# A needs assessment of the market for resource efficiency and cleaner production services in the Vaal Triangle

**TC Botha**

23829532

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Supervisor: Prof RA Lotriet

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## ABSTRACT

Major energy-consuming countries implemented new laws on energy-efficiency during the course of 2013. The new energy-efficiency law make provision for a 16% reduction in energy intensity by 2015 in China. New law in the United States of America requires new fuel-economy standards. European Union law aims for a cut of 20% in energy demand for the countries forming part of the European Union. Japan, with the country's new energy strategy aims to decrease electricity demand with 10% by 2030 as stipulated in the new energy strategy.

South Arica is currently experiencing a shortage in electricity generating capacity and operates within its reserve margin. The construction of new power stations is in process to address the shortage but Eskom must finance these assets by increasing the electricity tariff. Electricity prices are predicted to double from 2013 to 2017. In addition to the tariff increases, the Energy Conservation Scheme (ECS) is also planned by Eskom whereby all electricity consumers have to reduce their electricity consumption by 10% or face penalties.

Energy efficiency initiatives in South Africa will help meet some of the country's social, economic, and environmental goals. These initiatives are important as they immediately tackle the problem of electricity shortages and are a cost-effective way of increasing available electricity supply.

The aim of this study was to determine the need for businesses in the Vaal Triangle to be resource efficient and practice clean production in order to be able to capitalise on that need. With the current knowledge and technology available, Resource Efficiency and Cleaner Production (RECP) will prove to be a future necessity for industry. To determine the perceived readiness towards a green economy contribution is thus of importance.

The study did a review on RECP, energy efficiency, supply of energy in South Africa, focus areas for energy efficiency and the benefits thereof. The study discussed energy efficiency incentive schemes and subsidisation funds available in South Africa. The study assessed the primary fields for RECP, the drivers and barriers to RECP and the willingness to participate in RECP initiatives in the Vaal Triangle.

The study concluded that there exists a need in the Vaal Triangle for RECP initiatives and that there exists potential for the start of a green economy in the region. The research indicated the reaction towards RECP initiatives to be very positive in the studied region.

Key words: Energy efficiency, energy management, energy optimisation, demand side management, green energy, resource efficiency and cleaner production.

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| | | |
|---|---|---|
| BUSA | - | Business Unity South Africa |
| CFL | - | Compact fluorescent light |
| COP | - | Conference of the Parties |
| DFID | - | Department for International Development |
| DoE | - | Department of Energy |
| DSM | - | Demand Side Management |
| DTI | - | Department of Trade and Industry |
| ECS | - | Energy Conservation Scheme |
| EELN | - | Energy Efficiency Leadership Network |
| ESCo | - | Energy Service Company |
| GDP | - | Gross domestic product |
| GHG | - | Green house gas |
| HVAC | - | Heating, ventilation and air conditioning |
| IDC | - | Industrial Development Corporation |
| IDM | - | Integrated Demand Management |
| IEA | - | International Energy Association |
| IPAP | - | Industrial Policy Action Plan |
| IPCC | - | Intergovernmental Panel on Climate Change |
| KSIA | - | King Shaka International Airport |
| kW | - | Kilo Watt |
| kWh | - | Kilo Watt hour |
| MCEP | - | Manufacturing Competitiveness Enhancement Program |
| MW | - | Mega Watt |
| NBI | - | National Business Initiative |
| NCPC-SA | - | National Cleaner Production Centre - South Africa |
| NEES | - | National Energy Efficiency Strategy |
| NERSA | - | National Energy Regulator of South Africa |
| OECD | - | Organisation for Economic Co-operation and Development |
| PI | - | Production incentive |
| PJ | - | Peta joule |
| PSEE | - | Private Sector Energy Efficiency |
| PV | - | Photo voltaic |

| | | |
|---|---|---|
| RECP | - | Resource Efficiency & Cleaner Production |
| REMS | - | Real time energy management system |
| SADC | - | Southern African Development Community |
| SANAS | - | South African National Accreditation |
| SANEDI | - | South African National Energy Development Institute |
| SCS | - | Statistical Consultation Services |
| UNFCCC | - | United Nations Framework Convention on Climate Change |
| UNIDO | - | United Nations Industrial Development Organisation |
| UK | - | United Kingdom |

# CHAPTER 1: NATURE AND SCOPE OF STUDY

## 1.1 INTRODUCTION

The energy sector poses a challenge for growth in the green energy sector given the scale of change required and the extent to which many countries are locked into polluting and greenhouse gas emitting energy sources. Currently there are two trends driving the green energy, energy efficiency and green technology industries. Firstly there is a global realisation that human activities are having a profound effect on the earth's climate, which may lead to unintended and possibly dramatic changes, and, secondly, the world's fossil fuels are becoming scarcer and more expensive (OECD:2014).

Organisations therefore get involved in carbon emission's reduction and green energy projects for different reasons. They do so from a moral obligation / image / branding point of view: For instance, the UK government buys "carbon offsets" to offset the contribution caused by the air travel of its officials. Fruit and wine producers, particularly those exporting to European markets, actively pursue improving their "carbon footprints" in order to gain competitive advantage (Anon., 2009). They are forced to do so by law: For instance, under the Kyoto Protocol Annexure 1 countries have carbon emission reduction targets, and have to meet these targets, buy so-called "carbon credits" or pay penalties (UNFCCC, 2014). The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its parties by setting internationally binding emission reduction targets (UNFCCC, 2014). They are incentivised to do so: In many countries such as the European countries and South Africa there are investment and tax incentives to develop and implement "green technology" or generate energy from renewable sources (SANEDI, 2014c).

In November 2009 South Africa's monopolistic, parastatal electricity producer Eskom applied for an electricity price increase of 35% per year for the following three years (2010, 2011 and 2012). Eskom was given permission for a 25% increase in electricity for the three years applied for with the first increase realising in April 2010. During 2012 Eskom applied for five 16% increases for the years 2013 – 2017. Eskom was granted five 8% increases by the National Energy Regulator of South Africa (NERSA). These increases will more than double the current average electricity price, taking it from 61 cents per kWh

in 2013, to 128 cents per kWh in 2017 (Anon., 2013). Energy is thus becoming an expensive necessity.

South Arica is currently experiencing a shortage in electricity generating capacity. During the later months of 2007 South Africa started experiencing widespread rolling blackouts as electricity supply fell behind electricity demand, threatening to destabilize the national grid. With a reserve margin estimated at 8% or below, load shedding is implemented whenever generating units are taken offline for maintenance, repairs or re-fuelling (in the case of nuclear units). Most people and organisations have been severely affected by load-shedding and interruption in power supply due to unplanned outages at power stations. To improve this situation, Eskom is in the process of constructing two new power stations namely Medupi in Limpopo and Kusile in Mpumalanga. The first of these new power stations ("Medupi") will only be running at full capacity in 2016 and Kusile in 2018. The construction of the two power stations experienced problems with control and instrumentation systems, the quality of welding on supplied boilers and labour unrest during the period of 2013 – 2014. According to the Citizen newspaper this caused the initial deadline for completion of the Medupi power station to be extended from end 2013 to 2016 (Anon., 2014).

In addition to the new power stations, Eskom has been planning for the last two years to launch the Energy Conservation Scheme (ECS), as part of demand side management (DSM) whereby all electricity consumers have to reduce their electricity consumption by 10%. Most large industries have received notice of this and would need to register baselines for annual electricity consumption. Eskom's ECS scheme will initially start with large power users and will progress systematically to smaller power users. If a consumer exceeds this monthly energy allocation (baseline), excess tariffs will be charged. The aim is to discourage excessive usage. The consumer is able to decide for itself how to reduce energy consumption and meet its energy allocation (Eskom, 2014a).

Energy efficiency is an imperative for South African companies based on the high increases in electricity prices. Energy efficiency and related cost savings will drive improved production capacity and operational effectiveness. Investing in energy efficiency is a strategic approach to ensure business competitiveness. The benefits of this investment include, but are not limited to (IDC, 2014):

- Modernisation of industrial equipment and the use of energy efficient technologies will result in reduced energy and other costs.
- Improved product quality and production capacity while increasing the company's profitability.
- Improved company image due to contributions to carbon footprint reduction and South Africa's sustainable development goals.
- Lower vulnerability to increasing energy prices.
- Increased company value.

The term “Resource Efficiency and Cleaner Production (RECP)” not only refers to electrical energy efficiency but addresses three sustainability dimensions individually and synergistically. The three sustainability dimensions in terms of RECP include: production efficiency (energy, water, materials and other resources), environmental management (minimising the impact on the environment) and social responsibility (minimising risk to human stakeholders) (NCPC, 2014).

With the electricity supply capacity at critical levels and year-on-year energy price increases to finance capacity expansion projects, it exerts pressure on energy users to become more resource efficient. Consumers of resources can move towards a more sustainable future whilst unlocking substantial operational savings by investing into Resource Efficiency and Cleaner Production initiatives and methods.

## 1.2 PROBLEM STATEMENT

The Vaal Triangle can be considered an industrial hub for South Africa (Vaal Triangle Info, 2014) containing some of the largest manufacturing companies in the country including, Sasol, Arcelor Mittal, Omnia, Eskom, DCD and Samancor. These are only a few examples of large industrial companies in the Vaal Triangle that make extensive use of resources including energy, people and the natural environment.

Except for the parastatal companies, companies in South Africa compete in the free market where there is always the natural drive to be more efficient, competitive and cost effective. Resource Efficiency and Cleaner Production initiatives focus to address these

issues while adhering to the triple bottom line (profitability, social responsibility and environmental responsibility) as stipulated in the King Code III of Good Governance.

The need for industry to be resource efficient and practice clean production must be determined in order to be able to capitalise on that need. With the current knowledge and technology available RECP will prove to be a future necessity for industry. It is thus of importance to determine the perceived readiness towards a green economy contribution.

The National Cleaner Production Centre – South Africa (NCPC-SA) and the National Business Initiative's (NBI) Private Sector Energy Efficiency (PSEE) in South Africa are programs that specifically fund energy and clean production audits up to the point of a fully subsidised audit. The National Cleaner Production Centre of South Africa (NCPC-SA) is a national programme of government that promotes the implementation of resource efficiency and cleaner production (RECP) methodologies to assist industry to lower costs through reduced energy, water and materials usage, and waste management (NCPC, 2014). The Council for Scientific and Industrial Research (CSIR) hosts the program on behalf of the Department of Trade and Industry (DTI). The second program is the Private Sector Energy Efficiency (PSEE) program of the National Business Initiative (NBI), a voluntary group of leading national and multinational companies (DeBeers, Engen, Toyota and BMW), working together to achieve a sustainable energy sector in South Africa. Towards this goal, the NBI was awarded £8.6 million from the UK Department for International Development (DFID) to implement a countrywide support programme to the South African private sector for the purpose of energy efficiency improvement (NBI, 2014).

A key resource such as electricity is becoming more expensive and limited in capacity, national law developed carbon taxes to force industry to act environmentally and socially responsible. The question arises whether a need in the Vaal Triangle for Resource Efficiency and Cleaner Production assessments exists and the implementation thereof when subsidised by external funding. Also the question arises whether a need exists for RECP services when it is not subsidised by external funds (NCPC-SA and PSEE) as might be the case in future.

## 1.3 OBJECTIVES OF STUDY

The research will have a primary objective and three supporting secondary objectives.

### 1.3.1 Primary objective

The primary objective of this research is to assess the need in the Vaal Triangle, for Resource Efficiency and Cleaner Production improvement initiatives.

### 1.3.2 Secondary objectives

In order to evaluate Resource Efficiency and Cleaner Production (RECP) within the Vaal Triangle, the study had also to have obtained data from within the Vaal Triangle regarding the following objectives:

- Determine the primary fields of resource efficiency and cleaner production in which industry would prefer to improve on.
- Determine the drivers that will drive industry to become resource efficient and strive to practice clean production.
- Determine the perceived barriers to Resource Efficiency and Cleaner Production initiatives.

## 1.4 RESEARCH METHODOLOGY

### 1.4.1 Literature review

A broad literature review was conducted to clarify the concept of Resource Efficiency and Cleaner Production and to understand and isolate the drivers behind the desire to become resource efficient and practice cleaner production.

The literature review also sheds some light on the background in which the research is done. The literature review covers a short history and current affairs regarding South Africa's electricity situation. The literature review covers the barriers and the drivers that act on RECP initiatives. The study investigates current incentive schemes and rebates

offered in South Africa by the government and foreign funds that subsidises RECP initiatives in South Africa. The possibility of legislation enforcing RECP especially electricity demand reduction is also covered.

The literature review investigates existing RECP services and products that are offered in the market. Benefits that arise from RECP implementation are covered in the literature review. The literature review comprises textbooks, academic journals, government acts and regulations and research done on the World Wide Web.

### 1.4.2 Empirical investigation

A quantitative research approach was followed in order to meet the objectives specified in this research study. The quantitative research approach was used because the study relied on a probability sample with in-depth statistical analysis. The quantitative approach underlies the natural-scientific method in human behavioural research and holds that research must be limited to what can be observed and measure objectively. The approach strives to formulate laws that apply to populations and that explain the causes of objectively observable and measurable behaviour (Welman *et al*., 2005:6).

#### 1.4.2.1 Measuring instrument

The measuring instrument that will be used for this study is a structured questionnaire making use of a four-point Likert scale to answer the questions posed to the respondents. The questionnaire also includes open-ended questions. The questionnaire was developed to keep the questions clear and understandable.

The first section of questions in the questionnaire covers the demographics of the respondent. Section 2 of the questionnaire investigates the primary fields of RECP including energy efficiency and the participation in energy audits, on-site recycling of waste materials, operations optimisation, using environmentally friendly materials and fuels.

The questionnaire, in section 3, tests the response on the drivers for RECP including a reduced carbon footprint, increased corporate social responsibility as a result of RECP,

subsidisation of RECP initiatives, improved brand image as a result of RECP, rising energy prices, improving working conditions, and the reduction of the energy bill by increasing efficiency.

The instrument, in section 4, covers the barriers to RECP initiatives including investment risk, lack of information causing feasible RECP opportunities to be missed, hidden costs regarding the implementation and participation of RECP, overstated potential benefits and returns, lack of capital funds set aside for RECP improvement, the lack of energy capable engineering services to identify and manage RECP opportunities and the lack of management commitment towards the improvement of RECP.

Section 5 tests the respondents' willingness to participate in RECP initiatives. Each section of the questionnaire also contains an open-ended question where the respondent is free to share ideas on the subject of the particular section. Section 6 contains one open-ended question. Distribution of the questionnaire is aimed at management in businesses and respondents with knowledge of energy efficiency and positive environmental practises. The questionnaires will be distributed to respondents who represent companies within the Vaal Triangle geographical area. In order to test the questionnaire, a pilot questionnaire was at first distributed in order to get feedback on the questionnaire regarding ease of use and clarity of the questions.

#### 1.4.2.2 Sampling

The sample population includes all businesses in the Vaal Triangle area. The population size is not known and this was confirmed by Mrs Erika van der Walt from the statistical department of the Emfuleni Municipality covering the Vanderbijlpark, Vereeniging and Meyerton area (Van der Walt, 2014). The statistical department confirmed that the municipality does not have a business portfolio or a data base with all the companies registered in the Emfuleni municipal area. The Emfuleni Municipality noted that the municipality is in the process of setting up a business portfolio with the help of Prof Daniel Meyer from the North-West University. The Emfuleni Municipality covers the majority of the Vaal Triangle.

The quantitative sampling techniques in this research study include purposive sampling and snow-ball sampling (Welman *et al.*, 2005:56). Purposive sampling was used because the questionnaire used as measuring instrument specifically targeted business owners and managers within businesses to ensure an appreciation for the cost of resources. Snow-ball sampling occurred naturally with the process of the initial purposive sampling and references to other potential participants were followed up and used in this research study (Welman *et al.*, 2005:69).

The measuring instrument was distributed to the members of the Vanderbijlpark Business Chamber and also distributed to non-members within the Vaal Triangle.

#### 1.4.2.3 Findings

Findings in this research study were made by statistically analysing all questionnaires completed by respondents. The analysis was outsourced to Mrs Erica Fourie at the Statistical Consultation Services of the North-West University (Van der Walt, 2014). The results from the statistical analysis are discussed in detail and further statistically analysed to draw conclusions from. The findings are represented in a structured and logical manner.

## 1.5 SCOPE OF THE STUDY

### 1.5.1 Field of study

The research study focuses on companies that make use of resources such as electrical energy. The sample includes businesses making use of resources to manufacture and add value while producing waste by products. The study focusses on assessing the needs for Resource Efficiency and Cleaner Production initiatives that aims to optimise the use of energy, raw materials, water and also the assessment of current production practices and the implementation of cleaner production practices.

### 1.5.2 Geographic boundaries

The research study focusses on companies operating within the Vaal Triangle of South Africa. The Vaal Triangle is formed predominantly by three towns including Vereeniging, Vanderbijlpark and Sasolburg. The three towns are positioned geographically within a

radius of 15km of each other. The Vaal Triangle was selected for the study as this area was traditionally considered as an industrial hub in South Africa (Vaal Triangle Info, 2014).

## 1.6 LIMITATIONS OF THE STUDY

A limitation of the study is that the scope is geographically concentrated in a relative small area and it is not necessarily representative of the rest of South Africa. Also the unknown target population of businesses in the Vaal Triangle is a limitation to the study and therefore it is difficult to generalise to the rest of South Africa.

## 1.7 CONTRIBUTION OF THE STUDY

The expected value of the study will lie in the fact that it will provide meaningful insight into the market for RECP assessments and implementation in the Vaal Triangle, provide information on the potential RECP market in the Vaal Triangle and will aid in gaining more knowledge on the type of RECP services required by the business sector in the Vaal Triangle.

The needs of the business sector that currently finds itself in an energy constrained environment coupled with tough economic conditions will aid research literature with unique results obtained driven by the current conditions in South Africa. The study will also aid research literature in a sense where energy efficiency and renewable energy is looked at with a renewed interest out of necessity. The study will help determine the perceived readiness towards a green economy contribution and will also gain knowledge about business' attitude toward RECP.

## 1.8 LAYOUT OF THE STUDY

**Chapter 1** provides an introduction into the drive behind the need to become more resource efficient and practice cleaner production practices. The chapter sheds some light on current matters regarding energy in South Africa and also discusses the benefits of RECP. Chapter 1 then progresses to a problem statement and the statement of the primary and secondary objectives. The research methodology is discussed, followed by

the scope of the study, limits of the study, contribution of the study and lastly the layout of the research study.

**Chapter 2** consists of a broad literature review that was conducted to conceptualise the term RECP and to understand and isolate the drivers behind the desire to become resource efficient and practice cleaner production. The literature review includes history on RECP and discusses it in both an international and national context. The study sheds some light on the background in which the research is done. It covers a short history and current affairs regarding South Africa's electricity situation. The study investigates current incentive schemes and rebates offered in South Africa by the government and other possible foreign funds that subsidises RECP initiatives in South Africa. The possibility of legislation enforcing RECP especially electricity demand reduction is also covered. The literature review investigates existing RECP services and products that are offered in the market. Benefits that arise from RECP implementation are covered in the literature review.

**Chapter 3** provides an empirical study done amongst companies, of different sizes and backgrounds in the Vaal Triangle industrial sector. A questionnaire was designed and sent out to respondents to gather data in order to understand and meet the objectives specified in this research study.

**Chapter 4** provides the conclusions and recommendations that were drawn from the empirical study. It also covers possible opportunities for future research related to this research study.

## 1.9 SUMMARY

Chapter one provides an introduction into the drive behind the need to become more resource efficient and practice cleaner production practices. The chapter discusses current matters regarding energy in South Africa and also discusses the benefits of RECP. Chapter 1 then progresses to a problem statement and the statement of the primary and secondary objectives. The research methodology is discussed, followed by the scope of the study, limits of the study, contribution of the study and lastly the layout of the research study.

# CHAPTER 2: RESOURCE EFFICIENCY OVERVIEW AND ENERGY IN SOUTH AFRICA

## 2.1 INTRODUCTION

The literature review conceptualises the term Resource Efficiency and Cleaner Production (RECP). In order to better understand the concept of RECP the literature review covers the primary fields of RECP, isolates the drivers behind the desire to become resource efficient and practice cleaner production and discusses the barriers that exist toward RECP initiatives.

The literature review discusses RECP and the component of energy efficiency in both an international and national context. The study will shed light on the background in which the research was done. The review covers a short history and perused current affairs regarding South Africa's electricity situation. The study investigates current incentive schemes and rebates offered in South Africa by the government and other possible foreign funds that subsidise RECP initiatives in South Africa and also the possibility of legislation enforcing RECP especially. Electricity demand management and reduction also receive attention in this review.

The literature review investigates existing RECP services and products that are offered in the market. Benefits that arise from RECP implementation are covered in the literature review.

## 2.2 RESOURCE EFFICIENCY AND CLEANER PRODUCTION

According to the National Cleaner Production Centre (NCPC, 2014), resource efficiency can be defined as a systematic and integrated approach to managing energy, water, environmental and financial resources, eliminating or minimising waste and emissions to the environment, on a sustainable and cost-effective basis. RECP improves the means to meet human needs while respecting the ecological carrying capacity of the earth. RECP is measured by the reduction of the resource use and the environmental impact from materials, emissions, and accidental releases per unit of production, trade, and consumption of goods and services over their full life cycles (NCPC, 2014).

The National Cleaner Production Centre (NCPC, 2014) states that RECP accelerates the application of preventative environmental strategies to processes, products and services, leading to increased efficiency and direct benefits to humans and the environment. RECP addresses the three dimensions of sustainable development namely the environment, human stakeholders and profitability, individually and synergistically. Energy efficiency is a component of RECP.

In particular, RECP helps industry to achieve operational efficiency and performance excellence to (NCPC, 2014):

- Reduce greenhouse gas (GHG) emissions and adapt to climate change.
- Address the increasing scarcity and cost of water, fuels and other materials.
- Increase job opportunities in a sustainable manner.
- Reduce environmental degradation.

An RECP assessment and implementation service includes a suitably qualified energy engineer or engineering team, for larger projects, to visit an organisation that consumes resources, in order to assess the facility. The RECP assessment engineer or engineering team then identifies opportunities to optimise the facility in terms of resource consumption and the sustainable utilisation thereof (NCPC, 2014). Following the identification of opportunities is the facilitation of implementation to realise these improvement opportunities and to capitalise on them. RECP forms (NCPC, 2014):

- On-site recycling, for example, harnessing the heat of compressors or electricity generators to be distributed elsewhere in the production process where heat is required.
- Process modification to optimise operations.
- Product redesign that may include less environmentally taxing materials. Use recyclable materials.
- Technology change to reduce wasteful practices.
- Input material substitution for less environmental impact by switching to lower carbon fuels.
- Improved housekeeping around material flows and maintenance practices
- Energy efficiency.

- Change human practises in the workplace to operate at a higher level of productivity.

Improving energy efficiency is one of the basic elements of Resource Efficiency and Cleaner Production (UNIDO, 2014:15). The improvement of resource efficiency and cleaner production primarily originates from energy efficiency improvement. Using less of a specific energy source (coal, diesel, electricity and steam) reduces the dependence on resources and also reduces carbon emissions resulting in cleaner production.

## 2.3 ENERGY EFFICIENCY

Energy efficiency is the ratio or quantitative relationship between an output of performance, service goods or energy and an input of energy. Examples of energy efficiency in most basic terms include (Department of Energy, 2012:iv):

- Conversion efficiency – for example, how much joule of energy is consumed in terms of fuel for every joule of kinetic energy produced.
- Energy required / energy used – determines how energy-efficient the energy consuming process is operated.
- Output / input – hours of labour per unit of production.

The Department of Energy (2012:iv) requires that in the above examples both the input and output needs to be clearly specified in quantity and quality and be measurable.

Improving energy-efficiency can be defined as using less energy to provide the same level of service. For example, when a compact florescent light (CFL) uses less electricity than an incandescent bulb to produce the same amount of light, the CFL is considered to be more energy-efficient (International Energy Agency 2012:270).

Energy savings can arise from more than just switching to more energy-efficient technology. Fuel switching can also reduce primary energy needs. For example, switching away from a gas boiler for space heating to the use of heat pumps can substantially reduce energy needs per unit of heat produced.

The International Energy Agency (2012:270) states that energy consumption is also dependent on human behavioural factors, such as the chosen temperature level that is

maintained inside the workplace for a certain desired level of thermal comfort or the preference of which mode of transport to use for personal mobility (car, motorbike, public transport, and bicycle). In many cases, savings that arise from behavioural changes are classified as energy conservation, rather than energy-efficiency.

According to the International Energy Agency (2012:270) the main difference between the two is that reducing the absolute level of energy demand is the primary goal of energy conservation, if necessary, at the expense of personal comfort or satisfaction, while improved energy efficiency aims to reduce the energy consumed for delivering the same level of service or output.

### 2.3.1 The categories of energy efficiency management

According to Backlund *et al*. (2013:4) energy management practices can be adopted within four principal areas: energy-efficient technologies, load management, energy conversion, and encouraging more energy-efficient behaviour (energy conservation). Energy-efficiency in broad terms can be categorised into four energy management approaches (Department of Energy, 2012:15):

- Energy conservation
- Pure energy efficiency
- Fuel substitution:
    - Renewable energy
    - Other fuels (Fuel switching)
- Re-generation / own generation

The four management approaches are discussed in the following sections below. Recent research shows that, when not only adoption of technology but energy management practices is included, the energy-efficiency potential is in fact higher (Backlund *et al.*, 2013:4).

#### 2.3.1.1 Energy conservation

Energy conservation refers to the reduction of energy consumption without impacting on production and or safety. An example of energy conservation would be to switch off lights in unoccupied areas after hours.

#### 2.3.1.2 Pure energy efficiency

Pure energy efficiency is the relationship between a certain output and the amount of energy input required to obtain the specified output. An example of pure energy efficiency is to replace an incandescent light bulb with an energy efficient fluorescent light bulb, with a lower wattage rating, that still produces the same amount of luminescence as was produced by the incandescent light bulb.

#### 2.3.1.3 Fuel substitution

Fuel substitution can refer to adding renewable or “green” energy generation capacity to the demand side of utility supply. An example of switching to a renewable source of energy is to install photo voltaic (PV) panels to reduce electricity demand. Fuel switching can also refer to changing the current fuel source to an alternative source of fuel; for example, retrofitting an internal combustion engine that combusts diesel to use natural gas alternatively.

#### 2.3.1.4 Re-generation / own generation

Re-generation or own generation refers to the generation of energy from waste which is fed into the demand side of the utility supply to lessen the use of the utility supply. Generating electricity from waste process heat or generating process heat for use from burning waste materials are examples of re-generation and own generation respectively.

## 2.4 GLOBAL VIEW OF ENERGY EFFICIENCY

In 2013, all major energy-consuming countries introduced new legislation on energy efficiency, making provisions for a 16% reduction in energy intensity by 2015 in China,

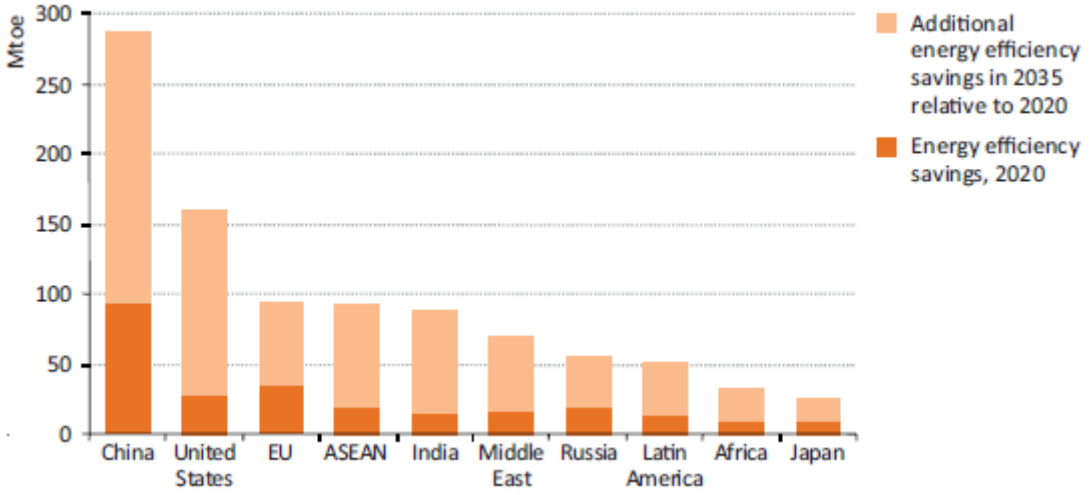
new fuel-economy standards in the United States and a cut of 20% in energy demand in the European Union in 2020. Japan also aims to achieve a 10% reduction in electricity demand by 2030 in its new energy strategy (International Energy Agency, 2012:269).

The International Energy Agency (IEA) (2012) refers to a New Policies Scenario in the World Energy Outlook publication. The New Policy Scenario takes into account broad policy commitments (including the Kyoto protocol) and plans that have been announced by countries, including national pledges to reduce greenhouse-gas emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments have yet to be identified or announced. This broadly serves as the IEA baseline scenario.

The World Energy Outlook 2012 (IEA, 2012:269) states that under the New Policies Scenario, increased efficiency accounts for about 70% of the reduction in projected global energy demand in 2035, compared with the Current Policies Scenario. China, the United States, the European Union and Japan account for more than half of the savings, reflecting their dominance in global energy use and the emphasis placed on energy-efficiency in these regions. Additional investment of $3.8 trillion to improve energy efficiency in end-use sectors is needed over 2012- 2035, an average of $158 billion per year. Energy efficiency measures in the New Policies Scenario account for 68% of the cumulative global savings in $CO_2$ emissions relative to the Current Policies Scenario.

In Figure 2.1 below the savings in primary energy (coal, crude oil, petroleum, gas, nuclear, hydro and renewables) due to energy-efficiency in the New Policies Scenario by 2035 is compared to the Current Policies Scenario.

Figure 2.1: New Policy Scenario compared to Current Policy Scenario.



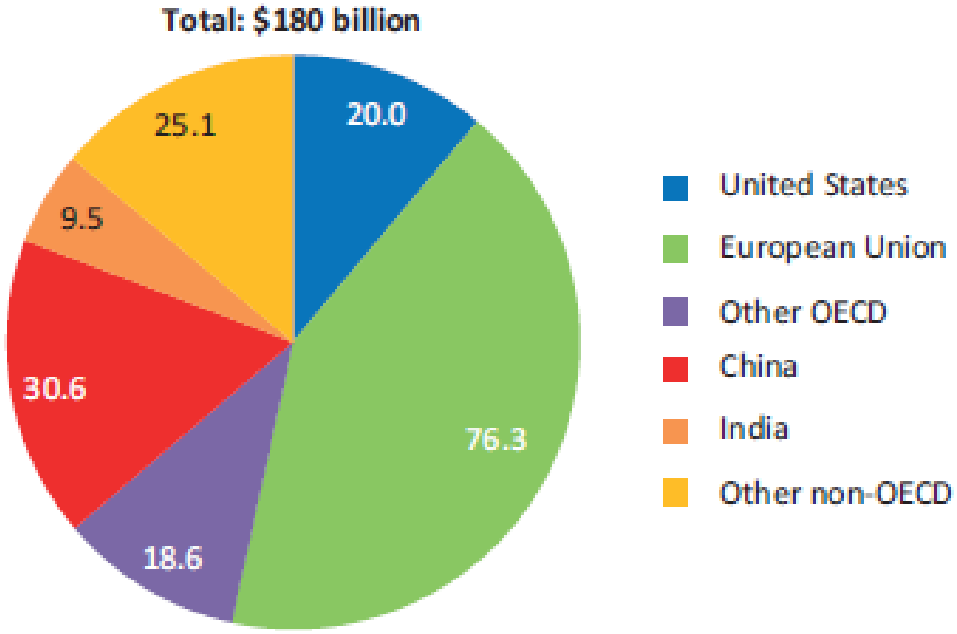

(Source: IEA, 2012)

Despite the vital role that energy-efficiency plays in cutting demand in the New Policies Scenario, only a small part of its economic potential is exploited. Over the projection period, four-fifths of the potential in the buildings sector and more than half in industry still remain untapped. Much stronger policies could realise the full potential of energy-efficiency and deliver significant economic, environmental and energy security gains.

### 2.4.1 Global energy efficiency investment

The World Energy Outlook 2012 (IEA, 2012:296) estimated global investment in projects aimed principally at improving energy efficiency amounted to $180 billion in 2011. This is significantly lower than the investment in expanding or maintaining fossil fuel supply (nearly $600 billion). About two-thirds of the estimated investment in energy-efficiency in 2011 was undertaken in *Organisation for Economic Co-operation and Development* (OECD) countries. Figure 2.2 below shows the invested amounts in energy-efficiency for different regions and countries.

Figure 2.2: Investment in energy efficiency by country and region.




(Source: World Energy Outlook 2012)

## 2.5 ENERGY EFFICIENCY IN SOUTH AFRICA

Frost and Sullivan (2014) state that energy-efficiency initiatives in South Africa will help meet some of the country's social, economic, and environmental goals. These initiatives are important as they immediately contribute to slowing the problem of electricity shortages and are a cost-effective way of increasing available electricity supply.

The World Energy Council has the Energy Sustainability Index that ranks countries in terms of their likely ability to provide sustainable energy policies through the three dimensions of the energy trilemma (World Energy Council, 2014):

- **Energy security**: the effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of participating energy companies to meet current and future demand.
- **Energy equity**: the accessibility and affordability of energy supply across the population.
- **Environmental sustainability**: the achievement of supply and demand-side energy efficiencies and the development of energy supply from renewable and other low-carbon sources.

The world index rank for a specific country measures overall performance and the balance score that highlights how well a country manages the trade-offs between the three competing dimensions: energy security, energy equity, and environmental-sustainability. The best score ‘A’ is given for a very high performance. Countries with good results are awarded with the score ‘B’. High performers receive the score ‘AAA’ while countries that do not yet perform well receive a ‘DDD’ score (World Energy Council, 2014).

South Africa ranks number 79 on the world index for energy sustainability and on the balance score achieves a BCD score. South Africa thus performs good in the field of energy security, performs poorly in terms of accessibility and affordability of energy and in the fields of energy-efficiency and the development of renewable energy sources performs very poor. The complete index with 129 ranked countries out 196 countries of the world can be viewed in Appendix A.

The National Energy Efficiency Strategy (NEES) of South Africa was officially implemented in 2005 and has eight key social, environmental, and economic goals (Department of Energy, 2012). These goals will be discussed in the next section.

### 2.5.1 South African energy efficiency strategy goals

The National Energy Efficiency strategy of 2008 listed the eight goals, to be achieved by 2015, of the strategy under the three categories of the Triple Bottom Line approach (Department of Energy, 2008 4):

#### 2.5.1.1 Social sustainability:

- Goal 1: Improve the health of the nation – energy-efficiency reduces the atmospheric emission of harmful substances such as oxides of sulphur, oxides of nitrogen, and smoke. Such substances are known to have an adverse effect on health and are frequently a primary cause of common respiratory ailments.
- Goal 2: Job Creation – studies show that jobs will be created by the spin-off effects of energy-efficiency implementation. Improvements in commercial economic performance, and uplifting the energy-efficiency sector itself, will inevitably lead to nationwide employment opportunities.

- Goal 3: Alleviate energy poverty – energy efficient homes not only improve occupant health and well-being, but also enable the adequate provision of energy services to the community at an affordable cost.

#### 2.5.1.2 Environmental sustainability:

- Goal 4: Reduce environmental pollution – energy-efficiency will reduce the local environmental impacts of its production and use. These impacts include the atmospheric emission of harmful and odorous gases.
- Goal 5: Reduce $CO_2$ emissions – energy-efficiency is one of the most cost-effective methods of reducing greenhouse gas emissions, and thereby combating climate change. Addressing climate change opens the door to utilising novel financing mechanisms, such as the CDM, to reduce $CO_2$ emissions.

#### 2.5.1.3 Economic sustainability

- Goal 6: Improve industrial competitiveness - adoption of appropriate energy efficiency measures has been demonstrated as one of the most cost-effective ways of maximising commercial profitability. Nationwide, this will improve South Africa's export performance and improve the value that the economy derives from indigenous energy resources.
- Goal 7: Enhance energy security – energy conservation will reduce the necessary volume of imported primary energy sources, crude oil in particular. This will enhance the robustness of South Africa's energy security and will increase the country's resilience against external energy supply disruptions and price fluctuations.
- Goal 8: Reduce the necessity for additional power generation capacity – the NEES estimated that the country's power generation capacity would be insufficient to meet the rising national maximum demand by 2007-2012. Energy efficiency is integral to Eskom's Demand Side Management program, which is intended to reduce the level of load growth by a cumulative value of 4255 MW by 2025, equivalent to a saving of a six unit coal-fired power station. Efforts will be made to give Eskom responsibility for meeting a portion of the target set out in this strategy through its annual shareholder compact.

The eight goals are used to set energy efficiency targets for all sectors in South Africa which translates into a targeted reduction in energy intensity of 12% by the end of 2015.

### 2.5.2 South African energy efficiency targets

The NEES set the following targets for reduction in energy usage per sector and for the reduction of the overall energy intensity of the country (Department of Energy, 2012: 11):

- Industry and mining sector – An energy efficiency improvement of 15% by 2015
- Power generation sector - An energy efficiency improvement of 15% by 2015 measured by looking at usage of all equipment other than that of the thermo dynamic cycle.
- Commercial and public building sector – An energy efficiency improvement of 15% by 2015
- Residential sector – An energy efficiency improvement of 10% per capita by 2015
- Transport sector – An energy efficiency improvement of 10% by 2015
- Total energy efficiency target – An overall reduction in energy intensity of 12% by 2015

Within each sector key areas exist for the implementation of energy efficiency with different factors that will determine the success of energy-efficiency initiatives.

### 2.5.3 Key implementation areas and success factors

According to Frost and Sullivan (2014), the key implementation areas for energy-efficiency and energy management projects are heating, ventilation, and air conditioning (HVAC); lighting; efficient motors; effective water heating; and building management and regular maintenance.

Frost and Sullivan (2014) state that the key success factors for energy-efficiency project implementation in South Africa include the following:

- Using some form of subsidisation or rebate scheme offered.
- Using real-time metering.
- Making optimal use of a company's resources.

- Using human capital effectively, and training staff on energy-efficiency and implemented initiatives.
- Planning energy management projects effectively.
- Targeting low-hanging fruit first (Efficient lighting).

### 2.5.4 Energy-efficiency accord

The Energy Efficiency Accord was introduced in 2005 after the implementation of the NEES. The initiative included a voluntary agreement between major energy users, industry associations, and the government through the Ministry of Energy and Minerals. The accord included companies from the commercial, industrial, and mining sectors, which are some of the country's top energy users. By signing the accord, companies agreed to individually and collaboratively work on achieving government energy targets as stipulated in the NEES (National Business Initiative (NBI), 2014).

The National Energy Efficiency Leadership Network (EELN) was launched in December 2011 at the 17th Session of the Conference of the Parties (COP17) by a partnership between the National Business Initiative (NBI), Business Unity South Africa (BUSA), and the Department of Energy (DoE). The EELN is voluntary and replaced the energy efficiency accord. The EELN allows its members to create and apply their own energy management plans, baselines, and energy-efficiency targets to their businesses. Signatories of the EELN voluntarily pledge to do the following (NBI, 2014):

- Develop internal energy-efficiency targets.
- Develop a roadmap for improved energy efficiency.
- Report on efforts and progress made to promote energy-efficiency.

Companies will also work with stakeholders to help develop energy-efficiency programs by driving behavioural changes and developing required skills to implement energy-efficiency initiatives. In order to be able to set targets for energy-efficiency in South Africa, it is important to understand the energy supply of the country.

## 2.6 PRIMARY ENERGY SUPPLY AND DEMAND IN SOUTH AFRICA

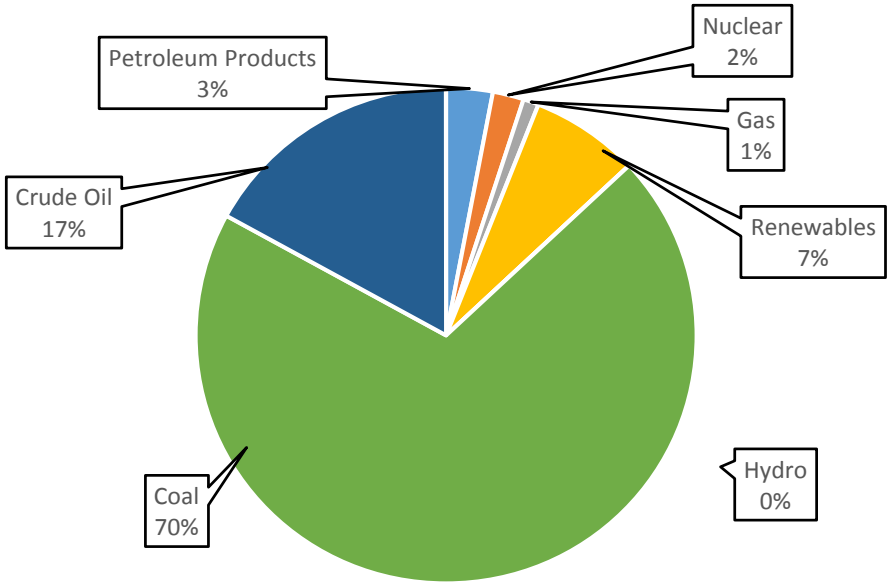
According to Roos (2009:4) South Africa is the 12th largest carbon dioxide ($CO_2$) emitter on the planet, but only the 30th largest economy. This is due, firstly, to the energy intensity of the economy and, secondly, to the fact that South Africa is overwhelmingly dependent on coal for energy, compared to other fuels. This also results in South Africa performing poorly in terms of the development of renewable energy sources as discussed in section 2.5. Energy intensity is calculated as units of energy per unit of GDP:

- 87.2% of electricity generation capacity by Eskom is based on coal-fired stations
- 30% of liquid fuel is made from coal by Sasol using the Fischer-Tropsch process, making the Sasol Secunda plant the biggest single point source of CO2 emission on the planet.

South Africa is a developing country but also has significant heavy-industrial and extractive-industrial (mining and mineral extraction) components in the economy. The country's large coal fields and mineral reserves have given the South African economy a competitive advantage that resulted in an industrialised economy (Department of Energy, 2012:5).

Figure 2.3 below graphically depicts the six primary sources of energy, in South Africa. From the chart it is clearly visible that coal and crude oil dominates the overall supply with 70% and 17% of the total supply respectively. The total energy supply to South Africa was 6 364 petajoule (PJ) in 2009 as against 4 295 PJ in 2000 (Department of Energy, 2012:6).

Figure 2.3: Primary Energy Supply in South Africa.

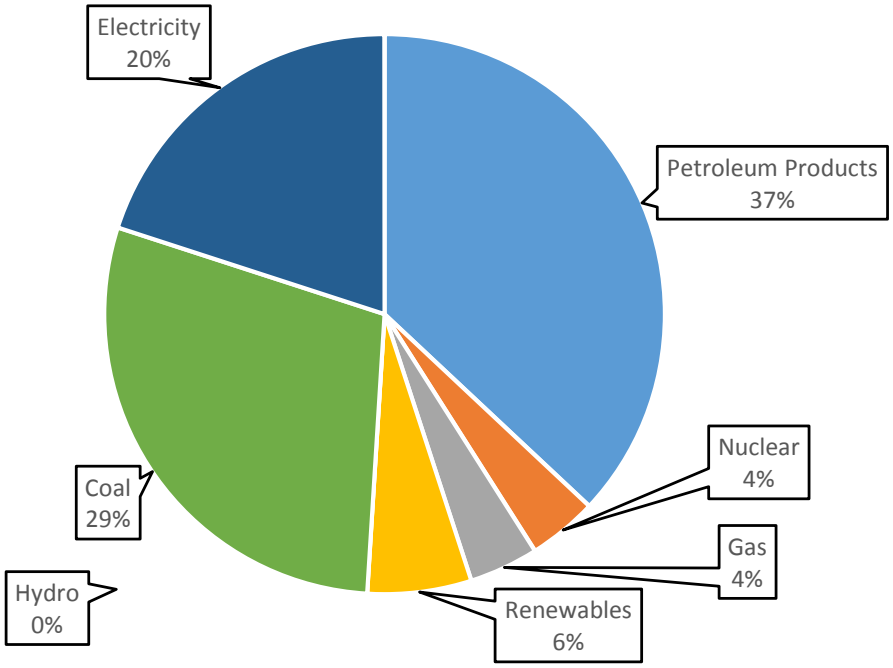



(Source: Department of Energy, 2012: 6)

Petroleum products are the largest of the energy carriers in terms of energy content. This is of significance to the national Balance of Payments because crude oil is South Africa's single largest import and most of its downstream products are utilized by the transport sector (Department of Energy, 2012:7).

Figure 2.4 below illustrates the split of final energy use for each individual energy carrier. Energy carriers include electricity and heat as well as solid, liquid and gaseous fuels. They occupy intermediate steps in the energy-supply chain between primary sources and end-use applications. An energy carrier is thus a transmitter of energy. For reasons of both convenience and economy, energy carriers have shown a continual shift from solids to liquids and more recently from liquids to gases (IPCC,2014).

Figure 2.4: Final Energy user by carrier.



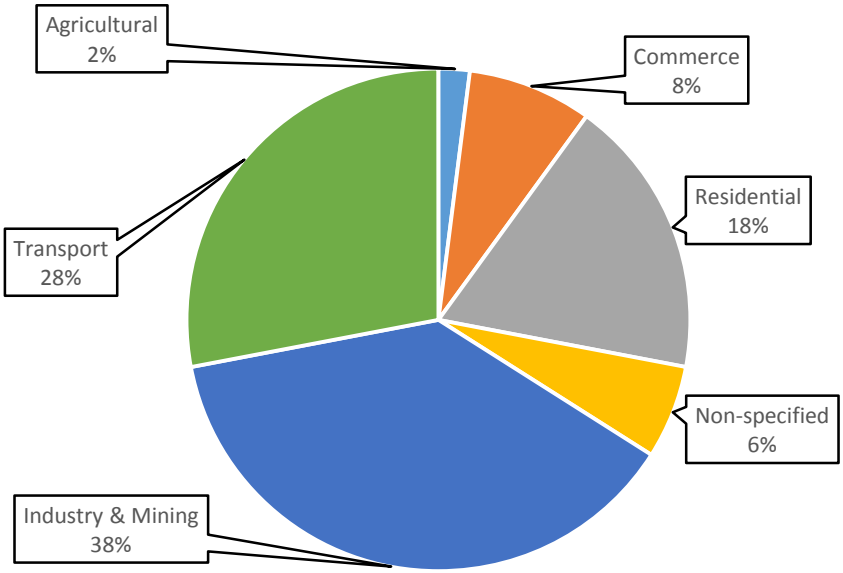

(Source: Department of Energy, 2012:8).

The top three forms of energy consumed in South Africa are illustrated in Figure 2.4 above. The top three carriers dominate the whole spectrum with petroleum products at 37%, coal at 29% and electricity at 20%.

The final use of energy is illustrated, in figure 2.5 below, for each sector in South Africa. There are three economic sectors accounting for 84% of the final usage:

- Industry and Mining (38%)
- Transport (28%)
- Residential (18%)

Figure 2.5: Final energy use by economic sector.




(Source: Department of Energy, 2012: 7).

The agriculture, commerce and non-specified economic sectors account for the remaining 16% of final energy usage in South Africa. The totalized final energy demand by sector in 2009 was 3 236 PJ, as against 2 193 PJ in 2000 showing 47% increase in energy demand for this period. (Department of Energy, 2012:7).

## 2.7 ENERGY INTENSITY IN SOUTH AFRICA

Energy intensity is calculated as units of energy per unit of GDP (Roos, 2009:4). A common way to measure and compare the energy intensity of different countries, and how this changes over time, is to look at the ratio of energy supply to gross domestic product (GDP). It should be noted that energy intensity is not the ultimate indicator or measure of energy-efficiency, as the latter depends on numerous elements such as the (OECD, 2012):

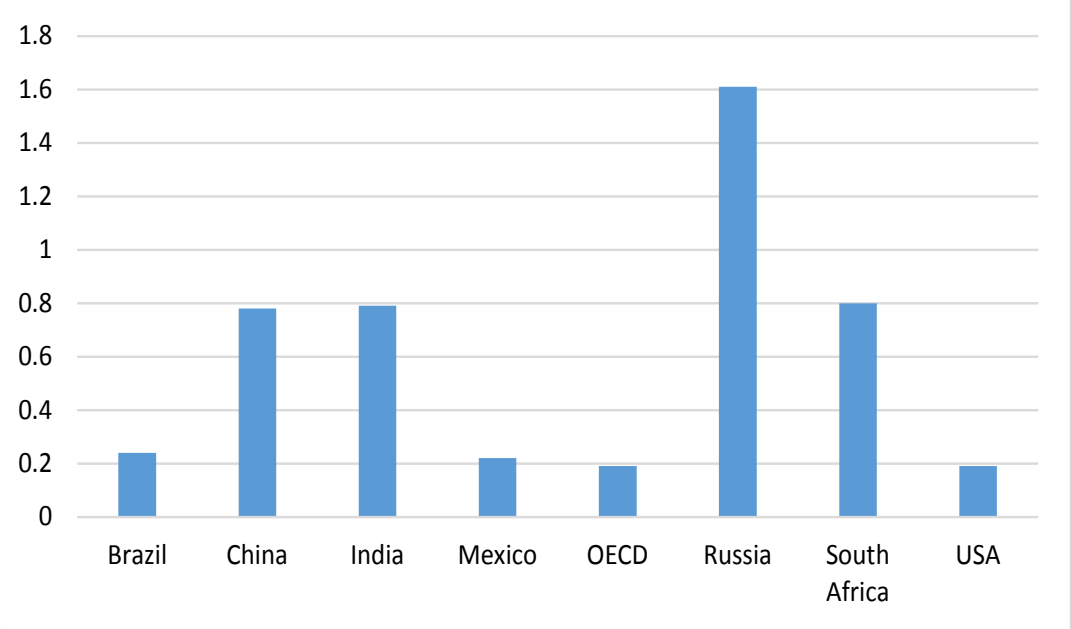
- Climate.
- Output composition.

- Outsourcing of goods produced by energy-intensive industries.

The abovementioned influencing factors are not considered by the simple measure of energy supply to GDP.

By international standards South Africa uses a high amount of energy per unit of GDP and in 2009 South Africa ranked third amongst the world's largest economies for the amount of primary energy supplied per unit of GDP as illustrated in Figure 2.6 below (Department of Energy, 2012:5). The energy prices in South Africa also increases rapidly as discussed in the next section.

Figure 2.6: Total primary energy supply per unit of gross domestic product (GDP).




(Source: Department of Energy, 2012:5).

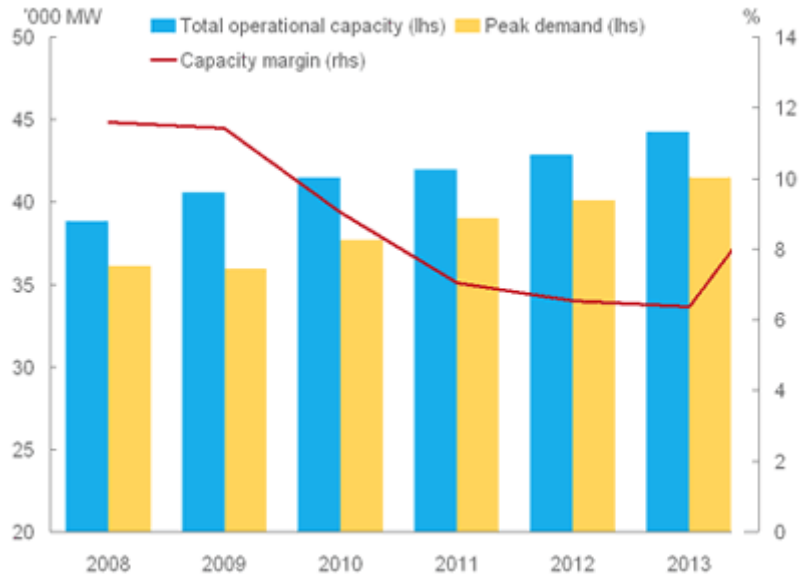
## 2.8 NATIONAL ELECTRICITY SUPPLY AND PRICE INCREASES IN SOUTH AFRICA

South Africa's monopolistic, parastatal electricity producer Eskom generates approximately 95% of the electricity used in South Africa and approximately 45% of the

electricity used in Africa (Eskom, 2014b). Eskom generates, transmits and distributes electricity to industrial, mining, commercial, agricultural and residential customers and redistributors. Redistributors are entities such as municipalities that resell the electricity from Eskom. Eskom has net maximum self-generated capacity of 41 194 MW. Eskom also buys electricity from and sells electricity to the countries of the Southern African Development Community (SADC) (Eskom, 2014b).

South Arica is currently experiencing a shortage in electricity generating capacity. During the second semester of 2007 and during 2008 South Africa started experiencing widespread rolling blackouts as electricity supply fell behind electricity demand, threatening to destabilize the national grid. The national grid is the assets and infrastructure owned and operated by Eskom that distributes electricity throughout South Africa. With a reserve margin estimated at 8% or below, load shedding is implemented whenever generating units are taken offline for maintenance, repairs or re-fuelling (in the case of nuclear units) (Department of Energy, 2012:5). Most people and businesses in South Africa have been severely affected by load-shedding and interruption in power supply due to unplanned outages at power stations. Eskom's historic reserve margin, operational capacity and peak demand is indicated in Figure 2.7 below.

Figure 2.7: Eskom Operational Capacity & Reserve Margin.




(Source: Sanlam Intelligence, 2009)

The reserve margin is the difference between operational generation capacity and peak demand. The capacity margin indicates the extent of the country's electricity supply constraint. During the electricity crisis in 2008, the reserve margin fell to near zero, resulting in the implementation of crisis measures, including power rationing and conservation. During 2008 it was expected that peak demand would have to be reduced by 3000 MW to 5000 MW. Subsequently, the 2008 recession alleviated the situation (Sanlam Intelligence, 2009).To improve this situation, Eskom is currently in the process of constructing two new power stations namely Medupi and Kusile. The first of these new power stations ("Medupi") will only be running at full capacity in 2016. The start date for Medupi was delayed due to construction problems.

In order to be able to finance Medupi and Kusile power stations Eskom applied at the National Energy Regulator of South Africa, in November 2009 for an electricity price increase of 35% per year for the following three years (2010, 2011 and 2012). Eskom was given the go-ahead for a 25% increase in electricity for the three years applied for with the first increase realising in April 2010. During 2012 Eskom applied for five 16% increases for the years 2013 – 2017. Eskom was granted five consecutive 8% increases by the National Energy Regulator of South Africa (NERSA). According to an article in the Mail & Guardian newspaper, this increases will more than double the current average electricity price, taking it from 61 cents per kWh in 2013, to 128 cents per kWh in 2017 (Anon 2013).

In addition to the new power stations, Eskom has been planning for the last two years to launch the Energy Conservation Scheme (ECS) whereby all industrial and commercial electricity consumers have to reduce their electricity consumption by 10%. Most large industries have received notice of this and would need to register baselines for annual electricity consumption. A baseline is the electricity required by a company to operate and from which the 10% reduction will be measured against. Eskom's ECS scheme will initially start with large power users and will progress systematically to smaller power users. If a consumer exceeds this monthly energy allocation (baseline), excess tariffs will be charged as penalisation. The aim is to discourage excessive usage. The consumer is able to decide for itself how to reduce energy consumption and meet its energy allocation (Eskom, 2014b).

## 2.9 BARRIERS TO ENERGY EFFICIENCY

Apeaning and Thollander (2007:206) state that although the prospects of increasing energy-efficiency are vast, the prospects are usually overlooked since the potential to implement cost effective energy-efficiency solutions are held back by some critical factors. These critical factors are referred to as barriers. A barrier in this regard can be defined as a postulated mechanism that inhibits investments in technologies that are both energy-efficient and (apparently) economically efficient (Sorrell *et al*., 2004). In order words, a barrier comprises all factors that either hamper the adoption of cost-effective energy-efficient technologies or slow down their diffusion in the market (Fleiter *et al.*, 2011). Energy-efficiency barriers are broadly classified under three main categories namely (Apeaning & Thollander, 2007:206):

- Economic barriers.
- Organisational barriers.
- Behavioural (psychological) barriers.

Schleich (2007:88) lists and describes barriers to energy-efficiency in further detail in Table 2.1 below.

Table 2.1: Taxonomy of barriers to energy-efficiency with the main category assigned

| Barrier | Claim |
|---|---|
| **Risk (Organisational)** | Short paybacks required for energy efficiency investments may reflect a rational response to higher technical or financial risk and business and market uncertainty. |
| **Imperfect information (Organisational)** | Lack of information on energy-efficiency opportunities may lead to cost effective opportunities being missed. |
| **Hidden Costs (Economic)** | Engineering-economic analyses may fail to account for either the reduction in utility associated with energy-efficiency technologies, or the additional costs associated with them. As a consequence, the studies may overestimate the energy efficiency potential. Hidden |

| | |
|---|---|
| | costs include overhead costs for management, disruptions to production, staff replacement and training, and the costs associated with gathering, analysing, and applying information. |
| **Access to capital (Economic)** | If the organisation cannot raise sufficient external funds, energy-efficient investments may be prevented from going ahead. Investment could also be inhibited by internal capital budgeting procedures, investment appraisal rules, and the short-term incentives of energy management staff. |
| **Split incentives (Behavioural)** | Energy-efficiency opportunities are likely to be foregone if stakeholders cannot appropriate the benefits of the investment. For example, if individual departments within an organisation are not accountable for their energy use, they will have no incentive to improve energy-efficiency. |
| **Bounded rationality (Behavioural)** | Owing to constraints on time, attention, and the ability to process information, individuals do not make decisions in the manner assumed in classical economic models. As a consequence, they may neglect energy efficiency opportunities, even when given good information and appropriate incentives. |

(Source: Schleich, 2007:88)

As opposed to the barriers to energy-efficiency certain drivers for energy-efficiency exist which are discussed in the following section.

## 2.10 DRIVING FORCES FOR IMPROVED ENERGY EFFICIENCY

Frost and Sullivan (2014) state that the drivers promoting the implementation of energy-efficiency initiatives in the commercial sector include the rising cost of electricity, government initiatives, and climate change. Lowered energy use and direct fiscal

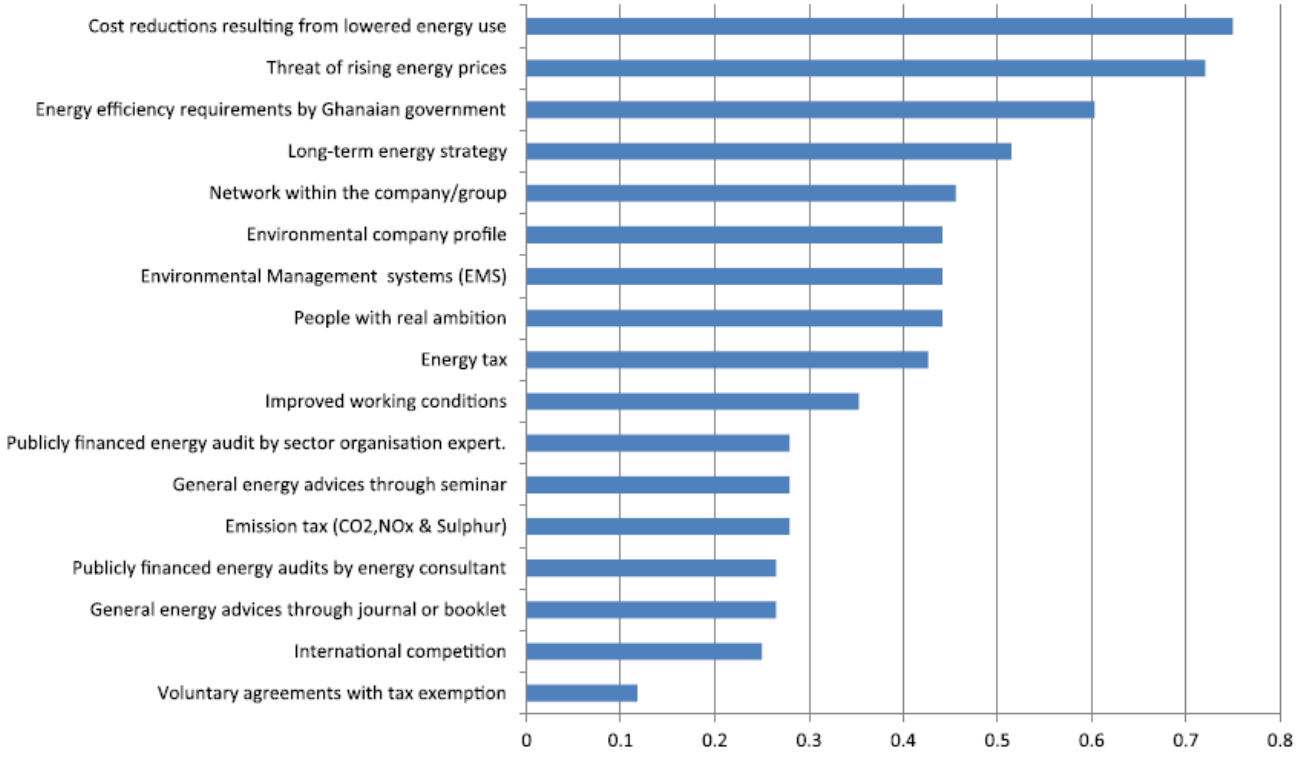
subsidies is ranked highest by De Groot *et al.* (2001:737) as drivers for improved energy-efficiency.

Financially related driving forces, followed by organisational ones, are evaluated as the most relevant. By looking at financial drivers, the threat of rising prices as well as cost reductions resulting from lowered energy use are indeed perceived as the strongest driving forces towards more energy-efficient production (Backlund *et al.,* 2013:16).

The relevance of organisational driving forces such as commitment from top management and people with real ambition shows that, in order to be effectively implemented, energy-efficient investments should become a priority on the agenda of company management (Backlund *et al.,* 2013:16).

Apeaning and Thollander (2007:206) rank the drivers for energy-efficiency improvement in African industries, using a scale of 0 (not important), 0.5 (often important) and 1 (very important), in Figure 2.8 below.

Figure 2.8: Ranking of driving forces for energy-efficiency improvement.




(Source: Apeaning & Thollander, 2007:206)

In Figure 2.8, “environmental company profile” and “environmental management systems” ranks in seventh and eighth position respectively. “Environmental company profile” and “environmental management systems” as driving forces were, however, ranked highly by multi-national companies and companies competing on international markets (Apeaning & Thollander, 2007:209).

## 2.11 PRIMARY ENERGY EFFICIENCY INCENTIVES IN SOUTH AFRICA

Eskom introduced the Integrated Demand Management (IDM) program in South Africa to create incentivised schemes to promote energy-efficiency. The program includes the following schemes (Eskom, 2014a):

- Standard offer program – The fundamental mechanism of the program is to offer a rebate at a predetermined rate per unit of electricity saved. This saving needs to be independently verified by an accredited Measurement and Verification (M&V) body.
- Standard product – Provides specific rebates for efficiency improvements derived from the implementation of approved technologies including energy-efficient lighting systems, energy and water-efficient shower heads and heat pumps.
- Rebate model – This initiative pays a rebate to customers that installed a solar water heating system as approved by Eskom.
- ESCo model – Energy Service Companies (ESCos) who are accredited by Eskom operate by establishing a three-way partnership between themselves, Eskom, and the customer, and use their knowledge of demand side management technologies and programs to determine the best way of obtaining results at customer premises.
- Performance contracting–- Aims to purchase bulk verified energy savings across multiple sites and technologies by contracting with a single Project Developer.

Due to significant financial constraints experienced currently (2014) by Eskom, it has been necessary to place all above listed programs on hold except for the Performance Contracting Model. This is due to the financial crisis at Eskom due to the financing of the planned power stations. As a result energy-efficiency initiatives are negatively influenced by the reduction in available incentives.

Section 12L in the South African Tax Act (No. 58 of 1962) (SA, 1962) allows for additional depreciation allowances up to 55% for greenfield projects over R200 million, one of the rating criteria being energy-efficiency savings (SA, 1962). Section 12L provides a tax deduction to a taxpayer that is energy-efficient, with a focus on renewable energy. Other tax allowances that are applicable to businesses include Section 12C, Section 11e, Section13 and others that provide general depreciation of asset allowances that are applicable not only to Energy Service Company (ESCo) businesses, but also to any business that meets the section requirements.

### 2.11.1 Eskom performance contracting

Integrated Demand Management (IDM) in Eskom launched an initiative called Performance Contracting to accelerate its Demand Side Management program. Performance Contracting aims to purchase bulk verified energy savings across multiple sites and technologies by contracting with a single Project Developer. Performance contracting will reduce administrative requirements regarding project approvals, reduce contractual complexity, improve sustainability and reduce project lead times (Eskom, 2014b).

The focus of Performance Contracting is on energy-efficiency. Eskom contracts for energy savings during daytime hours on weekdays. Savings are targeted and eligible for payment for 16 daytime (06:00 in the morning to 22:00 at night), weekday hours. In addition, savings during other periods are also compensated, but at a lower rate. The rate will be determined either through a fixed offer or through a competitive bidding process (Eskom, 2014c).

The minimum project size will be more than 30GWh of savings over a three-year sustainability period. The Project Developer is responsible for financing all capital costs incurred to achieve the energy savings. Programs can be financed by the Project Developer, the consumer or through a third party at the discretion of the Project Developer (Eskom, 2014c).

### 2.11.2 Section 12L Tax incentive scheme

The South African Income Tax Act (No. 58 of 1962) (SA, 1962) makes provision for a deduction in tax in respect of energy savings. Section 12L of the Act came into operation on the 1st November 2013. The key aspect to be addressed through this legislation is efficient use of energy, more than that of the generation of energy for which there are separate governmental programs (Govender, 2014:3).

The tax incentives are being introduced for businesses that can show measurable energy savings. The 12L regulation sets out the process for determining the quantum of energy-efficiency savings, and the requirements for claiming the proposed tax deduction. Section 12L incentives include all energy-efficiency projects that reduce energy use and is claimable until 2020. It is important to note that the tax incentive is available for savings in all energy forms and not only electricity (SANEDI a, 2014a).

The tax incentive provides for a 45c per verified kWh tax saving (Verified KWh x 45c x 28%). The tax incentive is currently offered per one assessment year of verified kWh savings. The tax incentive is only applicable to registered businesses and no simultaneous benefit is allowed. A South African National Accreditation (SANAS) accredited body needs to sign-off the metering and verification report of the kWh savings (SANEDI, 2014b).

### 2.11.3 The manufacturing competitiveness enhancement program (MCEP)

The Manufacturing Competitiveness Enhancement Program (MCEP) is one of the key action programs of the Industrial Policy Action Plan (IPAP) 2012/13 – 2014/15. The program provides support to enhance current manufacturing processes. The support aims to upgrade production facilities in order to sustain employment and maximise value-addition (DTI,2014).

The MCEP comprises two sub-programs: the production incentive (PI) and the Industrial Financing Loan Facilities which is managed by the Department of Trade and Industry (DTI) and the Industrial Development Corporation (IDC) respectively.

#### 2.11.3.1 Production Incentive

The production incentive is the largest component of the MCEP and makes up 80% of the total value. For the production incentive a company is able to receive up to 25% of the manufacturing value added, as a grant from the program (DTI, 2014).

The production incentive can be applied to the following five categories:

- Capital investment grant;
- Green technology and resource efficiency improvement grant;
- Enterprise-level competitiveness improvement grant;
- Feasibility studies grant; and
- Cluster interventions grant.

#### 2.11.3.2 Industrial Financing and Loan Facilities

The industrial financing and loan facilities are made up of two funding facilities namely, the pre and post-dispatch working capital facility and the industrial policy niche projects fund (DTI,2014).

- The pre/post-dispatch working capital facility offers a working capital facility up to a maximum of R30 million for a period of up to four years, at a preferential fixed interest rate of 6%.
- The industrial policy niche projects fund includes projects that are identified by the DTI. The focus of these projects is new areas with the potential for job creation, diversification of manufacturing output and contribution to exports. This type of funding can be structured as part of the borrower's equity contribution.

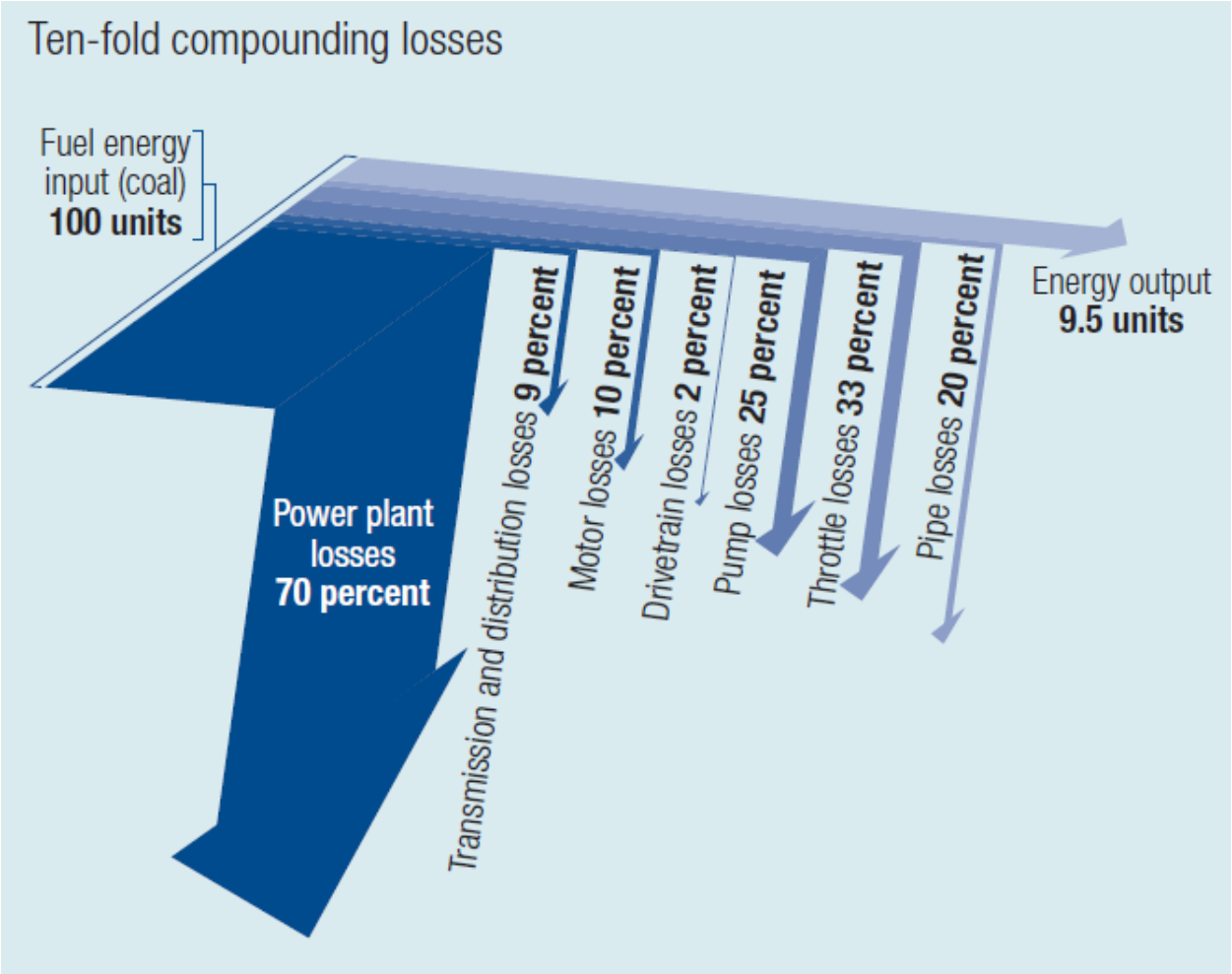
## 2.12 ENERGY EFFICIENCY IMPROVEMENT FOCUS AREAS

Industrial energy intensity can be reduced through technological progress and system changes that improve technical energy efficiency changes that increase output using the same amount of energy or that deliver the same output using less energy. These changes include replacing old technologies, adopting energy-saving technologies (preferably best available technologies), improving processes and optimising systems, and employing

energy management practices. They also include using more high-quality energy, such as gas and electricity; innovating product designs; and changing the output mix (United Nations Industrial Development Corporation, 2011:33).

A system's performance depends on the performance of each component and especially on overall system design and operation. Systems solutions thus consider technical improvements of individual energy-consuming components and systemic upgrades and improvements. Losses can occur at each stage in the energy supply chain. Through an energy-efficiency "leverage" effect, energy savings at any stage can lead to compound gains by the end of the chain, for example, to deliver one unit of energy service in a pipe requires about 10 units of fuel at a power plant. Those 10-fold compounding losses can be reversed to yield 10-fold compounding savings of fuel for each unit of reduced friction in the pipe as depicted in figure 2.9 below (United Nations Industrial Development Corporation, 2011:46).

Figure 2.9: Typical energy losses in energy driven systems.




(Source: United Nations Industrial Development Corporation, 2011:46)

The energy losses depicted in figure 2.9 can be reduced. Table 2.2 shows examples of energy-efficiency and improvement practices. For utility systems, the key performance factor is the efficiency of energy conversion, the ratio of useful energy in the output energy services (such as steam) per unit of useful energy input (such as fuel). For the manufacturing system, the determining performance factor is the economic use of energy in manufacturing operations. The aim of process economies is to produce more products with less use of energy services, for example, more beer per ton of steam use or more plates per unit of fuel consumption in the firing kiln. Both utility efficiency and process economies are levers for improving overall energy-efficiency.

Table 2.2: Common improvement practices for industrial energy-efficiency.

| Improvement practice | Example in industrial energy efficiency | |
|---|---|---|
| | Utility efficiency: utility system | Process economies: manufacturing system |
| Good housekeeping | • Identify and repair leaks in utility systems, including compressed air and steam<br>• Apply energy management systems<br>• Conduct preventive maintenance and clean steam traps, cooling tower fans | • Identify and repair leaks and spills<br>• Apply environmental management system<br>• Plan production for extended batches and reduced start-ups/shutdowns<br>• Reduce inventory |
| Substitute energy carriers | • Switch to lower carbon fuel (natural gas or biomass)<br>• Switch to solar process heating | • Replace electric motor drives with medium- or low-pressure steam drives<br>• Replace steam humidification with air cooling by ultrasonic humidifiers<br>• Replace compressed air tools with direct driven tools |
| Better process control | • Monitor exhaust gas to improve efficiency of boilers and kilns<br>• Control air intake for compressors | • Use timers and on-off controllers on equipment, lighting, air conditioning<br>• Control and balance peak load |
| Equipment modification | • Install variable-speed drives for motor systems<br>• Insulate hot utility systems<br>• Rationalize utility reticulation systems, including steam and compressed air | • Remove bottlenecks in the production line to optimize use of ovens, furnaces and kilns<br>• Optimize factory layout to reduce material transfer requirements<br>• Use advanced tank and reactor design to eliminate stirring<br>• Modify exhausts to reduce volume and increase temperature for heat recovery |
| Technology change | • Install energy-efficient energy equipment, including motors, boilers and furnaces | • Use process intensification<br>• Apply green chemistry and engineering (catalysis, ambient temperature and pressure) |
| On-site reuse and recovery | • Recover waste heat recovery from boilers, furnaces, kilns and other hot equipment<br>• Recover condensate as boiler feed<br>• Remove moisture from wet raw materials entering kiln<br>• Operate kilns on counter-current | • Recover solvents and other combustible process wastes and emissions as supplementary fuels |
| Production of useful by-products | • Use low-grade waste heat for building or district heating<br>• Desalinate with low-grade waste heat<br>• Store energy in ground reservoir, phase-change materials | • Switch to cogeneration or trigeneration systems |
| Product modification | • Not applicable | • Optimize dematerialization and product design to reduce breakage and cracks |

(Source: United Nations Industrial Development Corporation, 2011:47).

Globally, the industrial energy-consuming systems with the highest potential energy savings are motors, compressors and steam systems (United Nations Industrial Development Corporation, 2011:43):

### 2.12.1 Motor-driven equipment

Motor-driven equipment accounts for about 60% of manufacturing final electricity use and is ubiquitous worldwide. Motor systems, consisting of drives, pumps and fans, are a largely untapped, cost-effective source of industrial energy-efficiency savings that could

be realised with existing technologies. Some 55% of the electricity used by motor systems (16% of total industrial energy consumption) is lost before the motor systems do any work. Losses can be reduced by using more efficient motors and variable speed drives, sizing motors appropriately and optimising motor driven systems, such as pumps and conveyors (United Nations Industrial Development Corporation, 2011:44).

### 2.12.2 Compressed air systems

Compressors, drives, air treatment, compressed gas network and the end use devices driven by compressed air account for 10% of industrial consumption of electricity (United Nations Industrial Development Corporation, 2011:45). Compressors lose 80% of the mechanical work done by the motor, and leaks in the air distribution systems are rampant. Case studies show that savings of up to 50% are possible, but these are not being realised under current market and decision mechanisms.

### 2.12.3 Steam systems

Steam systems account for 35% of global industrial energy consumption. These systems lose an average 45% of their input heat before reaching point of use. In many developing countries, the losses are substantially larger (United Nations Industrial Development Corporation, 2011:45). For example, in the Russian Federation, most steam systems have no pipeline insulation. In China, many small-scale boilers operate with considerable excess air and incomplete coal combustion. Experience in well managed industrial facilities in OECD countries shows potential energy-efficiency gains of about 10% from system efficiency measures. Reductions in energy consumption are illustrated with case studies in the next sections.

## 2.13 CASE STUDIES OF SUCCESSFUL RECP IMPLEMENTATIONS

The following two sections discuss two case studies of successful RECP improvement implementations. The case studies also show the financial benefit that was realised by the improvement.

### 2.13.1 Case study by Eskom IDM program of a South African mining house

An investigation into the compressed air networks of a specific gold mining operation revealed an average energy-efficiency potential of 2.2MW. Potential refer to an opportunity that exists but has not been realised yet.

The site consists of seven compressor houses that supply compressed air to ten shafts and five plants. There are 14 underground levels. Five are non-productive while the remaining nine are fully productive. The compressed air system of the plant is an intricate arrangement consisting of surface compressors, pipe work, valves and drills, agitators, loading boxes, loaders, ventilation and other pneumatic equipment. Air is also distributed on surface where it is used by systems such as refrigeration plants, ore transportation and ore processing.

The installation of underground flow and pressure monitoring equipment, coupled with pressure and flow control valves, makes it possible to monitor, optimise and automatically control underground compressed air networks. The control valves are installed on those levels using the most air such as production levels. Through the optimised control of the pressure requirement of each level, air wastage is minimised. When the demand for compressed air drops, a reduction in the supply of compressed air will result, assuming that supply and demand are integrated and both controlled by a real time energy management system (REMS). This in turn manifests itself as an electrical power saving as the compressors ‘cut-back’ on absorbed power.

Improving the efficiency of air compression with the implementation of an REMS, provides the possibility of saving the mine in excess of 13 700MWh per annum. If this is translated into a cost saving at the prevailing price of electricity, it will deliver a reduction of more than R3.4 million (Eskom, 2014b).

### 2.13.2 NCPC King Shaka International Airport case study

King Shaka International Airport (KSIA) in Durban, KwaZulu-Natal was opened on 1 May 2010, replacing the old Durban International Airport. Built at a cost of R6.8 billion, it hosts a variety of facilities including banks, retail stores, fast-food outlets and restaurants, as well as a full range of air travel related services. The facility is three times larger than the old facility with five times more retail space (NCPC, 2013:1).

The airport consumes large amounts of electricity to run the heating, ventilation and air-conditioning (HVAC) system for the main terminal building (103 000m2 in size) and other buildings on site. Lighting for the various buildings as well as the highly specialised runway and taxiway lighting system also use significant quantities of electricity. Escalating electricity tariffs resulted in energy management becoming an organisational Key Performance Indicator at the airport (NCPC, 2013:1).

The industrial energy-efficiency project and specifically the implementation of an energy management system has been identified as an ideal mechanism to bring together all energy-efficiency initiatives. KSIA signed up as a candidate plant for the energy management system expert level training in October 2012.

KSIA implemented an energy management system. The implementation included expanding the key performance indicators of the airport and environmental policies to focus on energy requirements as well, energy training for members of senior management, identification of large energy consumers at the airport, formation of an energy management team, identification of potential energy saving opportunities, setting up a formal energy policy approved by management (NCPC, 2013:2).

The result of the implementation of the identified energy savings opportunities at the airport is summarised in table 2.3 below. The table summarises the opportunities in terms of capital cost required to implement the specific initiative, the energy saving realised in kWh per annum, the savings realised annually in rand (kWh saving multiplied by the electricity rate in R/kWh) and the payback period calculated by dividing the capital cost by the annual savings.

The last row in table 2.3 contains the information on a realised saving for the air conditioning system. The opportunity was realised by installing a building management system (BMS) to operate the air conditioning system when appropriate. The installation of this system cost R20 000, it saves 824 423 kWh per annum thus R1 179 445 per annum. Dividing the installation cost by the annual saving results in a payback of 0.19 month.

Table 2.3: Savings opportunities implemented at KSIA.

| System | Intervention | Capital Cost (ZAR) | Energy saving (KWh / annum) | Savings ZAR | Estimated Payback period (months) |
|---|---|---|---|---|---|
| Multi-storey parkade (MSP) lighting* | Reduced lighting demand by replacing old lighting with lower wattage light sources | 360 641 | 227 027 | 321 006 | 13.4 |
| Internal and external lighting of various areas | Programmed BMS control to reduce internal lighting by 35% and 65% to suit operational requirement and to switch off external lighting during the day | 20 000 | 881 297 | 1 260 798 | 0.20 |
| Air-conditioning | Programmed BMS control to switch off Air Conditioning to suit operations | 20 000 | 824 432 | 1 179 445 | 0.19 |
| **Totals** | | **400 641** | **1 932 756** | **2 761 249** | |

*BMS – Building management system.

(Source: NCPC, 2013:2)

### 2.13.3 Economic potential

From the two case studies presented above it is evident that vast amounts of money can be saved on an annual basis by implementing RECP initiatives. The case studies prove that the initiatives can benefit both the RECP consultant and the client company.

The options of remuneration for the RECP consultant that identifies and implements these savings opportunities can be presented as an hourly engineering fee paid for the duration of the project or the remuneration can be calculated as a percentage of the realised savings for an agreed amount of time after implementation.

## 2.14 THE SEVEN HABITS OF RESOURCE EFFICIENT COMPANIES

According to the PEW Center for research (cited by Niesing, 2012:37), there are seven habits of resource efficient companies. These seven habits of highly efficient companies are listed and described in table 2.4 below.

Table 2.4: The seven habits of highly efficient companies.

| |
|---|
| **1. Efficiency is a Core Strategy** |
| • Efficiency is an integral part of corporate strategic planning and risk assessment and not just another cost management issue or sustainability "hoop" to jump through.<br>• Efficiency is an ongoing part of the organization's aspirations and metrics for itself. |
| **2. Leadership & Organizational Support is Real & Sustained** |
| • At least one full-time staff person is accountable for energy performance.<br>• Corporate energy management leadership interacts with teams in all business units.<br>• Energy performance results affect individuals' performance reviews and career advancement paths.<br>• Energy efficiency is part of the company's culture and core operations.<br>• Employees are empowered and rewarded for energy innovation. |
| **3. The Company Has SMART Energy Efficiency Goals** |
| • Goals are organization-wide.<br>• Goals are translated into operating/business unit goals.<br>• Goals are specific enough to be measured.<br>• Goals have specific target dates.<br>• Goals are linked to action plans in all business units.<br>• Goals are updated and strengthened over time. |
| **4. The Strategy Relies on a Robust Tracking & Measurement System** |
| • The system collects data regularly from all business units.<br>• The data is normalized and baselined.<br>• Data collection and reporting is as granular as possible.<br>• The system tracks performance against goals in a regular reporting cycle.<br>• Performance data is visible to senior management in a form they can understand and act upon.<br>• Energy performance data is shared internally and externally.<br>• The system is linked to a commitment to continuous improvement. |
| **5. The Organization Puts Substantial Resources into Efficiency** |
| • The energy manager/team has adequate operating resources.<br>• Business leaders find capital to fund projects.<br>• Companies invest in human capital. |
| **6. The Energy Efficiency Strategy Shows Demonstrated Results** |
| • The company has met or beat its energy performance goal.<br>• Successful energy innovators are rewarded and recognized.<br>• Resources are sustained over a multi-year period. |
| **7. The Company Effectively Communicates Efficiency Results** |
| • An internal communications plan raises awareness and engages employees.<br>• Successes are communicated externally. |

(Source: Niesing, 2012:37)

## 2.15 SUMMARY

The literature review discussed the term RECP and energy-efficiency as a basic element of RECP. The study discusses South Africa's primary energy supply and demand. Literature shows that South Africa is heavily dependent on coal and crude oil imports. Industry and Mining are the biggest consumers of energy in the country consuming 38% of all energy. The second biggest energy consumer is the transport sector consuming 28% of all energy.

By international standards South Africa is one of the most energy intensive users in the world. The country uses a high amount of energy per unit of Gross Domestic Product (GDP) and in 2009 South Africa ranked third amongst the world's largest economies for the amount of primary energy supplied per unit of GDP.

Eskom generates approximately 95% of the electricity used in South Africa and approximately 45% of the electricity used in Africa. South Arica is currently experiencing a shortage in electricity generating capacity. In addition to the new power stations, Eskom has been planning for the last two years to launch the Energy Conservation Scheme (ECS) whereby all electricity consumers have to reduce their electricity consumption by 10%.

Enterprises can adopt energy management practices at plant level within four principal areas: energy-efficient technologies, load management, energy conversion, and encouraging more energy-efficient behaviour (energy conservation).

In the last year, all major energy-consuming countries introduced new legislation on energy-efficiency, making provisions for a 16% reduction in energy intensity by 2015 in China, new fuel-economy standards in the United States and a cut of 20% in energy demand in the European Union in 2020. Japan also aims to achieve a 10% reduction in electricity demand by 2030 in its new energy strategy. Energy-efficiency initiatives in South Africa will help meet some of the country's social, economic, and environmental goals. These initiatives are important as they immediately tackle the problem of electricity shortages and are a cost-effective way of increasing available electricity supply.

Energy-efficiency barriers are broadly classified under three main categories namely economic barriers, organisational barriers and behavioural (psychological) barriers. Financially related driving forces, followed by organisational ones, are evaluated as the most relevant. By looking at financial drivers, the threat of rising energy prices as well as

cost reductions resulting from lowered energy use are indeed perceived as the strongest driving forces towards energy-efficiency improvement.

It can be concluded from the literature that South Africa holds an environment where resource efficiency, with the focus on energy, is a necessity. The need to be energy-efficient is driven by a continuous increase in the totalised energy demand by sector for South Africa (47% increase from 2000 to 2009), 3rd place world ranking for South Africa for energy intensity and an electricity price that is predicted to double from 2013 to 2017.

Efficiency initiatives can be focussed on three sectors that account for 84% of the final energy use. The sectors include industry and mining (38%), transport sector (28%) and the residential sector (18%). Efficiency initiatives economic viability can be enhanced by subsidisation and rebate schemes offered by Eskom and by also leveraging on the Section 12L tax incentive scheme offered by the South African government for energy efficiency projects.

Vast amounts of money can be saved by implementing RECP initiatives. Case studies of successful implementations prove that the initiatives can benefit both the RECP consultant and the client company. The options of remuneration for the RECP consultant can be presented as an hourly engineering fee paid for the duration of the project or can be calculated as a percentage of the realised savings.

# CHAPTER 3: EMPIRICAL INVESTIGATION

## 3.1 INTRODUCTION

The literature review in Chapter two focussed firstly on Resource Efficiency and Cleaner Production (RECP) and energy-efficiency as the primary building block thereof was covered from a global perspective and a South African perspective. The energy situation in South Africa was discussed, which was narrowed down to specifically the electricity price, demand management and available electricity capacity in South Africa. The literature review was concluded with the drivers for energy-efficiency, barriers to energy-efficiency, focus areas for energy-efficiency improvement and incentive schemes for energy-efficiency. Successful case studies of RECP initiatives were also included in the literature review.

Chapter three covers the empirical investigation of the research study. The investigation aims to determine the primary fields (section 2.2) of Resource Efficiency and Cleaner Production (RECP), the drivers (section 2.10) for RECP, the barriers (section 2.9) to implementing and participating in RECP initiatives in order to assess the perceived readiness in the Vaal Triangle area to participate in RECP initiatives. No data exist for the stated objectives in the Vaal Triangle and market research had to be done. Issues pertaining to RECP initiatives were identified by conducting a comprehensive literature study together with liaison and interviews with businesses in the Vaal Triangle. Data on the discussed objectives was generated by distributing a questionnaire among the target population and statistically analysing the data from the questionnaires in Chapter three.

## 3.2 RESEARCH METHODOLOGY

### 3.2.1 Target population

The research study focusses on companies operating within the Vaal Triangle of South Africa. The Vaal Triangle is formed by three towns including Vereeniging, Vanderbijlpark and Sasolburg. The three towns are positioned geographically within a radius of 15km of each other. The Vaal Triangle was selected for the study as this area was traditionally considered an industrial hub in South Africa.

The sample population includes all companies in the Vaal Triangle area. The population size is not known and this was confirmed by Mrs Erika van der Walt from the statistical department of the Emfuleni Municipality covering the Vanderbijlpark, Vereeniging and Meyerton area (Van der Walt, 2014). The statistical department confirmed that the municipality does not have a business portfolio and is in the process of setting it up with the help of Prof Daniel Meyer from the North-West University (Vaal Triangle campus). The Emfuleni Municipality covers the majority of the Vaal Triangle.

### 3.2.2 Sample selection and procedures

The measuring instrument was distributed to the members of the Vanderbijlpark Chamber of Business consisting of 160 members. The Vanderbijlpark Chamber of Business represents businesses for the whole of the Vaal Triangle. The measuring instrument was also distributed to non-members of the chamber of business consisting of 140 potential respondents located within the Vaal Triangle area.

The sample selection procedure also targeted respondents that held a management position or at least had a supervisory role. The rationale behind this requirement was to ensure an understanding of energy and efficiency within the workplace to some extent. Identifying specific positions within companies that are tasked with the responsibility for RECP posed to be problematic. Each respondent represented a company.

The measuring instrument was electronically distributed to the Chamber of Business members and distributed in hard copy to the researcher's business network. The response rate for the Chamber of Business was 3.13%. Reminders were sent to all Chamber of Business members in order to increase the response rate. The response rate from the Chamber of Business shows a barrier to participation. The response rate for the non-members was 29%.

In total 300 questionnaires were distributed and 45 questionnaires were completed by the respondents. The combined overall response rate was 15%. The low rate of response can possibly be attributed to a lack of commitment or responsibility to complete electronically distributed questionnaires as was the case with the members of the Chamber of Business. Respondents might also ask what can be gained from participating and as a result might be deterred from participating.

### 3.2.3 Research instrument and design

The measuring instrument that was used for this research study is a questionnaire making use of a four-point Likert scale to answer the questions posed to the respondents. Sections 2 to 6 also contained an open ended question. The instrument was developed to keep the questions clear and understandable. The Statistical Consultation Services of the North-West University guided the process of developing the questionnaire and also approved it for use in this research study.

The questionnaire consists of six sections with the first section covering the demographical information of the respondent. The second section of the questionnaire investigated what the respondent regarded as the primary fields of RECP and included questions on energy-efficiency, recycling, operations optimisation, environmentally friendly raw materials and switching to lower carbon fuels. This section ended with an open ended question asking if there are any other fields of RECP that has potential for improvement.

Section three of the questionnaire tested the response on the drivers for RECP. The drivers tested by the questionnaire included a smaller carbon footprint, corporate social responsibility, subsidisation, brand image, rising electricity prices and improved working conditions. The section also included an open ended question asking if there were any other drivers not covered by the questions. Section four of the research instrument covered the barriers to RECP initiatives and included questions covering risk, cost, responsibility, potential commitment and information availability.

In section five the respondent's willingness to participate in an actual RECP consultation was evaluated. The respondent was asked whether an energy audit would be at the workplace, if the respondent would be willing to pay for an energy audit, what payment structure would be preferred and if the respondent thinks RECP increases sustainability. The open ended question at the end of the section asked the respondent to state anything that could further promote the implementation of RECP.

The final section of the questionnaire consisted of one open ended question asking whether there was anything in the respondent's view that was not covered in the questionnaire.

In order to test the questionnaire, a pilot questionnaire was first distributed to four respondents in order to get feedback on the questionnaire regarding ease of use and clarity of the questions (refer to Annexure C for an example of the questionnaire used in this study).

Results from the completed questionnaires were statistically analysed by the Statistical Consultation Services (SCS) of the North-West University. The SCS also tested the data for relevance and validity.

## 3.3 RESULTS FROM THE EMPIRICAL STUDY

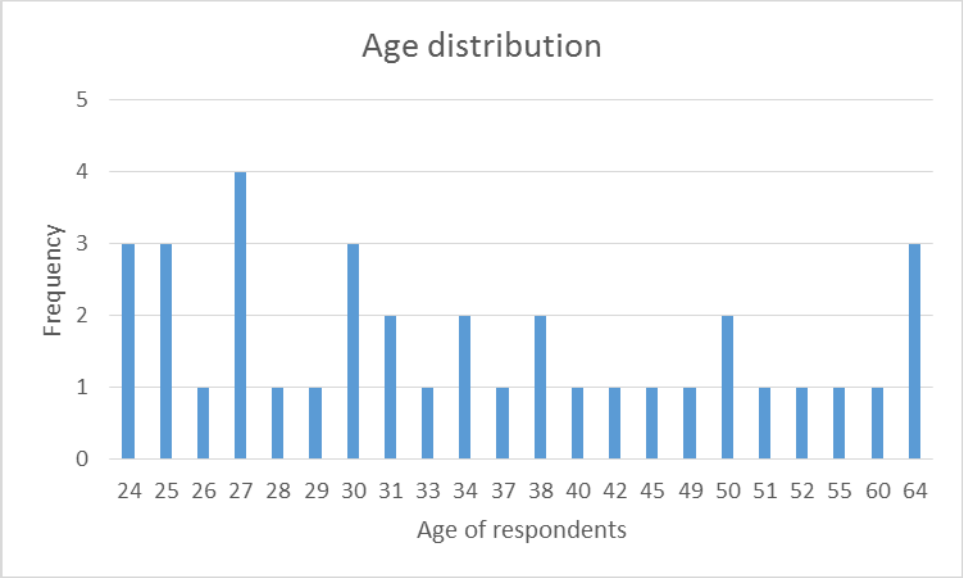
The data captured by the research instrument was statically analysed with the aid of the IBM SPSS software package (SPSS,2014).

### 3.3.1 Section 1: Demographics of the respondents

#### 3.3.1.1 Age of the respondents

The age of the respondents ranged from 24 years to 64 years. The mean age of the respondents was 38 years with a standard deviation of 12.8 indicating an even spread for the sample between the age range. The sample thus represents a well spread out age range between 24 and 64 years old as illustrated in figure 3.1. A total of 8 respondents failed to indicate the age (refer to Appendix A).

Figure 3.1: Age distribution of the research participants.



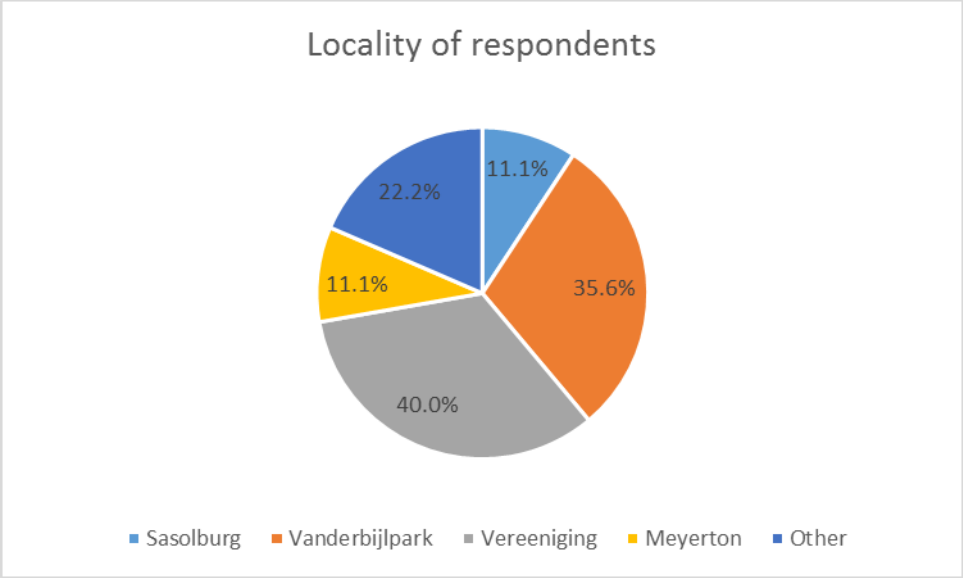

### 3.3.1.2 Gender of the respondents

The sample consisted of 22 males (55%) and 18 females (45%). Five respondents failed to indicate gender.

### 3.3.1.3 Locality of the respondent

All of the respondents indicated locality. All localities indicated falls within the boundaries of the Vaal Triangle with the percentages indicated for each locality in figure 3.2 below.

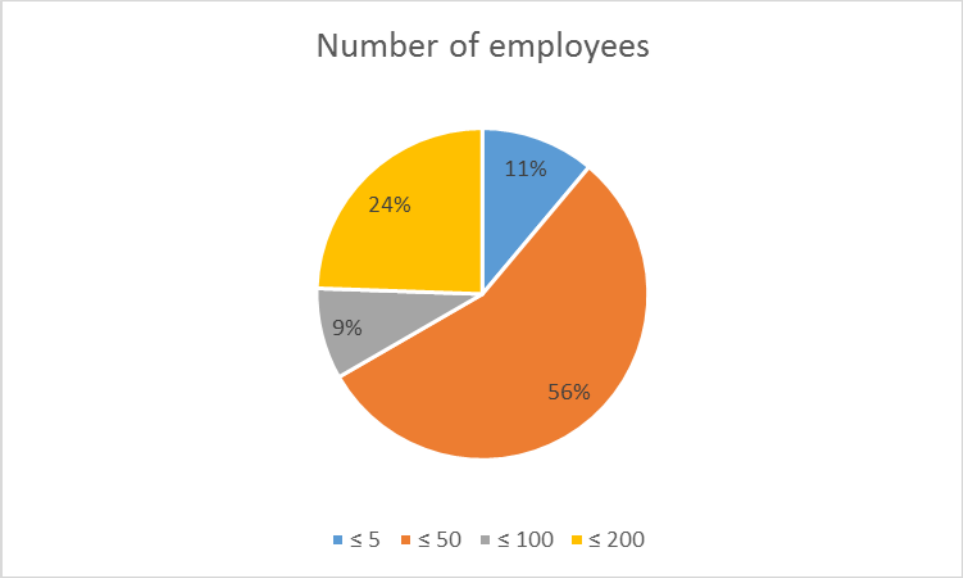
Figure 3.2: Locality of the respondents within the Vaal Triangle.




### 3.3.1.4 Number of employees at company

The majority (55.6%) of the number of employees indicated fell within the 5 to 50 range, indicating the sample containing more smaller-sized companies than large companies as is the case in the Vaal Triangle business sector. Business with a number of employees between 5 and 50 are regarded as small business, businesses with a number of employees between 50 and 250 represent medium-sized businesses. Businesses with the number of employees below 5 represent micro-sized businesses.

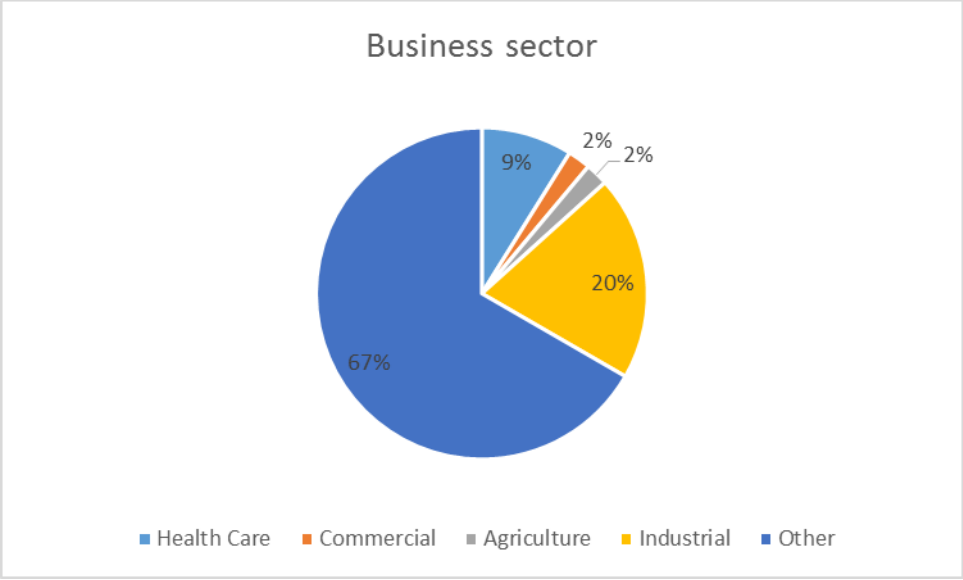
Figure 3.3: Number of employees at workplace.




### 3.3.1.5 Business sector

All of the respondents indicated the particular business sector with 66.7% indicating other business sectors than the listed sectors.

Figure 3.4: Business sector of the respondent.



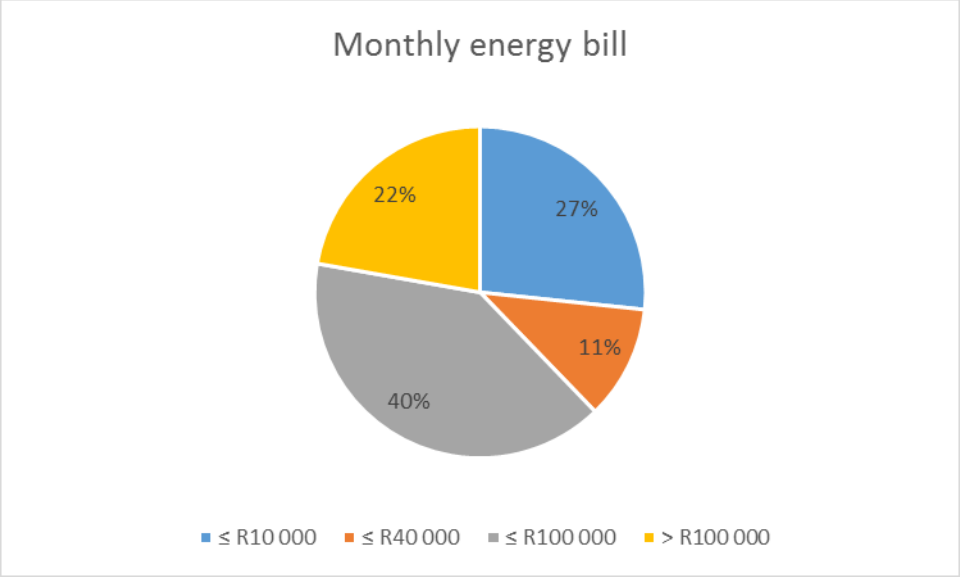
Other business sectors indicated by the respondents included:

- Education;
- Retail;
- Financial services;
- Manufacturing; and
- Services.

#### 3.3.1.6 Total monthly energy expenditure

The majority of the respondents (40%) indicated an energy bill of between R40 000 and R100 000 per month. This correlates with the data captured for the number of employees at the company which is also in the lower regions of the options available in the questionnaire. An energy bill of more than R100 000 per month was indicated by 22% of the respondents. The higher the energy bill, the more rewarding the potential energy savings can be in terms of money savings.

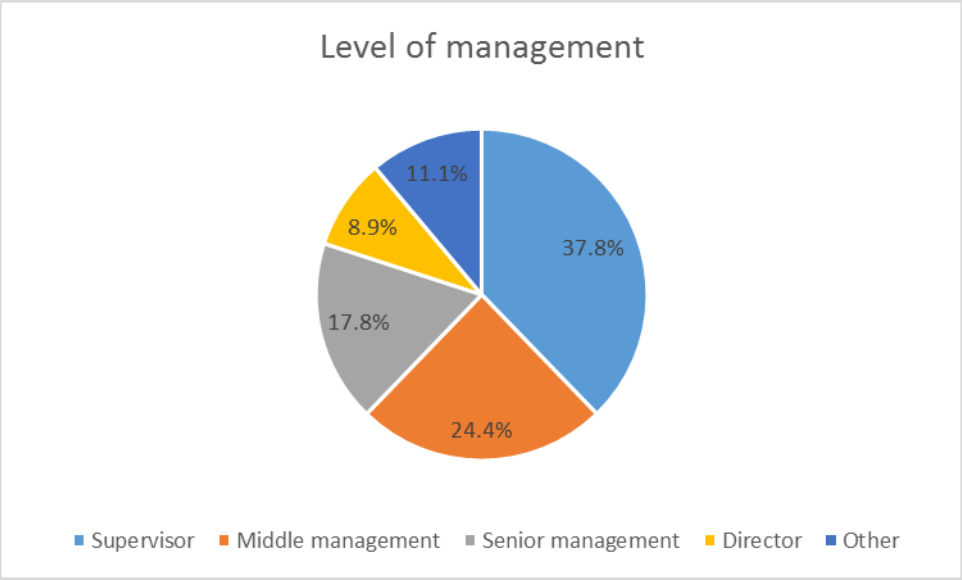
Figure 3.5: Monthly energy expenditure of company.



### 3.3.1.7 Level of management

The respondents had to indicate the level of management within the company. The majority of the respondents fell within the supervisory (37.8%) and middle management level (24.4%). Top level management made up 26.7% of the respondents.

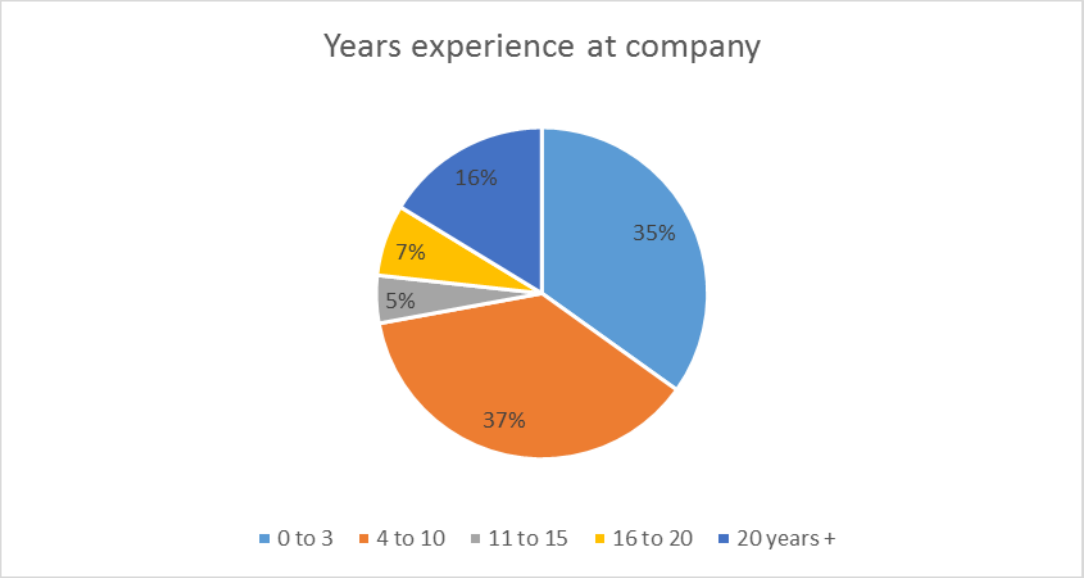
Figure 3.6: Respondents' level of management.




### 3.3.1.8 Number of years at company

Of the respondents 72% fell within the 0 to 10 years at company category. This correlates with the majority of respondents that indicated supervisory and middle management as the position. Two respondents failed to indicate the number of years present at the company they work for.

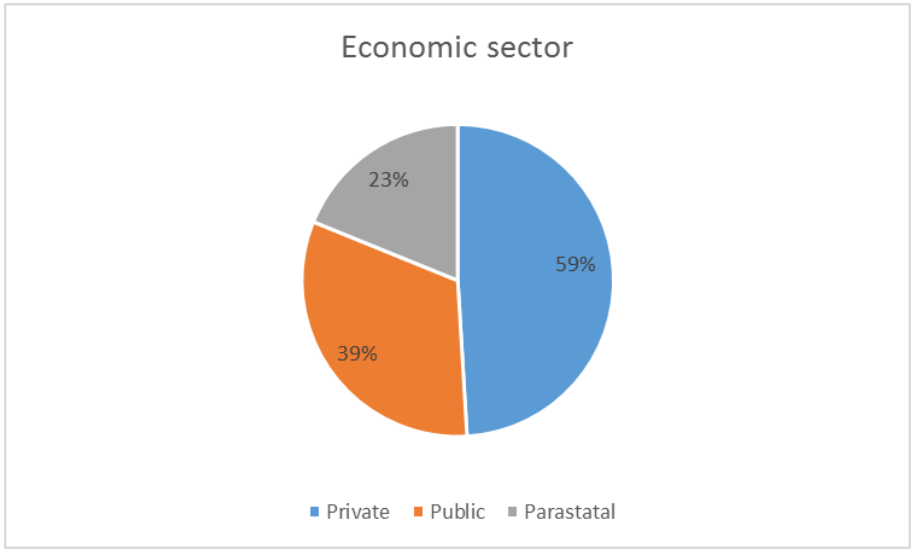
Figure 3.7: Respondents' number of years at company.




### 3.3.1.9 Economic sector of the respondent

The respondents mainly came from the private sector (59.1%). Respondents from parastatal companies represented 23% and respondents from public organisations represented 39%. One of the respondents failed to indicate the economic sector he/she falls within.

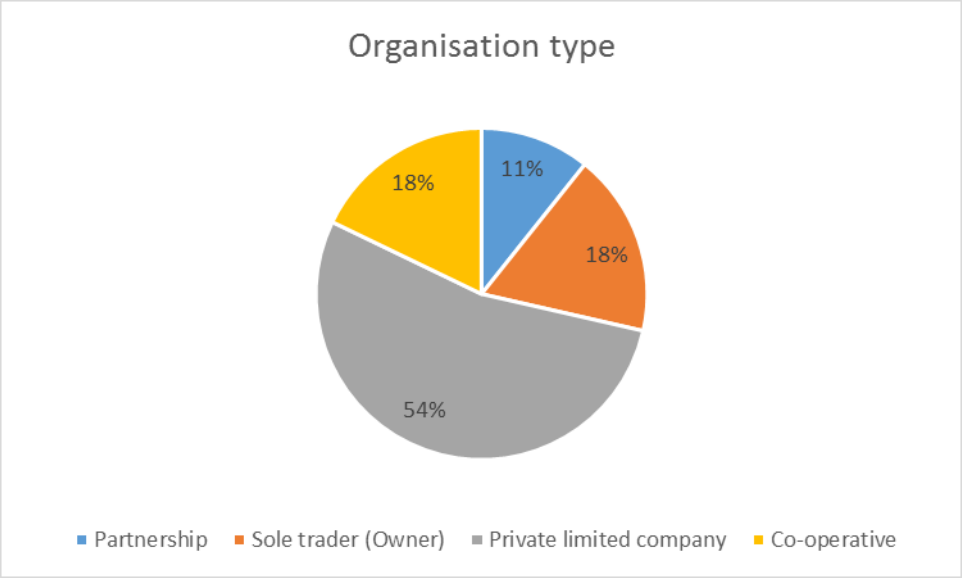
Figure 3.8: Economic sector within which the respondent fell.



### 3.3.1.10 Private sector organisations

Only respondents that indicated employment in the private sector in the question on type of economic sector had to participate in this question. Private limited companies represent 54% of the respondents, sole traders and co-operatives represent 18% each and partnerships represent 11% of the respondents.

Figure 3.9: Representation of organisation types in the private sector.




### 3.3.1.11 Previous RECP initiatives at company

The respondents were asked if they had taken part thus far in any RECP initiatives at their company. Only 8.9% of the respondents indicated that they have participated in any RECP initiatives previously at their company. Of the respondents 91.1% have never participated in any RECP initiatives. The low percentage (8.9%) of previous participation in RECP indicates a strong need for the implementation of RECP initiatives in the Vaal Triangle. This shows that there exists green business potential for RECP service providers in the Vaal Triangle and that businesses in the Vaal Triangle need to be sensitised in terms of RECP services.

#### 3.3.1.12 Designated organisational job description for RECP

Of the respondents 17.8% indicated that their company had a position tasked with RECP. The respondents were also asked to indicate the job title of the position if answered yes. Job titles indicated included:

- Business improvement manager
- Operations manager
- Procurement manager

Of the three positions indicated for being tasked with RECP, only the business improvement manager title can be regarded as being involved with RECP to a large extent. The operations manager and the procurement manager's main focus are not improving RECP, even though this can easily improve performance in the particular positions listed. The respondents that indicated a position tasked with RECP came from the 50 to 200 employers category (medium-sized business). This indicates that the larger companies are more likely to have a position tasked with RECP.

### 3.3.2 Descriptive statistics

The descriptive statistics was done for sections 2 to 5 of the research instrument. Sections 2 to 5 contain all the questions that made use of the four-point Likert scale. The open ended questions at the end of each section are also discussed.

The following abbreviations were used in the tables below: SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree and Std. dev = Standard deviation. The columns for SA, A, D and SD contains the frequency of respondents for each column with the mean response and standard deviation calculated for each of the questions.

### 3.3.3 Section 2: Primary fields for RECP improvements

In section 2 of the questionnaire respondents were tested on the primary fields of RECP. The section consisted of five questions.

Table 3.1: Descriptive statistics for questions on primary RECP fields.

| | SA | A | D | SD | Mean | Std. dev |
|---|---|---|---|---|---|---|
| 2.1. Companies should improve their energy efficiency. | 33 | 12 | 0 | 0 | 1.27 | 0.45 |
| 2.2. Companies should recycle on-site when possible. | 30 | 13 | 2 | 0 | 1.38 | 0.58 |
| 2.3. Companies should optimise operations by means of process modifications. | 21 | 23 | 0 | 0 | 1.52 | 0.51 |
| 2.4. Companies should substitute production materials for more environmentally friendly materials if possible. | 25 | 19 | 1 | 0 | 1.47 | 0.55 |
| 2.5. Companies should switch to lower carbon fuels (natural gas, solar, biomass) where possible | 25 | 19 | 1 | 0 | 1.47 | 0.55 |

Of the respondents 73.3% strongly agreed and 26.7% agreed in question 2.1. Respondents strongly agree that companies should improve energy-efficiency, when using the calculated mean score of 1.27 as an indication. The standard deviation indicates a low level of dispersion of responses over the four options given.

Of the respondents 66.7% strongly agreed, 28.9% agreed and 4.4% disagreed in question 2.2. Respondents strongly agree that companies should recycle on-site, when using the calculated mean score of 1.38 as an indication. The standard deviation indicates a low level of dispersion of responses over the four options given.

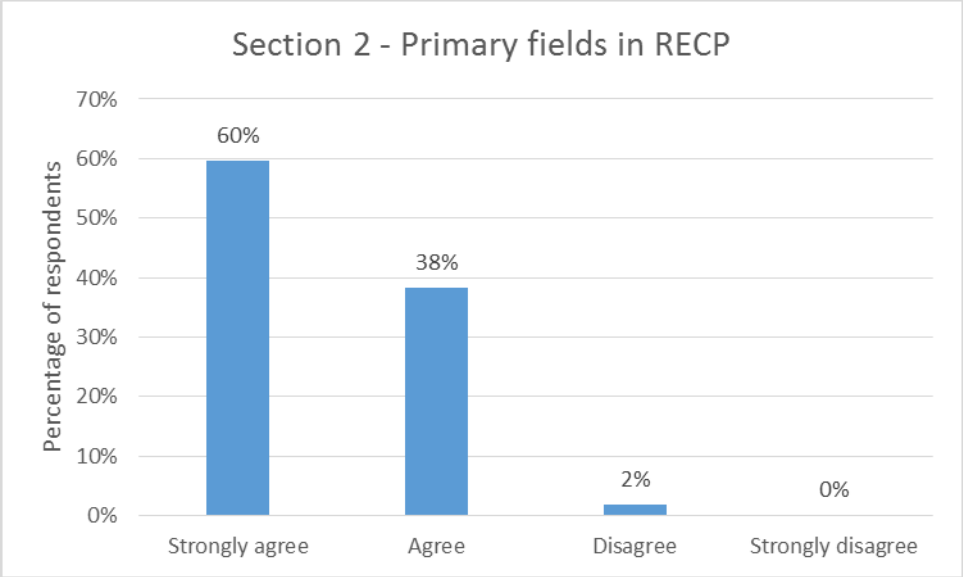
Of the respondents 47.7% strongly agreed and 52.3% agreed in question 2.3. Respondents agree that companies should optimise operations by means of process modifications, when using the calculated mean score of 1.52 as an indication. One of the respondents omitted to complete Question 2.3. The standard deviation indicates a low level of dispersion of responses over the four options given.

Of the respondents 47.7% strongly agreed and 52.3% agreed in question 2.4. Respondents strongly agree that companies should substitute production materials for more environmentally friendly materials, when using the calculated mean score of 1.47 as an indication. The standard deviation indicates a low level of dispersion of responses over the four options given.

Of the respondents 47.7% strongly agreed and 52.3% agreed in question 2.5. Respondents strongly agree that companies should switch to lower carbon fuels, when

using the calculated mean score of 1.47 as an indication. The standard deviation indicates a low level of dispersion of responses over the four options given.

Figure 3.10: Sectional response to primary fields in RECP




The data collected by the research instrument shows that the respondents strongly agree with the primary fields of RECP introduced to the respondents in the research instrument. Respondents strongly agree with all the RECP fields presented to them in the questionnaire with 98% of the respondents in agreement as indicated in figure 3.10. The RECP fields in the questionnaire include energy-efficiency, recycling, operations optimisation and environmentally friendly materials and fuels.

Although the exposure to RECP was indicated to be low in section 1, section 2 indicates that the respondents are positive about the necessity of implementing RECP in the fields presented in the questionnaire. The respondents were asked if there are any other fields of RECP that have the potential to be improved on. No response was received in this regard.

### 3.3.4 Section 3: Drivers for RECP

In section 3 of the questionnaire respondents were tested on the drivers for RECP. The section consisted of ten questions.

**Table 3.2:** Descriptive statistics for questions on the drivers for RECP.

| | SA | A | D | SD | Mean | Std. dev |
|---|---|---|---|---|---|---|
| 3.1. RECP initiatives (Ex. Reduce energy use) should be supported: | | | | | | |
| a) To reduce companies' carbon footprint. | 24 | 20 | 1 | 0 | 1.49 | 0.55 |
| b) To demonstrate corporate social responsibility. | 19 | 22 | 4 | 0 | 1.67 | 0.64 |
| c) When it is subsidised by external funds. | 13 | 21 | 7 | 2 | 1.95 | 0.82 |
| 3.2. Resource efficient companies enjoy a stronger brand image. | 15 | 21 | 6 | 1 | 1.84 | 0.75 |
| 3.3 Environmentally friendly companies enjoy a stronger brand image. | 23 | 18 | 2 | 1 | 1.57 | 0.70 |
| 3.4. Rising energy prices creates a need to support RECP. | 24 | 19 | 2 | 0 | 1.51 | 0.59 |
| 3.5. RECP initiatives will improve working conditions. | 13 | 25 | 5 | 1 | 1.86 | 0.70 |
| 3.6. Being resource efficient reduces the energy bill: | | | | | | |
| a) Short term (Less than 1 year) | 9 | 20 | 9 | 3 | 2.15 | 0.85 |
| b) Medium term (2 - 3 years) | 10 | 26 | 5 | 1 | 1.93 | 0.68 |
| c) Long term (3 years +) | 20 | 17 | 2 | 0 | 1.54 | 0.60 |

Of the respondents 53.3% strongly agreed, 44.4 agreed and 2.2% disagreed in question 3.1a. Respondents strongly agree, that carbon footprint reduction within the company should be supported, when using the calculated mean score of 1.49 as an indication. The standard deviation indicates a low level of dispersion of responses over the four options given.

Of the respondents 42.2% strongly agreed, 48.9 agreed and 8.9% disagreed in question 3.1b. Respondents agree that support of RECP initiatives demonstrates corporate social responsibility, when using the calculated mean score of 1.67 as an indication. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Of the respondents 30.2% strongly agreed, 48.8% agreed, 16.3% disagreed and 4.7% strongly disagreed in question 3.1c. Respondents agree RECP initiatives should be

supported when it is subsidised by external funds, when using the calculated mean score of 1.95 as an indication. Two of the respondents omitted to complete Question 3.1c. The standard deviation indicates a high level of dispersion of responses over the four options given. The 21% respondents that fell within the disagreement categories indicates that respondents are also willing to participate in RECP initiatives that are not subsidised and will rely on company capital and human resources.

Of the respondents 30.2% strongly agreed, 48.8% agreed, 16.3% disagreed and 4.7% strongly disagreed to question 3.2. Respondents agree that resource efficient companies enjoy a stronger brand image, when using the calculated mean score of 1.84 as an indication. Two of the respondents omitted to complete Question 3.2. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 34.9% strongly agreed, 48.8% agreed, 14.0% disagreed and 2.3% strongly disagreed to question 3.3. Respondents agree that environmentally friendly companies enjoy a stronger brand image, when using the calculated mean score of 1.57 as an indication. Two of the respondents omitted to complete Question 3.3. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 53.3% strongly agreed, 42.2 agreed and 4.4% disagreed to question 3.4. Respondents agree that rising energy prices creates a need for RECP, when using the calculated mean score of 1.51 as an indication. The standard deviation indicates a low level of dispersion of responses over the four options given.

Of the respondents 29.5% strongly agreed, 56.8% agreed, 11.4% disagreed and 2.3% strongly disagreed to question 3.5. Respondents agree that RECP can improve working conditions, when using the calculated mean score of 1.86 as an indication. One of the respondents omitted to complete Question 3.5. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 22.0% strongly agreed, 48.8% agreed, 22.0% disagreed and 7.3% strongly disagreed in question 3.6a. Respondents agree that RECP reduces the energy bill in the short term, when using the calculated mean score of 2.15 as an indication. Four

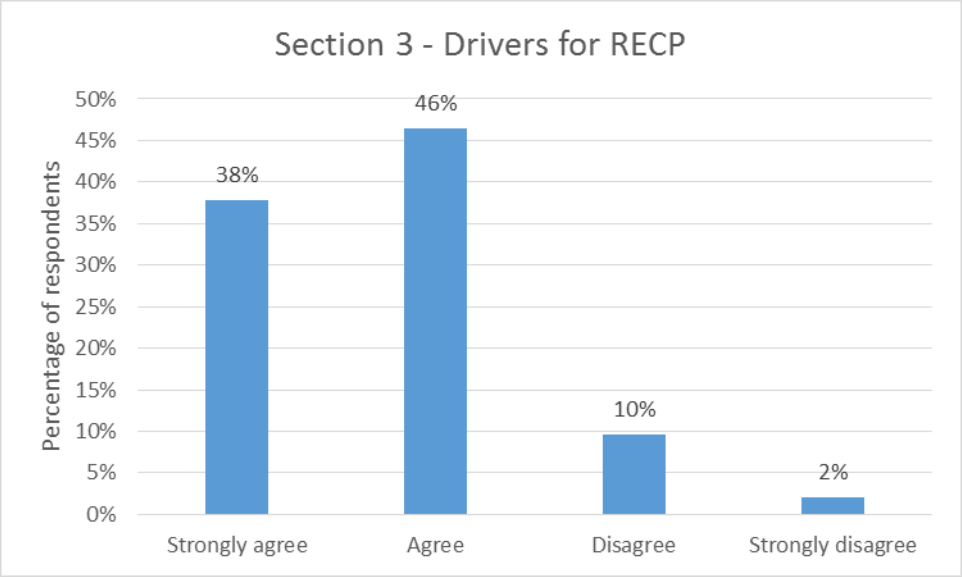
of the respondents omitted to complete Question 3.6a. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 23.8% strongly agreed, 61.9% agreed, 11.9% disagreed and 2.4% strongly disagreed to question 3.6b. Respondents agree that RECP reduces the energy bill in the medium term, when using the calculated mean score of 1.93 as an indication. Three of the respondents omitted to complete Question 3.6 b. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Of the respondents 51.3% strongly agreed, 43.6% agreed and 5.1% disagreed in question 3.6 c). Respondents agree that RECP reduces the energy bill in the long term, when using the calculated mean score of 1.54 as an indication. Six of the respondents omitted to complete Question 3.6 c. The standard deviation indicates a medium level of dispersion of responses over the four options given.

The majority of respondents agree that being resource efficient will reduce the company's energy bill in the medium to long-term. Previous participation in RECP initiatives was indicated to be low by the respondents. This can be the result of low exposure to RECP in the Vaal Triangle.

Figure 3.11: Sectional response to drivers for RECP.



The section on the drivers for RECP in the questionnaire indicated that the respondents agree (38% of the respondents strongly agree and 46% agree in figure 3.11 above) with the drivers as discussed in chapter 2 and the improvement in the company as a result of it. The drivers covered in the questionnaire included:

- Reduced carbon footprint;
- Corporate social responsibility;
- Subsidisation of RECP initiatives;
- Brand image;
- Rising energy prices;
- Working conditions; and
- Reduction of energy bill.

One of the respondents indicated in the open ended question that successful RECP implementations made available to the public can also act as a driver for RECP.

### 3.3.5 Section 4: Barriers to RECP

In section 4 of the questionnaire respondents were tested on the barriers to RECP. The section consisted of nine questions.

Table 3.3: Descriptive statistics for the perceived barriers to RECP initiatives.

| | SA | A | D | SD | Mean | Std. dev |
|---|---|---|---|---|---|---|
| 4.1. There are risks involved when investing in RECP initiatives. | 5 | 29 | 8 | 1 | 2.12 | 0.63 |
| 4.2. Lack of information is a cause of RECP opportunities being missed. | 18 | 23 | 3 | 0 | 1.66 | 0.61 |
| 4.3. There are hidden costs in most RECP opportunities. | 4 | 31 | 7 | 1 | 2.12 | 0.59 |
| 4.4. Efficiency potential is overstated in most opportunities. | 3 | 28 | 11 | 1 | 2.23 | 0.61 |
| 4.5. Access to financial capital is inhibited for investment in RECP opportunities. | 8 | 28 | 4 | 1 | 1.95 | 0.63 |
| 4.6. Responsibility for energy efficiency must be assigned. | 16 | 24 | 4 | 0 | 1.73 | 0.62 |
| 4.7. A Lack of RECP knowledge is a cause of profitable opportunities that is missed. | 17 | 24 | 4 | 0 | 1.71 | 0.63 |
| 4.8. A lack of energy engineering services prevents improvement on resource efficiency. | 17 | 19 | 8 | 1 | 1.84 | 0.80 |
| 4.9. Lack of top management commitment prevent the implementation of RECP opportunities. | 18 | 21 | 6 | 0 | 1.73 | 0.69 |

Of the respondents 11.6% strongly agreed, 67.4% agreed, 18.6% disagreed and 2.3% strongly disagreed to question 4.1. Respondents agree that there are risks involved when investing in RECP, when using the calculated mean score of 2.12 as an indication. Two of the respondents omitted to complete Question 4.1. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Of the respondents 40.9% strongly agreed, 52.3% agreed and 6.8% disagreed in Question 4.2. Respondents agree that a lack of information is a cause of RECP opportunities being missed, when using the calculated mean score of 1.66 as an indication. One of the respondents omitted to complete Question 4.2. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Of the respondents 9.3% strongly agreed, 72.1% agreed, 16.3% disagreed and 2.3% strongly disagreed to question 4.3. Respondents agree that there are hidden costs in RECP opportunities, when using the calculated mean score of 2.12 as an indication. Two of the respondents omitted to complete Question 4.3. The standard deviation indicates a low level of dispersion of responses over the four options given. More than 80% of the respondents showed agreement to the statements of RECP initiatives that include hidden costs.

Of the respondents 7.0% strongly agreed, 65.1% agreed, 25.6% disagreed and 2.3% strongly disagreed to question 4.4. Respondents agree that the efficiency potential is overstated in RECP opportunities, when using the calculated mean score of 2.23 as an indication. Two of the respondents omitted to complete Question 4.4. The standard deviation indicates a medium level of dispersion of responses over the four options given. 25.6% is the highest level of disagreement in the barriers section, this is positive towards RECP as it indicates that a group of respondents believes that the energy-efficiency potential of RECP opportunities is not always overstated.

Of the respondents 19.5% strongly agreed, 68.3% agreed, 9.8% disagreed and 2.4% strongly disagreed to question 4.5. Respondents agree that investment capital for RECP is held back by companies, when using the calculated mean score of 1.95 as an indication. Four of the respondents omitted to complete Question 4.5. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Of the respondents 36.4% strongly agreed, 54.5% agreed and 9.1% disagreed to question 4.6. Respondents agree that responsibility must be assigned for RECP, when using the calculated mean score of 1.95 as an indication. One of the respondents omitted to complete Question 4.6. The standard deviation indicates a medium level of dispersion of responses over the four options given.

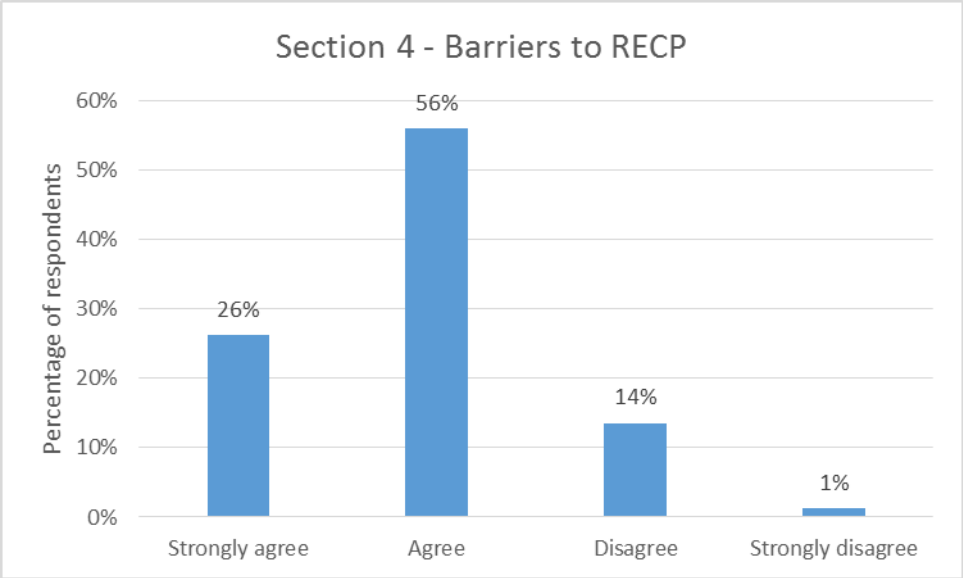
Of the respondents 37.8% strongly agreed, 53.3% agreed and 8.9% disagreed to question 4.7. Respondents agree that a lack of RECP knowledge can cause profitable opportunities to be missed, when using the calculated mean score of 1.71 as an indication. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Of the respondents 37.8% strongly agreed, 42.2% agreed 17.8% disagreed and 2.2% strongly disagreed to question 4.8. Respondents agree that a lack of energy engineering services prevents improvement on resource efficiency, when using the calculated mean score of 1.84 as an indication. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 40.0% strongly agreed, 46.7% agreed and 13.3% disagreed to question 4.9. Respondents agree that a lack of top management commitment prevent the implementation RECP opportunities, when using the calculated mean score of 1.73 as an indication. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Respondents indicated that they agree with the barriers that were presented in the questionnaire with 82% of the respondents in agreement (26% strongly agree plus 56% agree) as depicted in figure 3.12 below. The barriers that were tested included risk, lack of information, hidden costs, overstated potential, capital, energy capable engineering services and lack of management commitment.

Figure 3.12: Sectional response to barriers to RECP.




The respondents were asked to name any other barriers to RECP. The responses included experiences with energy audits that resulted in misleading information; cost data from reliable sources is not available to do life cycle assessments on RECP initiatives; vested interests in fossil fuel industry resulting in high costs to switch to greener alternatives, and lack of education in RECP and high capital costs.

### 3.3.6 Section 5: Willingness to participate in RECP

In section 5 of the questionnaire respondents were tested on the willingness to participate in RECP initiatives. The section consisted of twelve questions.

Table 3.4: Descriptive statistics on the willingness to participate in RECP

| | SA | A | D | SD | Mean | Std. dev |
|---|---|---|---|---|---|---|
| 5.1. My company would be willing to allow an energy audit at the company | 12 | 27 | 4 | 1 | 1.86 | 0.67 |
| 5.2. My company would be willing to take part in an energy audit at the company | 13 | 23 | 6 | 1 | 1.88 | 0.73 |
| 5.3. My company would be willing to pay for energy audit services conducted at the company | 6 | 16 | 19 | 3 | 2.43 | 0.82 |
| 5.4. My company would only participate in any energy audit if it was fully subsidised by external funding. | 7 | 19 | 16 | 2 | 2.30 | 0.79 |
| 5.5. My company is willing to pay an hourly engineering rate for energy audit services. | 1 | 20 | 19 | 3 | 2.56 | 0.67 |
| 5.6. My company is willing to pay a % of realised savings as a success fee. | 5 | 24 | 13 | 2 | 2.27 | 0.73 |
| 5.7. The company I work for or own should determine their carbon footprint. | 14 | 16 | 9 | 3 | 2.02 | 0.92 |
| 5.8. My company is willing to pay for a carbon footprint analysis. | 6 | 16 | 17 | 3 | 2.40 | 0.83 |
| 5.9. My company would only consider a carbon footprint analysis if it was subsidised by external funding. | 4 | 23 | 11 | 4 | 2.36 | 0.79 |
| 5.10. My company do not want to take part in any initiatives to become more resource efficient. | 3 | 2 | 23 | 13 | 3.12 | 0.81 |
| 5.11. Being resource efficient promotes sustainability. | 19 | 23 | 1 | 1 | 1.64 | 0.65 |
| 5.12. Practicing clean production promotes sustainability. | 17 | 23 | 2 | 1 | 1.70 | 0.67 |

Of the respondents 27.3% strongly agreed, 61.4% agreed, 9.1% disagreed and 2.3% strongly disagreed to question 5.1. Respondents agree that their company would be willing to allow an energy audit, when using the calculated mean score of 1.86 as an indication. One of the respondents omitted to complete Question 5.1. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Of the respondents 28.9% strongly agreed, 51.1% agreed, 13.3% disagreed and 2.2% strongly disagreed to question 5.2. Respondents agree that their company would be willing to take part in an energy audit, when using the calculated mean score of 1.88 as

an indication. Two of the respondents omitted to complete Question 5.2. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 13.6% strongly agreed, 36.4% agreed, 43.2% disagreed and 6.8% strongly disagreed to question 5.3. Respondents agree that their company would be willing to pay for an energy audit, when using the calculated mean score of 2.43 as an indication. One of the respondents omitted to complete Question 5.3. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 15.9% strongly agreed, 43.2% agreed, 36.4% disagreed and 4.5% strongly disagreed to question 5.4. Respondents agree, that their company would be willing to participate in an energy audit if it was fully subsidised, when using the calculated mean score of 2.3 as an indication. One of the respondents omitted to complete Question 5.4. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 2.3% strongly agreed, 46.5% agreed, 44.2% disagreed and 7.0% strongly disagreed to question 5.5. Respondents disagree, that their company would be willing to pay an hourly engineering rate for energy audit services, when using the calculated mean score of 2.56 as an indication. Two of the respondents omitted to complete Question 5.5. The standard deviation indicates a medium level of dispersion of responses over the four options given.

Of the respondents 11.4% strongly agreed, 54.5% agreed, 29.5% disagreed and 4.5% strongly disagreed to question 5.6. Respondents agree that their company would be willing to pay a % of the realised savings as a success fee, when using the calculated mean score of 2.27 as an indication. One of the respondents omitted to complete Question 5.6. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 33.3% strongly agreed, 38.1% agreed, 21.4% disagreed and 7.1% strongly disagreed in question 5.7 respondents agree, that their company should determine their carbon footprint, when using the calculated mean score of 2.02 as an indication. Three of the respondents omitted to complete Question 5.7. The standard

deviation indicates a very high level of dispersion of responses over the four options given.

Of the respondents 14.3% strongly agreed, 38.1% agreed, 40.5% disagreed and 7.1% strongly disagreed to question 5.8. Respondents agree that their company would be willing to pay for a carbon footprint analysis, when using the calculated mean score of 2.4 as an indication. Three of the respondents omitted to complete Question 5.8. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 9.5% strongly agreed, 54.8% agreed, 26.2% disagreed and 9.5% strongly disagreed to question 5.9. Respondents agree, that their company would only consider a carbon footprint analysis if it was subsidised, when using the calculated mean score of 2.36 as an indication. Three of the respondents omitted to complete Question 5.9. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 7.3% strongly agreed, 4.9% agreed, 56.1% disagreed and 31.7% strongly disagreed to question 5.10. Respondents disagree, that their company do not want to take part in any initiatives to become more resource efficient, when using the calculated mean score of 3.12 as an indication. Four of the respondents omitted to complete Question 5.10. The standard deviation indicates a high level of dispersion of responses over the four options given.

Of the respondents 43.2% strongly agreed, 52.3% agreed, 2.3% disagreed and 2.3% strongly disagreed to question 5.11. Respondents agree, that being resource efficient promotes sustainability, when using the calculated score mean of 1.64 as an indication. One of the respondents omitted to complete Question 5.11. The standard deviation indicates a medium level of dispersion of responses over the four options given.

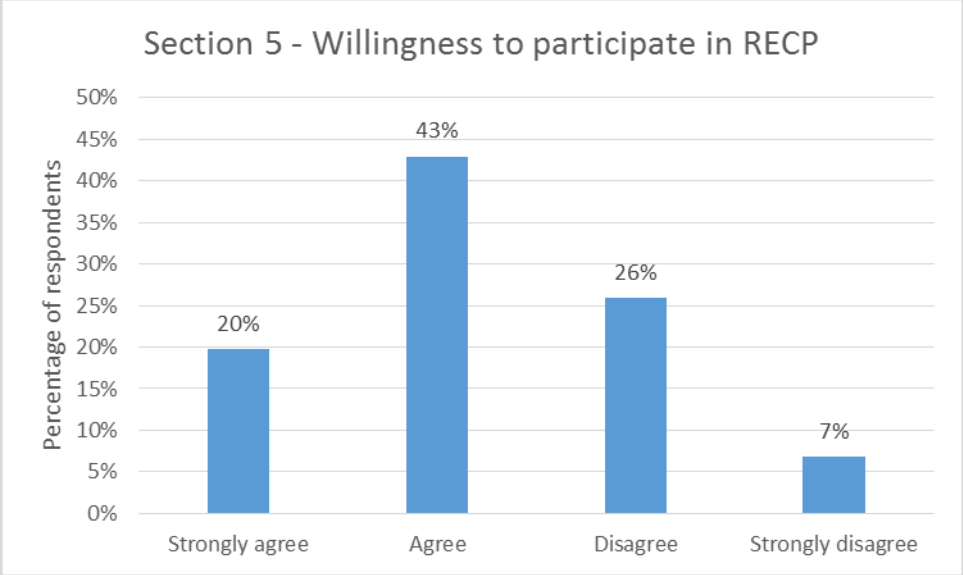
Of the respondents 39.5% strongly agreed, 53.5% agreed, 4.7% disagreed and 2.3% strongly disagreed to question 5.12. Respondents agree that practicing clean production promotes sustainability, when using the calculated mean score of 1.7 as an indication.

Two of the respondents omitted to complete Question 5.12. The standard deviation indicates a medium level of dispersion of responses over the four options given.

From the response for question 5.1 and 5.2 it is clear that respondents and their companies are willing to allow or participate in energy audits at the company. Of the respondents 50% indicate that they would be willing to pay for an energy audit. Respondents disagree to the proposal of paying an hourly fee for energy engineering services. From the data received the respondents indicate that the preferred method of payment would be a percentage success fee calculated from realised savings. Respondents indicated that a carbon footprint should be determined for the company and that the company would be willing to pay for it. Respondents feel that RECP initiatives promote sustainability.

The respondents indicated to be willing to participate in RECP with overall 63% (strongly agree 20% plus agree 43%) of the respondents in agreement with the questions posed to them as depicted figure 3.13. Of the respondents 33% were in a form of disagreement to the questions posed in section 5.

Figure 3.13: Sectional response for the willingness to participate in RECP.



Respondents were asked what in their view can improve the willingness to participate in RECP. Education and training in the field of RECP was repeatedly noted by respondents, participation in interdisciplinary conferences on RECP where information is shared, advertising and public awareness campaigns and incentive and subsidisation schemes for RECP initiatives both on a national scale and in the workplace.

### 3.3.7 Section 6: Open ended question

The questionnaire ended by asking the respondents to share any suggestions relating to RECP that was not covered in the questionnaire. Training in the field of RECP and public awareness regarding RECP was noted by 10% of the respondents.

## 3.4 RELIABILITY OF THE MEASURING INSTRUMENT

Cronbach's alpha coefficient is a measure of the internal consistency of a measurement or test. The coefficient shows the degree to which all the items in a measurement or test measure the same attribute. An alpha coefficient of 0.7 and larger indicates sufficient reliability of the data (Welman *et al.,* 2005:147). Reliability tests for the collected data was conducted by means of determining Cronbach's Alpha coefficient for sections 2 to 5 representing the data collected on the following topics relating to RECP:

- Primary fields;
- Drivers;
- Barriers; and
- Willingness.

The aggregate Cronbach alpha coefficient calculated for the sections 2 to 5 resulted in a coefficient of 0.79 indicating a high level of reliability of the data collected by the questionnaires.

Table 3.5: Reliability test for data on primary fields in RECP.

| | Cronbach's Alpha | Mean | Standard Deviation |
|---|---|---|---|
| **Primary fields in which to improve on Resource Efficiency & Cleaner Production (RECP)** | 0.77 | 1.42 | 0.38 |

The alpha coefficient in table 3.5 for the data on the primary fields in which to improve on RECP is 0.77, suggesting that the items have relatively high internal consistency with sufficient reliability. The mean of 1.42 indicates that the respondents agree with the primary fields that should be improved on.

Table 3.6: Reliability test for data on drivers for RECP.

| | Cronbach's Alpha | Mean | Standard Deviation |
|---|---|---|---|
| **Drivers for Resource Efficiency & Cleaner Production (RECP)** | 0.81 | 1.76 | 0.45 |

The alpha coefficient in table 3.6 for the drivers for RECP is 0.81, suggesting that the items have relatively high internal consistency with sufficient reliability. The mean of 1.76 indicates the respondents agree on the drivers for RECP.

Table 3.7: Reliability test for data on barriers to RECP.

| | Cronbach's Alpha | Mean | Standard Deviation |
|---|---|---|---|
| **Perceived Barriers to Resource Efficiency & Cleaner Production (RECP) initiatives** | 0.70 | 1.90 | 0.34 |

The alpha coefficient in table 3.7 for the perceived barriers to RECP is 0.70, suggesting that the items have relatively high internal consistency with sufficient reliability. The mean of 1.90 indicates the respondents agree on what they perceive as the barriers to RECP.

Table 3.8: Reliability test for data on willingness to participate in RECP.

| | Cronbach's Alpha | Mean | Standard Deviation |
|---|---|---|---|
| **Willingness to participate in Resource Efficiency & Cleaner Production (RECP) initiatives** | 0.89 | 2.11 | 0.50 |

The alpha coefficient for the data on willingness to participate in RECP initiatives, is 0.89 in table 3.8, suggesting that the items have relatively high internal consistency with sufficient reliability. The mean of 2.11 indicates the respondents agree on their level of willingness to participate in RECP initiatives.

### 3.4.1 Independent T-tests

T-test statistics measure any statistical significant difference between the means and distribution of samples (Welman *et al.,* 2005: 231). The independent t-test, also called the two sample t-test, was conducted to determine whether there is a statistically significant difference between the means for the private and public sector for the four topics covered in the research instrument (Primary fields, Drivers, Barriers and Willingness). In order to interpret the effect sizes from the independent t-tests, the following scale was adopted: $0 < x \leq 0.1$ = small, $0.1 < x \leq 0.3$ = medium and $0.3 < x \leq 0.5$ = large (Ellis & Steyn, 2003:52).

P-values are reported for completeness sake, but will not be interpreted, since a convenience sample instead of a random sample was used.

Table 3.9: T-test on the primary fields for RECP for the private and public sector.

| Primary fields in which to improve on Resource Efficiency & Cleaner Production | N | Mean | Standard deviation | P-value | Effect size |
|---|---|---|---|---|---|
| Private | 26 | 1.35 | 0.39 | 0.21 | 0.38 |
| Public | 17 | 1.49 | 0.35 | 0.20 | |

The effect size of 0.38 in table 3.9 indicates a large difference between what the private and public sector agree on in terms of the primary fields for RECP to improve on. The private sector tends to strongly agree with the primary fields for RECP whereas the public sector only agreed.

Table 3.10: T-test on the drivers for RECP for the private and public sector.

| Drivers for Resource Efficiency & Cleaner Production (RECP) | N | Mean | Standard deviation | P-value | Effect size |
|---|---|---|---|---|---|
| Private | 26 | 1.72 | 0.51 | 1.00 | 0 |
| Public | 17 | 1.72 | 0.28 | 0.99 | |

There are no difference between the view of the private and public sector for drivers for RECP when looking at the effect size of 0 in table 3.10. The private and public sector thus both agree to what is considered as drivers for RECP.

Table 3.11: T-test for the barriers to RECP for the private and public sector.

| Perceived Barriers to Resource Efficiency & Cleaner Production (RECP) initiatives | N | Mean | Standard deviation | P-value | Effect size |
|---|---|---|---|---|---|
| Private | 26 | 1.89 | 0.39 | 0.87 | 0.04 |
| Public | 17 | 1.91 | 0.27 | 0.86 | |

The effect size of 0.04 in table 3.11 indicates a small negligible difference between the means for the private and public sector for the perceived barriers to RECP. The private and public sector are thus in agreement as to what is considered barriers to RECP initiatives.

Table 3.12: T-test on the willingness to participate in RECP for the private and public sector.

| Willingness to participate in Resource Efficiency & Cleaner Production (RECP) | N | Mean | Standard deviation | P-value | Effect size |
|---|---|---|---|---|---|
| Private | 26 | 2.12 | 0.60 | 0.71 | 0.1 |
| Public | 17 | 2.06 | 0.32 | 0.68 | |

The effect size of 0.1 in table 3.12 indicates a small difference between the means for the private and public sector for the perceived barriers to RECP. The private and public sector's willingness to participate in RECP initiatives are thus at almost the same level.

### 3.4.2 Correlations for company energy bill and years at company

The Spearman rank-order correlation is a statistic used to measure the degree of association between two variables (Welman *et al.,* 2005:229). The Spearman's rank-order correlation coefficient was determined as a measurement of statistical dependence in order to describe the relationship between the data from the monthly energy bill for company and the primary fields for RECP, drivers for RECP, barriers to RECP and the willingness to participate in RECP. The Spearman's correlation coefficient was also determined to assess whether a significant relationship exists between the number of years at the current company and the primary fields of RECP, drivers for RECP, barriers to RECP and willingness to participate in RECP. The following scale was adopted for interpretation of the results: $0 < x \leq 0.1$ = small, $0.1 < x \leq 0.3$ = medium and $0.3 < x \leq 0.5$ = large.

The monthly energy bill was selected, as the potential for RECP improvement and savings can be determined from this information. The number of years at the company was selected because it represents experience that can be used as a proxy for insight into RECP processes and initiatives. The correlation coefficients are listed in table 3.13 and table 3.14 below.

P-values are reported for completeness sake, but will not be interpreted, since a convenience sample instead of a random sample was used.

Table 3.13: Correlation of the monthly energy bill to other sections in the research instrument.

| | N | P-value | Correlation coefficient |
|---|---|---|---|
| **Primary fields in which to improve on Resource Efficiency & Cleaner Production (RECP)** | 45 | 0.33 | -0.15 |
| **Drivers for Resource Efficiency & Cleaner Production (RECP)** | 45 | 0.41 | -0.13 |
| **Perceived Barriers to Resource Efficiency & Cleaner Production (RECP) initiatives** | 45 | 0.80 | 0.04 |
| **Willingness to participate in Resource Efficiency & Cleaner Production (RECP) initiatives** | 45 | 0.52 | -0.10 |

There is a medium correlation between the monthly energy bill of the company and the primary RECP fields in which to improve on. The value of -0.15 in table 3.13 indicates a negative association indicating that as the energy bill increases, the level of agreement in the primary fields of RECP decreases.

There is a medium correlation between the monthly energy bill of the company and the drivers for RECP. The value of -0.13 in table 3.13 indicates a negative association indicating that as the energy bill increases, the level of agreement in the drivers for RECP decreases.

There is no significant correlation between the monthly energy bill and the barriers to RECP.

A small negative association, with a correlation coefficient of -0.10 in table 3.13, exists between the monthly energy bill and the willingness to participate in RECP initiatives.

It is thus concluded that the larger the monthly energy bill, the less the respondents tend to agree with the primary fields and drivers for RECP presented to them. There also to a small degree, is a notion for businesses with the largest energy bills to be less willing to participate in RECP initiatives.

Table 3.14: Correlation of the number of years at the current company to other sections in the research instrument.

| | N | P-value | Correlation coefficient |
|---|---|---|---|
| **Primary fields in which to improve on Resource Efficiency & Cleaner Production (RECP)** | 43 | 0.13 | 0.24 |
| **Drivers for Resource Efficiency & Cleaner Production (RECP)** | 43 | 0.72 | 0.06 |
| **Perceived Barriers to Resource Efficiency & Cleaner Production (RECP) initiatives** | 43 | 0.16 | -0.22 |
| **Willingness to participate in Resource Efficiency & Cleaner Production (RECP) initiatives** | 43 | 0.88 | -0.02 |

There is a medium correlation between the number of years at the current company and the primary RECP fields in which to improve on. The value of 0.24 in table 3.14 indicates a positive association indicating that as the number of years at the current company increases, the level of agreement regarding the primary fields of RECP also increases.

There is no significant correlation between the number of years at the company and the drivers for RECP.

There is a medium correlation between the number of years at the current company and the barriers to RECP. The value of -0.22 in table 3.13 indicates a negative association indicating that as the number of years at the current company increases, the level of agreement regarding the barriers to RECP decreases.

There is no significant correlation between the number of years at the company and the level of willingness to participate in RECP initiatives.

It is thus concluded from the correlations that the longer the respondent's presence at the company the more agreement exist on the primary fields of RECP presented, but the less agreement with the barriers to RECP presented.

### 3.4.3 Correlations between primary fields, drivers, barriers and willingness

The Spearman's correlation coefficient was determined as a measurement of statistical dependence in order to determine whether there exists a relationship between the data collected by the research instrument on the primary fields of improvement for RECP, the drivers for RECP, the perceived barriers to RECP and the willingness to participate in RECP initiatives. The following scale was adopted for interpretation of the results: $0 < x \leq 0.1$ = small, $0.1 < x \leq 0.3$ = medium and $0.3 < x \leq 0.5$ = large.

P-values are reported for completeness sake, but will not be interpreted, since a convenience sample instead of a random sample was used.

Table 3.15: Correlation between primary fields, drivers, barriers and willingness for RECP initiatives.

| | | 1. | 2. | 3. | 4. |
|---|---|---|---|---|---|
| **1. Primary fields in which to improve on Resource Efficiency & Cleaner Production (RECP)** | **Correlation Coefficient** | | 0.37 | -0.11 | 0.41 |
| | **P-value** | | 0.01 | 0.47 | 0.01 |
| | **N** | | 45 | 45 | 45 |
| **2. Drivers for Resource Efficiency & Cleaner Production (RECP)** | **Correlation Coefficient** | 0.37 | | 0.31 | 0.48 |
| | **P-value** | 0.01 | | 0.04 | 0.00 |
| | **N** | 45 | | 45 | 45 |
| **3. Perceived Barriers to Resource Efficiency & Cleaner Production (RECP) initiatives** | **Correlation Coefficient** | -0.11 | 0.31 | | -0.12 |
| | **P-value** | 0.47 | 0.04 | | 0.42 |
| | **N** | 45 | 45 | | 45 |
| **4. Willingness to participate in Resource Efficiency & Cleaner Production (RECP) initiatives** | **Correlation Coefficient** | 0.41 | 0.48 | -0.12 | |
| | **P-value** | 0.01 | 0.00 | 0.42 | |
| | **N** | 45 | 45 | 45 | |

For the primary fields in which to improve on RECP there are the following correlations from table 3.15:

- A large correlation exists with the drivers for RECP. Positive association with a correlation coefficient of 0.37.
- A medium correlation exists with the perceived barriers to RECP. Negative association with a correlation coefficient of -0.11.
- A large correlation exists with willingness to participate in RECP. Positive association with a correlation coefficient of 0.41.

Thus the higher the level of agreement with the primary fields of RECP, the higher the levels of agreement with the drivers and willingness to participate in RECP.

For the drivers for RECP there are the following correlations from table 3.15:

- A large correlation exists with the primary fields in which to improve on RECP. Positive association with a correlation coefficient of 0.37.
- A large correlation exists with the drivers for RECP. Positive association with a correlation coefficient of 0.31.
- A large correlation exists with willingness to participate in RECP. Positive association with a correlation coefficient of 0.48.

Therefore, the higher the level of agreement is for the drivers for RECP, the higher the levels of agreement for the primary fields, and willingness to participate in RECP.

For the perceived barriers to RECP there are the following correlations from table 3.15:

- A medium correlation exists with the primary fields in which to improve on RECP. Negative association with a correlation coefficient of -0.11.
- A large correlation exists with the drivers for RECP. Positive association with a correlation coefficient of 0.31.
- A medium correlation exists with willingness to participate in RECP. Negative association with a correlation coefficient of -0.12.

For the willingness to participate in RECP initiatives there exist the following correlations from table 3.15:

- A large correlation exists with the primary fields in which to improve on RECP. Positive association with a correlation coefficient of 0.41.
- A large correlation exists with the drivers for RECP. Positive association with a correlation coefficient of 0.48.
- A medium correlation exists with the perceived barriers to RECP. Negative association with a correlation coefficient of -0.12.

Therefore, the higher the level of willingness is to participate in RECP initiatives the higher the level of agreement with the primary fields and drivers for RECP.

## 3.5 CONCLUSION

The target population for the research study was located within the boundaries of the Vaal Triangle. A questionnaire was used as research instrument. The questionnaire was distributed within the Vanderbijlpark Business Chamber which represents the Vaal Triangle and within the researcher's personal business network located in the Vaal Triangle. A total of 45 completed questionnaires was collected.

The questionnaire consisted of six sections with the first section covering the demographical information of the respondents. The second section of the questionnaire investigated what the respondents regarded as the primary fields of RECP. Section three

of the questionnaire tested the response on the drivers for RECP. Section four of the research instrument covered the barriers to RECP initiatives. In section five the respondents' willingness to participate in RECP initiatives were tested.

Each section except for the first ended with an open question. The final section of the questionnaire consisted of one open ended question asking whether there was anything in the respondent's view that was not covered in the questionnaire.

Demographically, the respondents were a balanced group of males and females located in the Vaal Triangle. Respondents' companies consisted of both the private and public sector from a wide range of business sectors. All respondents held a management level position at their respective companies.

The descriptive statistics revealed that for all sections of questions, the mean responses fell within a level of strong agreement or agreement. The reliability of the data was tested for sections 2 to 5 by calculating the Cronbach's alpha coefficients. The coefficient was ≥0.7 for each section indicating a sufficient level of reliability.

There is a medium to large difference between what the private and public sector agree on in terms of the primary fields for RECP to improve on. The private sector tends to strongly agree with the primary fields for RECP whereas the public sector only agrees. There are correlations between the primary fields for RECP, the drivers for RECP, the barriers to RECP and the willingness to participate in RECP initiatives.

# CHAPTER 4: CONCLUSION AND RECOMMENDATIONS

## 4.1 INTRODUCTION

Chapter 4 concludes the research study. The chapter summarises the main findings from the study and makes recommendations for RECP initiatives in the Vaal Triangle. The chapter discusses whether the primary and secondary objectives of the research study have been met and also points out the limitations of this study. Recommendations for future research in the field of RECP are also made in this chapter.

## 4.2 MAIN FINDINGS FROM THE STUDY

The main findings from the literature review and the empirical investigation are discussed in the sections below.

### 4.2.1 RECP improvement focus areas

#### 4.2.1.1 Sectorial

Efficiency improvement initiatives in South Africa can be focussed on three sectors that account for 84% of the final energy use. The sectors include industry and mining accounting for 38% of final energy use, the transport sector accounting for 28% of final energy use and the residential sector accounting for 18% of final energy use as depicted in figure 2.5.

The transport industry is the second largest contributor of final energy use as depicted in figure 2.5, but RECP improvements opportunities can prove to be limited by already fuel efficient systems driven by the high oil price. It can thus be advised to focus on the residential sector's electricity consumption and the industrial and mining sector's fuel and electricity consumption which are used to drive equipment and manufacturing plants.

#### 4.2.1.2 Technological

Motor-driven equipment accounts for about 60% of manufacturing final electricity use and is omnipresent worldwide. Approximately 55% of the electricity used by motor systems is

lost before the motor systems do any work (United Nations Industrial Development Corporation, 2011:44).

Compressors, drives, air treatment, compressed gas network and the end use devices driven by compressed air account for 10% of industrial consumption of electricity. Compressors lose 80% of the mechanical work done by the motor, and leaks in the air distribution systems are rampant. Case studies show that savings of up to 50% are possible (United Nations Industrial Development Corporation, 2011:45).

Steam systems account for 35% of global industrial energy consumption. These systems lose an average 45% of their input heat before reaching point of use. Focussing on motor-driven equipment, compressed air systems and steam systems for RECP improvements will realise the quickest and most substantial gains in terms of RECP improvements (United Nations Industrial Development Corporation, 2011:45).

### 4.2.2 Demographic profile

The sections below conclude the main findings from the demographical profile of the respondents that participated in the research study.

#### 4.2.2.1 Previous participation in RECP

The study shows that a very small percentage, below 10%, of the respondents indicated previous participation in any RECP initiatives. More than 80% of the companies indicated that they do not have a position within the company that is specifically tasked with the responsibility for RECP improvement and monitoring. This shows that there exists green business potential for RECP service providers in the Vaal Triangle and that businesses in the Vaal Triangle need to be sensitised in terms of RECP services.

Although previous exposure to RECP was indicated to be low, respondents still indicated a positive attitude about the necessity of implementing RECP in the fields presented.

Both the low rate for previous RECP participation in the Vaal Triangle and having a position tasked with the responsibility for RECP improvement within the companies calls for dedicated attempts to introduce companies in the Vaal Triangle with the concepts of

RECP and the related benefits. The introduction of RECP in the Vaal Triangle will also increase the number of positions in industry tasked with RECP improvement that will make use of the subsidisation, funding and incentive schemes offered in South Africa.

#### 4.2.2.2 Designated job title for RECP

The study showed that businesses indicating a designated position tasked with the responsibility to enhance RECP predominantly came from medium sized businesses (50 to 250 employees). Thus the larger the business, the more likely the business is to have an employee tasked with RECP due to the energy bill that becomes more significant as the size of the business increase.

### 4.2.3 Primary fields for RECP improvement

The research study shows that the respondents strongly agree with the primary fields of RECP introduced to them through this study. Respondents indicated that that they strongly agree with the implementation or improvement in the following primary fields of RECP including:

- Energy efficiency and the participation in energy audits.
- On-site recycling of waste materials.
- Operations optimisation.
- Using environmentally friendly materials and fuels.

### 4.2.4 Drivers for RECP improvement

Subsidisation of RECP initiatives act as a strong driver but the research proved that this is not a necessity for the participation in such initiatives. Respondents indicated that they are also willing to participate in RECP initiatives that are not subsidised and that will relay company capital and other company resources.

The main drivers for improving and participating in RECP initiatives that can be highlighted from this study include:

- A reduced carbon footprint;
- Increased corporate social responsibility as a result of RECP;
- Subsidisation of RECP initiatives;
- Improved brand image as a result of RECP;
- Rising energy prices;
- Improved working conditions; and
- Reduction of energy bill by increasing efficiency.

The study also indicated that more success stories on RECP implementations, for example, case studies should be made available to the public to act as an additional driver for RECP.

### 4.2.5 Barriers to RECP implementation

The most common barriers encountered when dealing with the implementation of RECP included investment risk, lack of information causing feasible RECP opportunities to be missed, hidden costs regarding the implementation and participation of RECP, overstated potential benefits and returns, lack of capital funds set aside for RECP improvement, the lack of energy capable engineering services to identify and manage RECP opportunities and the lack of management commitment towards the improvement of RECP.

The research study also produced additional barriers to RECP. These barriers include experiences with energy audits that resulted in misleading information, cost data from reliable sources is not available to do life-cycle assessments on RECP initiatives, vested interests in fossil fuel industry resulting in high costs to switch to greener alternatives, the lack of education or training in RECP and high capital costs required to switch to more efficient operations.

### 4.2.6 Willingness to participate in RECP initiatives

Businesses in the Vaal Triangle are predominantly willing to allow or participate in RECP initiatives. Of the businesses 50% indicate that they would be willing to pay for an energy

audit and 50% indicated that the companies would not be willing to pay for an energy audit. The preferred method of payment for RECP services would be a percentage success fee calculated from realised savings. Paying an hourly engineering fee for RECP services proved to be the least preferred method of payment. Businesses agree that a carbon footprint should be determined for the company but should rather be subsidised than paid for. Willingness to participate in an energy audit is thus more than the willingness to do a carbon footprint assessment as the benefits of an energy audit would be more tangible in the short term than that of a carbon footprint analysis.

The study identified additional means of improving the willingness of businesses in the Vaal Triangle to participate in RECP. These included:

- Education and training in the Field of RECP (repeatedly noted).
- Participation in interdisciplinary conferences on RECP where information is shared.
- Advertising and public awareness campaigns.
- Incentive and subsidisation schemes for RECP initiatives both on a national scale and in the workplace.

### 4.2.7 Private and public sector

Although it can be concluded form the study that companies in the Vaal Triangle regard the primary fields for improvement of RECP the same as proposed in the study, there seems to be a difference between the private sector and the public sector. The private sector tended to strongly agree with the proposed primary fields for RECP improvements whereas the public sector's agreement was at a lower level.

For the rest of the subjects tested by the study, including the drivers, barriers and willingness to participate in RECP initiatives no significant levels of statistical differences between the response of the private and public sector could be proved.

### 4.2.8 Correlations

#### 4.2.8.1 Monthly energy bill

There appears to be a small negative association between the monthly energy bill of the company and the primary RECP fields in which to improve on. As the size of the monthly energy bill increased, the less the respondents tended to agree with the primary fields of RECP presented in the research tool. The same notion was statistically determined between the monthly energy bill and the drivers for RECP. This occurrence can be attributed to the fact that larger companies can have different opportunities and drivers for RECP related activities.

The barriers to RECP are regarded as the same for companies across the spectrum of the size of the energy bill that was captured by the study for each company. No significant correlation between the monthly energy bill and the barriers to RECP could be proved statistically.

#### 4.2.8.2 Number of years at company

There is a medium correlation between the number of years at the current company and the primary RECP fields in which to improve on. As the number of years at the current company increase, the level of agreement regarding the primary fields of RECP also increases. The same finding holds for the barriers to RECP.

There is no significant correlation between the number of years at the company and the drivers for RECP, the same conclusion holds for the willingness to participate in RECP.

## 4.3 RECOMMENDATIONS

The Vaal Triangle business sector requires continuous sensitising towards RECP initiatives and the benefits thereof. Dedicated attempts to introduce companies in the Vaal Triangle with the concepts of RECP and the related benefits should be launched. The introduction of RECP in the Vaal Triangle will also increase the number of positions in industry tasked with RECP improvement that will make use of the subsidisation, incentive schemes and engineering services offered in South Africa.

RECP consultants should focus business on the industrial, mining and residential sector in South Africa. RECP consultants should present the percentage of realised savings as the preferred form of remuneration for services rendered in the field of RECP. RECP consultants should use the drivers identified by this study as selling points when approaching clients. Successful case studies of RECP initiatives should also be presented to potential clients.

Participants to the research study repeatedly noted that there is a need for education and training in the field RECP. Research can be done in this field in order to determine success of training on a national level as offered by the NCPC and also the success of internal training programs within companies. The long term viability of RECP should also be researched in order to determine if RECP training can be presented as separate curriculums at universities and technical education institutions.

More effective ways of public promotion of RECP should be researched as it was found in the Vaal Triangle most of the companies asked for the better promotion and information regarding RECP even though country wide bodies exist that fully subsidise RECP initiatives.

In order to increase the interest and participation in RECP in the Vaal Triangle, the related incentives should be made more attractive. This can be achieved by better marketing and increased skill from the consultant for RECP services or by government making the available incentives discussed in chapter 2 more attractive. This is a quick and sure way of enhancing the feasibility of RECP projects.

## 4.4 ACHIEVEMENT OF THE STUDY'S OBJECTIVES

### 4.4.1 Primary objective

The primary objective of this research was to evaluate if there exists a need in the Vaal Triangle, for Resource Efficiency and Cleaner Production improvement. This study found that there a need in the Vaal Triangle for RECP improvement. First this was indicated by the literature that indicated a need for RECP across South Africa due the alarming rate of energy price increases and the increase in final energy demand for the country as a whole. The increase in demand creates a shortage of energy resources and for South

Africa especially in the form of electricity. An effective way to address this problem is by becoming resource efficient.

### 4.4.2 Secondary objectives

The study showed that the primary fields to improve on RECP in the Vaal Triangle include energy-efficiency and the participation in energy audits, on-site recycling of waste materials, operations optimisation and using environmentally friendly materials and fuels.

The drivers for RECP in the Vaal Triangle determined by the study include having a reduced carbon footprint increased corporate social responsibility as a result, subsidisation of RECP initiatives, improved brand image as a result of RECP, rising energy prices, improved working conditions as a result and the reduction of the energy bill by increasing energy-efficiency.

The study determined the type of barriers that exists for the implementation of RECP initiatives within companies in the Vaal Triangle. Additional barriers to the originally proposed barriers were also identified by the study. Proposed and positively tested barriers include investment risk, lack of information causing feasible RECP opportunities to be missed, hidden costs regarding the implementation and participation of RECP, overstated potential benefits and returns, lack of capital funds set aside for RECP improvement, the lack of energy capable engineering services to identify and manage RECP opportunities and the lack of management commitment towards the improvement of RECP.

The additional barriers that were captured include experiences with energy audits that resulted in misleading information, cost data from reliable sources is not available to do life-cycle assessments on RECP initiatives, vested interests in fossil fuel industry resulting in high costs to switch to greener alternatives, the lack of education or training in RECP and high capital costs required to switch to more efficient operations.

The study also proved that companies in the Vaal Triangle specifically, are willing to participate in RECP initiatives. The companies indicated that they would be willing to participate in the initiatives whether subsidised or whether it would be relying on own funding and resources.

## 4.5 RECOMMENDATIONS FOR FUTURE RESEARCH

Even though the Vaal Triangle traditionally represents the industrial back-bone of South Africa (Vaal Triangle Info: 2014), geographically the area represents a very small part of South Africa. It is thus suggested to conduct a research study with a sufficient sample population to be representative of the South African market for RECP.

The sample size of this research study limited the number of correlations that could be done on the collected data.

## 4.6 CONCLUSION

The market needs to be educated and trained in the field RECP in order to ensure the successful deployment of such initiatives in the future. This will also increase the trust in these initiatives and promote the understanding that it is beneficial to a company to be resource efficient and to practice cleaner production methods. The participation in RECP will also be beneficial to the government of the country as it will reduce resource intensity and enhance future sustainability in the country.

### 4.6.1 The need to be resource efficient in South Africa

South Africa holds an environment where resource efficiency, with the focus on energy, is a necessity. The need to be energy efficient is driven by a continuous increase in the totalised energy demand by sector for South Africa (47% increase from 2000 to 2009), 3$^{rd}$ place world ranking for South Africa for energy intensity and an electricity price that is predicted to double from 2013 to 2017 (SAPA, 2013).

By looking at financial drivers, the threat of rising energy prices as well as cost reductions resulting from lowered energy use are indeed perceived as the strongest driving forces towards energy efficiency improvement. Barriers to RECP implementation include investment risk, imperfect information regarding the opportunities, hidden costs, inhibited access to capital, and split incentives across company departments.

There is a need in the Vaal Triangle for RECP initiatives and that the potential exists for the start of a green economy in the region. The reaction towards RECP initiatives was found to be very positive in the studied region.

### 4.6.2 Incentives for RECP

RECP initiatives' economic viability can be enhanced by subsidisation from the National Cleaner Production Centre (NCPC) and the Private Sector Energy Efficiency (PSEE) program from the NBI. Both institutions are based in South Africa and focus entirely on providing subsidised RECP assessments, the promotion thereof, to the public.

The DTI also offers the manufacturing competitiveness enhancement program (MCEP) which has funds specifically allocated to manufacturing enhancement programs (for example, operations optimization) and the implementation of green technologies and resource efficiency initiatives.

Eskom offers the performance contracting model which aims to purchase bulk verified energy savings across multiple sites and technologies by contracting with a single project developer. The South African government offers the Section 12L tax incentive scheme which offers a tax rebate on verified energy savings for energy-efficiency projects.

### 4.6.3 Sensitising towards RECP

The fact that industry request training on RECP and subsidisation for RECP initiatives in the Vaal Triangle indicates that RECP is not sufficiently promoted in the Vaal Triangle as subsidised training (hosted by the NCPC), subsidised RECP assessments (hosted by NCPC and PSEE) and subsidised efficiency improvement implementations (partially funded by the DTI's MCEP) are available throughout South Africa. It also proves that businesses in the Vaal Triangle need continuous sensitising towards the adoption of RECP through education, training and promotion of RECP.

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# ANNEXURES

## Annexure A: World Energy Council energy sustainability index

| RANK | Energy Sustainability Index (2013) | SCORE | RANK | Energy Security | RANK | Energy Equity | RANK | Environmental Sustainability |
|---|---|---|---|---|---|---|---|---|
| 1 | Switzerland | AAA | 1 | Canada | 1 | United States | 1 | Switzerland |
| 2 | Denmark | AAA | 2 | Russia | 2 | Canada | 2 | Costa Rica |
| 3 | Sweden | AAA | 3 | Denmark | 3 | Australia | 3 | Albania |
| 4 | Austria | AAB | 4 | Bolivia | 4 | Luxembourg | 4 | Colombia |
| 5 | United Kingdom | AAA | 5 | Colombia | 5 | France | 5 | Uruguay |
| 6 | Canada | AAB | 6 | Kazakhstan | 6 | Switzerland | 6 | Sweden |
| 7 | Norway | AAB | 7 | Angola | 7 | Austria | 7 | Austria |
| 8 | New Zealand | AAB | 8 | Qatar | 8 | United Kingdom | 8 | Norway |
| 9 | Spain | AAA | 9 | Romania | 9 | Qatar | 9 | France |
| 10 | France | AAB | 10 | Australia | 10 | Norway | 10 | Denmark |
| 11 | Germany | ABB | 11 | United Kingdom | 11 | Germany | 11 | El Salvador |
| 12 | Netherlands | ABB | 12 | United States | 12 | Saudi Arabia | 12 | Gabon |
| 13 | Finland | ABB | 13 | Nigeria | 13 | Belgium | 13 | Paraguay |
| 14 | Australia | AAD | 14 | Argentina | 14 | Sweden | 14 | Latvia |
| 15 | United States | AAC | 15 | New Zealand | 15 | Iceland | 15 | Ireland |
| 16 | Japan | ABB | 16 | Czech Republic | 16 | Spain | 16 | Mauritius |
| 17 | Belgium | ABB | 17 | Indonesia | 17 | Japan | 17 | Brazil |
| 18 | Qatar | AAC | 18 | China | 18 | Greece | 18 | Panama |
| 19 | Luxembourg | ABD | 19 | Switzerland | 19 | Bahrain | 19 | United Kingdom |
| 20 | Ireland | ABC | 20 | Slovakia | 20 | Oman | 20 | Portugal |
| 21 | Costa Rica | ABB | 21 | Peru | 21 | Finland | 21 | Croatia |
| 22 | Slovakia | ABB | 22 | Spain | 22 | Taiwan | 22 | Georgia |
| 23 | Portugal | ABB | 23 | Bahrain | 23 | Netherlands | 23 | Spain |
| 24 | Colombia | AAC | 24 | Sweden | 24 | Hong Kong | 24 | Italy |
| 25 | Slovenia | BBB | 25 | Ecuador | 25 | Denmark | 25 | Barbados |
| 26 | Argentina | ABB | 26 | Bulgaria | 26 | New Zealand | 26 | Lithuania |
| 27 | Taiwan | ABC | 27 | Brazil | 27 | Slovenia | 27 | Congo (Dem. Rep.) |
| 28 | Italy | ABC | 28 | Tunisia | 28 | Kuwait | 28 | Ecuador |
| 29 | Panama | ABB | 29 | Mexico | 29 | Israel | 29 | Luxembourg |
| 30 | Croatia | ABC | 30 | Congo (Dem. Rep.) | 30 | Ireland | 30 | Germany |
| 31 | Hungary | BBB | 31 | Germany | 31 | Croatia | 31 | Angola |
| 32 | Czech Republic | ABC | 32 | Azerbaijan | 32 | Czech Republic | 32 | Malawi |
| 33 | Iceland | ABC | 33 | Austria | 33 | Argentina | 33 | Japan |
| 34 | Brazil | ABC | 34 | Malaysia | 34 | Italy | 34 | Belgium |
| 35 | Ecuador | ABB | 35 | Gabon | 35 | Kazakhstan | 35 | Netherlands |
| 36 | Tunisia | BBB | 36 | Côte d'Ivoire | 36 | Cyprus | 36 | Guatemala |
| 37 | Malaysia | BBC | 37 | Finland | 37 | United Arab Emirates | 37 | New Zealand |
| 38 | Bahrain | AAD | 38 | Poland | 38 | Slovakia | 38 | Argentina |
| 39 | Greece | ABC | 39 | Philippines | 39 | Poland | 39 | Cameroon |
| 40 | Hong Kong | ABD | 40 | Guatemala | 40 | Malaysia | 40 | Sri Lanka |
| 41 | Mexico | BBC | 41 | Venezuela | 41 | Barbados | 41 | Iceland |
| 42 | Lithuania | ABC | 42 | Netherlands | 42 | Hungary | 42 | Slovenia |
| 43 | Latvia | ABD | 43 | South Africa | 43 | Singapore | 43 | Peru |
| 44 | United Arab Emirates | BBD | 44 | France | 44 | Iran | 44 | Hungary |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 45 | Peru | ABC | 45 | Saudi Arabia | 45 | Costa Rica | 45 | Finland |
| 46 | Uruguay | ACC | 46 | Hungary | 46 | Lithuania | 46 | Nepal |
| 47 | Singapore | BBD | 47 | Egypt | 47 | Mexico | 47 | Ethiopia |
| 48 | Poland | BBC | 48 | Japan | 48 | Malta | 48 | Slovakia |
| 49 | El Salvador | ABC | 49 | United Arab Emirates | 49 | South Korea | 49 | Namibia |
| 50 | Barbados | ABD | 50 | Mongolia | 50 | Macedonia | 50 | Chad |
| 51 | Saudi Arabia | ABD | 51 | Norway | 51 | Estonia | 51 | Singapore |
| 52 | Romania | ACC | 52 | Syria | 52 | Syria | 52 | Honduras |
| 53 | Mauritius | ABD | 53 | Panama | 53 | Portugal | 53 | Tanzania |
| 54 | Russia | ABD | 54 | Greece | 54 | Latvia | 54 | Philippines |
| 55 | Bolivia | ACC | 55 | Portugal | 55 | Venezuela | 55 | Dominican Republic |
| 56 | Gabon | ABC | 56 | Pakistan | 56 | Chile | 56 | Tunisia |
| 57 | Chile | BCC | 57 | Costa Rica | 57 | Tunisia | 57 | Montenegro |
| 58 | Kazakhstan | ABD | 58 | Mauritania | 58 | Panama | 58 | Hong Kong |
| 59 | Angola | ABD | 59 | Ukraine | 59 | Egypt | 59 | Taiwan |
| 60 | Albania | ACC | 60 | Slovenia | 60 | Mauritius | 60 | Canada |
| 61 | Guatemala | BBC | 61 | Swaziland | 61 | Russia | 61 | Tajikistan |
| 62 | Oman | ACD | 62 | Cameroon | 62 | Ecuador | 62 | Botswana |
| 63 | Cyprus | BCD | 63 | Belgium | 63 | Jordan | 63 | Kenya |
| 64 | South Korea | BCD | 64 | Turkey | 64 | El Salvador | 64 | Zambia |
| 65 | Philippines | BBC | 65 | Estonia | 65 | Serbia | 65 | Malta |
| 66 | Kuwait | BCD | 66 | Croatia | 66 | Georgia | 66 | Mozambique |
| 67 | Israel | BCD | 67 | Mozambique | 67 | Uruguay | 67 | Cambodia |
| 68 | Estonia | BCD | 68 | El Salvador | 68 | Algeria | 68 | Côte d'Ivoire |
| 69 | Sri Lanka | BCC | 69 | Italy | 69 | Armenia | 69 | Madagascar |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 70 | Bulgaria | ACD | 70 | Libya | 70 | Romania | 70 | Turkey |
| 71 | Malta | BCD | 71 | Taiwan | 71 | Montenegro | 71 | Bolivia |
| 72 | Georgia | ACD | 72 | Sri Lanka | 72 | Libya | 72 | Chile |
| 73 | Indonesia | ACD | 73 | Kuwait | 73 | Ukraine | 73 | Armenia |
| 74 | Paraguay | ACD | 74 | Malawi | 74 | Azerbaijan | 74 | Algeria |
| 75 | Turkey | BCC | 75 | Iran | 75 | Guatemala | 75 | Mexico |
| 76 | Egypt | BBC | 76 | India | 76 | Albania | 76 | Swaziland |
| 77 | Venezuela | BBC | 77 | Vietnam | 77 | Bulgaria | 77 | Ghana |
| 78 | China | ADD | 78 | Oman | 78 | South Africa | 78 | Bangladesh |
| 79 | South Africa | BCD | 79 | Trinidad and Tobago | 79 | Morocco | 79 | Nigeria |
| 80 | Congo (Dem. Rep.) | BBD | 80 | Niger | 80 | Sri Lanka | 80 | Cyprus |
| 81 | Azerbaijan | BCD | 81 | Tajikistan | 81 | Jamaica | 81 | Greece |
| 82 | Cameroon | BBD | 82 | Ireland | 82 | Turkey | 82 | Venezuela |
| 83 | Montenegro | BCD | 83 | Chad | 83 | Indonesia | 83 | Israel |
| 84 | Nigeria | ACD | 84 | Paraguay | 84 | Bolivia | 84 | Egypt |
| 85 | Armenia | CCC | 85 | Ghana | 85 | Colombia | 85 | South Korea |
| 86 | Macedonia | BCD | 86 | Algeria | 86 | Brazil | 86 | United States |
| 87 | Syria | BBD | 87 | Albania | 87 | Lebanon | 87 | Nicaragua |
| 88 | Algeria | CCC | 88 | Kenya | 88 | Thailand | 88 | Romania |
| 89 | Thailand | CCD | 89 | Macedonia | 89 | Moldova | 89 | Lebanon |
| 90 | Namibia | BCD | 90 | Chile | 90 | Honduras | 90 | Czech Republic |
| 91 | Iran | BCD | 91 | Thailand | 91 | Nicaragua | 91 | Niger |
| 92 | Swaziland | BCD | 92 | Uruguay | 92 | Gabon | 92 | Malaysia |
| 93 | Côte d'Ivoire | BCD | 93 | Lithuania | 93 | Philippines | 93 | Senegal |
| 94 | Malawi | BCD | 94 | Yemen | 94 | Namibia | 94 | Poland |
| 95 | Mongolia | BDD | 95 | Armenia | 95 | Trinidad and Tobago | 95 | Qatar |
| 96 | Jordan | BDD | 96 | Iceland | 96 | Peru | 96 | Morocco |
| 97 | Ukraine | BCD | 97 | Ethiopia | 97 | Botswana | 97 | Australia |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 98 | Trinidad and Tobago | CCD | 98 | Latvia | 98 | Swaziland | 98 | Azerbaijan |
| 99 | Botswana | BDD | 99 | Hong Kong | 99 | Paraguay | 99 | Russia |
| 100 | Honduras | BCD | 100 | Nicaragua | 100 | Mongolia | 100 | Pakistan |
| 101 | Vietnam | CDD | 101 | Serbia | 101 | China | 101 | Thailand |
| 102 | Ghana | CCD | 102 | Israel | 102 | Vietnam | 102 | United Arab Emirates |
| 103 | Mozambique | CCD | 103 | South Korea | 103 | Pakistan | 103 | Benin |
| 104 | Chad | BCD | 104 | Cyprus | 104 | Angola | 104 | Indonesia |
| 105 | Morocco | CCD | 105 | Madagascar | 105 | Ghana | 105 | Vietnam |
| 106 | Serbia | CDD | 106 | Georgia | 106 | Dominican Republic | 106 | Macedonia |
| 107 | Tajikistan | BCD | 107 | Luxembourg | 107 | Cameroon | 107 | Jordan |
| 108 | Kenya | BCD | 108 | Zambia | 108 | Côte d'Ivoire | 108 | Bulgaria |
| 109 | Lebanon | CCD | 109 | Mauritius | 109 | Tajikistan | 109 | Moldova |
| 110 | Dominican Republic | BDD | 110 | Morocco | 110 | India | 110 | Jamaica |
| 111 | Nepal | BDD | 111 | Honduras | 111 | Nigeria | 111 | Yemen |
| 112 | Ethiopia | BDD | 112 | Zimbabwe | 112 | Yemen | 112 | Mauritania |
| 113 | Nicaragua | CCD | 113 | Bangladesh | 113 | Cambodia | 113 | Syria |
| 114 | Pakistan | BDD | 114 | Dominican Republic | 114 | Kenya | 114 | Ukraine |
| 115 | India | CDD | 115 | Montenegro | 115 | Bangladesh | 115 | Trinidad and Tobago |
| 116 | Tanzania | BDD | 116 | Jamaica | 116 | Benin | 116 | Kazakhstan |
| 117 | Libya | CCD | 117 | Tanzania | 117 | Mauritania | 117 | Estonia |
| 118 | Cambodia | CDD | 118 | Barbados | 118 | Senegal | 118 | Serbia |
| 119 | Mauritania | BDD | 119 | Jordan | 119 | Ethiopia | 119 | Iran |
| 120 | Zambia | BDD | 120 | Senegal | 120 | Zambia | 120 | Oman |
| 121 | Jamaica | CDD | 121 | Cambodia | 121 | Congo (Dem. Rep.) | 121 | India |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 122 | Niger | CCD | 122 | Moldova | 122 | Nepal | 122 | Kuwait |
| 123 | Bangladesh | CDD | 123 | Namibia | 123 | Chad | 123 | Libya |
| 124 | Madagascar | CDD | 124 | Singapore | 124 | Mozambique | 124 | Saudi Arabia |
| 125 | Moldova | CDD | 125 | Nepal | 125 | Tanzania | 125 | Bahrain |
| 126 | Senegal | CDD | 126 | Botswana | 126 | Madagascar | 126 | China |
| 127 | Yemen | CDD | 127 | Lebanon | 127 | Niger | 127 | Zimbabwe |
| 128 | Benin | DDD | 128 | Malta | 128 | Zimbabwe | 128 | South Africa |
| 129 | Zimbabwe | DDD | 129 | Benin | 129 | Malawi | 129 | Mongolia |

## Annexure B: Demographic information

**Age**

| | Years | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 24 | 3 | 6.7 | 8.1 | 8.1 |
| | 25 | 3 | 6.7 | 8.1 | 16.2 |
| | 26 | 1 | 2.2 | 2.7 | 18.9 |
| | 27 | 4 | 8.9 | 10.8 | 29.7 |
| | 28 | 1 | 2.2 | 2.7 | 32.4 |
| | 29 | 1 | 2.2 | 2.7 | 35.1 |
| | 30 | 3 | 6.7 | 8.1 | 43.2 |
| | 31 | 2 | 4.4 | 5.4 | 48.6 |
| | 33 | 1 | 2.2 | 2.7 | 51.4 |
| | 34 | 2 | 4.4 | 5.4 | 56.8 |
| | 37 | 1 | 2.2 | 2.7 | 59.5 |
| | 38 | 2 | 4.4 | 5.4 | 64.9 |
| | 40 | 1 | 2.2 | 2.7 | 67.6 |
| | 42 | 1 | 2.2 | 2.7 | 70.3 |
| | 45 | 1 | 2.2 | 2.7 | 73.0 |
| | 49 | 1 | 2.2 | 2.7 | 75.7 |
| | 50 | 2 | 4.4 | 5.4 | 81.1 |
| | 51 | 1 | 2.2 | 2.7 | 83.8 |
| | 52 | 1 | 2.2 | 2.7 | 86.5 |
| | 55 | 1 | 2.2 | 2.7 | 89.2 |
| | 60 | 1 | 2.2 | 2.7 | 91.9 |
| | 64 | 3 | 6.7 | 8.1 | 100.0 |
| | Total | 37 | 82.2 | 100.0 | |
| Missing | System | 8 | 17.8 | | |
| Total | | 45 | 100.0 | | |

**Annexure C: Research instrument - Questionnaire**

# Resource Efficiency and Cleaner Production (RECP) survey

North West University Potchefstroom Business School

Potchefstroom

4 September 2014

## TO WHOM IT MAY CONCERN

**Purpose: Questionnaire to investigate the market readiness and demand for Resource Efficiency and Cleaner Production initiatives in the Vaal Triangle.**

As part of a Master's degree in Business Administration at the North West University, Potchefstroom Business School, I am currently conducting a research project aimed at understanding the primary fields, drivers and barriers associated with Resource Efficiency and Cleaner Production initiatives and the willingness to participate in these type of initiatives.

I kindly request your assistance to achieve this objective of gaining a better understanding of the market for RECP initiatives in the Vaal Triangle. **The information you provide will be treated as strictly confidential.**

The completion of this questionnaire should take approximately 12 minutes of your time and it will be appreciated if you can **return the filled questionnaire before or on the 26th of September 2014 by email.**

**Return email address: tc.botha1@gmail.com** or **tc@dnsconsultants.co.za**

Please contact me if you have any questions or wish to return the questionnaire by other means than email.

Yours truly

TC Botha
082 417 7932

# Resource Efficiency & Cleaner Production (RECP) survey

The term "Resource Efficiency and Cleaner Production" (RECP) addresses the three sustainability dimensions individually and synergistically:

- Production efficiency (Energy, water, materials and other resources)
- Environmental management (Minimising the impact on the environment)
- Social responsibility (Minimise risk to organisational stakeholders)

In Section 1 the survey deals with the demographics of the participant. In order to complete Sections 2 to 5, each statement must be rated on the four point Likert scale supplied for each statement. On the scale 1 represents "strongly agree", 2 "agree", 3 "disagree" and 4 represents "strongly disagree"

**1.1. Age of respondent:** _____

**1.2. Gender**

| | |
|---|---|
| Male | 1 |
| Female | 2 |

**1.3. Locality of company**

| | |
|---|---|
| Sasolburg | 1 |
| Vanderbijlpark | 2 |
| Vereeniging | 3 |
| Meyerton | 4 |
| Other | 5 |

Please specify if other: _____

**1.4. Number of employees at company**

| | |
|---|---|
| <= 5 | 1 |
| <= 50 | 2 |
| <= 100 | 3 |
| <= 200 | 4 |
| More than 200 | 5 |

**1.5. Category of respondent**

| | |
|---|---|
| Health Care | 1 |
| Commercial | 2 |
| Agriculture | 3 |
| Industrial | 4 |
| Other | 5 |

Please specify if other: _____

**1.6. Monthly energy bill for company**

| | |
|---|---|
| <= R10 000 | 1 |
| <= R40 000 | 2 |
| <= R100 000 | 3 |
| More than R100 000 | 4 |

**1.7. Level of management**

| | |
|---|---|
| Supervisor | 1 |
| Middle management | 2 |
| Senior management | 3 |
| Director | 4 |
| Other | 5 |

Please specify if other: _____

**1.8. How many years at this company**

| | |
|---|---|
| 0 to 3 | 1 |
| 4 to 10 | 2 |
| 11 to 15 | 3 |
| 16 to 20 | 4 |
| 20 years + | 5 |

**1.9. In which sector are you working**

| | |
|---|---|
| Private | 1 |
| Public | 2 |
| Parastatal | 3 |
| Other | 4 |

Please specify if other: _____

**1.10. Organisation type if private sector**

| | |
|---|---|
| Partnership | 1 |
| Sole trader (Owner) | 2 |
| Private limited company | 3 |
| Co-operative | 4 |
| Franchise | 5 |
| Public limited company | 6 |

**1.11. Have you ever taken part in any RECP initiatives at your company?**

| | |
|---|---|
| Yes | 1 |
| No | 2 |

**1.12. Does the company have a position tasked with resource efficiency?**

| | |
|---|---|
| Yes | 1 |
| No | 2 |

If "Yes", what is the tile of the position? _____

| Section 2: Primary fields in which to improve on Resource Efficiency & Cleaner Production (RECP) | Strongly Agree | Agree | Disagree | Strongly Disagree |
|---|---|---|---|---|
| 2.1. Companies should improve their energy efficiency. | 1 | 2 | 3 | 4 |
| 2.2. Companies should recycle on-site when possible. | 1 | 2 | 3 | 4 |
| 2.3. Companies should optimise operations by means of process modifications. | 1 | 2 | 3 | 4 |
| 2.4. Companies should substitute production materials for more environmentally friendly materials if possible. | 1 | 2 | 3 | 4 |
| 2.5. Companies should switch to lower carbon fuels (natural gas, solar, biomass) where possible | 1 | 2 | 3 | 4 |
| 2.6. Are there any other fields of RECP that have the potential to be improved on? | | | | |

| Section 3: Drivers for Resource Efficiency & Cleaner Production (RECP) | Strongly Agree | Agree | Disagree | Strongly Disagree |
|---|---|---|---|---|
| 3.1. RECP initiatives (Ex. Reduce energy use) should be supported: | | | | |
| a) To reduce companies' carbon footprint. | 1 | 2 | 3 | 4 |
| b) To demonstrate corporate social responsibility. | 1 | 2 | 3 | 4 |
| c) When it is subsidised by external funds. | 1 | 2 | 3 | 4 |
| 3.2. **Resource efficient** companies enjoy a stronger brand image. | 1 | 2 | 3 | 4 |
| 3.3 **Environmentally friendly** companies enjoy a stronger brand image. | 1 | 2 | 3 | 4 |
| 3.4. Rising energy prices creates a need to support RECP. | 1 | 2 | 3 | 4 |
| 3.5. RECP initiatives will improve working conditions. | 1 | 2 | 3 | 4 |
| 3.6. Being resource efficient reduces the energy bill: | | | | |
| a) Short term (Less than 1 year) | 1 | 2 | 3 | 4 |
| b) Medium term (2 - 3 years) | 1 | 2 | 3 | 4 |
| c) Long term (3 years +) | 1 | 2 | 3 | 4 |
| 3.7. Are there any other drivers for RECP? | | | | |

| Section 4: Perceived Barriers to Resource Efficiency & Cleaner Production (RECP) initiatives | Strongly Agree | Agree | Disagree | Strongly Disagree |
|---|---|---|---|---|
| 4.1. There are risks involved when investing in RECP initiatives. | 1 | 2 | 3 | 4 |
| 4.2. Lack of information is a cause of RECP opportunities being missed. | 1 | 2 | 3 | 4 |
| 4.3. There are hidden costs in most RECP opportunities. | 1 | 2 | 3 | 4 |
| 4.4. Efficiency potential is overstated in most opportunities. | 1 | 2 | 3 | 4 |
| 4.5. Access to financial capital is inhibited for investment in RECP opportunities. | 1 | 2 | 3 | 4 |
| 4.6. Responsibility for energy efficiency must be assigned. | 1 | 2 | 3 | 4 |
| 4.7. A Lack of RECP knowledge is a cause of profitable opportunities that is missed. | 1 | 2 | 3 | 4 |
| 4.8. A lack of energy engineering services prevents improvement on resource efficiency. | 1 | 2 | 3 | 4 |
| 4.9. Lack of top management commitment prevent the implementation of RECP opportunities. | 1 | 2 | 3 | 4 |
| 4.10. Are there any other barriers that will inhibit cleaner production and resource efficiency? | | | | |

| Section 5: Willingness to participate in Resource Efficiency & Cleaner Production (RECP) initiatives | Strongly Agree | Agree | Disagree | Strongly Disagree |
|---|---|---|---|---|
| 5.1. My company would be willing to allow an energy audit at the company | 1 | 2 | 3 | 4 |
| 5.2. My company would be willing to take part in an energy audit at the company | 1 | 2 | 3 | 4 |
| 5.3. My company would be willing to pay for energy audit services conducted at the company | 1 | 2 | 3 | 4 |
| 5.4. My company would only participate in any energy audit if it was fully subsidised by external funding. | 1 | 2 | 3 | 4 |
| 5.5. My company is willing to pay an hourly engineering rate for energy audit services. | 1 | 2 | 3 | 4 |
| 5.6. My company is willing to pay a % of realised savings as a success fee. | 1 | 2 | 3 | 4 |
| 5.7. The company I work for or own should determine their carbon footprint. | 1 | 2 | 3 | 4 |
| 5.8. My company is willing to pay for a carbon footprint analysis. | 1 | 2 | 3 | 4 |
| 5.9. My company would only consider a carbon footprint analysis if it was subsidised by external funding. | 1 | 2 | 3 | 4 |
| 5.10. My company do not want to take part in any initiatives to become more resource efficient. | 1 | 2 | 3 | 4 |
| 5.11. Being resource efficient promotes sustainability. | 1 | 2 | 3 | 4 |
| 5.12. Practicing clean production promotes sustainability. | 1 | 2 | 3 | 4 |
| 5.13. What in your view can promote participation in being more resource efficient and practicing clean production methods? | | | | |

**Section 6: Are there any other suggestions relating towards the issues of RECP that have not been identified in this survey?**

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**End**

If the survey participant is interested in having a subsidised or non-subsidised RECP assessment conducted at his/her company or place of employment, please feel free to supply a contact email address for the relevant information to be shared:

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**Your participation in this survey and contribution to the research is appreciated.**
**Thank you very much.**

## Annexure D: Proof of Language Editing


November 9, 2014

**TO WHOM IT MAY CONCERN**

### Re: Letter of confirmation of language editing

The dissertation "**A needs assessment of the market for RECP services in the Vaal Triangle**" by **TC Botha** (23829532) was language, technically and typographically edited. The sources and referencing technique applied was checked to comply with the specific Harvard technique as per North-West University prescriptions. Final corrections as suggested remain the responsibility of the student.

**Antoinette Bisschoff**

Officially approved language editor of the NWU since 1998
Member of SA Translators Institute (no. 100181)