondents to remind them of the questionnaire.

At the end 18 responses were received.

3.7 Data analysis and interpretation

Responses received from structure questions in the Likert scales were analysed using descriptive statistics. In this regard simple bar charts were used to cluster the responses. Results from unstructured questions were analysed through a process of content analysis, where specific characteristics and themes was identified (Zikmund, 2003), which formed the basis for data analysis. This was then used to supplement the responses to the structured questions.

3.8 Limitations of the study

The main limitation of the study is the use of available literature review to determine the factors that contributes to the adoption of renewable energy. Montalvo (2008) acknowledged that these factors are not static and change over time depending how respondents perceived these factors at any given time. According to Waarts et al. (2002) factors also change depending on whether it is “early adoption” or “late adoption”

process. Therefore, the results of the study may change if conducted in a different setting or at a different time.

3.9 Validity and reliability

3.9.1 External validity

External validity is the quality of being able to generalise the results to other subjects or other groups within the population (Zikmund, 2003). Because only firms within the energy intensive industries were selected the results of this study cannot be extended to other industries. Again, because of the dynamic nature of RET adoption factors the study may also yield different results even if conducted to the same firms, but at a different time.

3.9.2 Internal validity

Internal validity tests whether an experimental treatment was the sole cause of changes in the variable (Zikmund, 2003). Because of the nature of this study no internal validity exists.

3.9.3 Reliability

Reliability refers to the degree to which measures are free from error (Zikmund, 2003). The reliability of the data was sought by promising the respondents that their responses will not be attributable. Secondly, the fact that all the respondents occupy senior management position within their firms also improves reliability of their responses.

In order to discourage group thinking the questionnaire was sent directly to each individual respondent.

3.10 Demographic profile of respondents

Table **3** below shows the profile of the respondents who returned completed questionnaires. The questionnaire was sent to all 36 current members of EIUG and 18 responses were returned. All returned questionnaires were completed in full.

Table 3: Respondents details

Respondent's Code	Title
Respondent 1	GM: Strategic Sourcing
Respondent 2	Group Electrical Engineer
Respondent 3	Technical Manager
Respondent 4	Energy Manager
Respondent 5	Senior Manager
Respondent 6	Scientist
Respondent 7	Senior Manager
Respondent 8	Engineering Manager
Respondent 9	Technical Development Manager
Respondent 10	Engineering Manager
Respondent 11	Consulting Engineer
Respondent 12	Group Energy Manager
Respondent 13	Group Development Manager
Respondent 14	Manager: Energy Management
Respondent 15	Energy Superintendent
Respondent 16	Manufacturing Services Manager
Respondent 17	Manager: Electrical Systems
Respondent 18	Group Electrical Engineer

N = 18

All of the respondents occupy senior management positions within their respective firms and are involved in energy strategic matters at decision making level. As expected, most of the respondents were from basic mineral companies. Ten of the 18 respondents were mining companies; four were industrial metal companies, three were chemical industry companies, while one was a transport company.

Respondents were concerned about confidentiality of their responses; and they were then assured in the survey introductory letter that the

results will not be attributable **(see Appendix A).** In addition, a coding system has also been used in Table 3 and the rest of this report to ensure anonymity.

3.11 Conclusion

This chapter explained the methodological approach that was utilized throughout the study. This exploratory study sought a qualitative approach to address the key research question. This was achieved through administering a survey of the target population consisting of 36 EIUG member companies. Fifty per cent of the firms responded and the data that was collected was analysed using simple descriptive statistics and content analysis. The following chapter will present research findings.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

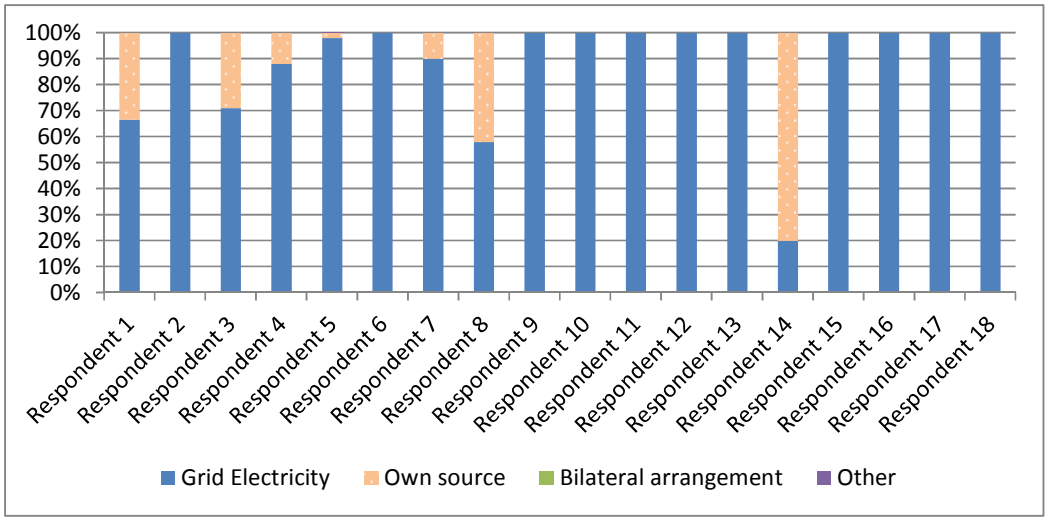
Chapter four presents the results of this research. The results are presented both graphically and in descriptive form guided by the research question. Results pertaining to current energy sources and RET adoption trends are presented first. Followed by the results relating to factors influencing RET adoption by industrial firms. These factors were grouped into three broad categories, namely external environment characteristics, internal (firm-level) environment characteristics and perceived technology attributes. For ease of interpretation Likert scale results were interpreted on the basis of the majority responses received. Comments made by the respondents are also presented, where relevant, to supplement the results.

4.2 Energy Sources and RET Adoption Trends

Below is the presentation of the results relating to current energy usage and the level of RET adoption by industrial firms in the sample. Results relating to the future prospects for RET adoption are also presented.

4.2.1 Current Energy Technology Sources

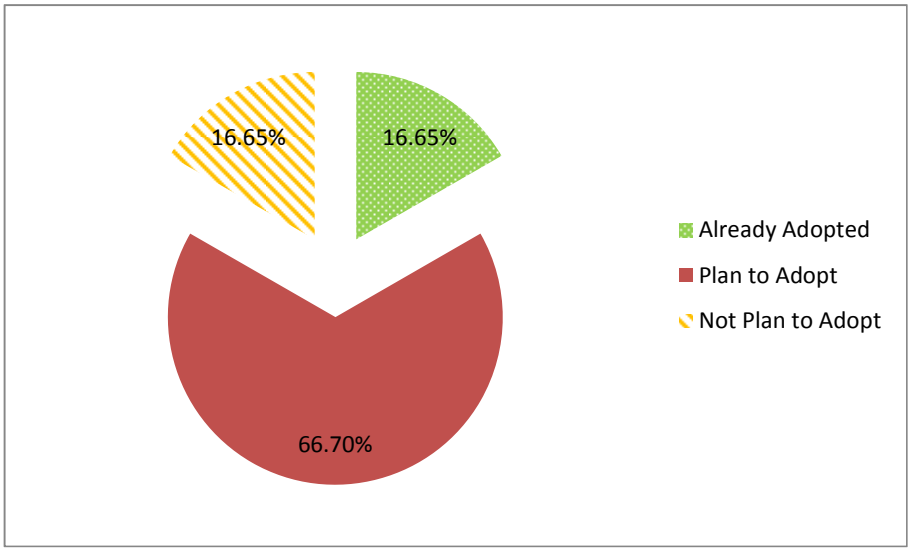
The data show that all respondents remain highly reliant on grid electricity as a source of energy for their business operations. Figure 5 shows the distribution of current energy sources. Sixty one per cent of the respondents (11 of 18) depend on grid electricity for all (100%) of their energy needs. The rest of the respondents (7 of 18) supplement grid electricity with other energy sources, however, data also show that most of these off-grid energy sources are fossil based energy technologies (i.e. coal and gas).



N=18

Figure 5: *Distribution of current energy sources*

The responses also show that the current level of RET adoption, in any form, is very low. In Figure 6 below**,** only 17% of the sample (three firms) have adopted some form of RET. Among these early adopters, RET use was insignificant, with rates of 1% or lower, as a proportion of total energy consumption by each firm. Of the three early adoptors, one firm reported that it recieves its renewable energy from a wind energy independent power producer (IPP) through a bilateral power purchase agreement, while the other two reported utilising RETs for small scale inhouse installations (most commonly solar PV panels, solar water geysers and heat pumps). The most cited reasons for low level of adoption are high costs of RET and the intermittance nature of RE production (see Table 4 below).

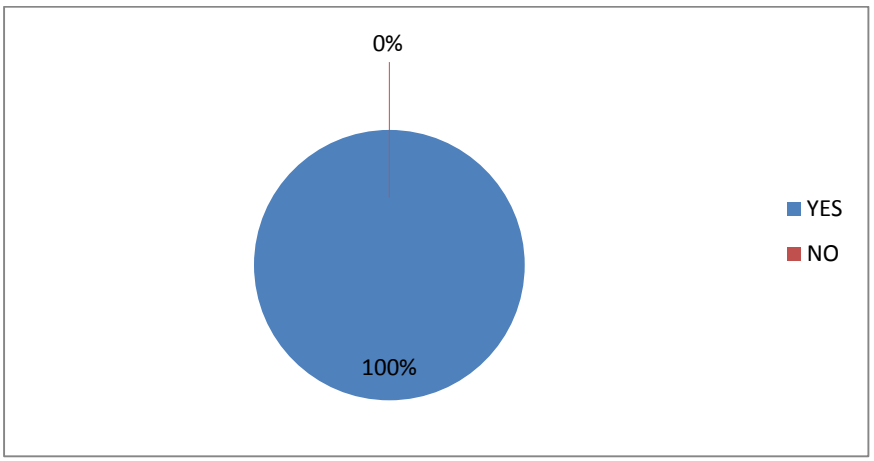


N=18

***Figure 6**: RET adoption trends*

4.2.2 Prospects for Future RET Adoption

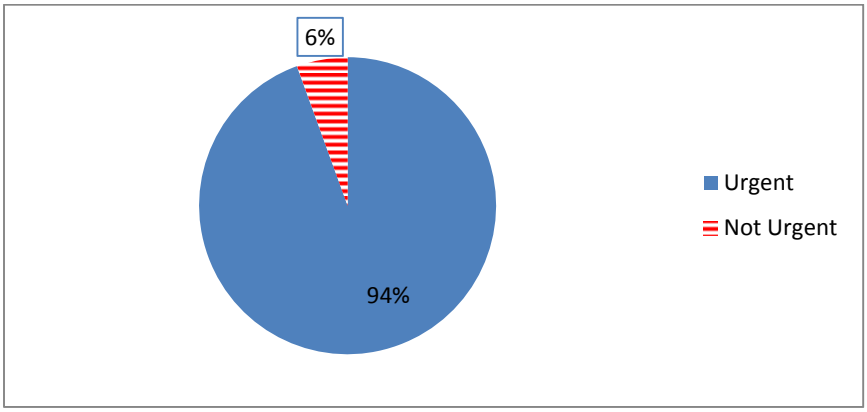
All respondents (100%) reported that they are monitoring their own contribution to the GHG emissions associated with the use of the incumbent fossil fuel based energy technologies (see Figure 7 below). This include emissions associated with grid electricity production technologies.



N=18

***Figure 7:** Awareness of own GHG emissions*

In adition, and according to Figure 8 below, 94% (17 of 18) of respondents agreed that there is an urgent need to address SA's GHG emissions.



N=18

Figure 8: *Level of urgency for RET adoption*

The data also show that 80% of the current non-adopters plans to adopt RET in future (see Figure 6 above). Only three respondents reported that they do not have plans to adopt RET in future.

From the qualitative comments presented in Table 4 overleaf, there appears to be great variety in terms of types of RE technology preference under consideration, size of project and the mode of production. Method of RE production range from self-generation to power purchase agreements with IPPs. Some firms also reported that they are planning to enter the electricity supply market as RE developers (or IPPs) by participating in government RE bidding programmes. Other firms are establishing new stand-alone energy business units that would focus on RE development. The most preferred RETs ranged from concentrated solar power, solar photovoltaic (PV), wind, biomass and landfill gas. The size of the planned RET projects remain small, with average RE project size ranging from 1MW to 40MW.

Table 4: Comments relating to energy sources and RET adoption trends

Respondent 1	We are doing a feasibility study for a large CSP project, and a small PV application
Respondent 2	We are investigating Biomass and facilitating Solar PV as part of REBID
Respondent 3	Concentrated Solar Power and concentrated PV
Respondent 4	Very limited. Cost is too high and most affordable renewables do not provide power for a 24 hour operation
Respondent 5	As a global organisation operating in an energy intensive industry, we are committed to manage the risks associated with climate change. We believe, however, that the technology we use in our operations is comparable to the best in the world and that significant savings on greenhouse gas emissions are not easily achievable. Further, in the South African context, we need to take into account the costs associated with transitioning our electricity supply sector to a low carbon footprint.
Respondent 6	As part of this strategy, [the company] has established a stand-alone energy company in joint venture to feed the national grid and third-party customers. We participate in the development of sustainable and cleaner technologies such as renewable energy (PV system for the head office and co-generation at operations). The board of directors approved the outcome of the bankable feasibility study for a 14MW co-generation plant
Respondent 7	Not that I am aware of
Respondent 8	Looking at Solar and Biomass as options as the cost of diesel and HFO is unsustainable
Respondent 9	Under consideration
Respondent 10	Pt Fuel cell
Respondent 11	We are in the process of piloting a 1MW PV plant for the generation off on site electricity with hopes of expanding this to 10MW.
Respondent 12	Heat pumps for heating shower water for approximately 2000 employees
Respondent 13	Waste gas generation from landfill. Waste heat recovery from our internal process for generation. Solar.
Respondent 14	We are currently looking into Solar and Wind Generation
Respondent 15	40 MW of concentrated solar to be installed, various smaller applications of 1MW each

N=15

4.3 External Environment Characteristics

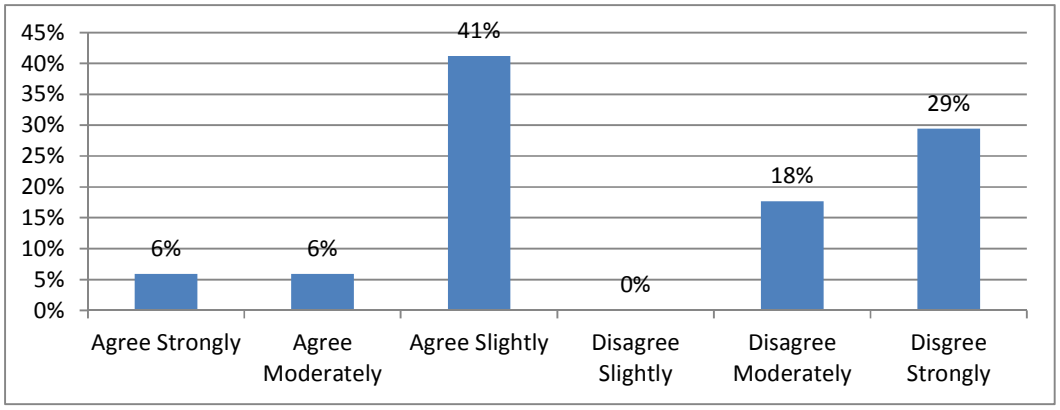
This section presents the results pertaining to external environment characteristics influencing adoption of RET by the industrial firms in South Africa. There were two external factors investigated, namely influence of public policy and external stakeholders, and these are looked at in turn.

4.3.1 Public Policy

In this subsection the results of an assessment of SA public policy on RET adoption are presented. The questionnaire assessed the level of consultation during policy formulation, policy clarity, chosen policy instruments as well as perceived effectiveness of the public policy. Criteria for policy effectiveness were whether respondents preferred any other alternative instrument and whether the current policy incentivise firms to adopt RET beyond government targets.

(a) Policy Clarity

The results in Figure 9 show that among the sample, 53 per cent of the respondents believed that South Africa had a clear and unambiguous energy policy to facilitate RET adoption; however, 41 per cent of those only slightly agree. Of the 47 per cent that disagree with this statement; none of them disagreed slightly, 18% disagreed moderately and 29% strongly disagreed.

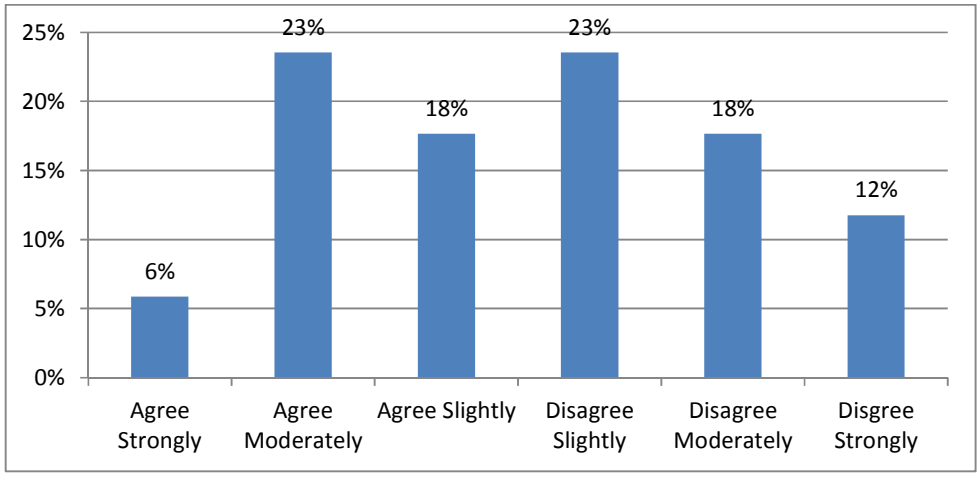


N=18

Figure 9: *Clarity of RET adoption policy*

(b) Consultation during RET policy formulation

Figure 10 below shows that 53 per cent of the respondents do not agree with the statement that there is adequate consultation in the development and implementation of RE policies in South Africa. Of the 47% that agree, 6 per cent agree strongly, 23 per cent agree moderately while 18 per cent agree slightly. Of the 53% that disagree, 23% disagree slightly, while 18 per cent moderately and last 12 per cent disagree strongly.

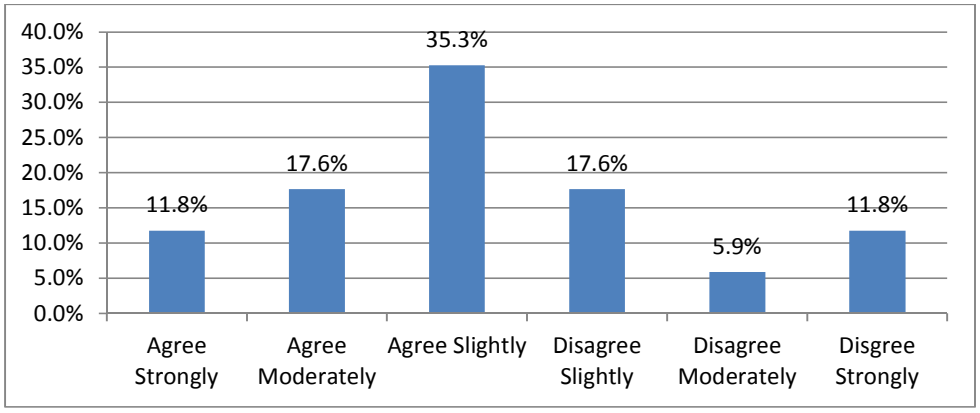


N=18, Mean=3.59

Figure 10: *Consultation in RET policy process*

(c) RE Policy instruments

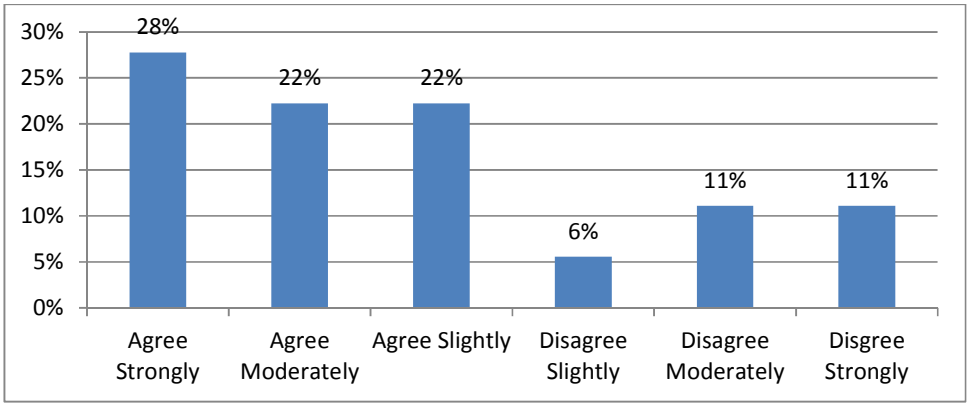
Almost two thirds (65%) of the respondents agree that public policy instrument (REFIT and carbon tax) will facilitate adoption of RET by their respective firms. Of the 65 per cent, 35 per cent agree slightly, while 18 per cent and 12 per cent agree moderately and strongly respectively. 36 per cent of respondents do not agree that these instruments will facilitate the adoption of renewable energy. This is shown in Figure 11 below.



N=18

Figure 11: *Assessment policy instruments (REFIT and Carbon Tax)*

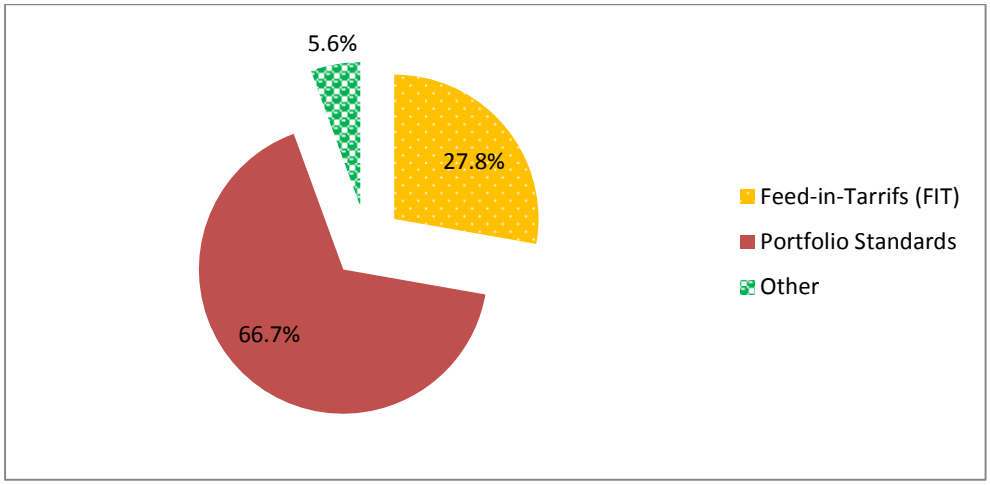
According to Figure 12 below, 72% of respondents reported that allowing bilateral markets where they can purchase renewable energy directly from RE developers will increase uptake of RET by their firms.



N=18, mean=2.83

Figure 12: *Assessment of bilateral RET markets*

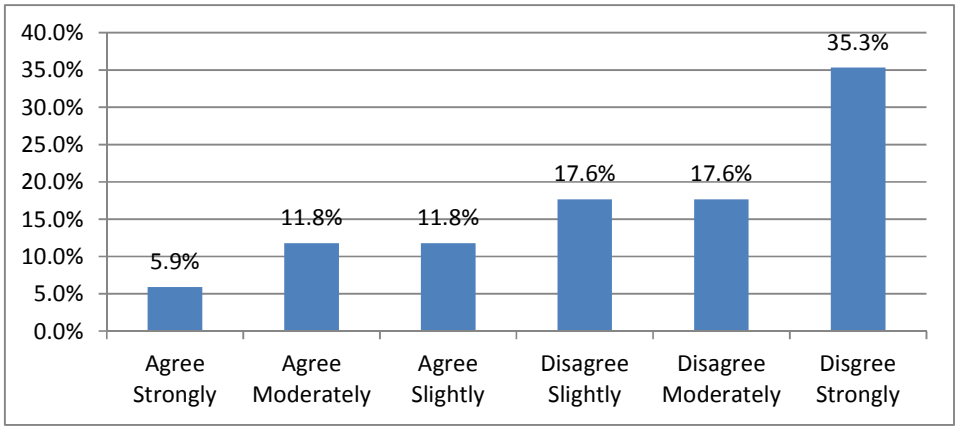
In line with the data presented in Figure 12 above, Figure 13 below indicates that almost two thirds (67%) of the respondents supports the portfolio standards whereas only 28% believe the renewable energy feed-in-tariffs are the best instrument to facilitate RET adoption in South Africa. One respondent selected option “other” but did not elaborate on a preferred RET economic instrument.



N=18

Figure 13: *Preferred RET economic instrument*

The responses show that 71% do not believe that the proposed public policy economic instrument (REFIT and Carbon Tax) incentivise them to adopt RETs beyond minimum government targets (with 35% of the 71% disagreeing strongly). This is shown in Figure 14 below. According to Respondent 2 in Table 5 “adoption of RET will mainly be a result of cost in carbon tax avoidance or saving”. Of the 30% that believe that current policy will make then adopt RET beyond government target, 12% agree slightly, another 12 agree moderately and only 6% agree strongly.



N=18, mean=4.35

Figure 14: *Effects of current energy policy instrument*

Table 5 below contains a list of qualitative comments regarding SA energy policy as a factor influencing RET adoption. The most common themes are concerns over costs of RET and intermittence nature of RE production (Respondents 2, 4, 5, and 6; 2012). Capacity of government to implement policy was also raised as a concern (Respondent 1, 2012)

Table 5: Comments regarding SA public policy on RET adoption

Respondent 1	South Africa is in general long on plans, and short on implementation. In my view we have enough renewables in the IRP2010, and focus must now stay on implementing the first windows (i.e. PPAs, generation licences, get bankability, sign connection agreements, get into commercial operation)
Respondent 2	Adoption of RET will mainly be a result of cost in carbon tax avoidance or saving
Respondent 3	Technical impact of RET on the Grid Operation is not clearly communicated
Respondent 4	South Africa's Renewable energy policy extends to the commitment in the NIRP and a tax allowance for accelerated depreciation for renewable energy projects. The high cost of, and the intermittent nature of renewable energy delivery (excluding hydro) are critical factors when considering RETs in an industry which requires power 24 x 7 for every week of the year.
Respondent 5	NERSA and ESKOM have allowed for pilot funding of 10MW of on-site generation using RET. However the pace of uptake will be increased as more funding is made available in the market. The risk is that this may threaten the ESKOM IPPs which have recently concluded their second rounds of bids.

Respondent 6	The heavy industry and mining (energy intensive) sector is very important to SA economy and, due to high cost and current technical constraints, it would be unrealistic to expect RET to form a very significant portion of our energy generation.

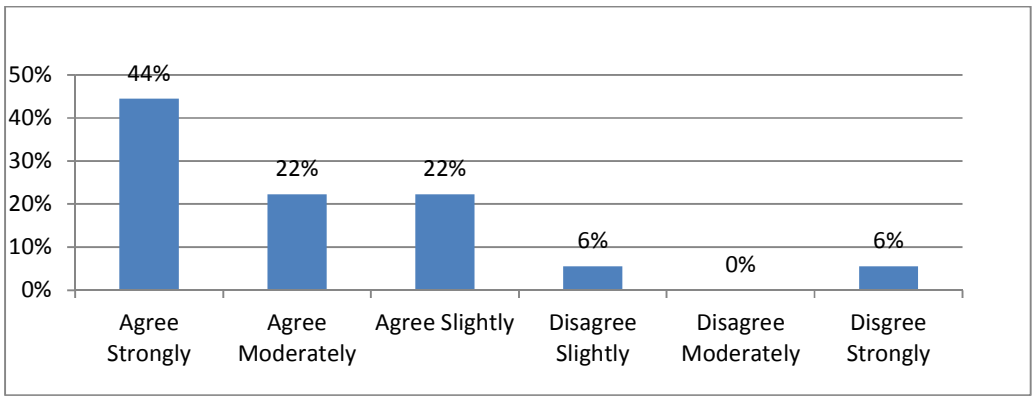
N=6

4.3.2 Stakeholder Influence

Results pertaining to the influence of stakeholders on RET adoption by energy intensive firms are presented in this section. The section begins by assessing whether firms are taking cognisance of the growing stakeholder awareness of RETs. Then the influence of the individual stakeholder is analysed. Respondent 1 stressed the fact that responses to these questions are dynamic and that Adoption of RET will mainly be a result of cost in carbon tax avoidance or saving may change with time.

(a) Growing stakeholder awareness

The results shown in Figure 15 indicate that 88% of the respondents are concerned that stakeholders (e.g. communities, employees, financiers &, NGOs) are increasingly becoming aware of the benefits of RET.

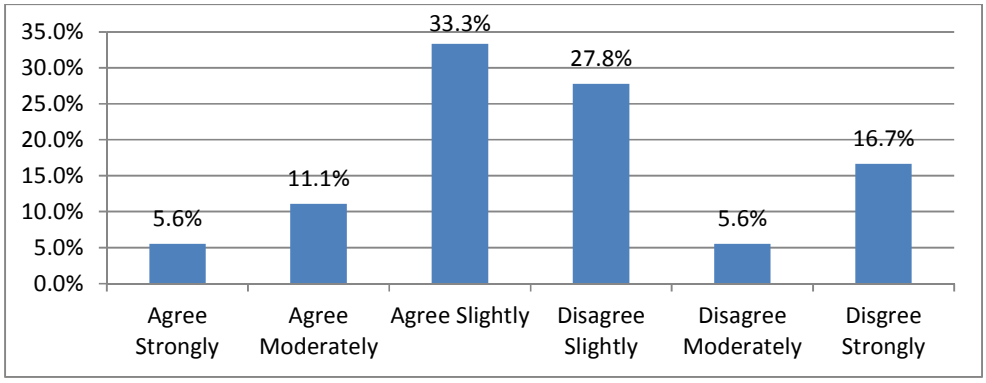


N=18

Figure 15: *Concern over growing stakeholder awareness of RETs*

(b) Influence of community pressure and public sentiment

Results from Figure 16 below are very evenly distributed. Fifty per cent of the respondents agreed that community pressure and public sentiment would influence their decision to adopt RET, while the other 50% disagree with this statement. 60% of the responses are scattered in the middle of the graph which indicates they do not have strong opinion about the impact of the community pressure and public sentiment. Most of those that showed strong opinions disagreed with the statement, 17% strongly disagreed while only 6% strongly agreed.

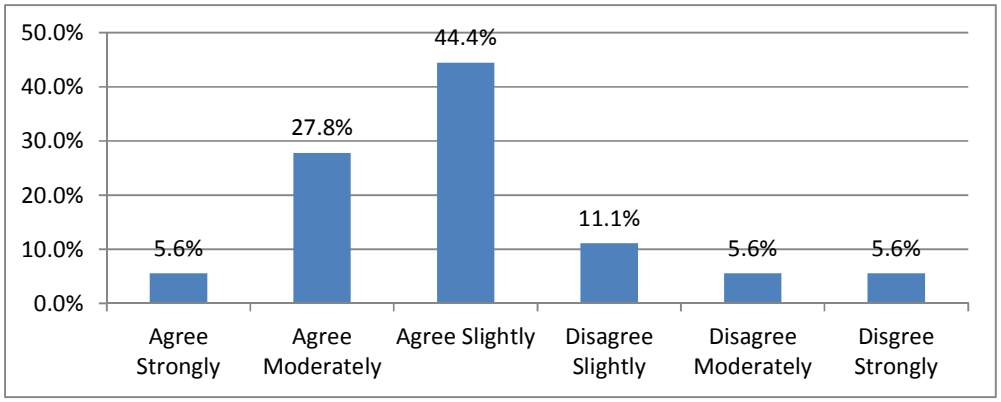


N=18

Figure 16: *Influence of public sentiments and community pressure*

(c) Pressure from financiers

As shown in Figure 17, 78% of the sampled firms agreed that pressure from financiers would influence the decision to adopt RET, of these, however, only 6% agreed strongly. Most of the respondence only agreed slightly and moderately with 28% agree moderately and 44% agree slightly. Of the 23% that disagree, 11% disagree slightly, 6% moderately and only 6% disagree strongly.

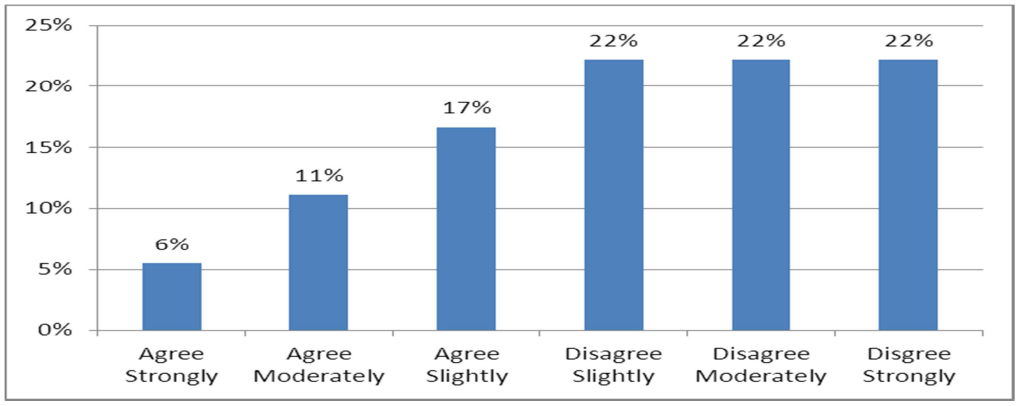


N=18

Figure 17: *Influence of financiers on RET adoption*

(d) Influence of customers

The results presented in Figure 18 show that the 66% of the respondents believe that customers currently do not require RETs as an energy input in their production processes and therefore do not influence their decision to adopt RETs. Of the 34% agreeing with the statement, only 6% agree strongly, 11% agree moderately and 17% slightly agreed.



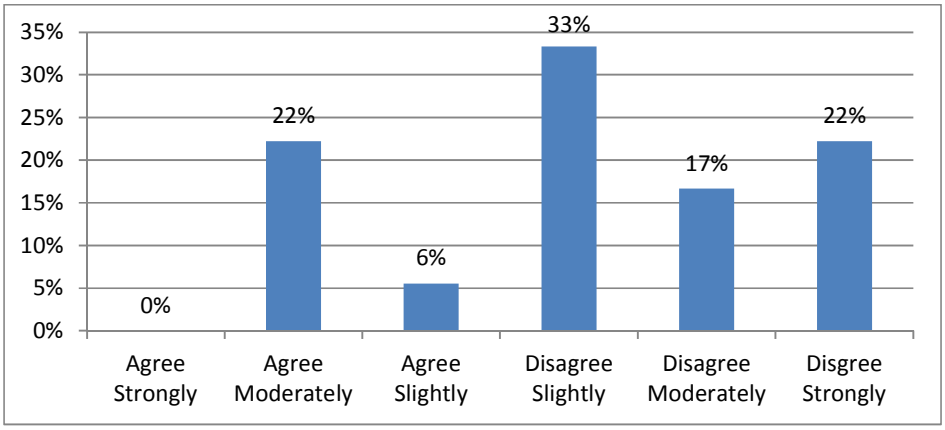
N=18

Figure 18: *Influence of customers on RET adoption*

(e) Influence of suppliers

According to the data as presented in Figure 19 below, the influence of suppliers is presently nonexistence with 72% of the respondents

indicating that their suppliers do not require RET to be utilised as an energy input in their production process. Interestingly, none of the respondents agreed strongly with the statement. 6% agreed slightly while the remaining 22% agreed moderately.



N=18

Figure 19: *Influence of suppliers on RET adoption*

Further comments from respondents on stakeholder influence are provided in Table 6 below. Most relevant comment was from Respondent 1 who emphasised the dynamic nature of stakeholder influence. Once again concerns over costs of RET and production variability were also raised.

Table 6: Comments regarding stakeholders influence on RET adoption

Respondent 1	Stakeholder influence is evolving over time, and the above answers may change in future
Respondent 2	The availability of RET is still a major concern in terms of generated power
Respondent 3	In a country where the unemployment rate is 30% there are more urgent matters than RET
Respondent 4	RET may be considered as part of the community projects to offset carbon emissions from fossil fuels based energy sources, but due to the nature of our operations it will not be feasible to adopt RET as a base energy source

Respondent 5	Eight managed coal mines produce 42,2Mtpa of power station, steam and coking coal as well as char. All power station coal produced is supplied to the national power utility, Eskom, and municipal power stations. The Company participates in the carbon CDP annually. The company is also involved in the initiatives of South African Independent Power Producers Association (SAIPPA), Coalteck 2020, Fossil Fuel Foundation, Peace Parks Foundation, and SA Centre for Carbon Capture and Storage with international and local partners, and Clinton Foundation.
Respondent 6	The drive for our region is purely voluntary.
Respondent 7	Our clients (which use our products in the manufacture of fuel cell technology) would prefer us to deploy fuel cells as a RET. I am not sure if fuel cells can be defined as a RET but the carbon footprint is lower than that of conventional coal.

N = 7

4.4 Internal Environment Characteristics

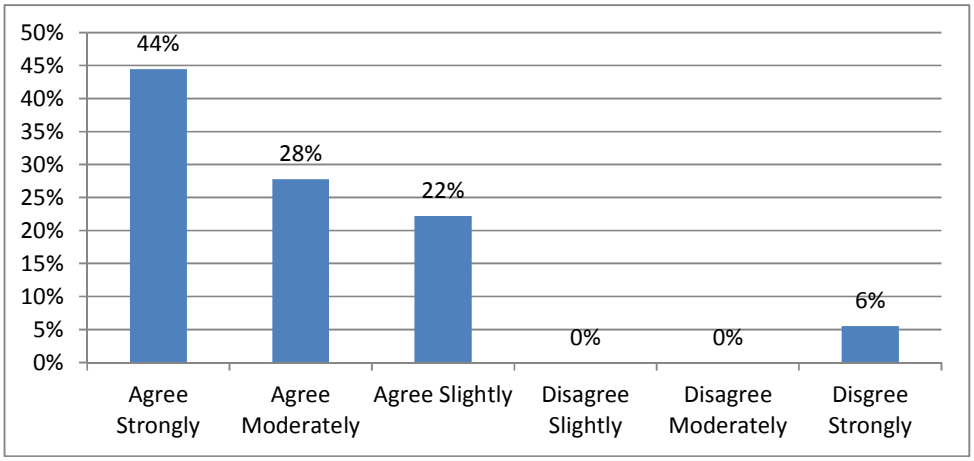
This section presents the results pertaining to intenal environment (firm-level) characteristics influencing adoption of RET by energy intensive firms; these factors include costs and benefits, oganisational capabilities and leadership values. All of these factors are considered from within the firm and will affect investment decisions.

4.4.1 *Costs* and benefits analysis

Elements of cost and benefits analysis investigated in the study were impact of RET adoption on energy cost, RET as a potential source of competitiveness, impact of learning rates and willingness to pay.

(a) Cost of energy

According to Figure 20 below, 94% of respondents agreed that they are concerned about the potential increase in the cost of energy resulting from RET adoption. Only one respondent strongly disagreed to this statement.

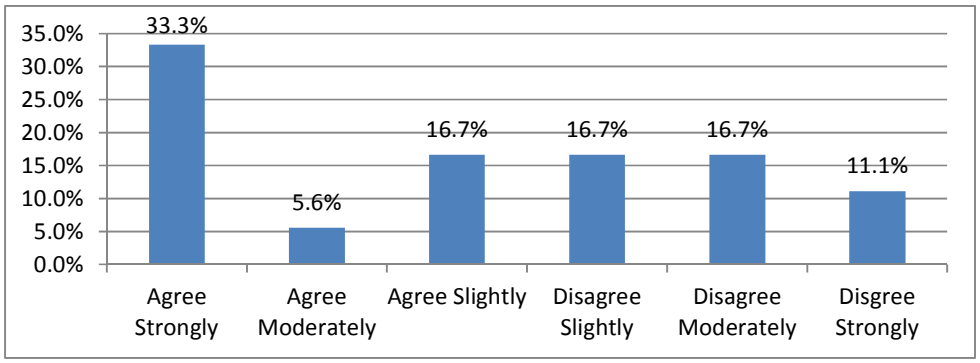


N=18

Figure 20: *Concern over increase in cost of energy*

(b) RET as a source of competitiveness

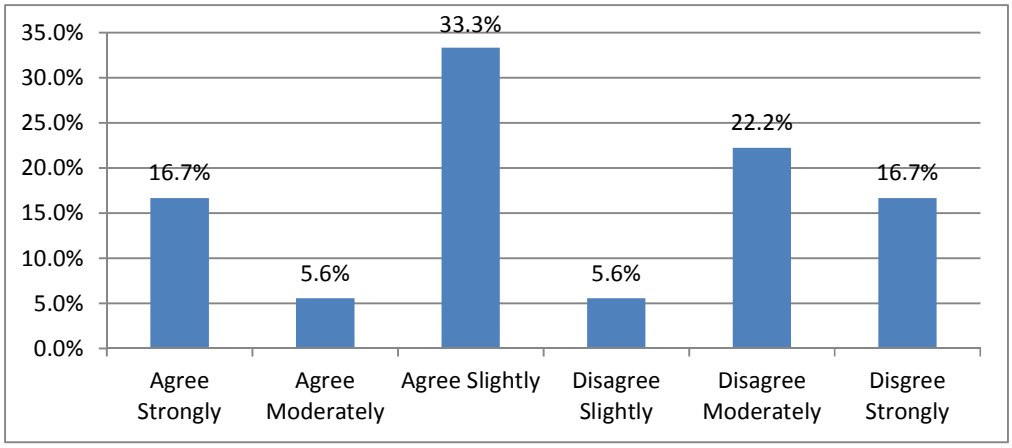
According to Figure 21 below, 56% of the sample agreed that in a carbon constrained world RET will be a potential source of competitiveness, of which 33% agreed strongly, 6% moderalty and 17% slighly agreed. Of the 44% that disagreed 17% disagreed slighly, another 17% moderately and the last 11% disagreed strongly.



N=18

Figure 21: *RET usage and competitiveness*

Similarly according to Figure 22, 56% of the respondents reported that they will adopt RET in order to gain new market opportunities.



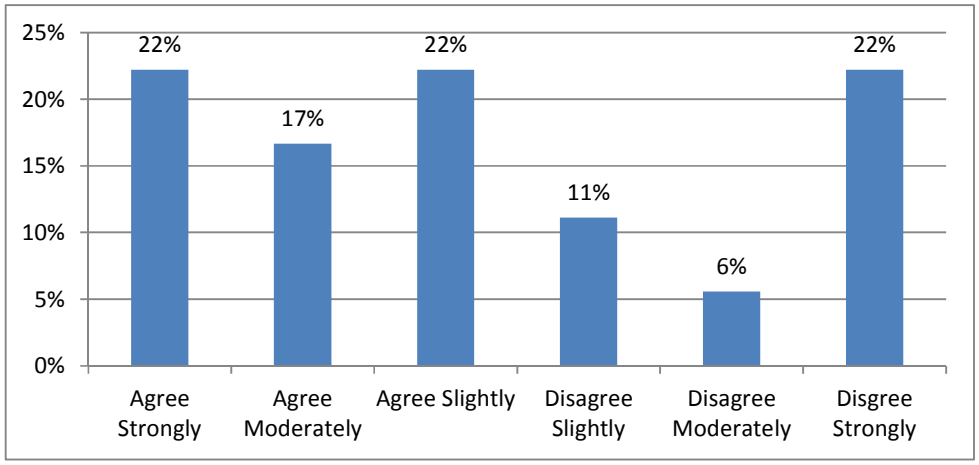
N=18, mean=3.61

Figure 22: *RET adoption as a source of new markets opportunities*

(c) RET Learning rates (early adopter advantage)

According the Figure 23 there is a strong sentiment that RETs will become cheaper in the long run, with 61% of the respondents agreeing that RET would be cheaper than conventional energy technologies in the long run. Of these 22% agreed slightly, 17% moderately, while the remaining 22% agree strongly. Of the 39% that disagree, 22% disagree strongly, 6% moderately and remaining 11% slightly disagree.

One respondent used potential learning rates to justify his view that he was not concerned about potential increase in energy cost. According to this respondent *"Initial costs are high but we see them going down in the life of RET installation"* (respondent 8, 2012).



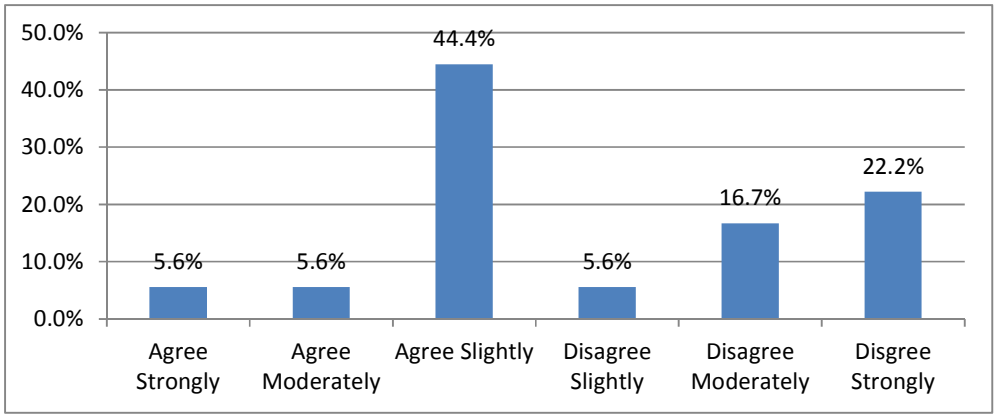
N=18

***Figure 23**: Affordability of RETs in the long-term*

Further details on the influence of cost/benefit on RET adoption is provided in Table 7 below.

(d) Willingness to pay

The results presented in Figure 24 below shows that 56% of the sample agreed to the potential benefits of RET and are willing to pay more to subsidise RETs, although 44% of these only agreed slighly to this statement, whereas only 6 per cent agreed strongly and the remaining 6% agreeing moderately. On the other hand 22% of those not willing to pay feel strongly about not willing to pay for RETs. It appears as though those willing to subsidise RETs do not want to strongly commit themselves while those not willing to pay are strongly against it subsidising RETs.



N=18

Figure 24: *Willingness to pay to subsidise RETs*

Table 7 below contains a list of qualitative comments regarding Costs and Benefits of RET as a factor influencing RET adoption. Respondents continue to highlight costs and production variability as key factors influencing lack of RET adoption (Respondents 3, 4,5 and 6; 2012)

Table 7: Comments related to costs and benefits of RET adoption

Respondent 1	Point 17 refers to solar PV, in the short- to medium term. However, you cannot really compare non-dispatchable RET with conventional technologies on price, since the one cannot replace the other
Respondent 2	The more RET is adopted, the cheaper it will be
Respondent 3	The primary objective of companies is to make money. Anything making economic sense will be explored. Companies that do not make profit for the investors will cease to exist. The proposed carbon tax structure will provide no benefit using RET, the only benefit will be passed through from Eskom if there are more RET in their energy mix.
Respondent 4	RET are not compatible with large continuous process industry. To include RETs in the energy supply mix in our company will require considerable over investment in RET capacity and back-up energy contracts which will add to the cost of production and reduce the viability of our operations
Respondent 5	We see the benefits of RET. Initial costs are high but we see them going down in the life of RET installation.
Respondent 6	There is currently no RET that can run at grid parity in SA yet. This will change in the future. Yes RET generation will be cheaper than grid in future but this will be determined by MYPD3. The current pitch for RET is in rapid expansion of business to offset consumption which cannot be supplied by ESKOM or as a quick fix in cases where NMD may be exceeded.
Respondent 7	Our businesses that are supplied by municipalities will be the first to use RET due to the high mark-up on Eskom prices. However it is likely that we would first invest in gas/coal based co-gen before any serious investment in RET

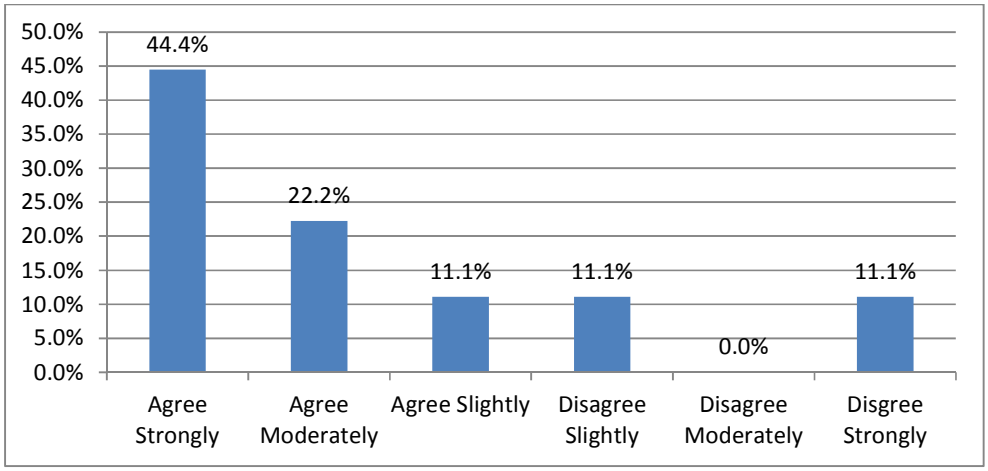
N=7

4.4.2 Organisational Capabilities

Elements of organisation capabilities investigated in the research are management commitment, whether RET adoption already forms part of energy strategies, capability to evaluate RET business cases and the level of awareness of RETs.

(a) Management commitment

According to Figure 25 below, 77% of the sample reported the high level of management commitment to RET adoption, with a dedicated senior manager responsible for energy planning including the choice of energy sources. Only 11% (two respondents) reported lack of management commitment to RET adoption.

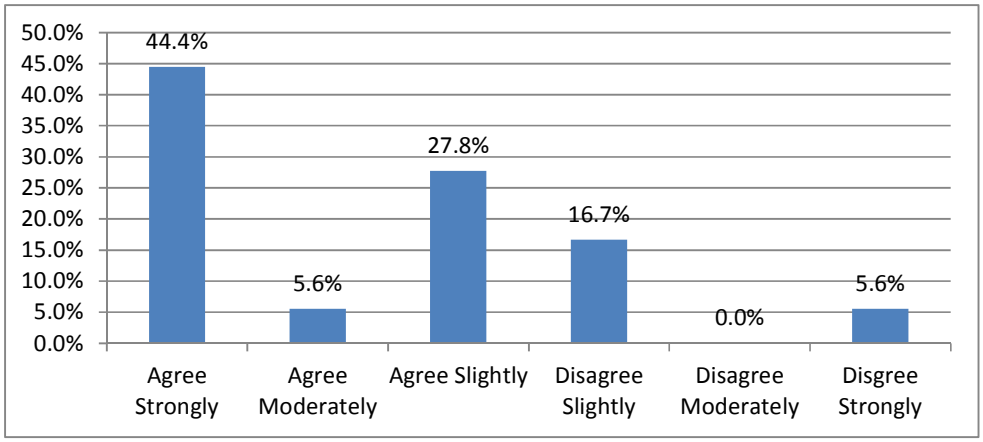


N=18

Figure 25: *Management commitment*

(b) RET included in energy strategies

Results presented in Figure 26 below show that energy strategies of 78% of sampled firms' make it possible to include non-conventional energy technologies such as RET, of which almost half of the sample (44%) agreed strongly. Only 1 company strongly disagree.

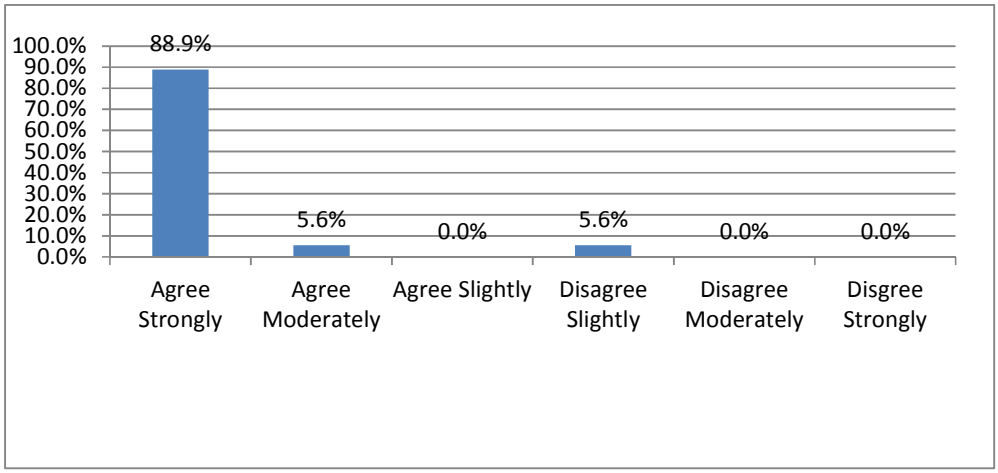


N=18

Figure 26: *RET adoption included in energy strategies*

(c) Capability to evaluate RET business cases

Figure 27 below indicates that 94% of the respondents reported that their companies are capable of evaluating RET business cases, with 89% agreeing strongly.

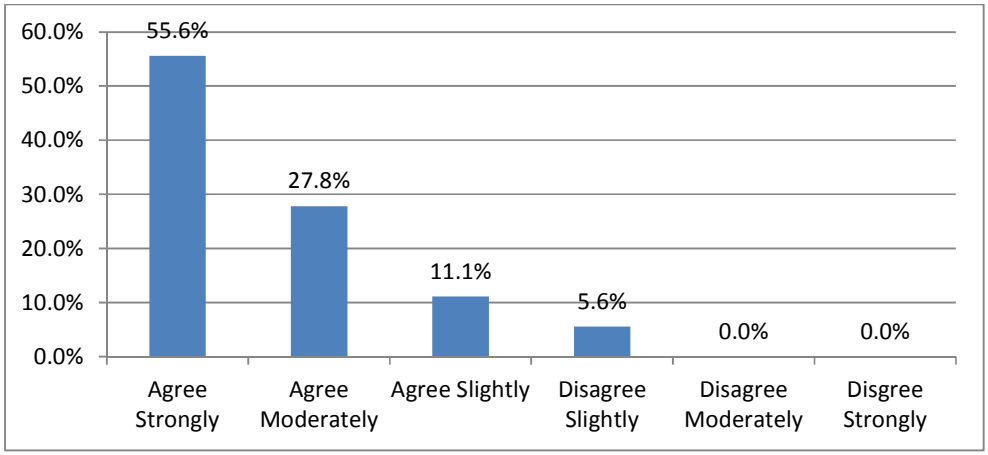


N=18

Figure 27: *Capability to evaluate RET business cases*

(d) Level of awareness about RETs

According to Figure 28 below about 94% of the companies reported high level of awareness about RET in that they are capable of absorbing and understanding RET information, including their usage and benefits. Only one company reported that they do not have the capability to absorb RET information.



N=18

Figure 28: *Capability to understand RET information*

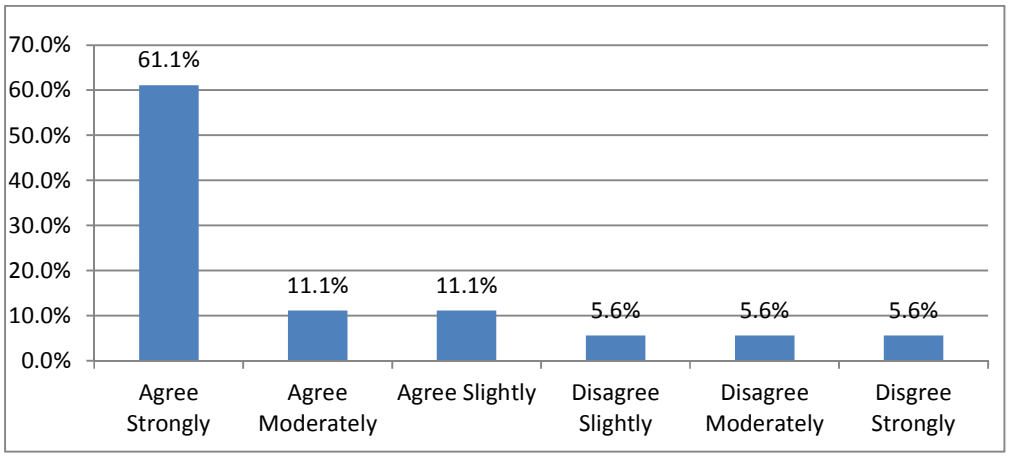
4.4.3 Leadership Values

Elements of leadership values investigated in the study were: the level of RET debates within the firm, whether steps have been taken to adopt RETs and whether there is communication within the organisation regarding dangers of GHG emission and the benefits of adopting RETs.

(a) RET adoption making strategic agenda

According to the data in Figure 29 below, 82% of the respondents reported a high level of leadership engagement in that RET usage has been discussed at the firm's Board level at least once in the last three years. 61% strongly agree which might be an indication of how serious RET adoption is filtering through organisations in SA. Only 18% (or 3)

respondents indicated that RET adoption was never discussed at Board level within their organisation in the last three years.

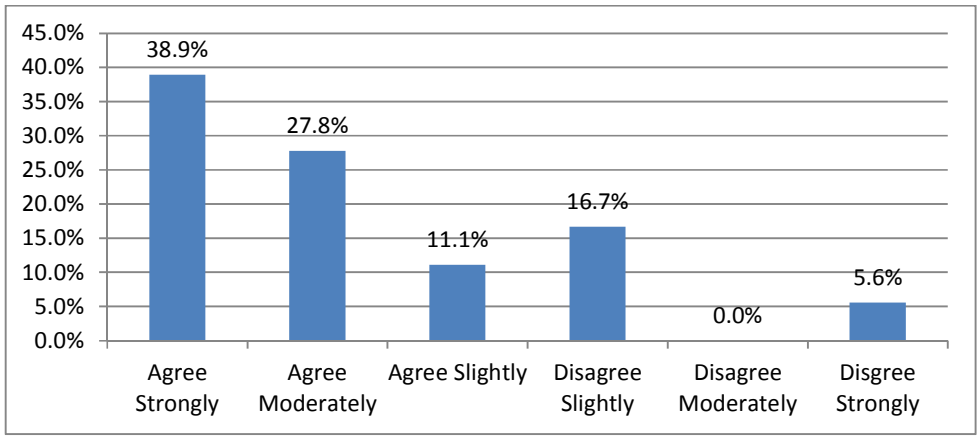


N=18

Figure 29: *Level of leadership engagement about RETs*

(b) Leadership commitment to RET usage

Figure 30 illustrates that 78% of the sample reported that they have already taken steps to use RETs, of which 39% strongly agreed, 28% agreed moderately while another 11% agreed slightly. Of the 23% that disagreed, only 6% disagree strongly and none disagree moderately.

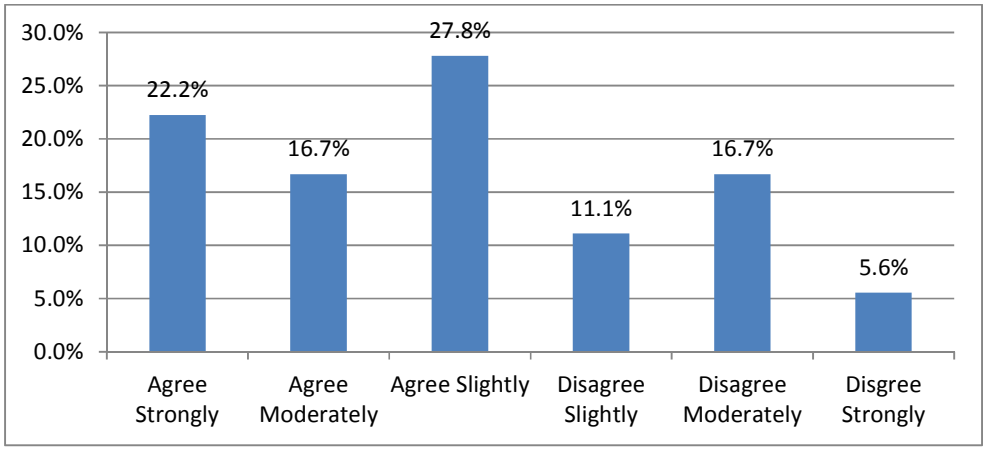


N=18

Figure 30: *Steps already taken to use RET*

(c) Communication within the organisation

According to Figure 31, two thirds of the respondents indicated that there is constant communication within the organisation about the dangers of GHG emissions and the benefits of adopting RETs.



N=18

***Figure 31**: Communication on RET within the firm*

Further comments from respondents regarding leadership commitment to RET adoption are provided in Table 8 below. Two respondents reported that their firms are establishing new business units to focus on RET projects.

Table 8: Comments regarding leadership commitment to RET adoption

Respondent 1	*[our company]* established a new business unit, to invest in renewable and low carbon power generation in order to reduce our carbon footprint
Respondent 2	A "new company" was formed to source, generate and market electricity from RET
Respondent 3	Why do you not include Nuclear as part of your RET? RET as available today cannot provide in the requirements of 24 hour industries or in the requirements of common households. Basic economic principles teach us supply and demand principles. It has no value to supply a product that the market does not need when you can supply it.
Respondent 4	*[our company]* participates in the ITCCC As a stakeholder in the mining industry, the company actively participates in shaping appropriate policies in South Africa through many channels, including NERSA, EIUG, National Electricity Response Team, Energy Efficiency Accord through the technical committee facilitated by the National Business Institute (NBI) and South African Chamber of Commerce and Industry's Electricity Dialogue

Respondent 5	Sustainability as an issue has been discussed at board level is sure. RET specifically am not sure

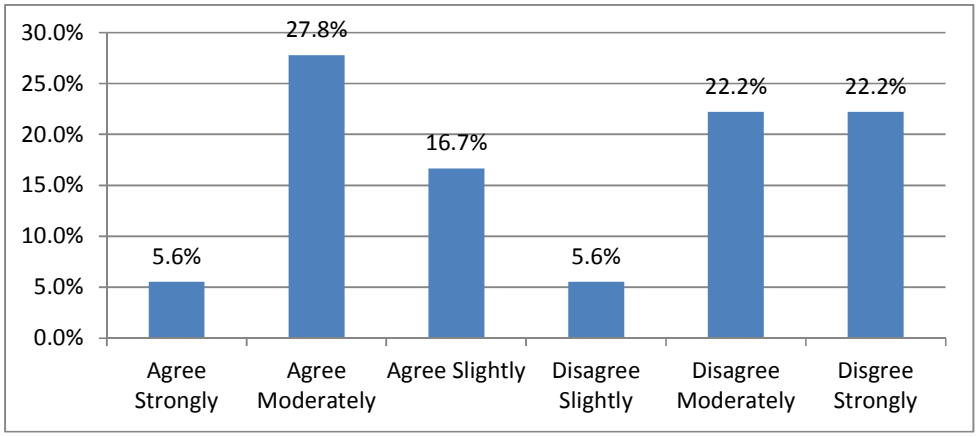
N=6

4.5 Technology Attributes

Technology attributes investigated in the study were compatibility or technology fit, relative advantage and perceived benefits.

4.5.1 Compatibility

The results were distributed evenly with half the sample indicating that it will be easy to introduce RET as part of the current energy technology mix. However of the 50% that believe RET is compatible with current technology, only 6% agreed strongly, whereas 22% disagreed strongly.

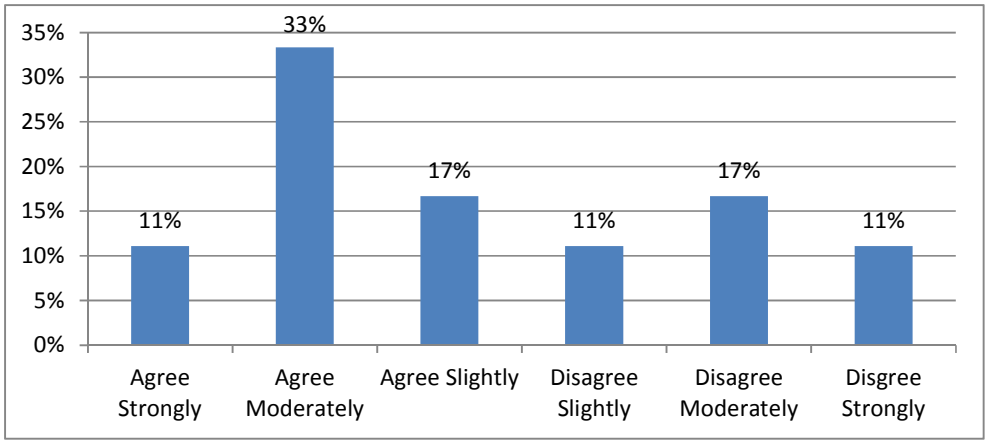


N=18

***Figure 32**: Compatibility of RET within current operations*

4.5.2 Relative advantage

Figure 33 below shows that 60% of the respondents agreed that RET will be the preferred technology choice for respondents to reduce their carbon footprint. They therefore posses relative advantage over conventional technologies



N=18

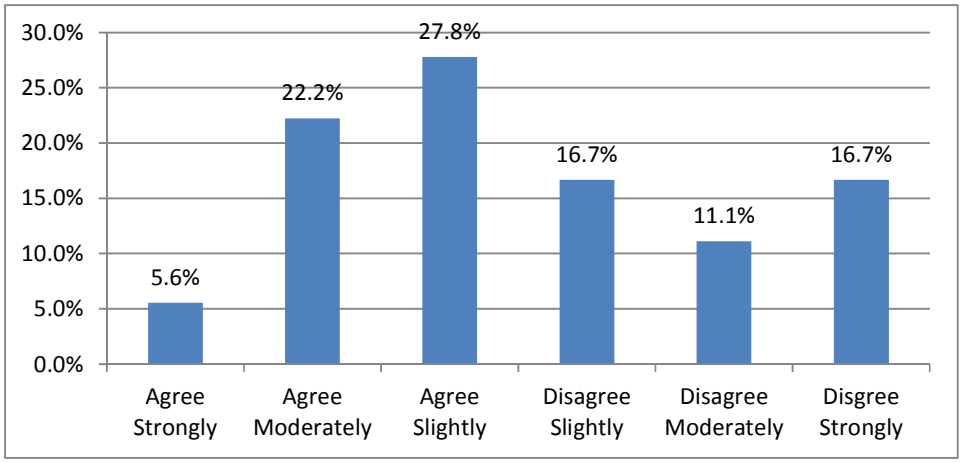
Figure 33: *RET as preferred technology to reduce GHG emissions*

4.5.3 Perceived Benefits

Considered elements of perceived benefits of RET adoption were respondents' assessment of RET as a preferred technology choice for business sustainability and potential benefits from technology learning rates

(a) Business sustainability

Figure 34 shows that compared to other technologies, 56% of respondents perceived RET as preferred technology for business sustainability. However, respondents do not show strong opinions on this view as only one respondent strongly agreed to this statement while the rest chose to remain cautious in their responses. Of those that disagreed, 17% disagreed strongly.

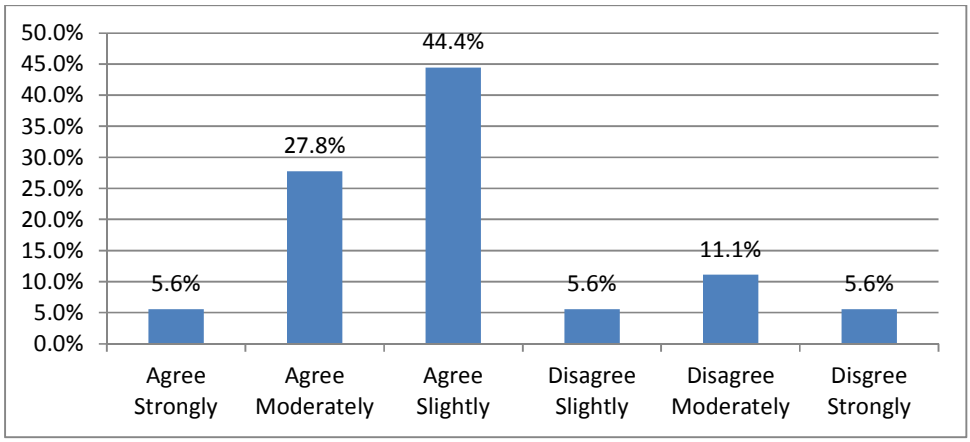


N=18

Figure 34: *RET as preferred technology for business sustainability*

(b) Potential technology learning rates

According to Figure 35, 78% of the respondents perceived positive benefits from RET and agreed that compared to other technologies, RET will soon become financially competitive from technology learning rates. However, 45% only agree slightly, 28% moderately and only 6% agree strongly.



N=18

Figure 35: *RET as preferred technology due to potential learning rates*

Further details on the influence of technology attributes on RET adoption is provided in Table 9 below. The common theme from comments is that

firms are still obsessed with coal technologies, remaining optimistic on developments around clean coal technologies.

Table 9: Comments regarding RET opportunities and capabilities

Respondent 1	26 is only true until carbon capture and storage (CCS) becomes technically viable
Respondent 2	The "new company" is also looking at opportunities in carbon capture and underground coal gasification
Respondent 3	Electricity is but 1 energy source companies use
Respondent 4	In our comments Hydro Power has been excluded as there is no real hydro opportunity in SA that would meet our requirements

4.6 Summary of the results

The results of this research study were presented in this chapter. The research question was further broken down into several components. Responses provided to these components allowed the researcher to understand the key issues within the research question. Varied responses show that addressing challenges facing energy systems and in particular RET adoption affected industrial firms differently. The results are summarised in Table 10 overleaf and explained thereunder.

Table 10: Summary of the results to research questions

Domain	Factor	Criteria	Perception of the respondents in SA context
External Environment characteristics	Public Policy	Policy clarity	▪ Most view policy as clear and unambiguous
		Participation / consultation	▪ Most believe consultation not enough
		Policy instruments effectiveness (REFIT and carbon tax)	▪ Most believed effective ONLY up to minimum government targets ▪ Majority preferred portfolio standards over current policy instruments
	Stakeholder Influence	Concern over stakeholder awareness	▪ Majority concerned over growing stakeholder awareness
		Community pressure and public sentiment	▪ Perceived not to influence the decision to adopt RET
		Financiers	▪ Perceived to influence the decision to adopt RET
		Customers	▪ Perceived not to influence the decision to adopt RET
		Suppliers	▪ Perceived not to influence the decision to adopt RET
Internal Environment Characteristics	Cost and Benefits	Cost of energy	▪ Most believe costs has major influence on the decision to RET adoption
			▪ However, most are slightly willing to pay
		Competitiveness	▪ No influence in the decision to adopt
		Long-term benefits	▪ Most have positive long term view (that RET costs will come down)
	Leadership Values	Leadership Commitment	▪ Most are discussing RET adoption at company Board level
		Steps taken	▪ Most have already take steps to adopt RET
		Communication	▪ Most constantly communicate to staff dangers of GHG emissions and RET benefits
	Organisational Capabilities	RET champion	▪ Most have dedicated Senior Manager
		RET strategies	▪ Most have RET already included in energy strategies
		RET awareness	▪ Most firms can absorb RET information
		Investment decision making	▪ Most firms can evaluate RET business cases
Perceived Technology Attributes	Compatibility	Technology fit	▪ Strong sentiment is RET is incompatible with current operations
	Relative Advantage	Relative advantage	▪ Most preferred RET to reduce own GHG emissions
	Perceived RET Benefits	Sustainability	▪ Most prefer RET adoption for sustainability
		Learning rates	▪ Most believe RET costs will come down

Source: Author, 2013

Results for current energy resources show that industrial firms are highly dependent on grid electricity for their energy need. Although RET adoption remains very low at present, the results show that firms are starting to appreciate the importance and potential of changing the current energy technology mix through RET adoption. Firms are increasingly becoming aware of the problems associated with incumbent energy technologies and are starting to appreciate the need to introduce RET to their energy mix.

Although there were greater variations within the results of each component of the key research question, the overall results show that most factors identified from literature do influence RET adoption by industrial firms.

External environment factors appear to have limited influence on RET adoption. Respondents indicated that government policy instruments will drive RET adoption only up to minimum compliance to the set targets. The influence of stakeholders is currently limited to financiers while results for other stakeholders (namely communities, customers and suppliers) indicated lack of influence by these stakeholders.

Internal environment factors are most influential to the decision to adopt RET, with cost of energy having considerate influence above the rest. Results show highest leadership commitment and organisational capability to adopt RET.

Results for technology attributes show that firm's attitude towards RETs and the benefits they offer over traditional energy technologies were generally positive, especially considering issues of sustainability and reduction of GHG emissions. However, RETs were generally viewed as incompatible with current operations, mainly on the basis of variability in energy production. The results presented in this chapter are further analysed further in the following chapter five.

CHAPTER 5: ANALYSIS OF THE RESULTS

5.1 Introduction

Chapter five analyses the research results that were presented in chapter four. This is addressed through identifying the linkages between research results and literature that was developed in chapter two.

The chapter is structured so that the analysis of the data occurs in the same format as the manner in which the data was presented in chapter four. This allows for an in depth discussion of each component of the research question. It covers energy sources and RET adoption trends, external environment characteristics, internal environment characteristics, and perceived technology attributes.

5.2 Energy Sources and RET Adoption Trends

5.2.1 Introduction

In order to address whether RET is seen as a solution to industrial firms GHG emissions, the study investigated industrial firms' current energy sources, current level of RET adoption as well as prospects for RET adoption in future. This section analyses data reported by the respondents pertaining to these issues.

Literature presented in chapter two has shown that the SA energy system is characterised by high level of carbon lock-in (Unruh 2000, Pegels 2010), in which RET adoption is expected to be slow resulting from "preventative innovation" effect (Rogers, 2003). These assertions were confirmed by the results of this research.

5.2.2 Current energy sources

Results regarding current energy sources show that a considerable number of firms in the sample rely on grid electricity as a main source of energy for their business operations. Approximately 90% of grid electricity is generated from coal based technologies (Eskom, 2011), of which industrial firms consume about 44% of electricity (EIUG, 2011) and as a result most of the industrial firms' contributions to GHG emissions is attributable to electricity production technologies. Moreover, results also show that the little diversification in energy sources that currently exist among the sample (in the form of cogeneration and own generation) is mostly produced from fossil fuel based energy technologies.

These results gave evidence of carbon lock-in effect (Unruh, 2000), caused by factors such as historically reliance on cheap coal based energy sources, as well as research and development strategy that was always centred on fossil fuel based technologies (Pegels, 2010).

5.2.3 RET Adoption Trends

Regarding the current level of RET adoption the results indicate that RET adoption does not seem to be a highly prioritised issue for a considerable proportion of the firms in the sample. Firms have shown very little evidence of a shift towards RET adoption as shown in chapter four. Although 17% of the samples have adopted some form of RET; even for these firms RE accounts for less than 1% of total energy usage. Coupled with the fact that South Africa did not invest in new electricity production capacity for more than two decades, the results was a slow pace of change in the energy mix. Therefore, up till now existing RET adoption could have been motivated by other considerations such as a desire to prevent environmental degradation and social appearances, but not shortage of energy

The main arguments offered by respondents for the lack of transformation towards RET were the high upfront costs and

intermittence nature of RETs. As one respondent puts it: “the cost is too high and most affordable renewables do not provide power for a 24 hour operation” (respondent 5, 2012).

However, the results also show that, amid the increasingly high degree of carbon lock-in and a slow uptake of RETs, there are signs of a shift towards RET adoption. All firms reported that they are not only concerned about the country’s high level of GHG emissions, but have started monitoring their own contributions to emissions. In addition, 94% agreed that there is an urgent need to address SA’s GHG these emissions, 17% have already adopted some form of RET, while a further 67% reported that they plan to adopt RET in future. The projected RET diffusion rate, however, remains very slow with planned projects ranging from 1MW to 40MW. These results support the view of Rogers (2002) that adoption of preventative inovation is very slow due to delayed rewards.

5.3 External Environment Characteristics

5.3.1 Introduction

External environment characteristics investigated in the study are public policy and stakeholder influence. The results are presented in the previous chapter are analysed in the following sections.

5.3.2 Public Policy

According to Ellis (1996), IEA (2008), Sebitosi and Pillay (2008) and Montalvo (2008) RET adoption in other markets and countries has largely been driven by public policy. Characteristics of public policy used to assess level of influence (or lack thereof) SA public policy had on RET adoption by industrial firms were participation (or consultation) during policy development, clarity of the public policy and effectiveness of

selected policy instruments. In order to assess the influence of public policy on their decision not to adopt RET respondents were asked to rate their perception of these elements.

Literature showed that consultation with and participation of industry stakeholders in policy development and implementation processes is an important factor in ensuring RET adoption (Jacobsson and Bergek 2004, Madlener and Stagl 2005, Sebitosi and Pillay 2008 and Ellis 2010). The general perception of respondents is that there is not enough consultation during renewable energy policy formulation in South Africa. This is reflected in the average score of 3.59 or “slightly disagree”. These results indicate that lack of RET adoption by industrial firms at present may be as a result of insufficient consultation during policy development process.

Although a slight majority perceived SA RET policy as clear and unambiguous, majority of those who disagreed showed very strong opinion while those who agreed only slightly agreed. This is evidenced by the mean of 4.6 (disagree moderately) which implies that an average respondent viewed South African policy on RET as unclear and ambiguous. According to IEA (2008) one of the fundamental principles for RE policy design is the need for predictability and transparency. Unclear policies increase the level of uncertainty resulting in erratic demand for other technologies, guiding firms away from RET adoption (Jacobsson and Bergek (2004). Accordingly, lack of RET adoption by industrial firms may also be attributable to unclear and ambiguous RET policies.

About two thirds of the respondents believed that the current RET policy instruments (i.e. REFIT and carbon tax) will facilitate the adoption of RET by their firms. This is in line with Montalvo (2008) and one possible reason for this view is that these are mandatory policy instruments coordinated by government and firms do not generally have a choice whether or not to support RET adoption as the costs of adoption are

normally socialised among all consumers in proportion to their energy consumed (Diaz-Rainey and Ashton 2008).

However, in agreement with the finding by Montalvo (2008), most of the respondents (71%) were also of the view that the current command and control policy instruments do not incentivise them to adopt RET beyond government targets as reflected in the policy. Therefore under these policies firms will only adopt RET on the basis of “minimum compliance” to government targets. Respondents preferred alternative policy instruments such as portfolio standards over current government policy. Under portfolio standards firms are allocated RE targets and they decide on the choice of RE technology, RE developer and ultimately the level of RET diffusion. This finding confirms the position in literature that government policy interventions should only be limited to providing conditions and stimuli for firms to take lead with regard to actual RET adoption (Montalvo 2008). Capacity of the government to implement RE policies was also raised by respondents as a challenge.

In conclusion, the results indicate therefore that current policy instruments whose implementation reside entirely in the government may have contributed to the lack of RET adoption by industrial firms.

5.3.3 Stakeholder Influence

Stakeholders investigated in the current study social communities, financiers, customers and suppliers. Literature has shown that stakeholders play an important role in influencing industrial firms to adopt new technology, for example in Sweden (Wang 2006). The study conducted in Sweden by Wang (2006) found that community involvement in the form of NGOs mattered in influencing the decision of industrial firms to adopt new technology. This was found not to be case in South Africa, as shown in chapter four, where not all stakeholders have significant influence on the decision by industrial firms to adopt RET. In contrast to other countries with well-developed advocacy and community

lobbying, the SA society presents little influence on RET adoption decision by industrials firms.

The results pertaining to the influence of community pressure and public sentiment show that these stakeholders are considered not to have strong influence in the decision of industrial firms to adopt RET in SA. These results may be a reflection of the current low level of awareness about RET by the public and the ineffectiveness of community organisations in general.

Majority of the respondents in the study confirmed that financiers do influence the decision of industrial firms to adopt RETs in SA, in support of the literature finding. Possible reason for this is that sources of capital (such as the World Bank Group) are becoming highly influential in driving environmental responsible behaviour by corporations.

Perception of the two thirds of the sample is that customers of industrial firms do not influence the decision by these firms to adopt RET in South Africa. The results are possibly reflective of the nature of business of these firms. Their products are mainly internationally traded commodities where there is little or no product differentiation and as a result customer influence is almost non-existent at present. These results imply that industrial firms' customers do not influence their decision to adopt RET.

Similarly, 72% of the respondents in the study is that industrial firms' suppliers do not influence the decision of these firms to adopt RET in SA. The results might reflect strong bargaining power of industrial firms over their suppliers.

In conclusion, results of this research suggest that only financiers may have significant influence on the decision by industrial firms to adopt RETs in South Africa. Other stakeholders, namely communities, customers and suppliers, may have contributed to the slow adoption of RET by industrial firms in SA. What is encouraging though is that an

overwhelming majority of the firms (88%) acknowledged the increasing stakeholder awareness of the benefits of RET adoption.

5.4 Internal Environment Characteristics

Internal environment characteristics investigated in the study are costs and benefits considerations, organisational capabilities and leadership values. Results presented in chapter four are analysed in the following sections.

5.4.1 Costs and Benefits

According to literature the costs and benefits of RET to the adopting firm have been found to be the most important factor impeding RET adoption to date (Sorensen 1991; Turner 1999; Rogers 2003; Winkler 2003; Owen 2004; Wang 2006; Burer 2007; Sebitosi 2007; Montalvo 2008 and Winkler et al. 2009). Elements of cost and benefits investigated in the study included perceived increase in cost of energy, competitiveness and early adopter advantage or learning rates.

Overall, in line with findings from literature review, results of the research provided evidence that costs and benefits considerations were the main consideration slowing down industrial firms from RET adoption. Respondents were concerned that RET adoption would increase the overall cost of energy. This view was shared by 94% of the respondents. These respondents were concerned about the short-term impact of RET adoption on energy costs. Potential increase in energy cost was their primary concern even though they acknowledge that in the long-term RET costs will come down from economies of scale and learning rates. This finding is in line with the theory of “diffusion of preventative innovation” postulated by Rogers (2002). This theory states that preventative innovations are expected to diffuse rather slowly due to the delayed benefits, which are only expected sometime into the future.

Cost of energy has always been a major concern for EIUG, and this was evident in the recent article voicing the association's concern over potential tariff increases that was planned by the national utility Eskom in its application to the national energy regulator (Engineering News Online, 2011). This view is expected given that these firms operate energy intensive industries and energy is a significant cost driver for their business operations (Engineering News Online, 2011). Furthermore, most of these firms have been established on the basis of historically cheap coal based electricity. Wang (2006) found similar results in Sweden when change in technology was about to be introduced. The results indicate that cost of energy strongly influences the decision of industrial firms to adopt RET in SA.

Although respondents are concerned about potential increase in energy cost as a result of RET adoption, ironically most of the respondents are "slightly" willing to pay for RET. Possible reasons are that firms have already cautiously priced in the possibilities of impending REFIT programme and the potential introduction of carbon taxation. On the contrary, the small minority that is not willing to pay for RET showed strong sentiment about their unwillingness.

With regard to market influence the general perception of the respondents is that RET will neither improve firm's competitiveness nor any prospects for gaining new market share. These findings imply that firms do not regard markets of their products and services as having any influence in their actions. This is also supported by earlier finding, in this research, that customers do not have any influence in the decision of industrial firms to adopt RET and this is possibly based on lack of direct competition for customers in commodity based markets.

RET costs are expected to drop over time from technology learning rates (Winkler et al. 2009), and this was also the view of most respondents who expected the price of RET to decrease over time.

5.4.2 Organisational Capabilities

Capabilities of the adopting firm have been found to be an important factor in predicting new technology adoption in other markets (Rogers 2003 and Montalvo 2008). Elements of this factor investigated in the study were whether the firm has a dedicated RET champion, whether RET adoption form part of the firm's energy strategies, ability of the firm to understand RET information and to evaluate RET business cases. The results for this dimension indicated that firms possess very strong organisation capabilities to be able to drive RET adoption. Most firms reported that they have a dedicated senior manager responsible for energy management (78%), expressed strong ability to absorb RET information (94%) including evaluating RET business cases (94%) and that their current energy strategies already include RET adoption (78%). However, there is very little evidence to support these views when considering the current level of RET adoption within these firms. The results indicate that although organisational capabilities have been found to influence adoption of RET, the current lack of RET adoption by industrial firms in SA is not due to lack of organisational capabilities.

5.4.3 Leadership Values

Conduct and commitment of top management to cleaner production are of great relevance to the diffusion of cleaner technologies (Montalvo, 2008). Perceptions of the respondents in the study showed very strong leadership commitment driving RET adoption within these firms. Most respondents reported that RET usage has been discussed at company Board level at least once in the last 3 years (82%); that there is constant communication within the firms on the dangers of GHG emissions and benefits of RETs (67%) and that firms have already taken steps to adopt RETs (78%). Two respondents reported that their firms have "established new business units to invest in RET" (responded 1, 2012 and respondent

3, 2012). Most respondents also reported to have strong management capability and leadership values to support RET adoption.

Assuming this to be correct, and also considering the current low level of RET adoption; these results indicate that leadership values and organisational capabilities play a minor role in ultimate decision of firms to adopt RET. Montlavo (2008) also emphasised that technology adoption factors are interdependent and should not be considered in isolation. Leadership attitude is shaped by their level of awareness of Technology attributes, for example the level of compatibility of new technology with current operations (Rogers, 2002). The results of the current study show that most companies are concerned about costs of RETs and compatibility of RETs to current operations. Although there is high level of leadership commitment, concerns over technology attributes and costs and benefits may be hindering RET adoption.

5.5 Technology Attributes

Perceived attributes of new technology has been found to be an important factor that influence adoption of new technology (Rogers 2003), including the adoption of cleaner technologies (Montalvo 2008). Compatibility (or technology fit) with the current operations, relative advantage and perceived benefits were the three elements of technology attributes investigated in the current study.

5.5.1 *Compatibility*

Compatibility measured the degree to which RET can be incorporated into the current operations of the firms (Rogers, 2003). Most respondents reported that RET is incompatible with current operations. The most common cited reason for this was the intermittence nature of renewable energy production. This was viewed as having a negative impact on the firms' business operations, which require a constant and continuity of

energy supply. This supports the view that variability of RET is still considered a major barrier as it may result in double invest in energy solutions to supplement energy supply during times of RET unavailability (Turner, 1999).

5.5.2 Relative Advantage

Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes (Rogers, 2002). The key element of relative advantage was reducing industrial firms' carbon emissions. Industrial firms perceived RET as preferred technology in solving their carbon emission problems. Over 60% of the respondents supported this view, while the other 40% opted for other technologies. One respondent stated that nuclear energy technology was more preferable to RET (respondent 4). Other technologies mentioned as options are carbon capture and storage (respondent 1, 2012), and coal gasification (respondent 1 2012; and respondent 3 2012). Once again cost and variability of RE production were highlighted as main disadvantages RET.

5.5.3 Perceived benefits

Attitude of majority of the respondents towards RET was generally positive. Most respondents perceived RET innovation as beneficial for them. They regarded RET as preferred technology choice both to reduce the individual firm's contribution to GHG emissions and for business sustainability. In addition respondents also believed that RET will soon become financially competitive from technology learning rates. Considering the low level of RET adoption at present, the results seem to suggest that perceived benefits on its own is not sufficient to influence industries to adopt RET.

5.6 Conclusion

This chapter has analysed the results of the study on factors influencing decisions to adopt RET by industrial firms in SA. There was variation across the sample but sufficient consensus in predominant trends. In general, the results from this research study coincided with literature and explained some of the reasons for slow uptake of RET by energy intensive firms. Where the results differed with literature, they further highlight the complexities of transforming the SA energy system. In addressing this complexity for successful RET adoption, some core themes including the role of public policy versus organisational internal decision making processes should be considered.

Although most respondents perceived SA public policy on RET adoption as clear and unambiguous, they were concerned about lack of stakeholder consultation during policy development. Majority of respondents did not support the current government command and control policy instrument (REFIT) as they reportedly believe that it will lead to minimum compliance. Instead respondents preferred alternative RET supporting instruments, such as portfolio standards, which allows firms-level adoption decisions to be made by the firms themselves with limited government involvement.

Except for financiers, the findings suggest that external stakeholders exert little influence on RET adoption by industrial firms. Communities, customers and suppliers were perceived not to have strong influence on RET adoption.

There is a strong sentiment that an unfavourable cost/benefit ratio emerges from RET adoption. Costs and benefits came out as the major barrier to RET adoption, although firms do acknowledge that RET costs will reduce over time.

Respondents reported strong organisational capabilities and leadership commitments to support RET adoption. However, the results also show that these factors on their own are not sufficient to facilitate RET adoption as evident from low levels of RET adoption rate at present.

Respondents' attitudes towards RET attributes were generally positive with regard to relative advantage they offer, especially to reduce GHG emissions and business sustainability reasons. Furthermore, most respondents anticipated cost of RET to come down in future from technology learning rates. However, RET are still perceived as having low level of compatibility with technologies utilised by the most industrial firms at present.

The following chapter concludes this research enquiry.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter present conclusions and recommendations of this research study based on the results and analysis presented in the previous two chapters. RET adoption is still evolving and while there has been much written to support RET deployment from policy perspective, the concept has not been fully understood from the energy users perspective. This study began by raising this issue particularly from the context of a developing country marked by a carbon lock-in energy system. The discussion that follows addresses key themes that have emerged throughout this research in addressing the main research question. Several recommendations are made. The chapter ends with several suggestions for further research.

6.2 Energy sources and RET adoption

The results confirmed that South Africa experiences a high degree of carbon lock-in, resulting in slow RET adoption by industrial firms. Evidence of a shift towards RET adoption was however noted; although it is still early days to suggest that the current RET adoption of firm level plans will eventually bear fruits.

The key objective of the study was to explore factors influencing RET adoption by industrial firms in SA. The overall conclusions from the study are presented in Table 11 overleaf and also discussed in the following paragraphs.

Table 11: Importance of factors as a facilitator of RET adoption in SA

Domain	Factor	Importance		As a facilitator of RET adoption
		Literature Review	SA Firms	
External Environment	Public Policy	Strong	Moderate	Negative
	Stakeholder Influence	Strong	Weak	Improving
Internal Environment	Economic Benefit	Strong	Strong	Negative
	Organisational Capability	Strong	Strong	Positive
	Leadership Values	Strong	Strong	Positive
Technological Attributes	Compatibility / Technology fit	Strong	Strong	Negative
	Relative Advantage	Strong	Moderate	Improving
	Perceived Benefits	Strong	Moderate	Improving

Source: Author

The study suggested that external environment factors only have a moderate influence on the decisions by industrial firms to adopt RET. Industrial firms perceived SA public policy in a negative light and not facilitating accelerated RET adoption. Firstly, respondents are of the opinion that government policy process lacks industry participation and the current renewable energy policy is also perceived as unclear and ambiguous. Secondly, according to respondents current “command and control” policy economic instruments (i.e. REFIT and carbon tax) will

increase RET adoption, however, only to minimum compliance to meet policy targets. In order to increase RET adoption beyond government targets, portfolio standards might have to be incorporated into the policy to allow firms to make their own technology choices.

Stakeholder influence was perceived by many to be limited to financiers. Of great concern is the lack of influence by the public and communities where these firms operate.

Internal Environment factors have strong influence on the decision by industrial firms to adopt RETs. The results seem to suggest very strong organisational capabilities to facilitate RET adoption, supported by leadership values that promote RET adoption. However costs and benefits, mainly due to the high upfront costs of RET, appears to be the main reason for slow adoption of RET by industrial firms. The long term outlook is however positive, as firms acknowledged that RET costs with reduce in future due to technology learning rates, in which case RET adoption by these firms is expected to accelerate.

Industrial firms viewed RET attributes positively and as a preferred technology to reduce their carbon emissions. However, they are concerned that RET in their current form may not be compatible with current operations. Respondents were generally positive attitudes towards RETs and potential benefits they could bring for business sustainability.

The research has managed to identify factors that are critical in RET adoption by industrial firms and the level of importance they have on firms decision making process. In addition, the study also uncovered perceptions of industrial firms towards these factors in the SA context.

Concerns over cost of RET and incompatibility with current industrial operations are considered the most critical factors hindering RET deployment by industrial firms.

6.3 Recommendations

Based on the outcome of this research, the following recommendations are suggested to policy makers and industrial firms.

6.3.1 Recommendations to policy makers

- Policy makers should encourage stakeholder participation in the policy development process and this will also ensure that ultimate policy outcome is clearly articulated and easy to implement by the different players.

- Government must also consider limiting its involvement to creating stimulating policies that allows industry to take lead in RET adoption.

- Africa has been identified as a continent that is prone to the negative consequences of climate change. Increasing stakeholder awareness by government, especially community advocacy groups would improve stakeholder involvement in influencing RET adoption by industrial firms.

6.3.2 Recommendation to industrial firms

- The results showed that, over and above grid tied RET solution, there is potential market for entrepreneurs to develop RET technology solutions that are aimed at directly integrating RET to industrial processes.

6.4 Suggestions for further research

This research touched on several areas of the SA energy systems and the following suggestions are made for further research.

- Factors influencing RET adoption are dynamic and will change over time and as the level diffusion increases. It is highly probable that this study would yield different results if conducted at a different time or after some level of RET adoption has taken place in SA.

- The results found incompatibility of RETs as another major concern to most firms. An entrepreneurial opportunity exists in research channelled at identifying opportunities to make RET compatible for large scale industrial applications.

- A study could be conducted on the competitive dynamics between the emerging renewable energy independent developers and the incumbent electricity monopoly supplier.

- Some of the industrial firms indicated the intention to participate in the government REFIT programme. In this regard a study should be conducted on industrial firms' transition from being intensive energy users to RE independent developers.

- Influence of technological lifecycles on RET cost/performance patterns is also worth investigating.

REFERENCES

Arkesteijn, K. and Oerlemans, L. (2005) The early adoption of green power by Dutch households: An empirical exploration of factors influencing early adoption of green electricity for domestic purposes, *Energy Policy*, 33 (2), pp. 183-196.

Batlle, C. (2011) A method for allocating renewable energy source subsidies among final energy consumers, *Energy Policy,* 39, pp. 2586-2595.

Baumann, J. (2008) From corn to computers: diffusion of innovations, *Conference Papers – National Communication Association*, p. 1.

Biswas, A.K. (1986) Communication on energy renewable energy and environment policies in Africa, *Energy Policy*, 14(3)*,* pp. 281-284.

Brown, S (2010) Rural electric cooperatives' adoption of renewable energy technology, *M.S. dissertation, Purdue University,* available from http://www.proquest.com (publication number AAT 1489650; accessed October 7, 2011).

Büscher, B. (2009) Connecting political economies of energy in South Africa, *Energy Policy,* 37(10), pp. 3951-3958.

Carley, S. (2009) State renewable energy electricity policies: An empirical evaluation of effectiveness, *Energy Policy,* 37(8), pp. 3071-3081.

DEAT (Department of Environmental Affairs and Tourism) (2004) National Climate Change Response Strategy for South Africa, Pretoria.

Diaz-Rainey, I. and Ashton, J.K. (2008) Stuck between a ROC and a hard place: Barriers to the take up of green energy, *Energy Policy,* 36, pp. 3053–3061.

DME (Department of Minerals and Energy) (1998) White Paper on Energy Policy for South Africa, Pretoria.

DME (2003) White Paper on Renewable Energy, Pretoria.

DME, Eskom & CSIR (2001) *South African renewable energy resource database*, last accessed 12 October, 2012, from www.csir.co.za/environmentek/sarerd/contact.html.

Eggertson, B. (2002) Clear intentions: South Africa's transition towards renewable energy, *Refocus*, 3(5), pp. 42-44.

EIUG (Energy Intensive Users Group) (2011) last accessed 16th August, 2011, from http://www.eiug.org.za/about/.

Ellis, J. (1996) Why promote renewable energy?, *The OECD Observer, 201*, p. 17.

Engineering News Online (2011) *SA's Power Prices Approaching Affordability Tipping Point*; last accessed on 29 August, 2011, from http://www.engineeringnews.co.za/article/sas-power-prices-approaching-affordability-tipping-point-2011-08-29.

Eskom (2011), Annual Report, last accessed October, 2012, from http://www.eskom.co.za.

Fluri, T.P. (2009) The potential of concentrating solar power in South Africa, *Energy Policy,* 3, pp. 5075–5080.

Heiman M.K. and Solomon B.D. (2004) Power to the people: electric utility restructuring and the commitment to renewable energy, *Annals of the Association of American Geographers,* 94(1), pp. 94-116.

Inglesi-Lotz, R. and Blignaut, J.N. (2011) South Africa's electricity consumption: A sectorial decomposition analysis, *Applied Energy*, 88(12), pp. 4779-4784.

IEA (International Energy Agency) (2008) *Deploying renewables: principles for effective policies*, last accessed October, 2012, from http://www.iea.org/G8/2008/G8_Renewables.pdf.

IEA *2009 Energy Balance for South Africa*, last accessed 05 February, 2012, from http://www.iea.org/.

Jacobsson, S. and Johnson, A. (2000) The diffusion of renewable energy technology: An analytical framework and key issues for research, *Energy Policy*, 28. pp. 625-640.

Kalish S. and Lilien G.L. (1983) Optimal price subsidy policy for accelerating the diffusion of innovation, *Marketing Science*, 2(4), pp. 407-420.

Krupa, J. Burch, S. (2011) A new energy future for South Africa: The political ecology of South African renewable energy, *Energy Policy, 39* (*10*)*,* pp. 6254-6261.

Krey, V. and Clarke, L. (2011) Role of renewable energy in climate mitigation: a synthesis of recent scenarios, *Climate Policy, 11(4),* pp. 1131-1158.

Lim, M. (2007) Clean Energy and Environmental Responsibility: How Your Company Can Benefit, *Enviromation*, pp. 415-417.

Madlener, R. and Stagl, S. (2005) Sustainability-guided Promotion of Renewable Electricity Generation, *Ecological Economics*, pp. 147-167

Mani, S. and Dhingra, T. (2011) Diffusion of innovation model of consumer behaviour: ideas to accelerate adoption of renewable energy sources by consumer communities in India, *Energy Policy.*

Maphisa, E. (2010) Factors influencing adoption of PBMR technology by energy intensive firms in South Africa, An MBA research report, Wits Business School, Johannesburg, South Africa

Menyah, K. and Wolde-Rufael, Y. (2010) Energy consumption, pollutant emissions and economic growth in South Africa, *Energy Economics,* 32, pp. 1374–1382.

Mewton R.T. and Cacho, O.J. (2011) Green power voluntary purchases: price elasticity and policy analysis, *Energy Policy*, 39, pp. 377-385.

Mining Weekly (2012) *NERSA lowers 2012 power price increase from 25.9% to 16%,* last accessed on 12 July, 2012, from http://engineeringnews.co.za/article/nersa-lowers-2012-power-price-increase-to-16-2012-03-09.

Montalvo, C. (2008) General wisdom concerning the factors affecting the adoption of cleaner technologies: a survey 1990–2007, *Journal of Cleaner Production,* 16(1), pp. S7-S13.

Nan Z., Xunhua, G. and Gouging, C. (2008) IDT-TAM Integrated Model for IT Adoption, *Tsinghua Science and Technology, 13(*3).

National Treasury (2010) *Reducing Greenhouse Gas Emissions: the Carbon Tax Option, Discussion Paper for Comment*, Pretoria, South Africa.

Odhiambo, N. (2011) Economic Growth and Carbon Emissions in South Africa: An Empirical Investigation, *The International Business & Economics Research Journal*, 10(7), pp. 75-83.

Owen, A.D. (2007) Renewable energy: Externality costs as market barriers, *Energy Policy,* 34, pp. 632–642.

Painuly, J.P (2002) Barriers to renewable energy penetration: a framework for analysis, *Renewable Energy*, 24(2), pp.73–89.

Pegels, A. (2010) Renewable energy in South Africa: Potentials, barriers and options for support, *Energy Policy*, 38(9), pp. 4945-4954.

Perkins R, Neumayer E. (2005) The international diffusion of new technologies: A multitechnology analysis of latecomer advantage and global economic integration, *Annals of the Association of American Geographers.*

Rao, K.U. and Kishore V.V.N. (2009) A review of technology diffusion models with special reference to renewable energy technologies, *Renewable and Sustainable Energy Revi*ews, 14, pp. 1070–1078.

Rogers, E. M. (1983) Diffusion of Innovations, 3rd ed. New York: The Free Press.

Rogers, E.M. (2002) Diffusion of preventative innovations, *Addictive Behaviours*, 27, pp. 989-993.

Rowley, J. (2002) Using case studies in research, *Management Research News*, 25(1), pp.16-27.

South Africa (2011a) Electricity Regulations Act No. 4 of 2006: Electricity Regulations on New Generation Capacity, *Government Gazette number 34262*, Government Printers, Pretoria.

South Africa (2011b) Electricity Regulations Act No. 4 of 2006: Electricity Regulations on the Integrated Resource Plan 2010 – 2030, *Government Gazette number*, Government Printers, Pretoria.

Schimmoller, B.K. (2004) Renewables get into the mix, *Power Engineering*, pp. 22-30.

Sebitosi, A.B and Pillay, P. (2005) Energy services in sub-Saharan Africa: how conducive is the environment?, *Energy Policy*, 33(16), pp. 2044-205.

Sebitosi A.B and Pillay P. (2008) Renewable energy and the environment in South Africa: A way forward, *Energy Policy,* 36, pp. 3312-3316.

Sebitosi, A.B and Pillay, P. (2008) Grappling with a half-hearted policy: The case of renewable energy and the environment in South Africa, *Energy Policy*, 36(7), pp. 2513-2516.

Sorensen B. (1991) A history of renewable energy technology, *Energy Policy.*

Straub, E. (2009) Understanding Technology Adoption: Theory and Future Directions for Informal Learning, *Review of Educational Research,* 79(2), pp. 625-649.

Surridge, A.D. Cloete, M. (2009) Carbon capture and storage in South Africa, *Energy Procedia*, 1(1), pp. 2741-2744.

Truffer, B., Markard, J. and Wu¨ Stenhagen, R. (2001) Eco-labelling of electricity: strategies and trade-offs in the definition of environmental standards, *Energy Policy*, 29(11), pp. 885–897.

Turner, J.A. (1999) A realisable renewable energy future, S*cience, New Series,* 285(5428), pp. 687-689.

Tyler, E. (2010) Aligning South African energy and climate change mitigation policy, *Climate Policy,* 10(5), pp. 575-588.

Unruh, G.C. (2000) Understanding carbon lock-in, *Energy Policy,* 28(12), pp. 817-830.

Utterback J.M. (1974) Innovation in industry and the diffusion of technology, *Science, New Series*, 183(4125), pp. 620-626.

Van Alphen K., Kunz H.S and Hekkert M.P (2007) Policy Measures to promote the widespread of utilisation of renewable energy technologies for electricity generation in the Maldives.

Waarts, E., van Everdingen, Y.M. and van Hillegerbrg, J. (2002) The Dynamics of Factors Affecting the Adoption of Innovations. *Product Innovation Management,* 19, pp. 412-423.

Wang, Y. 2006. Renewable electricity in Sweden: an analysis of policy and regulations, *Energy policy, 34(10), p*p. 1209-1220.

Windsor, D. (2010) The role of dynamics in stakeholder thinking, *Journal of Business Ethics: Supplement* 96, pp. 79-87.

Winkler, H (2005) Renewable energy policy in South Africa: policy options for renewable electricity, *Energy Policy, 33(1)*, pp. 27-38.

Winkler, H. Hughes, A. and Haw, M (2009) Technology learning for renewable energy: Implications for South Africa's long-term mitigation scenarios*, Energy Policy,* 37(11), pp. 4987-4996.

Winkler, H (2007) Energy Policy for Sustainable Development in South Africa*, Energy for Sustainable Development,* XI(1), pp. 26-34.

WRI (World Resources Institute) (2005) Navigating the numbers: greenhouse gas data and international climate policy; last accessed 5 February, 2012, from http://cait.wri.org/.

Wustenhagen, R. Wolsink, M. and Burer, M.J. (2007) Social acceptance of renewable energy innovation: An introduction to the concept, *Energy Policy*, 35, pp. 2683–2691.

Yuqiong, Z. (2008) Voluntary adopters versus forced adopters: integrating the diffusion of innovation theory and the technology acceptance model to study intra-organizational adoption, *New Media & Society,* pp. 475-496

Zawilska, E. Brooks, M.J (2011) An assessment of the solar resource for Durban, South Africa, *Renewable Energy*, 36(12), pp. 3433-3438.

Zikmund, W. (2003) *Business Research Methods*, 7th ed. South-Western, a division of Thomson Learning.

APPENDIX A

Research Instrument

Letter to the respondents

The Graduate School of Business Administration
2 St David's Place, Parktown,
Johannesburg, 2193,
South Africa
PO Box 98, WITS, 2050
Telephone: +27 11 717 3684
Website: www.wbs.ac.za



25 May 2012

Dear Respondent,

I am an MBA student at the Graduate School of Business Administration, University of the Witwatersrand and am conducting research as part of the fulfilment of requirements for the degree.

My research aims to explore factors that would influence the adoption of renewable energy technologies (RETs) by energy intensive users in South Africa. This research is timely and addresses an area of importance for South Africa given the need for firms to respond to issues arising from global climate change and national energy policies.

In carrying out this research project, I have prepared a short questionnaire directed at members of Energy Intensive Users Group (EIUG) of South Africa. As someone who is knowledgeable about the issue under investigation, you have been identified as a qualified source of information and insight. I hereby humbly request your input about your company's view on RETs adoption. The questionnaire should take approximately 25 minutes of your time and your co-operation would be much appreciated.

Information supplied as part of the survey will be used for academic purposes only, and all comments will be **non-attributable**.

My research is supervised by Professor Gillian Marcelle and she is available to answer any queries that you may have regarding the research process. Prof Marcelle can be reached at Gillian.Marcelle@wits.ac.za (mobile: +27 (0)82 492 3251).

Completed questionnaire can be emailed to magorotb@eskom.co.za or faxed to 086 663 8418.

Yours Sincerely,

_____

Bernard Magoro
MBA Student: Wits Business School
Tell: 011 871 2774
Mobile: 082 335 0872
Email: magorotb@eskom.co.za

Questionnaire

Research Topic:

Factors Influencing Adoption of Renewable Energy Technologies (RETs) by Energy Intensive Users in South Africa

Completed questionnaire to be returned to:

Bernard Magoro

Tell: 082 335 0872

Email: bernard.magoro@eskom.co.za

Fax: 086 663 8418

Respondent's information:

Name of Respondent	
Company	
Position within the company	
Email address	

Definition of Renewable Energy

Renewable energy is defined as energy sources derived from natural processes that are continually renewed (mainly through the heating of the earth). RET encompasses a wide range of energy sources and technologies; including solar power and heat, wind power, geothermal energy, bioenergy, hydroelectric power and ocean-based energy etc.

Q1. General Questions

1. How much energy does your company receive from any of these energy sources as a percentage of total energy usage?

Source of energy	**% of total energy usage**
Electricity from the grid	
Own source (e.g. co-generation)	
Bilateral arrangement with an independent supplier	

Other sources (please specify)	

2. Has your company already adopted any form of renewable energy technology (RET) in its energy mix? Please check appropriate box.

   ☐ YES

   ☐ NO

3. If your answer in **2 above is YES**, how much of your company's energy source is currently derived from RETs (as a percentage of total energy usage).

   _____ %

   Please provide the details of the RET sources_____

   _____

   _____

4. If your answer **in 2 above is NO**, does your company plan to adopt RET in future? Please check appropriate box.

   ☐ YES

   ☐ NO

   Please provide the details_____

   _____

   _____

5. Our company believes that there is an urgent need to address SA's greenhouse gas emissions associated with current energy technologies. Please check appropriate box.

   ☐ YES

   ☐ NO

6. Our company is aware of its contribution to the greenhouse gas emissions associated with current energy technologies. Please check appropriate box.

   ☐ YES

   ☐ NO

7. Our company prefers the following RET adoption strategy(s). Please check appropriate box.

Feed-in-Tariffs schemes where RET costs are socialised to all consumers and consumers have no choice of energy source they consume	☐
RE Portfolio Standard (self-build or bilateral arrangement with an independent RET developer)	☐
Other (please specify)	☐

Q2. Factors Influencing adoption of RET

Literature indicates that adoption of renewable energy technology (RET) by industry is influenced by many factors. The following sets of questions evaluate factors that **INFLUENCED** (if already adopted) or **WOULD INFLUENCE** your company's decision to adopt RET.

Please check ONE box for each question.

Q2.1. Public Policy

		Agree Strongly	**Agree Moderately**	**Agree Slightly**	**Disagree Slightly**	**Disagree Moderately**	**Disagree Strongly**
8.	South Africa (SA) has clear and unambiguous energy policy to facilitate the adoption of RET by our company.	☐	☐	☐	☐	☐	☐
9.	Our company is of the view that there is adequate consultation in energy policy development and implementation processes in SA.	☐	☐	☐	☐	☐	☐
10.	SA chosen economic instruments (i.e. RET feed-in-tariff and Carbon tax) will facilitate the adoption of RET by our company.	☐	☐	☐	☐	☐	☐
11.	Current SA energy policy incentivise our company to go beyond minimum government RET targets.	☐	☐	☐	☐	☐	☐
12.	Allowing bilateral RET markets (where a customer buy directly from the RET developer) will increase the rate of RET adoption by our company.	☐	☐	☐	☐	☐	☐
	Any other comment regarding SA renewable energy policy:						

Q2.2 Economic benefits

		Agree Strongly	Agree Moderately	Agree Slightly	Disagree Slightly	Disagree Moderately	Disagree Strongly
13.	RET usage will increase the cost of energy (e.g. electricity tariff) and it is a concern for us.	☐	☐	☐	☐	☐	☐
14.	Our company sees the potential benefits of RET and therefore willing to pay more to subsidise RET usage.	☐	☐	☐	☐	☐	☐
15.	RET usage will enhance our company's competitiveness in a carbon constrained world.	☐	☐	☐	☐	☐	☐
16.	Our company will adopt RET in order to gain new market opportunities.	☐	☐	☐	☐	☐	☐
17.	Our company is of the view that RET will be cheaper than conventional energy technologies in the long term.	☐	☐	☐	☐	☐	☐
	Any other comment regarding economics of RET perceived by your company:						

Q2.3 Stakeholder Influence

		Agree Strongly	Agree Moderately	Agree Slightly	Disagree Slightly	Disagree Moderately	Disagree Strongly
18.	Our company is conscious of the fact that our stakeholders (e.g. communities, employees, financiers, NGOs) are becoming increasingly aware of the benefits of RET.	☐	☐	☐	☐	☐	☐
19.	Our company will adopt RET due to **community pressure** and **public sentiment** towards fossil fuels based energy sources.	☐	☐	☐	☐	☐	☐
20.	Our company will adopt RET if our **financiers** requires us to do so in order to fund future projects.	☐	☐	☐	☐	☐	☐
21.	Our **customers** do require RET to be utilised as input in our production process.	☐	☐	☐	☐	☐	☐
22.	Our company is of the view that our **suppliers** do require RET to be utilised as input in our production process.	☐	☐	☐	☐	☐	☐
	Any other comment regarding stakeholder influence in RET adoption by your organisation:						

Q2.4 Leadership Values

		Agree Strongly	Agree Moderately	Agree Slightly	Disagree Slightly	Disagree Moderately	Disagree Strongly
23.	RET usage by our company was discussed at Board level at least once in the last 3 years.	☐	☐	☐	☐	☐	☐
24.	Our company has already taken steps to use RET.	☐	☐	☐	☐	☐	☐
25.	Our company constantly communicate to staff to create awareness of causes and dangers of global warming and the benefits of RET.	☐	☐	☐	☐	☐	☐
	Any other comment regarding your company leadership's commitment towards RET adoption:						

Q2.5 Technological opportunities and capabilities

		Agree Strongly	Agree Moderately	Agree Slightly	Disagree Slightly	Disagree Moderately	Disagree Strongly
26.	Compared to other technologies, RET will be the best technology choice for our company to reduce its **carbon footprint**.	☐	☐	☐	☐	☐	☐
27.	Compared to other technologies, RET will be the best technology for ***business* sustainability**.	☐	☐	☐	☐	☐	☐
28.	Compared to other technologies, RET will soon become **financially competitive from technology learning rates**.	☐	☐	☐	☐	☐	☐
29.	It will be easy to introduce RET in our current operations as part of our energy technology mix.	☐	☐	☐	☐	☐	☐
	Any other comment regarding opportunities and capabilities the RET can bring to your organisation:						

Q2.6 Organisation capabilities

		Agree Strongly	Agree Moderately	Agree Slightly	Disagree Slightly	Disagree Moderately	Disagree Strongly
30.	Our company has the dedicated Senior Manager responsible for energy planning including the choice of energy sources.	☐	☐	☐	☐	☐	☐
31.	Our company energy strategy makes it possible to consider non-conventional technologies (such as RET).	☐	☐	☐	☐	☐	☐
32.	Our company has the capability to absorb required information in order to understand RET, their benefits and usage.	☐	☐	☐	☐	☐	☐
33.	Our company has the capability to evaluate RET business cases.	☐	☐	☐	☐	☐	☐
	Any other comment regarding your organisation's capabilities to adopt RET:						