

Barriers to energy-efficiency implementation:
**A study of the uptake of energy-efficiency initiatives offered through
incentive schemes in South Africa**

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Acknowledgements

It is with great sincerity that I would like to acknowledge all of those who have contributed to my earning this Master's degree.

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"We are never given a dream without also being given the power to make it come true." – Richard Bach

Executive summary

Energy efficiency has been widely recognised as a powerful tool for improving the energy situation across the globe. Whether by increasing energy security, reducing carbon emissions or alleviating grid strain, proven methods of energy-efficiency management can bring about significant savings at a multitude of levels. Although energy-efficiency practices are gaining traction globally, their uptake is still less than optimal, and this is especially true of South Africa. The country is currently facing an energy crisis that brings with it a variety of complex challenges, all which can be assuaged through energy efficiency, if applied to the energy-intensive economy.

It is important to understand the South Africa-specific barriers that hinder implementation of energy efficiency. While government has made strong commitments to supporting the uptake of energy-efficiency initiatives, there have been several interruptions and a lack of execution. An abundant amount of top-down research has been conducted to identify the various barriers to implementation; far less research, however, identifies barriers from *within* these energy-intensive economies. If these barriers could be identified from a more qualitative and participant-centred perspective, the key role-players in the sector might be able to better address energy-efficiency implementation, leading to more widespread benefits and results.

To this end, the researcher performed an explanatory investigation, analysing seven energy-intensive companies that had recently participated in a fully funded local incentive scheme called the Private Sector Energy Efficiency Programme (PSEE). The PSEE performed an energy audit on each company, followed up by a report on its findings. The report clearly outlined the company's key energy-savings opportunities, in kilowatt-hours (kWh), Rand and CO₂ emissions. It also estimated the costs and payback periods of the projects. Despite these reports indicating significant savings potentials and reasonable payback periods, a lack of uptake still remained.

The researcher extracted and analysed the relevant quantitative data from the PSEE reports and conducted one-on-one, semi-structured interviews with the participants to identify and understand the participant-specific barriers to the recommended energy-efficient measures. The researcher also interviewed three coordinators of the PSEE programme, in the hope of identifying any PSEE-specific barriers. The other main party involved in this research was PSEE energy-efficiency ESCO which has been given an alias name ESCO E, who delivered the reports to the participants.

The research found that the barriers in place in South Africa resemble those that have been identified at the global level. However, the mixed-methods approach and data sample employed in this study create a very interesting picture about the barriers that exist at the company level. The research found that there were significant saving opportunities available to companies but that, mainly due to a lack of financial support, human-resource capacity and time, there has been little to no implementation of the recommended projects. The available literature and provided global experience, coupled with participants' responses and suggestions, allow the researcher to make relevant recommendations that pertain to the study:

- Lower payback periods through further incentives
- Accessible funding and subsidies
- Ensured continuation, longevity and growth of incentive programmes
- Client-specific cost alternatives
- Extensive and supported detail around each recommendation
- Human resource capacity support to ensure energy management
- Required energy seminars and skills training to programme participants
- Increased government support and energy efficiency resources; namely an Energy Hub, which will provide a stable platform for energy efficiency
- Participant-specific report alignment to encourage uptake and increased trust between incentive host and participant
- More stringent government regulated technological standards.

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List of main acronyms and abbreviations

BUSA	Business Unity South Africa
CO ₂	Carbon dioxide
CSIR	Council for Scientific and Industrial Research
DECC	UK Department of Energy and Climate Change
DOE	Department of Energy
dti	Department of Trade and Industry
EE	Energy efficiency
EU	European Union
ESCOs	Energy Saving Company
Gt	Gigatonne
GHG	Greenhouse gas
IEA	International Energy Agency
IEE	Industrial Energy Efficiency
IIASA	International Institute for Applied Systems Analysis
kWh	Kilowatt hours
MW	Megawatt
Mt	Million tonnes
Mtoe	Million tonnes of oil equivalent
M&V	Measurement and Verification
NCCPC	National Cleaner Protection Centre
OECD	Organisation of Economic Co-operations and Development
OPEC	Organisation of the Petroleum-Exporting Countries
PJ	Petajoules
PSEE	Private Sector Energy Efficiency

R	Rand
RE	Renewable energy
R&D	Research and Development
REIPPPP	The Renewable Energy Independent Power Producer Procurement Programme
SANAS	South African National Accreditation System
SME	Small and Medium Enterprises
UNIDO	United Nations Industrial Development Organisation
US	United States

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Key concepts and definitions

Climate change: According to the Intergovernmental Panel on Climate Change (IPCC), climate change is a change of climate over time due to natural variability or as a result to human activity (IPCC, 2007).

Energy efficiency: The improvement of the technology, management or consumption of energy while maintaining and meeting energy demand; delivering the more services using the same amount or less energy.

Energy intensity: The proportion/measurement/ratio/relationship of energy use to economic or physical output (IPCC, 2014a: 123).

Energy-intensive industries: Typically, energy-intensive industries can be defined as high-energy users such as steel, aluminium, copper, paper, and textiles. Arguably so, other industries (especially when the country is heavily dependent of coal-fired energy) such as hospitality, agriculture, chemical, manufacturing, retail and industries which use process heating, high temperatures, compressed air, ventilation, refrigeration, motor and drives, and air conditioners are also considered to be energy intensive for this thesis.

Energy savings: For this thesis energy savings can refer to the kWh, CO₂, or financial savings derived from energy efficient measures.

Energy security: This term is widely understood at the global and national levels as a target for maintaining or securing an “adequate, stable and predictable energy supply” (IPCC, 2014a: 123). The outcome would be that the energy supply will meet demand (at competitive prices) and that there is secure energy infrastructure in place, “enabling development and deployment of technologies; building sufficient infrastructure to generate, store and transmit energy supplies and ensuring enforceable contracts of delivery” (IPCC, 2014a: 123). Energy planning, management and monitoring, as well as having a strong energy mix, are necessary for achieving this target.

Eskom: Eskom is a state-owned utility provider of South Africa, responsible for generating about 95% of the consumed electricity for the following sectors:

industrial, mining, commercial, agricultural and residential customer and redistributors (Eskom, 2015a).

Load shedding: Due to the lack of energy security, coupled with the high demand for electricity, Eskom is forced to use load shedding or load reduction to prevent a total blackout nationwide. Eskom schedules electricity cuts during periods of high demand in specific areas when the national electricity grid is under pressure (Eskom, 2015b).

National Business Initiative (NBI): This combined action is made up of South African and multinational companies committed to promoting, accelerating and “working towards” sustainability and development in South Africa through business leadership and action (National Business Initiative, 2015).

National Cleaner Production Centre (NCPC) Industrial Energy Efficiency Improvement Project (IEE Project): This programme was introduced by the United Nations Industrial Development Organisation (UNIDO); it is hosted by the NCPC at the CSIR and supported by South Africa's Department of Trade and Industry (DTI) and Department of Energy (DoE), the Swiss Secretariat for Economic Affairs (SECO), and the UK Department for International Development (DFID).

Private Sector Energy Efficiency (PSEE): This programme, from the National Business Initiative, is supported by South Africa's Department of Energy and fully funded by UK Aid. The programme aims to help South African businesses become more energy efficient, by reducing costs, demand and reliance on imported energy sources. This programme will be explained further in section 2.3.1 below (Private Sector Energy Efficiency, 2015a).

Sustainability/Sustainable development: A term often misunderstood, sustainability essentially entails a fully functioning relationship among all parties in the natural and human environment, who consider one other and do not deplete one more than the other: “A dynamic process that guarantees the persistence of natural and human systems in an equitable manner” (IPCC, 2014a: 127). The two most contested definitions of sustainability reflect the

divide between the social approach to sustainability and the more scientific approach, while in fact the two approaches should exist in parallel.

IEA Countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

1 Introduction

Chapter 1 presents the background for this research and provides a platform for understanding its significance. This chapter includes the main questions, objectives and assumptions of the research. It also defines the key concepts relevant to the research, lays out the structure of the thesis, and discusses the limitations and ethical considerations related to the thesis.

1.1 Background

South Africa is currently facing a multifaceted energy crisis. Factors such as rising and unaffordable electricity prices, the immediate need for energy security and the need for carbon reduction all contribute to the complexity of the current energy situation and increase the momentum towards energy efficiency.

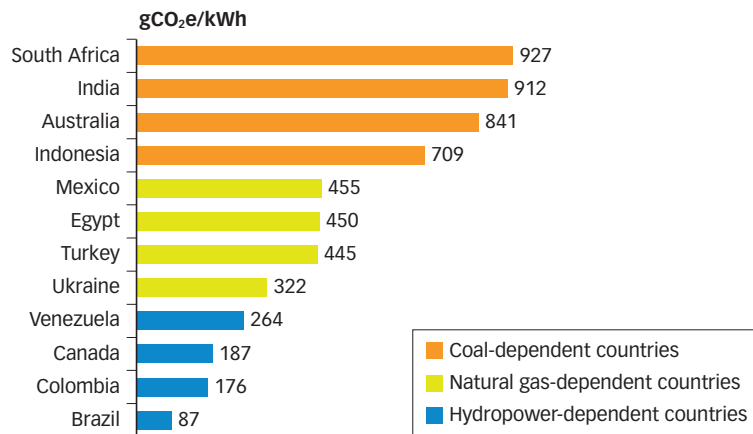
Historically, South Africa has been a capital- and energy-intensive economy, and this remains the case today. In fact, by international standards, the South African economy is exceptionally energy intensive, with energy intensity in South Africa concentrated in the most energy-intensive sectors, such as manufacturing and transport (Winkler and Marquard, 2009: 52). The high-energy industries that exist in South Africa have been enabled by the vast amount of easily extracted coal in South Africa thus prices of South African electricity and coal in the last four decades have only been around 40% of US average prices (Winkler & Marquard, 2009: 48, 52). Because of cheap coal-fired electricity production, South Africa has, until recently, had some of the cheapest prices of electricity in the world (which in turn has driven its energy intensive economy): The energy crisis began in 2008; Sean Moolman, energy expert and owner of Poweroptimal South Africa, further supports this, “From 2007 to 2015, electricity tariffs increased by 300%...” (Moolman, 2015) thus indicating a quadrupling of tariffs and a major contributor towards the energy crisis in South Africa.

For the most part, having access to cheap coal has dissuaded investment in alternative energy supplies and has also hindered energy efficiency across all sectors (Winkler & Marquard, 2009: 52). South Africa has undergone increasing power outages, known as load shedding since 2007 due to Eskom’s incapacity

to meet electricity demand. Load shedding, a temporary relief of power deficit, is scheduled by Eskom. Specifically since the end of 2014, load shedding has become a consistent and more detrimental occurrence (Baker et al., 2015).

As previously mentioned, easily harvested coal is an abundant indigenous resource in South Africa. Natural renewable resources (namely, solar irradiation and wind) are similarly abundant. Although renewable resources have a significantly less negative environmental impact, South Africa is an energy-intensive, coal-dependent country. The combination of relatively expensive renewable technology (“in strict financial terms”), cheap access to copious amounts of low-grade coal, out-dated policies and regulation and a state-regulated monopoly utility (Eskom) has dominated the energy-generation market in South Africa (Copenhagen Centre on Energy Efficiency, 2015). This has caused South Africa to be one of the largest global emitters of carbon emissions: with leading emissions of 927 grams of carbon dioxide (CO₂) per kilowatt-hour (kWh), the South African energy sector is the most coal-dependent, CO₂-intensive energy sector globally, as seen in Figure 1 (World Bank, 2015: 1-3) (Winkler and Marquard, 2009: 51). Devarajan et al. (2009) have suggested that South Africa produces 65% of Africa’s CO₂ emissions. In 2010, national emissions derived from the coal-dependent electricity sector were 45% or 237 Mt CO₂-equivalent (Baker et al., 2015). Furthermore, “coal-fired plants account for 85% of installed capacity and 92% of electricity produced” (Baker et al. 2015: viii). Only recently, in August 2011, has South Africa finally been able to successfully begin to diversify its energy supply and alleviate coal-ridden electricity constraints through the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). This programme alone, however, is not rigorous enough to immensely cut carbon emissions as coal-generated power is still the dominant source.

Figure 1: Emission factors for selected countries



Source: World Bank (2015: 2).

The uptake of energy efficiency can help alleviate the troubling issues outlined above; however, research suggests that there are countless challenges involved in the uptake of energy efficiency.

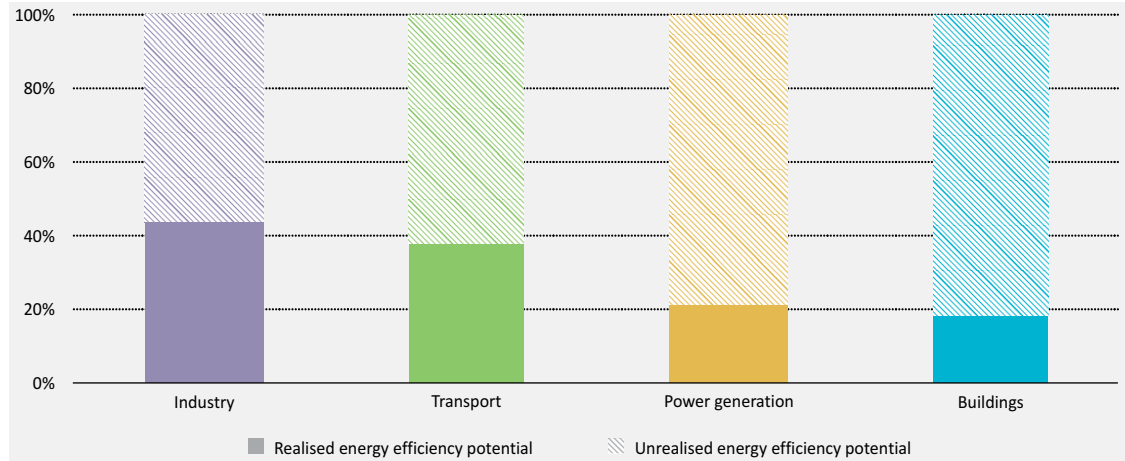
The International Energy Agency (IEA) World Energy Outlook Special Report (2015a: 65) has claimed that energy efficiency can reduce energy intensity by 13% by 2030 in South Africa; this would allow for less strain on the electricity grid and lower electricity bills for consumers. In addition, it is thought that South Africa will see a “peak, plateau and decline” of CO₂ emissions only if current energy-efficient drivers continue to improve energy efficiency in end-user sectors and coal-dependent power sectors.

1.2 Rationale and significance of the study

Both globally and in South Africa specifically, there is relatively limited transformation of energy-efficiency uptake within energy-intensive sectors. Additionally, there is a noted *lack of knowledge* on how to effectively become more energy efficient by saving kilowatt-hours, costs and CO₂. IEA (2014) *Capturing the Multiple Benefits of Energy Efficiency* further highlights “projections to 2035 show that as much as two-thirds of energy efficiency potential will remain untapped unless policies change” (IEA, 2014: 19). This situation is depicted in Figure 2 below where the off-coloured areas represent

global unrealised energy efficiency potential in the most energy intensive sectors.

Figure 2: Global long-term energy-efficiency economic potential by sector



Source: IEA (2014: 19).

Moreover, there are a limited number of energy-efficient schemes and incentives available in South Africa, in fact there are only two EE Incentive Programmes the National Cleaner Production Centre (NCPC) Industrial Energy Efficiency Programme (IEE), the Private Sector Energy Efficiency Programme (PSEE) and four currently running government incentives and grants the 12I, 12B, 12L and the Critical Infrastructure Programme (CIP). These schemes will later be discussed in section 2.5. This limitation highlights the need for the continuation, improvement and expansion of successful schemes to promote the uptake of energy efficiency. The present research focuses on companies that have taken part in one of the existing energy-efficiency schemes (PSEE), and become aware of their consumption levels, but have failed to implement any of the recommended key savings.

Assuming that energy-efficiency implementations would dramatically reduce energy consumption, the argument from an economic standpoint involves legitimate savings and growth concerns. For instance, if returns on capital for energy efficiency can exceed investment returns in the business, generating positive cash flows with proven technology and management, what is preventing

uptake? Incentive programmes such as energy auditing programmes, would greatly benefit companies by providing them with the proper knowledge and assistance towards energy efficiency implementation.

This thesis harnesses the existing research and data surrounding the current energy-efficiency incentive schemes, and presents new qualitative data on the subject, in order to highlight and identify the incentives, perceptions and barriers associated with energy-efficiency uptake in South Africa. The bulk of the findings come from data extracted and further researched from the PSEE programme. This thesis hopes to provide relevant and potentially impactful insights to businesses, government, policy-makers and other key energy-efficiency role-players, aimed at ensuring the more successful uptake of energy efficiency in the future South African context.

1.3 Main research questions

In order to achieve the aim of this study, the following main research questions and sub-questions must be addressed:

1. What are barriers to EE implementation within the PSEE programme?
2. What are PSEE participants' perceptions of energy efficiency and why didn't they implement any of the recommendations?
3. What are the participant-specific incentives for/drivers of the uptake of energy efficiency (assuming the participant would implement all recommendations made in their PSEE energy audit)? Relatedly:
 - What are the total cost savings in annual energy expenditure?
 - What is the total reduction of kWh's per annum?
 - What are the total CO₂ emissions savings per annum?
4. What are participant-specific barriers to EE uptake?
5. What are the possible methods for overcoming all identified barriers?

1.4 Main research objectives

This study is guided by the following primary objectives:

1. To explore one current energy-efficient scheme, PSEE and understand the participants and programme coordinators barriers for successful uptake.
2. To holistically understand participants' perceptions of energy efficiency and the uptake of energy efficiency through qualitative data.
3. To assess the participant-specific incentives/drivers by examining data from energy audits.
4. To identify the participant-specific barriers to the implementation of the energy efficiency recommendations of their energy audits.
5. To understand what the participants need in order to implement the recommendations, assuming they want to reap the benefits of the PSEE report.

1.5 Main assumptions

This research is defined by the following key assumptions:

1. The energy audit reveals significant opportunities for energy efficiency in energy-intensive sectors.
2. Energy efficiency is not of great concern to participants/businesses.
3. Energy efficiency will decrease energy spent, kilowatt-hours and CO₂ emissions.
4. Barriers will include inadequate knowledge or access to financial opportunities or government grants, human resource capacity, time management, knowledge of energy efficiency and understanding of energy audits. These assumptions will be gauged throughout the research collection.

1.6 Thesis structure

This thesis is divided into the five distinct chapters.

Chapter 1: This chapter introduces the research topic and the significance of the study.

Chapter 2: This chapter provides a detailed literature review of the topic of energy efficiency, including case studies both globally and locally, and an overview of incentive schemes, financial opportunities, barriers to and drivers of energy efficiency, and key role-players.

Chapter 3: This chapter explains the methodology employed by the study.

Chapter 4: This chapter outlines the findings and discussions of the research.

Chapter 5: This chapter concludes the thesis with a summary of the main findings and a presentation of the recommendations going forward.

1.7 Scope of work and limitations of the study

This research is limited to seven energy-intensive industrial companies in the commercial sector of South Africa. The participants had previously participated in one of the incentive schemes offered in South Africa: namely, the Private Sector Energy Efficiency Programme. The quantitative aspect of this research involves the participants' data from recent energy audits (quantitative) as well as data from interviews (qualitative) carried out by the researcher in order to understand the participants' perceptions of the uptake of energy efficiency and the barriers to energy-efficiency implementation. All seven of the participants received energy audits from the same accredited energy-efficiency consultant, anonymously named ESCO E, which may limit understanding if there was a problematic relationship between participant and consultant. The study does not include participants who *did* follow through with immediate energy-efficiency uptake after PSEE participation for the reason that this research focuses solely on the barriers to EE uptake, not successful implementation. However, another limitation from not interviewing those who did implement EE recommendations is that it fails to take advantage of the opportunity to know if there were any

barriers and how they were overcome; more time and resources are deemed necessary to extend this research.

1.8 Relevant ethical considerations

Many steps were taken to avoid unethical outcomes in the course of this research. Firstly, and from a sciences perspective, the Assessment of Ethics in Research Projects was approved by the Faculty of Engineering and the Built Environment at the University of Cape Town on March 6, 2015, before the commencement of any collection or analysis of data (Found in Appendix 6). Secondly, and from a social-sciences and human-service professions perspective, the following relevant ethical guidelines, suggested by De Vos et al. (2011: 115), were incorporated:

- Voluntary participation;
- Informed consent;
- No deception of respondents;
- No violation of privacy/anonymity/confidentiality;
- Clarity on compensation, cooperation with contributors and sponsors;
- Publication of the findings.

All human subjects and businesses were requested to participate either via email or telephonic call. Prior to the interview, the participants were required to sign a consent form. The consent form (Appendices 1 and 2) clearly stated the motive of the research. All company and participant names are kept confidential. No financial compensation was given. However, it was clearly stated that a final copy of this research dissertation would be distributed to them in the hope of achieving better energy-efficiency uptake within each company. The sponsoring company ESCO E, willingly paid for the petrol and phone calls used during the interviewing procedure, as part of the researchers internship stipend. All the findings of this study will be stated clearly and unambiguously in this thesis.

1.9 Summary

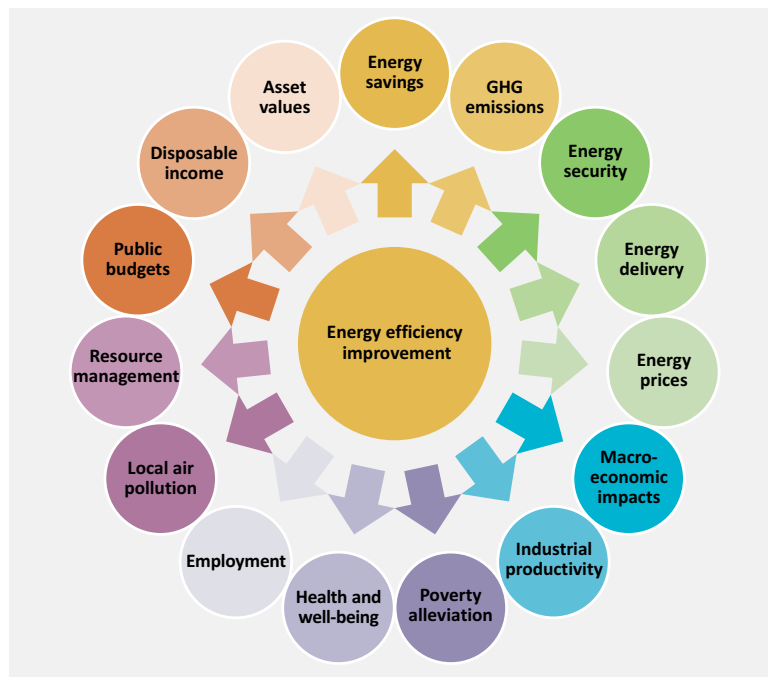
Chapter 1 aims to give a brief summary of the research conducted for this thesis by introducing the topic, stating the main research questions, objectives and assumptions, defining the key concepts, providing an overview of the thesis's structure, stating the scope of the work and limitations to the study, and reviewing the relevant ethical considerations. Again, this thesis aims to understand the barriers to energy-efficiency incentive schemes, implementation and uptake in South African energy-intensive industries.

2 Literature Review: Review of energy efficiency

2.1 The benefits of energy efficiency

In addition to the obvious reductions in energy use, the European Environment Agency (EEA) (2013: 39) highlights the many additional benefits of the uptake of energy efficiency, all of which contribute to improved social, economic and environmental well-being, as shown in Figure 3. The most relevant benefits for this research are the following: a reduction in GHG emissions, downward pressure on energy prices through reduced demand, natural resource conservation, and contribution to increased energy security (Ryan & Cambell, 2012) (EEA, 2013: 39). Furthermore, fifteen key benefits of energy-efficiency improvements have been identified and outlined, all of which are globally beneficial, but also critical to the current energy crisis in South Africa (IEA, 2014: 20).

Figure 3: Multiple benefits of energy-efficiency improvements



Source: IEA (2014: 20)

This literature review looks specifically at EE as a tool for mitigating climate change, improving energy security and improving energy savings. Undoubtedly, energy-efficiency uptake “is the quickest and least costly way of addressing energy security, environmental and economic challenges” (IEA, 2011: 3). What follows is a thorough review of the above-mentioned benefits at both the global and national levels.

2.1.1 Energy efficiency to mitigate climate change

Energy and Security: Toward a New Foreign Policy Strategy (Kalicki & Goldwyn: 2005) feature energy experts such as, Baumert (2005: 487) who has argued that “[c]limate change is primarily an energy problem.” While this thesis does not aim to put emphasis on the challenge of global climate change, it is important to highlight that climate change is caused by the extraction of carbon-based fuels from beneath the earth’s surface and the burning of these fuels for human activity, creating anthropogenic greenhouse-gas emissions that are released into the atmosphere (IPCC, 2014a: 44) (Baumert, 2005: 487). The same experts have highlighted that since before the industrial revolution, there have been large increases in emission pollutants and greenhouse gasses, creating rises in global surface temperature. The Intergovernmental Panel on Climate Change (IPCC) (2014a: 46) highlights that CO₂ emissions from fossil-fuel combustion and industrial processes “contributed about 78% to the total GHG emission increase between 1970 and 2010” this trend holds over recent and much shorter period between 2000-2010 with (high confidence). From 2000 to 2010, the emissions increase “came directly from the energy (47%), industry (30%), transport (11%) and building (3%) sectors” (IPCC, 2014a: 46). Justifying Baumert’s (2005: 487) statement that “climate change is primarily an energy problem,” the IPCC (2014a: 46-47) has stated that, in 2010 alone, and without taking into account about 31% and 19% for indirect emissions, “35% of GHG emissions were released by the energy sector, 24% (net emissions) from agriculture, forestry and other land use (AFOLU), 21% by industry, 14% by transport and 6.4% by the building sector.”

The IPCC (2014a) and the IEA (2015a) has called for urgent action and continued international commitment to keep temperatures to below two degrees Celsius (2 degrees C), relative to pre-industrial levels. Additionally “over the past two-and-a-half decades, global CO₂ emissions increased by more than 50%” (IEA, 2015a: 26) and, according to the IPCC (2014b: 47), global economic and population growth will continue to drive CO₂ emissions. Kenderdine and Moniz (2005: 428) highlight the increased “potential for regional political instability and tensions” as a result of fossil-fuel combustion and CO₂ emissions:

Increased energy consumption will further exacerbate its effects on the environment. The environmental risks posed by global warming and climate change raise security risks by their capacity to change agricultural or disease patterns that stress particular populations. (Kenderdine and Moniz, 2005: 427)

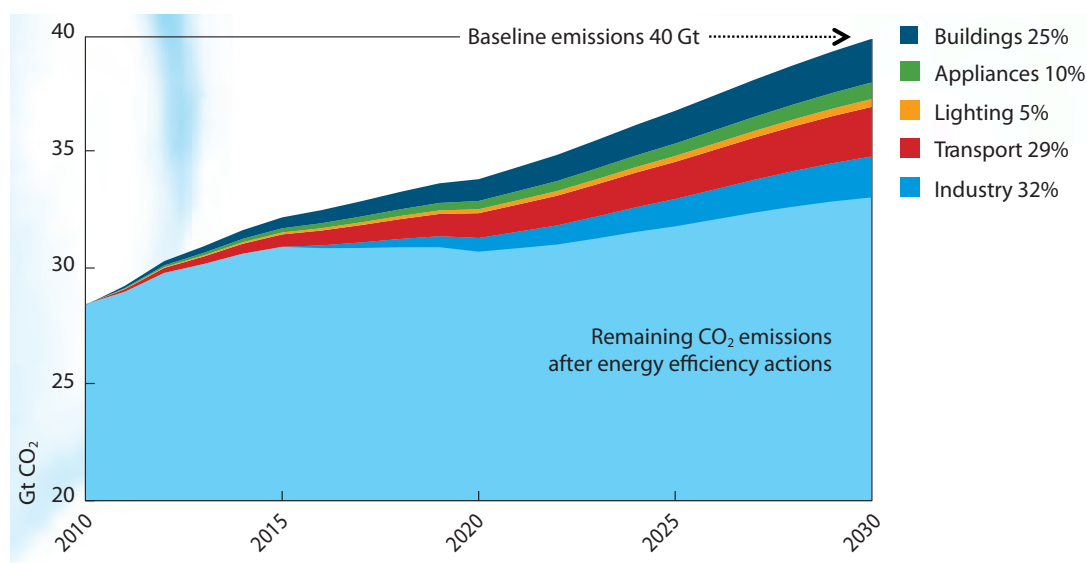
The issue of energy security will be returned to later in the chapter, but the use of energy-efficiency technology can certainly help overcome multiple global challenges. One of the many benefits of energy efficiency is the reduction of negative environmental impacts, such as the emission of pollutants and greenhouse gases (Goldemberg and Lucon, 2010: 243). Recent studies show that “growth in GHG emissions can be arrested through accelerated energy efficiency technology deployment” (Shiller et al. 2008: 8-338).

Alongside their ambitious commitments to cut carbon emissions in the hopes of mitigating climate change, many governments “strategically align energy efficiency policies and GHG reduction goals” (IEA, 2014: 30). In 2008, the IEA developed twenty-five energy-efficiency policy recommendations to benefit its member countries. The recommendations focused on seven key areas: cross-sectoral, building, appliances and equipment, lighting, transport, industry and energy utilities. All of these areas were highlighted by the IPCC (2014b:46) as major contributors to CO₂ emissions.

The IEA (2011) suggest that, if these twenty-five policies were implemented globally, an abatement of 7.6 gigatonnes (Gt) of CO₂/year would be reached by

2030. Although minimal in comparison to the remaining CO₂ emissions, Figure 4 demonstrates the CO₂ savings potential of the above-suggested EE policy recommendations. Most relevant to this research is the observation that industry accounts for 32% of the potential savings. The industrial sector accounted for 13 Gt of CO₂ direct and indirect emissions in 2010, with projected increases of 50-150% by 2050, “unless energy efficiency improvements are accelerated significantly” (IPCC, 2014b: 23)—hence the importance and immediate action of stringent technological, governmental and behavioural energy-efficient measures. “Energy efficiency”, as one research has put it, “is the most important and cost effective means for mitigating greenhouse gas emissions from industry” (Worrell et al., 2009: 109). The recent evidence surrounding climate change has shifted the climate change policy debate from an “if” position to the more forward-thinking and immediate position of “when” and “how” with regard to the abatement of greenhouse gas emissions (Duane, 2010: 712). While energy efficiency is not the only contributor to the reduction of GHG emissions, it is clearly a significant tool for achieving these global goals.

Figure 4: Potential CO₂ savings from the twenty-five implemented EE measures



Source: IEA (2011: 3)

2.1.2 Energy efficiency to alleviate energy insecurity

One of the many advantages of energy-efficiency uptake is the “security of supply increases and resources which are finite are saved” thus energy-efficiency is seen as an effective way to alleviate energy insecurity (Goldemberg and Lucon, 2010: 243). Generally, energy security can be understood as the approach to avoid, or alleviate energy insecurity; The International Institute for Applied Systems Analysis (IIASA) (2012: 327) defines energy security as “uninterrupted provision of vital energy services” and further differentiates energy insecurities between industrial or developed countries and emerging economies. This can create “unaligned” global energy-security goals (Winzer, 2011: 2). Winzer (2011: 2) has outlined some of the varying political insecurities, which again highlight the importance of utilising energy efficiency to benefit energy security:

- US: A reduction of vulnerability to political extortion (through advocating energy independence and rising shares in renewable energy);
- Brazil: A reduction of vulnerability to political extortion (through increasing shares in fossil-fuel imports and decreasing shares in RE);
- Protecting the poor against commodity-price volatility;
- Protecting the economy against disruptions of energy-service supplies by allowing the prices of commodities to rise during periods of scarcity;
- Ensuring a reliable provision of fuels, including the role of nuclear energy to enhance security;
- Reducing hazards from accidents, including the proliferation and expansion of the nuclear industry as a potential threat to energy security.

Cherp and Jewell (2011) highlight three different approaches to energy security that have been academically debated and selectively developed according to the separate policy agendas outlined above. The three approaches or perspectives are as follows: political science; natural science and engineering;

and economics and complex-systems analysis. Similar to Winzer (2012), Cherp and Jewell (2011) highlight the following policy agendas and their triggers:

- Fuels for armies and transport;
- Uninterrupted provision of electricity;
- Ensuring market and investment effectiveness.

The historical triggers or insecurities, which have brought significant focus on energy security, as described by Cherp and Jewell (2011), are explained extensively below.

The need for energy security can be dated back to the first half of the twentieth century, and the climax of World War II. Demand for fuel-supplies were high, yet many parties at the time, such as the British Navy, could not escape dependence on imported oil. During this time, there were battles over oilfields in regions such as the Middle East and Romania, causing many countries and their armies to become vulnerable due to a lack of energy resources.

Furthermore, during this time, industrialised nations depended heavily on more oil than they could indigenously produce. Obtaining the oil was vital for transport, food production, manufacturing, and electricity generation, among other functions. This dependence of developing, battle-ridden oil countries also increased concerns about energy security. Conversely, the same developing oil countries became dependent on oil exports for economic and political stability, creating an “oil weapon” system. For example, in 1973, OPEC and non-OPEC Arab countries “cut oil supplies to the USA, the Netherlands and later to several other countries in protest of the US support to Israel” (Cherp and Jewell, 2011: 2); a fourfold strategy was developed in response to the ensuing “hostage-like” oil crisis.

1. Establishing international regimes;
2. Fostering a global market for oil products;
3. Establishing the IEA to co-ordinate emergency response;
4. Encouraging oil production in friendlier countries, changing energy users and promoting energy conservation.

Despite these efforts to manage the oil crisis, the insecurity of oil supplies is on the rise, due to growing economies, quickly depleting natural resources (causing price increase), and the higher demands of consumption in the Organisation for Economic Cooperation and Development (OECD) countries, causing dependence and concentration in already (and historically) high-tension areas such as the Middle East and the Soviet Union (Cherp and Jewell, 2011:2).

Following this developed ongoing dependence trends of natural resources in the twentieth century. The EU, for example, heavily relies on imported natural gas for electricity. Because of disruptions to supply availability in the 2009 Russian-Ukrainian gas crisis, the EU experienced urgent concerns about the security of its energy. The restricting of pipelines for imported gas into Western Europe, coupled with the momentous initial costs of improving the import routes into landlocked Eurasian countries, also exemplifies the rise in energy insecurities and a possible shift towards improving energy efficiency and the security of energy as a whole for industrial countries (Cherp and Jewell, 2011:2) (IIASA, 2012: 327). While this thesis does not focus on the issue of oil security, it does highlight the negative impact of being solely dependent on one fuel, as South Africa is on coal.

Global security issues such as “international terrorism instability in the oil-rich Arab countries, parts of Asia, Africa, and the former Soviet union, [and] the acquisition of nuclear weapons by India and Pakistan and the changing role of China” (Cherp and Jewell, 2011:3) also contribute to the significant rise in global concern about energy security. Yergin (2005: 51) in Kalicki et al. (2005) reinforces this point: “Regional and social turmoil unsettles the Middle East, while global terrorism threatens the entire supply system...[Iraq] remains vulnerable to sabotage and terrorism”; this security issue also extends to countries such as Nigeria and Venezuela. While Yergin (2005: 51) study focuses on oil, it also reaffirms the need to be less dependent on liquid fuels and more efficient in energy-use in general, aiming for “continuing innovation and diversification.”

Cherp and Jewell (2011) go on to highlight the concept of “global limited resources”, which contribute to the concern of energy security. It is scientifically evident that economic and population growth cannot be sustained due to limited and finite natural resources. Simply put, humans are depleting the earth’s natural resources faster than they can naturally be recovered. More recently, the contribution of the use of these finite resources to climate change has brought much attention to the issue of energy security. The heavy dependence of energy systems operated and fuelled by depleting resources such as coal or oil, as is the case for the majority of large-scale power generation technologies, raises issues around “main stream energy security” (Cherp and Jewell, 2011:4). An ongoing debate over the safety of nuclear power plants also contributes to the definition of energy security in many parts of the world, since the negative consequences of disasters such as Chernobyl and Fukushima have been so long-lasting.

Cherp and Jewell (2011: 4) question the ability of deregulation to deliver energy more efficiently, with its depoliticising of energy systems: the energy supply’s transition from a public good (with physical availability) to a market commodity (with a commodity price) has allowed “price” and “affordability” to become part of the definition of energy security. Because of market and regulation flaws, energy deregulation efforts have not achieved the true security of energy, but have instead created cheap and possibly insecure investments that are profit-driven (Cherp and Jewell, 2011:4).

Winzer’s (2012) analysis and the historical paradigm provided by Cherp and Jewell (2011) confirm that a variety of global issues collectively define “energy security”. Naturally, this makes the term “energy efficiency”, and its role within energy security, just as complex. The IEA (2014) has made the following critical statement:

While policy makers are alert to the contribution of energy efficiency to improving energy security, the multi-dimensional nature of energy security makes it difficult to quantify; to date few studies have attempted

to examine this link on a comprehensive, economy-wide scale. (IEA, 2014: 34)

Kenderdine and Moniz (2005:428) propose “key related policy objectives” to address these energy-related security challenges. Many of these objectives involve energy efficiency: developing alternatives to oil, diversifying oil reserves, reducing oil demand, changing the transportations paradigm, increasing the efficiency of fossil-fuel use, and developing carbonless energy technologies (Kenderdine and Moniz, 2005: 428). The IEA (2014: 34) has suggested that, by implementing energy efficiency and reducing energy demand, we will see significant improvements in energy security within four dimensions of risk. The four dimensions are parallel with the above-mentioned theories from Winzer (2012), Cherp and Jewell (2011), and Kenderdine and Moniz (2005: 428): “fuel availability (geological), accessibility (geopolitical), affordability (economic) and acceptability (environmental and social)” (IEA, 2014: 33).

Lastly, the IPCC (2014b: 475) suggests that mitigation and energy-efficiency improvements “would make energy systems more resilient to various types of shocks and stresses and would help insulate economies from price volatility and supply disruptions” (IPCC, 2014b: 475). Energy efficiency is undoubtedly a solid solution, for its ability to help alleviate the threats of energy security through many different avenues. It is apparent that no matter the energy in security spectrum, energy efficiency should be a top priority for policy and energy development.

2.1.3 Energy efficiency to improve energy savings

Key energy savings are an inevitable aspect of the implementation of energy efficiency measures and play a key role in incentivising EE uptake and addressing current global energy issues.

Energy efficiency and energy savings are becoming increasingly important components of government policy around the world in response to a range of challenges including perceptions of resource scarcity, high

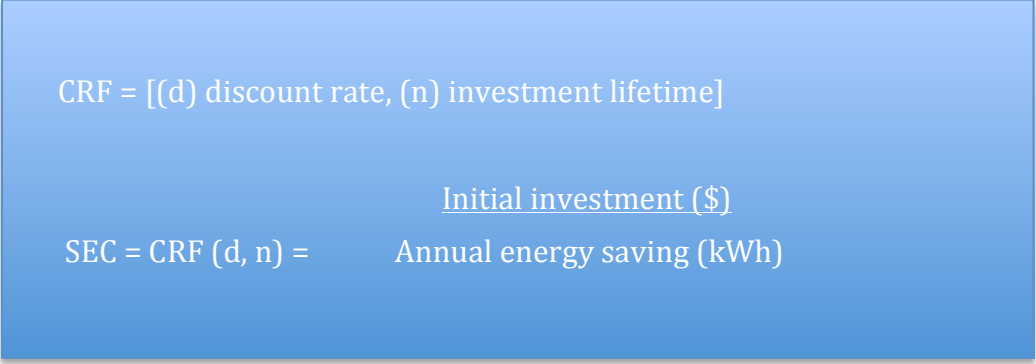
energy prices, security of energy supply and environmental protection.
(Andrews-Speed, 2008: 1331)

“Energy savings are widely recognized as a means to save money”, according to the European Climate Foundation (ECF) (2010). Goldemberg and Lucon (2010: 245) state that energy savings derived from energy efficiency create a chain reaction of savings, beyond energy and energy costs: “The reduction in energy use (while delivering the same services) may also lead to a decrease in water consumption and that of other inputs, generating more savings” (Goldemberg and Lucon, 2010: 245). Parallel to this, the ECF (2010) highlights that energy savings can contribute to energy security, a reduction of CO₂ emissions, an increase in sustainable energy supply and potentially job creation (ECF, 2010). Furthermore, the IEA (2014:35) claims that company productivity and value creation can be improved by reaping benefits from EE implementation, such as enhanced production and capacity utilisation, reduced resource use and pollution, and lower operations and maintenance costs. These fiscal savings (both achieved and potential) are difficult to globally define, since reports produced by energy experts, institutions and academics all use different agents, methods and markets.

Given that energy savings play a significant role in decarbonisation, while also enhancing energy security, it is important to recognise “energy savings” as one of the most important benefits of energy-efficiency uptake. Goldemberg and Lucon (2010:243) emphasise that, too often, the actual fiscal benefits or the “investment return rate” is generally not taken into account when considering energy-efficiency uptake: in fact, “there are micro and macroeconomic gains associated with an increase in productivity and in industrial competitiveness” (Goldemberg and Lucon, 2010:243). *Energy savings* can be calculated using a number of different methods, as a relevant example, let us focus on how the *cost of energy saved* is derived. Save energy cost (SEC) is a measure that represents “the cost equivalent to an energy unit saved, considering the discount rate and the service life of the investment in EE” (Goldemberg & Lucon, 2010:249). For this equation you need to know the capital recovery factor (CRF),

which considers the discount rate and the investment lift-time to determine when the investment will be recovered. Simply, one would divide the annual cost of the investment in energy efficiency by the annual cost of the investment in energy efficiency by the annual energy savings obtained. This calculation is demonstrated in Figure 5, below.

Figure 5: Save Energy Cost calculation


$$\text{CRF} = [(d) \text{ discount rate}, (n) \text{ investment lifetime}]$$
$$\text{SEC} = \text{CRF} (d, n) = \frac{\text{Initial investment (\$)}}{\text{Annual energy saving (kWh)}}$$

Adapted from: Goldemberg and Lucon (2010: 249)

Payback periods (the period needed to recover an initial outlay, as shown above) are vital criteria for companies when determining the priority of a project. Almost all companies, when it comes to successful project uptake, would like to see payback periods of two years or less: “To motivate consumers, payback periods often need to be very short, especially where relatively modest amounts of spending are involved and financed by individuals who may struggle to afford more costly, efficient equipment and appliance” (IEA, 2015a:119). This point can be directly related to SMEs, where project outlay is especially limited.

2.2 Global experiences

This section will discuss international energy-efficiency practice, the savings achieved through various incentive schemes, the barriers to energy efficiency, and how these barriers have or could be addressed. Section 2.3 will specifically discuss energy-efficiency practice within the South African context.

Winner of the Pulitzer Prize, Daniel Yergin's (2011) *The Quest: Energy Security, and the Remaking of the Modern World* put forth that a previous global misconception of energy efficiency, or energy "conservation", is that it is a form of punishment, an approach to reduce living standards or a tactic to deny developing countries equal opportunity for growth and higher living standards (Yergin, 2011: 614-615).

Despite these previously held beliefs, many countries are realising the scale and benefits of energy efficiency: "a global consensus is emerging around the key-and essential-role of energy efficiency" (Yergin, 2011:614-615). Yergin goes on to highlight global efforts in this regard:

China has explicitly put energy efficiency at the top of its energy policy, with a goal of doubling efficiency. The European Union has set a target for a 20 percent improvement in energy efficiency by 2020...Russia set a goal of reducing the energy intensity of the Russian economy by 40 percent by 2020. In the United States the Obama administration has focused on energy efficiency investments as an engine of economic growth. (Yergin, 2011: 615)

It is widely agreed that current global efforts are constrained, reserved and limited, and that there is much more room for growth, improvement and, thus, savings. The United Nations (2007) Expert Group on Energy Efficiency, suggested that if the G8 nations (industrialised countries, including Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States) increased their energy-efficiency uptake by an additional 2.5%, the following savings would transpire by 2030:

[Their actions would place] CO₂ concentrations below 550 ppmv (parts per million volume), avoid \$3.0 trillion worth of new generation, save consumers \$500 billion per year by 2030, eliminate the same amount of energy supplied by 2000 coal power plants, return the globe to 2004 energy consumption levels, and drive business productivity improvement and new employment opportunities. (UN, 2007:1)

A hypothetical study presented by Goldemberg and Lucon (2010: 244) suggests that, “[w]ithout the energy savings obtained between 1973 and 1998, energy consumption in the OECD would have been 50 per cent higher.” This added environmental and economic strain would have been catastrophic, compounding the issues that governments face today. Furthermore, Goldemberg and Lucon (2010: 244) highlight that developing countries could potentially see a 65% energy saving between 2006 and 2026 through energy-efficiency measures alone; while this statement is hypothetical, it is critical that developing nations take advantage of the energy-efficient opportunities that exist, especially when considering that some of the biggest potential energy-efficiency gains can be found in “the five developing countries which are the largest emitters of greenhouse gasses (specifically addressing the steel sector)” (Goldemberg & Lucon, 2010: 244).

The IEA, *The Medium Term Energy Efficiency Market Report* (2015b: 16) claims that IEA countries have successfully avoided a cumulative 10.2 billion tonnes of CO₂ emissions as a result of energy efficiency investments in 2014. Moreover, the same countries avoided (also in 2014) “at least 190 Mtoe (7790 petajoules [PJ]) of primary energy imports” (IEA, 2015b: 16), thus improving energy security by enabling the avoidance of at least USD 80 billion worth of imported energy. IEA (2015b: 16) also suggests that, despite the growing rate of economic and population growth and the flat electricity demand, businesses are taking advantage of energy-efficiency services as a way to increase profits: “electricity consumption in IEA countries has flattened partly as a result of energy efficiency improvements; energy efficiency investments since 1990 saved 2200 terawatt hours in 2014” (IEA, 2015b: 16). Energy efficiency improvements simply allow consumers to spend less on energy (5.7 trillion in the case of IEA countries since 1990) while enjoying a high quality and amount of energy.

The U.S. Energy Information Administration’s (2012) Annual Energy Outlook (AEO2012) and the Electric Power Research Institute (EPRI) (2014) both highlight additional impressive savings opportunities for the United States. EPRI

(2014) has adopted the potential savings put forth by the AEO2012 and claims that an additional potential reduction of 352 to 494 billion kWh in electricity consumption can be achieved by 2035. This would adjust the achievable electricity-consumption reduction (through energy-efficiency programmes alone) to a total of 488 to 630 billion kWh by 2035.

The United Kingdom Department of Energy and Climate Change (DECC) (2012) largely recognises the notable potential savings that can be derived from energy-efficiency implementation and highlights government's commitments and responsibilities towards achieving those barriers. The 2011 DECC Carbon Plan and the 2012 DECC Energy Efficiency Call for Evidence have identified (and aim to deliver) savings of 163TWh (9%) by 2020, amounting to 19 power stations (DECC, 2012: 17). However, the DECC's "Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK" publication (2012) also explicitly highlights *additional* remaining energy-efficiency potential within the UK, claiming "that through socially cost-effective investment in energy efficiency we could be saving 196TWh in 2020, equivalent to 22 power stations" (DECC, 2012: 5), which allows for the "final energy consumption in 2020 to be 11% lower than the business as usual baseline" (DECC, 2012: 8). This strategy also acknowledges the possibility for further potential given a stronger understanding of energy efficiency and an evaluation of the impact of policy on incentives to invest in energy efficiency.

The above-mentioned analyses, both global and country-specific, again highlight current and additional savings, which can be derived from progressive energy efficiency implementation. It is apparent that the uptake of energy efficiency alleviates multiple savings, thus addresses multiple challenges; all of these are intertwined. The remainder of this section will review various country-specific policies, the EE movement, case studies, and incentive schemes to highlight EE savings and barriers and identify ways to overcome existing and potential barriers.

2.2.1 Japan

Policy and energy-efficiency movement

Japan adopted energy-efficiency measures early (Yergin, 2011: 616). In 1947, there was an emphasis on efficient heat management to preserve domestic coal resources (The Energy Conservation Centre, Japan [ECCJ], 2006). Japan switched from coal to imported oil, which then changed the efficiency concerns from resource availability to import dependency (ECCJ, 2006). When the 1973 oil crisis hit, Japan's oil dependency was at least 80% of the total primary energy demand (ECCJ, 2013: 3). Thus, ample resources were poured into research and the development of higher technology such as high-efficiency gas turbines, fuel cells and waste-to-heat technologies to improve plant operation and management (Geller et al., 2006: 561; ECCJ, 2006). As a result of another oil crisis in 1979, which exposed Japan's lack of energy diversification through its "detrimental effects to the Japanese economy" (Shiel et al., 2011: 3), the Japanese government established the Energy Conservation Law (Geller et al., 2006: 561; ECCJ, 2006). This collaboration between industry and government focused on retrofits and facility improvements (ECCJ, 2006). Supply and demand levels and continued efforts lowered oil dependency by 44.6% in 2010 (ECCJ, 2013: 3). The Energy Conservation Law, although revised, is still in use today, acting as a major role for energy-efficiency policies for four major sectors: industry, commercial/residential, machinery/equipment, and transportation (Geller et al., 2006; Shiel et al., 2011: 6). Under the law are various programmes and policies aimed at energy conservation for the above-mentioned four sectors. While there is considerable debate as to whether or not Japan is exerting sufficient vitality into its energy-efficiency policies (Moe, 2012: 263; De Wit, 2013), this is not the focus of this research project.

Energy-efficiency schemes

The Energy Conservation Centre of Japan's Free Energy Audits for Small- and Medium-Sized Companies

Energy efficiency has been stimulated through incentive schemes for the industrial sector in Japan. The IEA (2015c) discusses the programme Free Energy Audits for Small- and Medium-Sized Companies, which was commissioned by the Ministry of Energy, Trade and Industry (METI) through the Energy Conservation Centre, Japan. The ECCJ audits began in 1997 and, as of 2014, was allocated a budget of JPY 0.5 billion. From 1997 to 2009, there were 7,437 audits, and the programme is still running. Little academic research and few empirical reviews of the program are obtainable; however, Kitagawa (2014) from the ECCJ highlights (limited) programme details and results. The audits are targeted at small and medium enterprises (SMEs). SMEs participation is voluntary, whereas large enterprises are mandated by government to implement energy-efficient measures.

In short the audit consists of two heat and electricity experts who inspect the premises in one day and advise on where there is room for improvement. Energy savings (an expected 6 to 8% of the factory's energy consumption), costs and expected investments are relayed to the participant, along with follow up meeting to discuss the results. There is some financial support available, including tax incentives, low interest loans and subsidies, technical support (i.e., the energy audits and requested training), as well as an online platform with relevant case studies and resources (Kitagawa, 2014; Price and Lu, 2011: 2-49).

In addition, the ECCJ communicates to the public the importance of EE through "educational seminars, technical courses, monthly magazines, and handbooks" (Price and Lu, 2011: 2-049). According to Kitagawa (2014), one third of the proposals have been carried out, while the rest are under consideration. There is little information available about the actual savings achieved by the programme.

Barriers to energy efficiency

According to Kitagawa (2014) and De Wit (2013), the challenges and barriers to the Free Energy Audits for Small- and Medium-Sized Companies programme are the following:

- One third of the recommended EE measures are not implemented (Kitagawa, 2014)
- An excessive portion of the audit is allocated to utilities (Kitagawa, 2014)
- Difficulty with the installation of equipment (Kitagawa, 2014)
- Limited financial support (Kitagawa, 2014)
- Disinterest in EE (De Wit, 2013)
- Informational/knowledge barriers (De Wit, 2013)

Overcoming barriers

While energy audits are an optimal way to identify and acknowledge energy deficiencies, there must be integrated efforts among government policies, academics and key stakeholders to ensure significant results. Kitagawa (2014) identifies plans for overcoming the barriers, including additional financial support and installation of EE equipment; however, limited literature could be found regarding how the ECCJ proposes to address the specific existing barriers.

2.2.2 United Kingdom

Policy and energy-efficiency movement

The United Kingdom's Department of Energy and Climate Change (DECC) upholds concerted efforts and strong vested interests for energy-efficiency uptake, focusing on four core aims: savings on consumers energy bills, decarbonising the UK, ensuring and sustaining access to energy supplies (energy security), and intensifying economic growth (DECC, 2013).

Success, of course, lies with proper policy alignment and goals. Burton (2011: 10), drawing on Marquard's (2006) notion of "policy domains", highlights the critical policy cohesion between and within domains to ensure aligned goals, as one domain and its goal (for example, energy) can contradict another domain's goal (say, climate change or climate mitigation). The UK epitomises this notion through the solidity of developed goals for both energy and climate change; by implementing a variety of policies targeted at reducing energy consumption in households, businesses and the public sector, the DECC has been able to reduce carbon emissions (DECC, 2014a). The DECC's (2014a) National Energy Efficiency Action Plan claims that successful EE implementation has decreased final energy consumption for eight of the last nine years, and is now 13% lower than in 2003 (DECC, 2014a: 3).

The DECC's government EE policies are easily accessible through search engines and are clearly stated in recently updated reports (see: <https://www.gov.uk/government/organisations/department-of-energy-climate-change>) (DECC, n.d.). There are a number of private-sector initiatives and non-profit organisations that help extend the platform for achieving energy-efficiency targets: for example, the Carbon Trust. The foremost governmental platform which aims to tackle energy efficiency, is DECC 2012 "The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK" and has since been updated in 2013 highlighting the existing barriers and further energy-efficiency potential within the UK (DECC, 2013). The document outlines a step by step public commitment on how the government plans to overcome the barriers and achieve an energy efficient sustainable future.

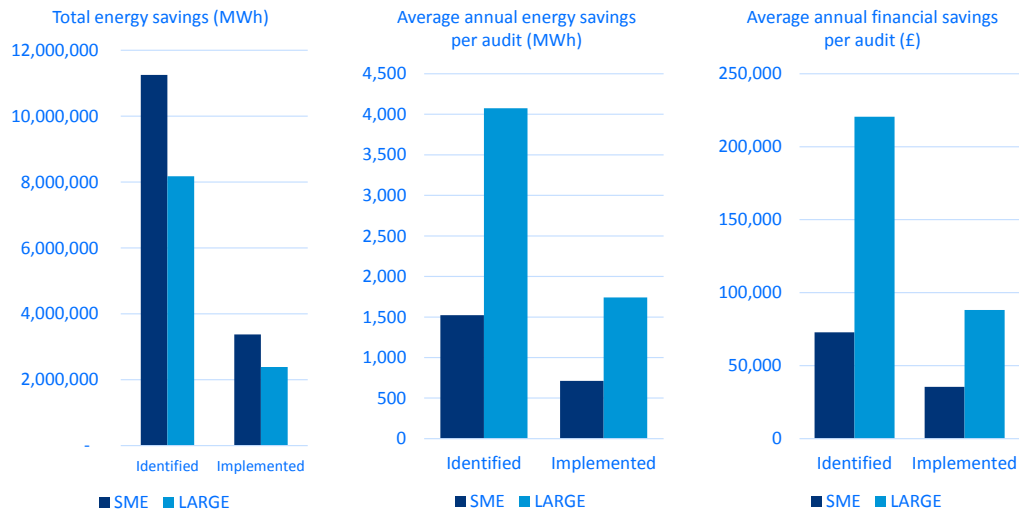
Energy-efficiency schemes

UK Carbon Surveys (Carbon Trust) and Energy Savings Opportunity Scheme (ESOS)

The UK Carbon Trust supplies free Carbon Surveys (energy audits) to SMEs in the UK. To qualify for the audit, the company must have an energy expenditure of more than 50,000 pounds but less than 500,000 pounds. As of June 2014,

large enterprises (an estimated 7,300) are required to conduct energy audits to meet national energy requirements. The Carbon Trust recommends that these businesses “go beyond compliance and take advantage of real opportunities in ESOS” (Carbon Trust, 2016). With a thorough standard assessment, the carbon trust has been very successful in identifying key recommendations for delivering an abundant amount of energy savings through various efforts: audits, training, education, public promotion of EE, financing, and ongoing and follow-up assistance. According to the DECC’s (2014a) UK National Energy Efficiency Action Plan, the Carbon Trust carried out 9,397 audits with 65,070 EE recommendations for a total of 8,457 individual company accounts (1,671 larger enterprises and 6,786 SMEs) between 2006 and 2011 (DECC, 2014a; Carbon Trust, 2013). (Data is not available beyond 2011.) The Carbon Trust (2013) claims that 3,962 (nearly half) of the companies implemented a total of 64,070 (30%) of the identified recommendations (see Figure 6 below). Figure 6 highlights the potential savings (total energy savings, annual average energy savings per audit, and annual financial savings per audit) against actual EE implementation for both large and small companies. The organisation claims that 60% of these implemented recommendations happen within a year, and that 80% of the measures implemented have a payback period of less than two years. This highlights the importance of having lower costs and short payback periods to ensure uptake.

Figure 6: Potential vs Implementation of energy-savings recommendations



Source: Carbon Trust (2013: 12)

CRC energy-efficiency scheme

This mandatory scheme includes 2000 participants in large public and private sectors (DECC: 2014a: 10). Through drivers such as carbon price, standardised monitoring, and reporting of energy consumption, the CRC scheme hopes to encourage participants to invest and improve energy efficiency, in addition to cutting carbon emissions. Participation in the scheme is efficient in itself, as the website is compliant, easy to understand and assessable, with easily understood requirements and an online application (see: <https://www.gov.uk/guidance/crc-energy-efficiency-scheme-qualification-and-registration>) (DECC, 2014b).

Barriers to energy efficiency

The DECC's (2013:8) Energy Efficiency Strategy identified the following main barriers to EE uptake in the UK:

- Embryonic markets: Although there is an existing EE market, it is too small and does not satisfy or recognise the full potential or benefits of EE uptake.

- Limited information: The available information is limited, foreshortened and not relevant or applicable to businesses and their specific needs or contexts (in other words, it is generic). Furthermore, it is likely that the information is aimed at particular opportunities (or goals), thus hindering the businesses from seeing the full potential of their investment.
- Misaligned financial incentives: While there are many benefits of EE uptake, especially external benefits, typically the investor is not “directly” reaping the benefits from his or her outlay.
- Undervaluing energy efficiency: Many are apprehensive of EE uptake due to a “lack of trusted information on the market” or the uncertainty of savings. Thus, EE investments are not noted as a priority. (DECC, 2013:8)

Overcoming barriers

The UK government prioritised a suitable plan for overcoming these four barriers. According to the Energy Efficiency Strategy Update (DECC, 2013), “since the publication of the Energy Efficiency Strategy the Government has introduced new policies and simplified existing ones” (DECC, 2013: 8). Below, in Table 1, the solutions to overcoming the abovementioned barriers are presented. (See pages 8-9 of the DECC’s (2013) Energy Efficiency Strategy Update for a full review of solutions.)

Table 1: Barriers and solutions to EE uptake in the UK

The four identified barriers	Solutions (including but not limited to)
1. Developing market	<ul style="list-style-type: none"> • Schemes such as the Green Deal and the Energy Company Obligation created a larger and more competitive market; homeowners and businesses can receive assessments, installations and financing through approved

	assessors/installers/providers of their choice
2. Information (or lack thereof)	<ul style="list-style-type: none"> The Energy Savings Opportunity Scheme (ESOS) and the Carbon Trust energy audits allow for large companies to fully understand company-specific EE potentials, with updated assessments every four years
3. Misaligned financial incentives	<ul style="list-style-type: none"> Helping companies understand how they are saving money on their bills Creating and supporting financial institutions such as the UK Green Investment Bank, which aims to support EE initiatives
4. Undervaluing EE	<ul style="list-style-type: none"> Creating a world-class standard regulation for all quoted companies, such as the <i>Mandatory Greenhouse Gas Reporting Scheme</i>, creates transparency for companies, thus allowing investors to know “which companies are effectively managing the long-term costs of greenhouse gas emissions” (DECC, 2013: 9) Raising awareness of the benefits of EE through awards and recognition

Source: DECC, The Energy Efficiency Strategy Update (2013)

The UK government has made clear and concise commitments to overcoming its barriers and to the promotion of EE. Significant progress has been made since the release of the Energy Efficiency Strategy.

2.2.3 China

Policy and energy-efficiency movement

Despite the important role that energy efficiency has played in China's government policy since the 1980s, the economic growth spurt of 2002 resulted in major energy shortages (in all forms) by 2004 (Andrews-Speed, 2008: 1331). Moreover, China's energy efficiency still remains "fairly low relative to other developed countries and regions" (Ma, Oxley & Gibson, 2009: 1797). Previous energy-efficiency policies (from the 1980s to 2000) were determined by energy use and gross domestic product (GDP). The policies quickly plummeted as a result of a "four-fold increase in GDP" and a "doubling of energy use": the policies were "dismantled" between 2001 and 2005 due to the inadequacy of the existing model (Price and Wang, 2007: 1).

Yergin (2011: 616-617) highlights a study in 2004 that indicated that, if current rates continued, China would consume *more oil* than the *entire global production* by 2030. As a result of this indication, the government quickly (in 2005) declared an ambitious national goal to cut emissions by 20%. With an overall reduction of 19.1%, China was just short of its national carbon abatement goal (Romankiewicz et al., 2012). However, many of the nation's policy efforts met or surpassed their targets:

For instance, the key energy saving projects program targeted savings of 240 million tons of coal equivalent (Mtce) but achieved a total savings of 340 Mtce, while the Top 1000 enterprises program targeted a savings of 100 Mtce and ended up saving 150 Mtce (Romankiewicz et al., 2012: 2)

Romankiewicz et al. (2012) highlight claims by the Climate Policy Initiative (CPI) that China's total carbon-emissions reduction from energy savings was 1265 millions tonnes of carbon dioxide (MtCO₂), and that 61% of this reduction was driven by incentives (Romankiewicz et al., 2012: 2). There were many commitments and efforts led by government and the private sector to achieve the 20% target. Two of these strategies are discussed below.

Energy-efficiency schemes

11th Five-Year Plan

“Jieneng Jianpai: Save energy! Cut Emissions!” This was a slogan that was often used to promote the 11th Five-Year Plan, announced by government in 2005 (Yergin, 2011: 617). The reduction assumed an economic growth rate of 7.5% and the plan was expected to save 640Mtce (Million tonnes of coal equivalent) over the course of the five years. Due to an unexpected higher economic growth rate between 2005 and 2007, this plan was not fully successful, but still very helpful. The plan aimed to close all small plants and phase out inefficient and out-dated energy-intensive industries such as electricity, cement, coal, pulp and paper, alcohol and steel (Zhou et al., 2010: 6446). More specific closures were allocated to each industry (Zhou et al., 2010: 6446): for example, “up to 100 million tons in steel, 250 million tons in cement, and 400 million tons in coal mines” (McKinsey, 2009: 86). Zhou et al. (2010: 6446) draw on research from China’s National Development and Reform Commission (NDRC) (2008), which claims that, as of 2007, the following had been closed: 14GW of small thermal power plants, 47 millions tonnes of inefficient production capacity of iron foundries and 38 million tonnes of steel mills.

Top-1000 Energy-Consuming Enterprise Programme

To fulfil its 11th Five-Year Plan, China enacted numerous incentive policies towards improving industrial energy efficiency. An example is the Top-1000 Energy-Consuming Enterprise Programme, which began in April 2006. This programme targeted the 1,008 highest energy-consuming enterprises, which accounted for approximately 50% of the total industrial-sector energy consumption and 30% of the total energy consumption in China (Romakiewicz et al., 2012: 5; Zhou et al., 2010: 6446). In 2004, the total energy use for these enterprises amounted to 673 Mtce (19.7EJ). The programme aimed to reduce consumption to 100 Mtce (2.9 EJ) during the five-year span, in the hope of contributing to the “11th Five-Year Plan’s goal of reducing energy consumption

by 20% per unit of GDP” (Zhou et al., 2010: 6446). The programme consisted of many key players but mainly relied on contracts between government and industry at the provincial level, holding those involved responsible for fulfilling energy-conservation commitments (Price & Wang, 2007: 4-6). The enterprises were expected to achieve a number of tasks that would ensure successful energy conservation, according to Price and Wang (2007: 5). The tasks were as follows:

- Establish an energy-conservation organisation
- Formulate energy-efficiency goals
- Establish an energy-utilisation reporting system
- Conduct energy audits
- Conduct training
- Formulate an energy-conservation plan
- Adopt energy-conservation incentives
- Invest in energy-efficiency improvement options

Furthermore, each enterprise was required to submit its quarterly fuel consumption online to the National Bureau of Statistics. While the data would not reveal private enterprise-specific information to the public, it was provided to the NDRC for monitoring purposes (Price & Wang, 2007: 6).

The two above-mentioned strategies are key role-players in China’s energy-efficiency programme, alongside government policies, and are still contributing to China’s accomplishments and ambitious targets. Despite these and other strategies, however, China still faces many barriers to energy efficiency. They are discussed below.

Barriers to energy efficiency

Romakiewicz et al. (2012: 6) claim the barriers to industrial energy-efficiency investments in China are parallel with the rest of the world. Figure 7 highlights the financial and institutional barriers relevant to this research. Similarly,

Andrews-Speed (2009: 1342) has identified four major constraints surrounding energy-efficiency uptake in China:

An apparent unwillingness to use economical and financial incentives;

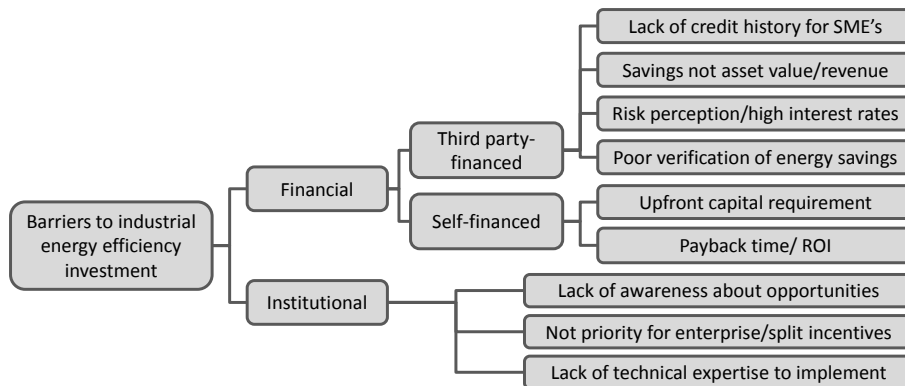
An apparent unwillingness to integrate energy efficiency in other sector policies;

The systems of political decision-making and public administration;

A shortage of technical skills. (Andrews-Speed, 2009:1342)

Andrews-Speed (2009: 1342) puts forth that “energy users see no economic incentive to save energy because energy prices have been tightly constrained.” While China may have excellent policies and ambitious goals for improving energy efficiency, energy users in the country, especially SMEs, cannot easily gain access to financial opportunities or tax incentives and therefore cannot invest in new equipment or processes (Andrews-Speed, 2009: 1342). Furthermore, SMEs are reluctant to seek financing from third parties that will throw off their balance sheet (high payback periods), and a lack of credit history prevents SMEs from borrowing from loan officers (Romakiewicz et al., 2012: 7). Due to these tight constraints, SMEs have to turn to private lenders who discourage the uptake of EE measures because of their “astronomical interests rates” (Romakiewicz et al., 2012: 8).

Figure 7: Barriers to industrial energy-efficiency investment



Source: Romakiewicz et al. (2012: 6)

Echoing the above hurdles, Wang, Wang and Zhao (2008) highlight thirteen main barriers to energy saving, following an extensive literature review of energy experts and academics. Their findings are as follows:

- Lack of awareness;
- Lack of experience in technology and management;
- Lack of funding and financing;
- Limited policy framework;
- Lack of research personnel or trained manpower;
- Lack of public participation;
- Inadequate data and information;
- Reluctance to invest;
- Objection from vested interest groups;
- Inappropriate industrial framework;
- Lack of strategic planning;
- Lack of appropriate production technologies; and
- Lack of incentive support.

Identifying barriers directly from industry respondents prevents unnecessary tautology and offers insightful results from a holistic, qualitative point of view. Romakiewicz et al. (2012:10) highlight a published comprehensive survey by Johnson Controls, published in 2011. When participants across multiple sectors were asked what they believed was their top barrier to pursuing energy efficiency in their enterprise, the most commonly listed barriers were the following:

- Insufficient payback periods;
- Lack of technical expertise;
- Lack of funding;
- Uncertainty regarding savings; and
- Lack of awareness about opportunities.

These same barriers were identified by Romakiewicz et al. (2012:10), as represented in Figure 7 above, and present a common ground for government, policy makers and key role-players to rely on when considering how to better implement energy-efficiency uptake.

Overcoming barriers

“Prioritizing investment in energy efficiency rather than pouring money into expanding energy supply should be strongly recommended” (Ma et al., 2009: 1798). It is clear that China must now focus on how to overcome barriers to energy efficiency, specifically regarding financing—especially for SMEs. Romakiewicz et al. (2012: 16) highlight the need to design policies that cater less to large enterprises with access to ample capital and more to SMEs. In the hopes of addressing EE barriers, government has extended successful incentive policies and introduced tax holidays to ESCOs, allowing tax exemption for the first three years and only 50% of the income tax rate for the second three years on qualified projects (Romakiewicz et al., 2012: 12). Lastly, Romakiewicz et al. (2012:16) suggest that further research is necessary to overcome all existing barriers.

2.2.4 United States

Energy-efficiency scheme

Industrial Assessment Centres (IACs)

Hosted by the US Department of Commerce, the Industrial Assessment Centres (IACs) were established in 1976 as a response to the oil crisis and rising energy costs in the foreseeable future. In 1978, the US Department of Energy (DOE) became the primary sponsor of the project. The project is still in existence and is administered through the Advanced Manufacturing Office under the Office of Energy Efficiency and Renewable Energy, DOE. Similar to the UK Carbon Trust, the IACs conduct free energy audits to all manufacturing SMEs that meet their specific criteria.

(See the following link for the criteria list: <http://energy.gov/eere/amo/industrial-assessment-centers-iacs>.)

To date, the IACs have achieved an average annual saving of up to \$136,508.00 per every participant. To date, more than 17,281 assessments have been conducted, making 131,027 recommendations (see Figure 8). Accredited university teams disbursed across the US carry out these audits. This approach allows training for “the next generation of energy savvy engineers”, since the programme enables students to have hands-on experience by assisting with in-depth evaluations of energy efficiency. Above all, the IACs’ website provides an extensive platform that enables individuals, businesses, academics, governments, and nations to understand the importance of energy-efficiency implementation. The IACs provide case studies of their participants, which then allow similar companies to compare inefficiencies and infer how they would benefit with similar implementation.

Figure 8: Average recommended savings per assessment

Average Recommended Savings Per Assessment	Cost (\$) Savings	Usage Reduction	Unit
All Energy	\$78,550	12,694	MMBtu
Electrical	\$42,933	804,923	kWh
Natural Gas	\$21,518	3,858	MMBtu
Waste	\$9,069		
Productivity	\$48,889		
TOTAL	\$136,508		

Source: IAC (n.d.) (<https://iac.university/statistics>)

Barriers to IACs

The American Council for an Energy-Efficiency Economy (ACEEE) has worked alongside the IACs programme for the last 29 years. Chittum et al. (2010) of ACEEE have identified barriers that limit the success of the IACs programme:

- Limited funding;
- Limited training of next-generation energy engineers;
- IACs is the only nationwide programme but it only extends to 26 areas;
and
- Limited access to technology.

In June 2015, the US DOE identified 42 barriers to industrial efficiency that, if addressed, would help to accelerate energy efficiency. The report also provided successful examples and opportunities for overcoming the identified barriers. The barriers can be broken down into three key groups: economic and financial; regulatory; and informational. In some cases, the barriers can fall into multiple groups: for example, the “limited training” barrier listed above (Chittum et al., 2010) could fall into the economic and financial or the informational group. It is necessary to keep in mind both the general barriers to energy-efficiency uptake and the scheme-specific barriers, to ensure a more successful outcome in the future.

Overcome the barriers

Chittum et al. (2010) have made the following recommendations to Congress, in the hope of overcoming the above-mentioned barriers:

- Expand funding for IACs assessments and training of engineers;
- Expand funding for research of energy-efficient technologies; and
- Expand funding for technology deployment.

2.2.5 Summary of global experiences

Identified savings, results and global efforts regarding the practice of energy efficiency have proven that energy-efficiency uptake is a major tool for successful energy development. Indubitably, all international EE schemes (successful or not) present room for improvement. The barriers experienced by the above-mentioned countries should be used as *lessons learnt* for those countries that require the adoption or retrofitting of energy-efficiency incentives and practices. The researcher reviewed only a few incentive programmes, in

only four countries, barely scraping the surface of EE efforts globally. Still, she was able to identify at least twenty-five total combined barriers, many of which could be identified in all the programmes. By adopting the “grouping of barriers” approach of the U.S. Department of Energy (2015: ix), the above-mentioned barriers mentioned in 2.2.1-2.2.4 have been allocated to their most relevant group, shown in Table 2. These barriers must be addressed using relevant, customised mechanisms, in order to ensure a better success rate. These mechanisms are shown in Table 3, which outlines the above-mentioned apparatuses for overcoming the barriers. These various barriers and mechanisms will be considered in the discussion and conclusion of this research for the PSEE-specific found barriers.

Table 2: Case Study Identified Global barriers

<p style="text-align: center;">Economic and financial</p> <ul style="list-style-type: none"> • Lack of financial and incentive support • Misaligned financial incentives • Lack of appropriate production technologies • Installation of equipment • Limited access to technology • Lack of research personnel or trained manpower • Lack of training of next-generation energy engineers (shortage in technical skills) • Insufficient payback periods 	<p style="text-align: center;">Regulatory</p> <ul style="list-style-type: none"> • Embryonic markets • Misaligned financial incentives • Inappropriate industrial framework • Lack of strategic planning • Limited policy framework • An apparent unwillingness to integrate energy efficiency in other sector policies • Lack of programme availability
<p style="text-align: center;">Informational</p> <ul style="list-style-type: none"> • Disinterest in EE • Reluctance to invest 	<p style="text-align: center;">Other</p> <ul style="list-style-type: none"> • Objection from vested interest groups

<ul style="list-style-type: none"> • Lack of public participation • Lack of research personnel or trained manpower • Lack of awareness • Inadequate data and information • Lack of experience in technology and management (lack of technical expertise) 	<ul style="list-style-type: none"> • An unwillingness to use economical and financial incentives • Undervaluing energy efficiency
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Table 3: Highlighted mechanisms for overcoming barriers

<p>Economic and financial</p> <ul style="list-style-type: none"> • Expanding funds for incentive schemes • Introduce tax holidays • Prioritising investments in EE • Creating and supporting financial institutions, which will then support EE initiatives 	<p>Regulatory</p> <ul style="list-style-type: none"> • Prioritised policies that cater to country-specific barriers • Extension of successful policies • Creating a world-class standard regulation for quoted companies • Introducing more energy audits with follow-up services to allow companies to identify their inefficiencies more regularly.
<p>Informational</p> <ul style="list-style-type: none"> • Raising awareness through awards and recognitions • Helping companies understand their savings opportunities • Further research in EE technology, measures, incentives and barriers 	<p>Other</p>

The next section will review energy-efficiency practice, policy, commitments, incentive schemes and barriers to uptake in South Africa.

2.3 Energy efficiency in South Africa

South Africa is in the midst of a serious electricity-supply crisis. As mentioned, Eskom cannot keep up with the current growing electricity demand thus the country is experiencing nationwide power outages (loadshedding). Despite academic recommendations and projections about an increasing electricity demand (on the basis of declining real prices), government shied away from efforts to increase generation capacity. Coupled with an energy-intensive economy (driven by historically low electricity prices), this has had devastating consequences (The Dept of Minerals & Energy, 2005) (Inglesi-Lotz & Pouris, 2012: 114).

It is thought that EE can be a main driver for alleviating the ongoing energy crisis. The most pressing factors that encourage the uptake of energy efficiency in South Africa include (but are not limited to) the following:

- Rising costs of electricity tariffs;
- Growing strain on the electricity grid and national blackouts; and
- Growing concerns and need for the reduction of CO₂ emissions.

Regardless of the context, energy efficiency has been scientifically proven to help address and alleviate all the above-mentioned current challenges, and has an important role to play in the change of the energy sector. While government has attempted to bring about the promotion of end-use energy efficiency, through policies, strategies, incentive schemes, financial subsidies, rebates and tax incentives, success has been minimal in comparison to the potential. Key role-players in energy efficiency have not been engaged, authorised, allowed or empowered to act as effectively, or as efficiently, as possible in promoting uptake and successfully implementing energy-efficiency measures within energy-intensive sectors.

2.4 Policy and the EE movement in South Africa

The following policies are an indication of a more regulated energy system. There are government standards that move towards an energy-efficiency future; however, it seems there is a lack of implementation.

Energy Policy White Paper (1998)

The Energy Policy White Paper, released in 1998, recognises the relationship between energy and social and economic development. It further recognises that sustainability is important and that efficiency should be considered above all: “the state should ensure that energy production and utilization are done with maximum efficiency at all time” (Dept. Minerals & Energy, 1998). The paper highlights that significant potential exists for energy-efficiency improvements and that the government is committed to creating policies that will help overcome the existing barriers within the energy markets.

National Energy Efficiency Strategy (2005)

The Department of Minerals and Energy published the National Energy Efficiency Strategy in 2005, which has been revised in 2008 and 2013. The first statement made by the government in this paper admits that South Africa is careless with its energy consumption: “In South Africa we take energy for granted, with the consequence that our energy consumption is higher than it should be” (Dept. Minerals & Energy, 2005). The paper aims to provide goals and targets as well as plans to deliver an energy-efficiency improvement of 12% by 2015. Unfortunately the National Energy Efficiency Strategy (2005) is a barrier-example of poor government policy and regulation as to support EE for the reason that the latest “update is more than four years overdue” (CCEE, 2015: 29).

Energy Efficiency Accord (2005)

In an attempt to follow the Energy Efficiency Strategy, twenty-four energy-intensive users and seven industry associations negotiated a commitment with government to try and meet a 15% reduction in final energy demand for the

industrial sector by 2015. The negotiation used a variety of energy-efficiency measures, including: demand-side management, reporting of energy usage from all energy sources, and energy auditing and protocol (IEA, 2013).

Other policies emerging out of this strategy include, but are not limited to:

- Product standards and labelling (2005);
- The Energy Efficiency and Demand Side Management Programme (2010);
- Climate Change Response Policy White Paper (2011); and
- SANS 204: Energy efficiency in building (2011).

The IEA (2016) provides clear information on the energy-efficiency policy framework for South Africa, including years, policy statuses, types and targets. (See:

<http://www.iea.org/policiesandmeasures/energyefficiency/?country=South%20Africa>)

2.5 Incentive schemes in South Africa

Even though the character of the economy is energy intensive, the historically low prices and the lack of public awareness about the consequences of extensive energy usage have provided little incentive to save energy. (Inglesi-Lotz & Pouris 2012)

Incentives need to be accessible and equipped to deliver confident, secure and reliable results. Given the history of South Africa and the “electricity is cheap so let’s use it” mindset, incentives need to be easily adopted by those who have previously had no incentive to save energy. The following current or most recent incentive schemes were deemed most relevant to this research.

2.5.1 Private Sector Energy Efficiency

On December 3, 2013, the National Business Initiative housed and launched the Private Sector Energy Efficiency Programme (PSEE). The programme ended in November 2015, and was still in full operation at the time of this research. The

programme was fully funded by the UK Government's Department for International Development (DFID) and was supported by the UK Carbon Trust, through the provision of technical assistance. Prior to the programme launch, the DFID assessed and concluded that the scope for and impact for energy efficiency was high, however, the following barriers existed and prevented the country from exploiting this potential resource: lack of general awareness of energy efficiency, lack of capability within industry to identify opportunities for energy efficiency and lack of capacity within companies to access available finance, and develop a business case for energy efficiency projects that would get board level support. (PSEE, 2015a &b).

Thus, the objective of the programme was as follows: "The PSEE aims to improve energy efficiency in commercial and industrial companies in South Africa through the provision of various services to assist companies in identifying and implementing energy saving measures" (PSEE, 2015b). Governed by a multi-stakeholder Steering Committee, the PSEE is led by the South African Department of Energy (DoE) and the NBI (PSEE, 2015b). The PSEE aimed to address the following challenges:

- A lack of awareness of energy efficiency.
- A lack of capability within industry to identify opportunities for energy efficiency.
- A lack of capacity within companies to access available finance and develop a business case for energy- efficiency programmes that would get board-level support. (PSEE, 2015)

There are three levels of service that the PSEE offers participants. The level is determined by the size of the business, which is in turn determined by its total annual energy spend. The energy spend includes electricity, fossil and liquid fuels, and can be determined by a review of the last twelve months of energy statements. These levels are presented below in Table 4.

Table 4: Levels of service and company size criteria

Business size	Annual energy spend	Level of service
Small	N/A	<ul style="list-style-type: none"> • Unlimited personal advice through in-house technical experts via phone • Access to workshops on EE and topics such as lighting, motors and drives • Access to tools and publications
Medium	R750 000- R45 million	<ul style="list-style-type: none"> • Access to a four-day fully-funded support • Site surveys • Energy audits • Face-to-face engagements to identify energy-efficiency opportunities • Mitigation exposure • Follow-up services • Long-term support in developing energy saving strategies
Large	At least R45 million	<ul style="list-style-type: none"> • Holistically designed strategic energy-management engagements to improve operational EE and an energy and carbon strategy—this service includes up to 60 days' support from a third-party consultant and is funded up to R500k (60% subsidised)

Adapted from: PSEE (2015b)

According to the PSEE Seminar: Managing our energy futures (2015a), nearly all of the PSEE targets were reached during the duration of the programme, those reached and not reached are shown below in Table 5. As of 10 November 2015, the programme identified over 16,000 GWh in project-lifetime energy savings (it is assumed that most projects have a lifetime of at least 20 years) and implemented 617 GWh's of project-lifetime energy savings.

Table 5: PSEE progress to date (10 November 2015)

	Identified	Implemented	Target
Number of sites	860	294	765 medium 35 large
Number of opportunities identified	5505	697	N/A
Annual energy savings (GWh)	1531 GWh	123.4 GWh	N/A
Lifetime energy savings (GWh)	16, 672 GWh	617 GWh	2,576 GWh
Lifetime carbon savings (MtCO ₂ e)	13.0 MtCO ₂ e	424,748 MtCO ₂ e	2.0 MtCO ₂ e
Capex leveraged (R m)	R 2,6bn	R 68.2m	R 750m
Average payback of opportunities	2.3 years	1.4 years	N/A
Average capacity usage (MW)	490.7 MW	39.5 MW	60 MW (estimated)

Source: PSEE (2015b)

While the PSEE programme delivered impressive results, without further funding it was unable to continue due to funding. During the course of its operations, the programme was able to identify and address barriers and challenges. One of the many barriers noted in the 2015 PSEE Seminar was financial restraints. The PSEE recognised this and formulated a partial solution, which delivered a

specific service to participants who asked for more help: the service included a business case (financial report) for the participant to apply for funding, and tariff changes. However, no direct financial facilitation was made available for the participants. More barriers will be discussed in the later part of this thesis.

2.5.2 Industrial Energy Efficiency Programme (IEE)

Established in 2010, the Industrial Energy Efficiency (IEE) Programme is hosted by the National Cleaner Production Centre of South Africa, which is housed by the Council for Scientific and Industrial Research (CSIR). The multi-stakeholder steering committee includes the Department of Trade and Industry (DTI), the Department of Energy (DoE), the Department of Environmental Affairs (DEA) and Business Unity South Africa (BUSA), as well as international involvement and funding from the United Nations Industrial Development Organisation (UNIDO) and the Swiss State Secretariat for Economic Affairs. The aim of the project is to focus on and improve the capacity of the industry sector by improving energy efficiency, reducing CO₂ emissions and demonstrating the possibility of increased profitability through in-plant energy management (NCPC, 2011). The ultimate goal of this project “is to demonstrate the positive impact of energy management as a means of reducing carbon-dioxide emission and to demonstrate the effectiveness and financial impact of in-plant energy management” (NCPC, 2014).

According to the NCPC’s (2016) IEE Project, the IEE implements energy savings through management systems and staff training. International experts train local experts who then train experts at the company level. As shown in Figure 9, successful uptake is facilitated through an energy-management philosophy: an energy-intensive company (in the industrial sector) is identified, energy audits/assessments are conducted and fully explained to the participants, staff are fully trained, funding is facilitated to see out the projects and recommendations, implementation of the projects is facilitated through reliable technology and experts, and follow-up services are provided to monitor and report on savings.

Figure 9: The IEE energy-management philosophy



Source: NCPC IEE Project (2016)

From 2010 to 2015, the IEE project achieved a total energy savings in 82 plants amounting to 1800GWh; this amounts to 12 months of electrification for 250,000 middle-income SA homes. The potential savings identified from energy assessments for 231 SMEs were R111.5 million. In only five years, 1.7 million tonnes of CO₂ savings at the industry level were achieved. The IEE Project has successfully achieved energy savings of over R1.54 billion for the industrial sector from 2010-2015 and this number is continuing to grow (NCPC, 2016). There have been 114 South African experts trained at the energy-management level, and 58 national trainers and 3000 professionals were trained at the advanced level. At least thirty-five case studies have been made available to the public through the project's website. The second phase of this project will continue from 2015 to 2019 (NCPC, 2016). According to Alf Hartzenburg, head of the IEE Programme, there are still many barriers that the IEE faces. Table 6 shows the identified barriers and the strategies proposed to overcome these barriers.

Table 6: IEE barriers and strategies

Barriers	Strategies to overcome barriers
<ul style="list-style-type: none"> • Limited policies and enforcement • Duplicate EE programmes • Lack of management awareness • Lack of management commitment • Limited knowledge and information • Implementation-financing not accessible • Shifting priorities • Results not sustained • Narrow focus • Defensiveness • Unstable labour force 	<ul style="list-style-type: none"> • Create well-defined national policy environment • Identify ideal energy-intensive industry sectors • Provide funding for industrial energy programmes • Develop sector flagships • Organisational stability and commitment • Resource allocation • Access to technical expertise • New technologies

Source: Hartzenburg (n.d.)

Again, these barriers reflect the same challenges that were identified at the global level. EE programmes are not short-sighted in identifying the barriers these face; the problem seems instead to lie with making sure the resulting strategies are fully implemented. What is incredibly impressive about this programme is its longevity and dedicated

2.5.3 Manufacturing Competitiveness Enhancement Programme (MCEP)

Cash grants reduce the overall cost of energy-efficiency projects. These cash grants are typically provided by government departments. The most relevant grant incentive in South Africa for EE is described below.

Run by the Department of Trade and Industry (dti), the MCEP incentive programme aims to support manufacturing enterprises with competitiveness-improvement interventions. These production incentives, including the Green Technology and Resource Efficiency Improvement Incentive, provide support to manufacturers investing in green-technology upgrades that will lead to cleaner production: they are therefore directly applicable to energy-efficiency uptake. The incentive offers a cost-sharing cash grant of between thirty and fifty percent of the investment, up to a maximum of R50 million. MCEP guidelines stipulate the following: Applicants with total assets amounting to a historical cost below R5 million should have a minimum investment in machinery and equipment of R500, 000, with an additional 10% bonus grant available if an additional 10 jobs are created or if at least 50% of the procured machinery, equipment and tooling are manufactured in South Africa.

To be considered for this incentive, applicants must submit an audit or assessment report from an accredited service provider, such as the National Cleaner Production Centre IEE report or the Private Sector Energy Efficiency report, on the status of its clean-production, green-technology and energy-efficiency interventions. This report may not be older than 18 months when the application is submitted. The company must also hold level-four Broad-Based Black Economic Empowerment (B-BBEE) status in order to be considered for this incentive, which encourages and enhances the economic participation of black South Africans within the company.

Although this incentive is independent, the MCEP can be used alongside the PSEE and NPCP programmes when businesses implement EE measures, granted that the business meet the criteria required by both incentives. Applicants can simply apply online for the cash grant via the dti database, where

they can also access the guidelines, paperwork and contacts for the programme.

During the inception of this research, the MCEP was in full operation; however, on 28 October 2015, the dti announced that it was temporarily suspended and shut down for new applicants, since all the funding set aside for the programme had been allocated to previously approved applicants. The dti hopes to reopen a window application in 2016, funding permitted (DTI, n.d.a).

This programme exemplifies government's commitment towards energy efficiency; however, this study has explored multiple existing barriers, such as a lack of funding, misaligned policies and incentives, a lack of information and slow programme turn around.

2.5.4 Tax Incentives

Tax incentives are designed to encourage energy-efficiency projects by reducing the tax liability of a business; government usually runs them. In the case of South Africa and energy efficiency there are two main tax incentives, 12L and 12I. Of the two, 12L is the most relevant and tailored towards the uptake of energy efficiency development, it is discussed first.

The 12L tax rebate

12L is a tax-incentive rebate led by the government and the South African National Energy Development Institute (SANEDI). This incentive was introduced on 1 November 2013, with the aim of promoting the efficient use of all forms of energy (not restricted to electricity alone). 12L is offered to businesses that can demonstrate measurable energy savings through energy-efficiency measures across all forms of energy (electricity, fossil and liquid fuels) (typically excluding renewable energy); the expected tax relief was introduced at 45-cent per kWh but was increased on March 1, 2016 to a 95-cent deduction on taxable income per kilowatt hour of energy saved for a benefit period of one year (SANEDI, 2013) (SANEDI, 2015a). This rebate requires a South African National Accredited System (SANAS) Measurement and Verification (M&V) report. There

is very limited academic, empirical or government research on the progress or status of the 12L rebate and whether this incentive is actually contributing to EE uptake. One presentation, SANEDI (2015b) highlights the progress to date from June 2015 (note that this was prior to the increase of 95-cent per kWh from March 1, 2016); it states that at this time there were 100+ registered users with a total of 74 projects registered on the 12L system. SANEDI (2015b) claim there is a potential “+3 1000 000 kWh’s” saved from the 74 projects. The document also puts fourth that there are 5 accredited M&V bodies. The presentation also breaks down the projects by sector, they are as follows: Mining 28, Agriculture 3, Industrial 20, Commercial 21, Transport 2. This narrow document provides a bulleted list of key barriers, however these are not thoroughly explained: poor M&V facilities and available bodies, perceived high cost of M&V, limited M&V training opportunities and costs, exclusion of rooftop solar PV, REIT- structures, and unobtainable initial project capital (SANEDI, 2015b). There is no further discussion of how these barriers can or will be addressed nor is there available research which stipulates who is address these barriers.

The 12I tax rebate

This tax allowance incentive was promulgated in 2010 and supported projects until 28 February 2015. During these five years, the tax incentive supported a total investment up to R46 billion for 50 projects. The program has since been reopened and extended for an additional two years from 31 December 2015 to 31 December 2017. The incentive is to support Greenfield and Brownfield investments (according to the Dti (N.d.b), Greenfield investments are new industrial projects and Brownfield investments are expansions or upgrades of existing projects) which support the following: “investment in manufacturing assets, to improve the productivity of the South African manufacturing sector, and training of personnel, to improve labour productivity and the skills profile of the labour force” (dti, N.d.b). The most relevant energy-related aim of this tax rebate states that the project should “upgrade an industry within South Africa via an innovative process, cleaner production technology or improved energy

efficiency” (dti, N.d.b). The 12I incentive uses a point system to determine the outcome of your application, to reach a qualifying status the project must achieve four of the total eight points while preferred projects are to achieve seven out of eight points. The points, according to dti (2015) include the following:

- “Upgrade an industry within South Africa by utilising innovative processes (max. 1 point);
- Utilising new technology that results in improved Energy Efficiency and cleaner production technology (max 2 points);
- Provide general business linkages within South Africa (max 1 point);
- Acquire goods and services from SMMEs (max 1 point for Greenfield & 2 points for Brownfield);
- Provide skills development in South Africa (max 2 points); and
- In the case of a Greenfield project, is located within a Special Economic Zone (max 1 point)” (dti, 2015).

The 12I application can be accessed on the dti website. There is limited research regarding the outcome of the 12I however dti (N.d.b) highlight that the chemical (21 projects), cement and ceramic (7 projects), and agro-processing (3 projects) sectors represent 80 per cent of the total investment. Furthermore dti (N.d.b) claim that the “all 50 [original] projects will create approximately 6 200 direct jobs and 65 000 indirect jobs. It is further estimated that R11 billion worth of opportunities will be created through small medium and micro enterprise procurement” (dti, N.d.b), however there is little empirical evidence to prove these statements. There is no mention of energy efficiency-derived savings, or exiting barriers within the programme.

2.6 Financial opportunities for energy efficiency in South Africa

This section will identify and explore the relevant funding available for energy-efficiency opportunities in South Africa. The section is rendered necessary for the assumption of finance-related barriers to energy efficiency.

2.6.1 Commercial banks

Commercial banks are an option for those businesses that do not have the capital upfront. Some banks in South Africa offer or are conduits for special loans that fund energy savings and greening initiatives, such as CapEx for energy-efficient and renewable technologies and other elements that enable a business to be more energy efficient. The participating commercial banks are identified below:

- *ABSA*
- *FNB*
- *Investec*
- *Nedbank*

Table 7: Loan summary

Bank loan	Description of offering
ABSA: Clean Energy Financing Opportunity	ABSA, together with the French Development Agency, provides funding up to R100 million to projects specifically aimed at driving energy efficiency or renewable energy. A 7% rebate of the total loan amount to qualifying projects, which will go towards reducing the principal loan amount. (For more information see: http://www.sanedi.org.za/energy%20financiers/absa/)
First National Bank: Eco Energy Loan	“Invest in upgrading your premises to make them more energy efficient, reducing your operating costs” (FNB, N.d.); This loan is for projects with a minimum of R2000 and a maximum of 1 million. The annual turnover must be double the asking amount (First

	National Bank, N.d.).
Sasfin Holdings Ltd	This loan offers asset finance for energy-efficiency and renewable-energy projects based on \$10 million credit from a World Bank Fund: the International Finance Corporation’s Climate Change Investment Program in Africa (CIPA) and the Swiss State Secretariat for Economic Affairs (SECO). Projects eligible for funding range from office equipment, such as laptops and printers, to water heating, manufacturing equipment, heat pumps and materials handling equipment. Preferential interest rate offered (Sasfin, 2016).

Source: Parker, personal communication, 2015 & above listed web addresses also found in References.

2.6.2 Suppliers and Energy Service Companies (ESCO’s)

Suppliers of energy-efficiency technology offer either in-house funding or discounted rates through a financial institution that offers an equipment leasing/rental mechanism.

Energy Service Companies (ESCOs), like equipment providers, are typically compensated for their services based on performance contracts, but their compensation is directly tied to the energy savings achieved. (In this instance, an Energy Performance Contract (EPC) is concluded either as a Shared Savings Agreement or as a Guaranteed Savings Model. This adds strict requirements for the type of projects that are funded. For instance a supplier will not agree to offer in-house funding for something such as new underground pipelines, because this technology cannot be removed.

2.7 Conclusion

In conjunction with the academically identified global and national barriers, identifying empirical, qualitative, participant-perspective barriers to the programmes and incentive schemes outlined above would allow for more holistic insight into what is required for government, policy makers, and the private sector to foster more successful energy-efficiency uptake.

3 Methodology

The aim of this research is to identify and explain the barriers of EE uptake.

To achieve this aim, the researcher analysed data collected from participants who recently participated in an incentive scheme in South Africa. There were two focus groups for this data-collection: group X and group Y.

Group X: Quantitative data was collected from the participants' reports (given to them by ESCO E), which were received through the incentive scheme, PSEE programme, while additional qualitative data was collected by the researcher in the form of semi-structured interviews.

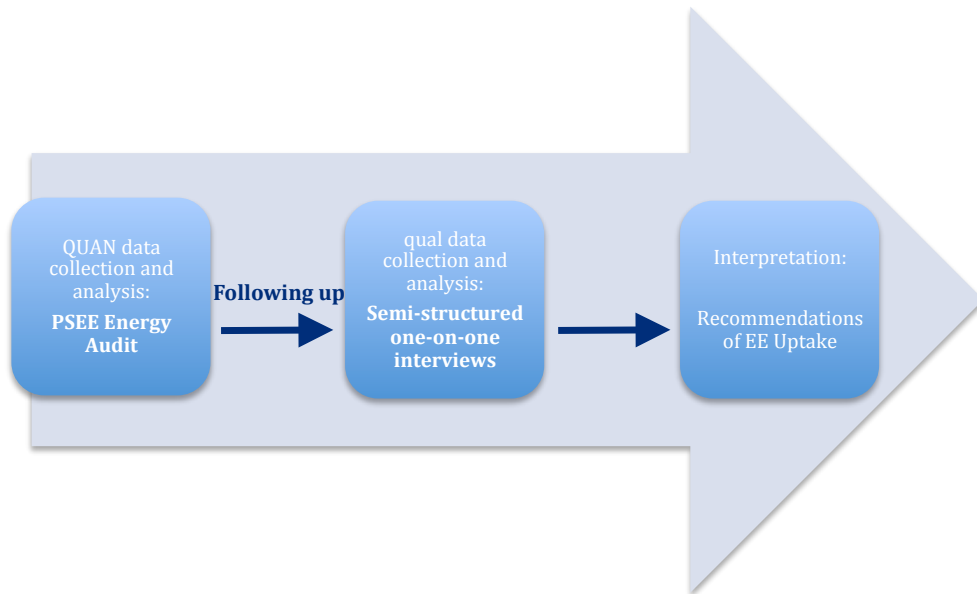
Group Y: The researcher, in the form of a semi-structured focused group interview, collected only qualitative data from the coordinators of the incentive scheme.

3.1 Research design: mixed methods

As previously mentioned this research uses qualitative research to then explain quantitative results. Thus, the collection and analysis of both qualitative and quantitative data requires the utilisation of a mixed-methods approach. Having a mixed methods approach provides multifaceted, more in depth and unbiased results rather than assuming or making conclusions solely on the basis of one realm of data (De Vos et al., 2011: 433-436). The researcher felt that a qualitative explanation was critical to holistically understand and address the lack of EE uptake after participants were delivered a report which identified their potential.

To do this numerical (quantitative) data retrieved from Group X—such as key savings costs, kWh, CO₂ emissions and the payback period—were necessary to first identify the participants' real energy-efficient savings opportunities. After the researcher could clearly identify the savings potential, qualitative data was necessary to collect through semi-structured one-on-one interviews to understand and interpret why there was a lack of EE uptake. This is shown below in Figure 10.

Figure 10: Explanatory mixed-methods design for Group X



Source: Adapted from De Vos et al. (2011:441) and Creswell and Plano Clark (2007: 73)

3.2 Permission to gain entry

Group X

The researcher was given access to participants' details and PSEE reports through the sponsoring company, ESCO E. Each potential participant was invited to a voluntary study via email and/or telephonic call. Once the participant had accepted the invitation, the participant signed a formal information sheet and consent form.

Group Y

The same method applied for focus Group Y. A copy of the relevant consent forms can be found in Appendix 1.

3.3 Sampling procedure

Group X

This sample included seven selected participants from a specific population. All participants were past clients of ESCO E to whom ESCO E had delivered a

PSEE report within the last twelve months. The PSEE has delivered more than 300 reports (1 report per company) to medium-size companies (with an energy spending of R 750,000-R45 million per annum), of which during this research, ESCO E has delivered 32 reports. Of those 32, 11 companies did not implement any recommended energy-efficiency measures; while 21 companies did implement EE measures, this research solely considered companies that did *not* apply any changes (this decision is discussed in 3.7 Limitations). Each of the 11 companies was individually contacted for the purposes of this research. Of the 11 companies, only 7 responded and agreed to do the research and together they formed the sample group. To allow a fair and adequate comparison and results, these participants all met the following criteria:

- Participant was the managing director or decision maker responsible for receiving the PSEE report
- A registered medium-sized South African business
- An annual energy spending (electricity, diesel, fuel) of at least R750, 000-R45 million
- Had received a PSEE report in the last 12 months
- Did not go through with EE uptake after receiving the report
- Are energy-intensive

Table 8: Group X overview

Participant	Industry	Annual energy spend (Approximate)	tCO₂ from electricity	Date of report	Date of interview
Participant A	Food production	551 629	412.23	September 2014	April 2015
Participant B	Cold storage agri-business	754 077	957.5	February 2015	April 2015
Participant C	Shoe manufacturer	613 000	427	August 2014	April 2015
Participant D	Industrial printing company	1 947 002	2240	October 2014	April 2015
Participant E	Petrol and convenience store	1 082 933	812	November 2014	April 2015
Participant F	Wine manufacturer and restaurant	1 047 182	1111.6	October 2014	May 2015
Participant G	Wine manufacturer	3 231 878	3046.6	March 2015	April 2015

Group Y

This sample included three coordinators of the PSEE programme. These participants were contacted via telephonic call and email using the PSEE contact details web link. The participants were chosen at random, and were readily available in the office when we agreed to meet. This sample was interviewed collectively; however, each participant had the chance to respond to each particular question individually. The significance of this qualitative data collecting was to gain a broader understanding to common barriers the coordinators experienced throughout the programme. This will allow a

comparison between the participants of the programme (Group X) and the programme (Group Y) and could provide details to support collective barriers.

3.4 Data-collection instrumentation and approach

Data instruments

Quantitative: Obtaining data from participants' PSEE reports was required for this process. The critical information extracted included the following:

- Annual energy spending
- Key energy-savings opportunities:
 - Sub-organised by kWh
 - Costs
 - CO₂ emissions
- Economics:
 - Total costs of the projects
 - Payback period
- Annual savings and cumulative savings with a standard estimated 8% electricity-tariff increase

The aforementioned data was significant because it was assumed that each participant's PSEE data would show significant savings opportunities and incentives for energy-efficiency uptake for that specific participant. The relevant data will be considered and highlighted during the qualitative data collection. Table 9 is a template for the data collection and shows how the energy efficiency opportunities were presented to and extracted from the participants' reports. Each participant's data capturing can be found in Appendix 3.

Table 9: Example of key energy-efficiency opportunities

Group X Participant	Key annual savings					Economics	
	kWh	Rand	CO ₂	Annual savings (8% increase)	Cumulative savings (8% increase)	Project cost	Payback period in years
Recommendation							

Qualitative: The qualitative data required the utilisation of a survey, which was created in response to the main research objectives in the hope of understanding the perceptions of and barriers to energy-efficiency uptake. With the assistance of ESCO E, academic supervisors and colleagues, the final questions were developed. The survey was administered through semi-structured one-on-one interviews. It was necessary to create an interview schedule that provided order, structure but also leniency, allowing the participant to give his or her perceptions and thoughts on energy-efficiency uptake (De Vos et al., 2011: 347 & 353).

Interview settings

Group X: Four of the interviews took place at the participants’ offices, one at a coffee shop (for distance reasons), and three via telephonic call, with all interview settings drawing sufficient engagement from participants. The interview schedule, as shown in Appendix 4, asked strategic, open-ended questions to allow the participant to elaborate on the perceptions, incentives and barriers surrounding energy-efficiency uptake. This method was adapted using different variations of integrated analysis, as highlighted by De Vos et al. (2011).

Group Y: This focus group interview was conducted over the telephone for the sake of simplicity and travel convenience. The interview schedule also allowed for strategic, open-ended questions; it can be found in Appendix 5.

3.5 Data analysis

This research used two analysis methods, one to analyse the quantitative data and the other to analyse the qualitative data. Both are explained below.

Quantitative: The quantitative data was prepared and analysed by ESCO E through the PSEE reports. The findings of each report were based on the information provided by the participants. The data included access to the premises, monitoring of the distributions boards, and records of at least twelve months energy spending (utility bills) and fuel consumption (diesel, petrol etc.). Following careful analysis and expertise, the report includes details of the most significant and cost-effective opportunities that would have the greatest influence on reducing energy costs and consumption. Lastly, each report is carefully written with PSEE standards and was reviewed and edited before being delivered to the participant (who was a client at the time). Because of the thorough process behind the report, the researcher felt comfortable that the data and the attendant analysis were of a high and trusted quality for the purposes of research; the researcher simply extracted the information from the original PSEE report.

Qualitative: As previously explained, the explanatory interview schedule was guided by the research questions. The framework was developed using general themes and categories that corresponded with the main research. The main results are presented in table form, while more in-depth, representative and relevant quotes were selected for discussion. Having fewer participants, allowed for more in depth understanding, discussion and presentation of the results. Table 10 below demonstrates the themes and categories that emerged.

Table 10: Coding process

Main themes	Categories
Perceptions of energy-efficiency uptake	<ul style="list-style-type: none">• Importance/appetite for EE<ul style="list-style-type: none">○ Financial○ Environmental

	<ul style="list-style-type: none"> ○ Both
Current energy situation and knowledge of incentives	<ul style="list-style-type: none"> • Management plan • Metering and monitoring • Incentive schemes, incentives or tax rebates (y or n)
Understanding of PSEE report and further activity	<ul style="list-style-type: none"> • Positive • Negative • Unknown
Barriers to energy-efficiency uptake	<ul style="list-style-type: none"> • Financial • Lack of communication • Human-resource capacity • Time • Other • In-depth explanation of the above
Further comments on the PSEE report and energy efficiency	<ul style="list-style-type: none"> • In-depth perceptions and barriers

Some of the questions included in the survey are listed below. (Full questionnaires can be found in Appendices 4 and 5.)

Group X Questionnaire

1. *Is there an appetite for energy efficiency?*
2. *If not, why, considering the significant energy price increases?*
3. *Do you have an energy-management plan in place? If yes, can you elaborate?*
 - 3.1 *Do you have a metering, monitoring and targeting system in place?*

3.1.2 Do you measure energy per unit cost?

4. Was the proposal understood or are there further questions?
5. What are the incentives for and barriers to proceeding with implementation?
 - Financial restraints/benefits?
 - Energy policy guiding decisions (or lack thereof)?
 - Lack of open lines of communication?
 - Human resource capacity?
 - Time?
 - Other?
6. Is there a need for further feasibility studies, such as an M&V exercise?
7. Are you aware of 12L/12I tax rebates or government grant opportunities?
8. Further comments?

The researcher felt that a deeper analysis was possible without coding due to the fact that there was only one interview with three respondents, which allowed time for a deep content breakdown. The researcher simply highlighted and summarised the most critical and relevant information that emerged.

Group Y Questionnaire

1. Is there an appetite for energy efficiency in the participants you approach?
2. If not, why, considering the significant energy-price increases and the current energy crisis?
7. How successful do you feel the programme is?
8. Do the participants fully understand the report?
9. What do you feel the barriers are to energy-efficiency uptake in South Africa?
10. How could South African key role-players better assess the uptake and implementation of energy efficiency in South Africa?
11. Do you have any further comments about the uptake of energy efficiency in South Africa or this programme?

3.6 Participant observation

To better enhance the researcher's understanding of the PSEE incentive scheme, an eight-month internship with ESCO E was fulfilled during the course of the research. This gave the researcher direct access to participant files as well as expert advice and support and a full understanding of the processes of the incentive scheme.

Furthermore, the researcher was formally invited to attend the PSEE Seminar: Managing our energy futures on Tuesday 15 November, 2015. The information and knowledge shared at the seminar involved the PSEE's progress update, case studies from the Western Cape region, and strategic energy-efficiency issues/barriers identified at the PSEE conference. Any information extracted from this conference is fully referenced in this report.

3.7 Limitations

Having a small sample size allowed for in-depth, textual qualitative data. However, an increased sample size would have permitted a fairer comparison and would have benefitted this research greatly. Furthermore, it may be deemed more beneficial, if the researcher were to compare the results of both implemented and non-implemented groups of data. Another identified limitation involves possibly skewed results due to the business-client relationship. It is possible that there was not a strong business-client relationship (between ESCO E and the participant) or that expectations were not met, resulting in a lack of uptake. This would represent another kind of barrier. Expansion of the sample to include participants from other energy-efficiency consultancies could have alleviated this potential limitation.

3.8 Summary

This section reviewed the methodology employed for this research. Both quantitative and qualitative data were collected using a mixed-methods design. Firstly, the quantitative data was collected from PSEE reports to identify savings opportunities. Following this, face-to-face qualitative interviews were carried out

to obtain further insight into participant-specific perceptions of and barriers to energy-efficiency uptake. The results of the study will provide key role-players, such as government, policy makers, energy consultants and incentive schemes, with information about how to overcome the barriers to energy-efficiency uptake. The results will be especially insightful for energy consultants trying to achieve a more successful uptake rate from their EE recommendations. There were no relevant ethical or safety issues surrounding the methodology of this research. Participants' details were kept confidential and all participants signed a consent form.

4 Discussion and results

4.1 Quantitative results: Group X

Group X were Participant A-G who undergone a recent PSEE report housed by ESCO E. These participants were chosen because they had not implemented any of the EE Recommendations. The following table represents the total potential annual savings results for each participant.

Table 11: Total Potential annual savings

Group X Participant	Annual savings				Economics	
	kWh	KVA	Rand	tCO ₂	Cost	Payback period
A	69,001	-	106,290	172	206,050	1.94
B	390,439	-	576,714	174	180,661	3.45
C	442,136	120	665,337	447	2,045,502	3.07
D	666,815	-	692,821	674	592,121	0.85
E	96,140	-	67,827	97	64,723	0.95
F	42,811	-	359,257	427	570,900	1.59
G	1,061,194	-	891,107	1073	1,246,884	1.40

These results show significant possible savings. Two out of the seven participants had a payback period of less than one year; five out of the seven participants had a payback period of less than two years; two out of the seven participants had a payback period of less than four years.

As suggested by the IEA & the World Bank's, Progress Toward Sustainable Energy (2015: 119), claim that projections with payback periods under two years have shown to have higher success rates for uptake, thus motivating participants to follow through with implementation; again, as results show above, five participants had a payback period of less than two years, if this is compared to the literature, it would imply that these five participants had *other* barriers for

implementation. The qualitative research hoped to identify and understand what those barriers are.

Table 12: Total potential annual savings of seven participants

kWh	Rand	tCO ₂
2,768,536	3,359, 353	3,064

4.2 Qualitative results: Group X

This section provides the results and analysis of the qualitative research findings, highlighting the themes and categories presented in Table 10. This section hopes to answer and fulfil the main research questions and objectives. The findings will be supported by quotes from the transcripts, and will be compared to the sources in the literature review, as well as to additional literature when deemed necessary. When relevant, participants' quantitative data will be mentioned to support their response.

4.2.1 Perceptions of energy-efficiency uptake

When asked if there was an appetite for energy efficiency within the company, all seven of the participants answered yes. When the participants were asked why, or to please elaborate, and were prompted to think about multiple reasons including financial, environmental, social responsibility, customer relationships etc, four of the seven participants (Participants A, B, E and G) put forth the following main motivations: financial benefit and environmental sustainability. Participants C, D and F are interested in energy efficiency uptake purely from financial benefit standpoint.

Participant E: "Yes there is, because that is the right appetite to have. You need to link energy, electricity, water, maintenance or whatever uses energy and this boils down to a massive amount of rand every day...We would like to cut down on energy use; it is better for the country...There is no way that load-shedding

can come to an end by the end of the year, so it is the right thing to do, to cut down on energy usage. But at the end of the day we also want to make money.”

Participant A: “Always, ultimately, as a business, as a commercial concern, it is about saving money; it is good to do the right thing.”

These outgoing responses affirm that there is an appetite for energy-efficiency uptake, because of concerns related to profitable responses or financial benefits from uptake, and because of concerns surrounding environmental impacts. However, no participant linked EE appetite directly to “reduction of CO₂ emissions”. This suggests that there is a lack of formal monitored policy that caps or taxes CO₂ emissions. This critical theme highlights the lack of urgency surrounding CO₂ emissions and the negative environmental impacts created by their production or the participant in this interview mentioned manufacturing activity and services as nothing else about the environment.

4.2.2 Current energy situation and knowledge of incentives

When the participants were questioned about their current energy situation and their knowledge of EE incentives, the results were mostly negative; the majority of the participants had experienced negative company/production growth and high monthly energy overheads.

When asked whether they have a current energy-management plan in place, only three of the seven participants answered yes. When asked to elaborate, the researcher was given these responses:

Participant A: “We made efforts towards monitoring, in a rudimentary form, we read electricity rates but we don’t break it down into categories. We don’t have the ability to break it down (refrigerator uses X amount, etc.). We look at the month and the usage (same with water/chemicals utilisation); we look if the consumption is in the norm and make sure we are not outside of the norm.” This response highlights an interesting perspective in which the participant is

referring to the norm from within the company and not necessarily the normal industry standard.

Participant F: “We have a powertell system on that monitors and we check it once a week.” The researcher then asked the participant what is checked by the powertell system, and the participant simply responded that if anything looks “unnormal” then it is investigated. There seemed to be little interest in the current energy-management system that is in place. Very similar to Participant A, this response demonstrates lack of understanding/acknowledging industrial standards or “norms” as they are only comparing their data to their previous data. Furthermore, by only checking the data once a week and only comparing it to previous weeks results in poor energy management practises.

Participant E: “Yes, we started thinking what to do...Simple things that we have started [are] switching off the lights where it is needed...We put curtains up on the fridges to preserve the cold air.” While these responses are positive indications of awareness these incremental changes do not warrant the further possible savings opportunities. Furthermore, all of these changes are undocumented energy management practices; there are no formal processes and that track these changes such as switching lights off and putting curtains up, thus the company is not aware of the actual or tangible savings that are being achieved by implementing these minor changes.

Negative responses included the following:

Participant D: “Nothing at all. We just pay the bill at the moment.” Participant D’s quantitative data show the most significant payback period of the entire sample. It was somewhat frustrating that the participant’s appetite for EE was purely financially driven (as mentioned in 4.2.1), especially because there was not a management plan in place and because R692, 821 in annual savings could be derived from projects that have a payback period of 0.85. Section 2.2.2 of the literature suggests that projects with payback periods of less than two years are most likely to follow through with implementation; however, Participant D has not implemented any of the recommendations from the PSEE report with a payback

period of under one year. This adds further concern and confusion to the main barrier towards uptake .

Participant C: “We just look at the statement (the utility bill) and pay it.” There seems to be a correlation between C and D, insofar as both participants are driven financially to EE, and even though their quantitative data suggests significant savings, neither currently shows interest in energy management. One difference between participant D and C is the payback period of the recommended projects. The three-year payback period would not incentivise participant C to invest in EE project uptake, as suggested by 2.2.2 of the literature review.

Table 13: Participant D’s quantitative data

kWh	Rand	CO ₂	Cost of projects	Payback period
666,815	692,821	674	592,121	0.85

Table 14: Participant C’s quantitative data

kWh	KVA	Rand	CO ₂	Cost of Projects	Payback Period
442,136	120	665,337	447	2,045,502	3.07

Regarding EE incentives such as the MCEP and the 12L tax rebate, only one participant (Participant A) was currently utilising both the government incentives identified in 2.5.3 and 2.5.4. The other six participants (Participants B-G) had absolutely no knowledge of the incentives and all requested that the researcher forward the information to them. They did not even recognize the name of the incentives. This would suggest that there is a major lack of communication and knowledge about EE incentives. It is critical to note that, although Participant A was currently aware of and utilises the MCEP and the 12L, the participant asserted that it was very difficult to find the relevant information—in fact, an external employee had to suggest the programmes to Participant A: “ As a small

business your resources are limited; getting the correct information to apply for the grants was like trying to draw blood from a stone. It would be good to have a director say, 'This is where you need to go and these are the rebates you need to apply for.' Especially for small businesses this information is not readily available...There is so much out there but it is not easy to navigate it; it is very hard to get information..."

After this response the researcher and Participant A continued to discuss how this barrier could be alleviated. The participant suggested the following approach: "It would be helpful if there was a *resource centre* that government could set up and you went to the centre that was relative to your industry and all of the information that you need was retrieved quickly and easily." This comment ascertains several noteworthy points: it is favourably ostensible that the participant is concerned and dedicated to the uptake of EE and has exhausted the available opportunities for uptake but experienced extreme difficulty accessing the government offers. This would suggest that the EE uptake barriers in South Africa are similar to those found in the global context, as discussed in Chapter 2 and highlighted in Table 2. Therefore, it is necessary to consider the mechanisms for overcoming these barriers that were highlighted in Table 3 above under the "Informational" heading; the central most beneficial solution to this problem would be to create a platform where all energy information can be found, an *Energy Hub* which will later be discussed in the recommendations section of this report.

4.2.3 Understanding of PSEE report and further activity for implementation

A fully funded energy audit can seem very attractive and pleasing for most energy-intensive companies, and while the PSEE programme delivers undeniably rigorous recommendations for EE uptake, the literature suggests that a lack of knowledge or understanding of the details of the report would result in a lack of implementation, as shown in Chapter 2. When participants were asked if they understood the PSEE energy audit, many of the results were positive. Four of the participants (Participants C,D, F and G) responded with a generic

“Yes, it was understood”, while two participants (Participants B and E) suggested that the report was very helpful and would be used in the future. Participant E is using the given graphs and information from the report on a daily basis to help monitor current energy consumption. One participant (A) was an outlier for this response. Although Participant A felt that the report was very useful, and understood the majority of the context, there were still major concerns about the quality of the provided information with regard to project costs: “They don’t detail the R200,000? We would need to get quotes from contractors and they [PSEE] do not break that down into their reports; I would like to validate these estimates because they seem low.” This identified barrier is categorized under the *level of detail around opportunities*.

Participants were asked if there was a need for further feasibility studies, such as an M&V exercise or explanation. Unfortunately, six out of the seven participants said that they needed further feasibility studies before the implementation of any projects. Some responses were similar, but they’re many correlations between the six participants, all, which identify financial barriers. These are discussed in the following section.

4.2.4 Barriers to energy-efficiency uptake from a qualitative perspective

In addition to identifiable barriers found throughout the process of the survey, participants were asked to identify their biggest barrier to uptake. The following table identifies participants’ perceived barriers, followed by a discussion.

Table 15: Identified main barriers

Barriers	Participants
Financial restraints	A, B, C, E, F, G
Energy policy and incentive guidance	C
Level of detail around opportunities	A
Human resource capacity/time	B, C, D
Other	D

The results reveal “financial restraints” to be the largest identified barrier. Below are the most relevant and significant responses.

Participant E: “It’s not so bad, the R67, 827, but the money has to come from somewhere.” When further asked about the company’s investment criterion for capital projects and whether it rates energy projects on the same scale as other projects, the following response was given: “You have to make a choice. [In our company,] anything you want to do on a large scale has to be considered, from large to small investments.” Although the question was not directly answered the participant expressed high interest in making significant changes and improving energy efficiency, noting that every year the company has to make improvements and energy-efficiency uptake is an investment that would prevent them from needing to make other investments on appliances or technology that have a direct impact on profits (i.e., a refrigerator that keeps the cold drinks cold for clients). While the company expresses interests in energy efficiency uptake, the key points are that projects and given saving opportunities are not being implemented.

Participant F: “The cost involved to spend that over a few years is too much at the moment. We understand the report enough; it is just that money is not there at the moment. It is difficult to afford that especially during harvest time; there are no excess funds for other investments because our electricity bill is so high.” The participant was consistent in letting me know that sustainability is “very important but for the moment we cannot go forward.” This unfortunate catch 22 situation would simply need to be addressed with a financial solution.

Participant C: Participant C had a payback period of 3.07 years, as shown in Table 14. “Finance is our biggest barrier; we have asked for a consultant to help access funding and grants. The grant application is quite extensive, so people who do applications could help us.” A more stable government platform such as the IAC’s website would allow for easier implementation. Not only has Participant C identified the barrier; the participant has suggested a way to help

overcome that barrier. The solution highlights an additional barrier: namely that there is a lack of human capacity and time to sort through the difficult application forms. This barrier highlights the need to factor time and human capacity into the payback calculation of the opportunity, as thus there is no such thing as a zero-cost opportunity because someone in the company will need to implement the opportunity and monitor and manage the change. It is critical to emphasise and define the hidden cost of displacing an employee from his or her job duties or hiring an additional employee to overlook the EE practises.

Participant A: This participant called attention to multiple financial barriers that directly link to knowledge and understanding of the provided PSEE report: “My finance board said no way [to the potential savings]. We don’t have enough supporting data to clarify the numbers provided in the report. Logically of the four [recommendations] the last two seem to be most critical to have an end result...We question whether it would be as good as the number says in the report.” The participant continued to suggest ways to overcome this barrier, pointing to a need for an explanation or breakdown of how the figures were calculating: “I would be a lot more impressed with the number and would want to pursue it [EE uptake] because you [could] actually do the math yourself and come up with the same numbers...Especially the first two projects, they [the numbers] just seem mad...It would cost more money to put in the monitoring system.” Overall the participant felt that the PSEE report was “incredibly valuable” but that the numbers needed to be clarified.

Participant G: “We presented the report to the board. Now we know how much money we will save and how much it will cost...We know we must do something and we are going to put it (the projects) in the budget for the following 4-5 years.” This approach shows good management practice and suggests that the initial cost is too high, but the quantitative results in fact show an extremely low payback period. This indicates that, for this specific participant, the low payback period did not enable or financially allow the uptake of these projects.

Table 16: Participant G's quantitative data

kWh	Rand	CO ₂	Cost of the project	Payback period
1,061,194	891,107	1,073	1,246,884	1.40

The lack of open lines of communication, limited human resource capacity and limited time were among the other key barriers for EE uptake identified.

Participant B: “The energy audit didn’t include irrigation, pumping of water... It may be that the energy audits are more industry focused, not agriculture.” This barrier would present a misalignment between the client’s needs and what the PSEE programme offers. Without catered energy-efficiency programmes, the participant will receive generic feedback that is not applicable to his or her company. Participant B did, however, also highlight that the report was very helpful, since the company does not currently have managers to organise its energy-use.

Participant E: This participant highlighted the need for further knowledge in understanding the technology: “We need to have a simple understanding of an energy-monitoring system that tells me that I have use X amount of energy, not difficult electrical engineering.” The researcher further engaged with the participant to understand this response and gathered that the participant needed access to a simple technological solution that is easily understood at very basic levels (meaning with little to no education or skills set around energy-monitoring systems).

Participant C: Once the company is handed the PSEE report, if it does not have an allocated human-resources department that deals with energy, uptake will not be implemented. As Participant C explained: “We do not have anyone that focuses specifically on energy management.” This comment reveals that energy has not been made a priority in the company, resulting in a lack of knowledge about the importance of energy efficiency.

Participant D: This participant identified a barrier that none of the other participants identified. “We agreed to do the audit, then once the audit was done we were very impressed with the presentation with the energy savings report...We took it to the board but there is a dispute on the property because we do not own the property. Until it is resolved we can’t go forward.” This barrier would highlight the need to improve or adapt the participant criteria for the audit.

4.3 Qualitative results: Group Y

4.3.1 Perceptions of energy-efficiency uptake

When asked whether there was an appetite for energy efficiency, Group Y responded with the following remarks:

“Many clients will ask, ‘Free? What’s the catch?’ Only once they realise that there is no catch [do] they seem to be interested.” This comment suggests a lack of knowledge and trust around the programme and energy efficiency in general, as highlighted by the identified barriers in Table 2. It also would suggest that participants, or clients feel that if something is “free” than it is of little or no value. This would suggest that the PSEE opportunity is not attractive to clients.

“There is more uptake for EE when there isn’t a struggle for EE. Energy always loses, followed by maintenance, when it comes to budget. There is an appetite and its gone hand in hand with the current situation with Eskom.” This response would suggest that there is a lack of knowledge surrounding the long-term benefits of energy-efficiency uptake.

“Large companies are doing things in EE, it’s not a new thing for them, but what the programme has found is that only 37 large companies have signed up in the last two years, but there are still a lot of companies that aren’t interested in the programme. Why? This is what we do not know.” The perception gathered by the researcher is that the large companies feel that they “know what to do” and that they are not interested in more or additional information of help, when in reality, and in the definition of energy efficiency, there is always room for

improvement, thus highlighting a behavioural barrier within the uptake of energy efficiency.

These answers suggest that there is an appetite for EE but only as a response to the current energy crisis in South Africa. However, it is also important to note that, even with the current energy crisis, EE is not a high or “priority” concern and that the appetite for energy efficiency is less than optimal. There seems to be a lack of interest, although that is slowly changing as companies face greater energy challenges.

4.3.2 Current EE and programme situation

Group Y participants were asked, in a series of questions, to assess the current energy and programme situation. The most significant responses are detailed below.

When asked how successful the programme is, one participant responded, “It depends on how you want to quantify success in South Africa; we have only scraped the surface of EE in SA. [It has been] very successful given the short time that we have had; the companies have benefitted a lot.” However, Group Y felt that success has only been delivered at the introductory level, not the implementation level: “We have been successful at opening eyes to EE in South Africa. [The programme has been] hugely successful at auditing but not with implementation! We cannot oblige people to go through with implementation—so on purely a numerical basis there are only some achievements. [There is] 10-15% implementations, which with international experience that’s in the normal ranges—but some countries can, hit 30-45% implementation with EE programmes. We would like to see these numbers.” Group Y also discussed the failure in CO₂ reduction: “The programme was paid for by the UK government; from this they want to buy carbon abatement and contribute to energy savings...[But] we haven’t been able to prove the abatement of carbon emissions that we are meant to hit.” According the Table 5, PSEE have a Target of 2.0 MtCO_{2e} but only achieved an implemented 424,748 MtCO_{2e}.

Group Y felt strongly that current electricity prices are dissuading companies from EE uptake. They also felt that the PSEE programme is a forced, unnecessary measure, since EE uptake should be a “no brainer”: “EE is very strange; it should happen by itself. It shouldn’t require market interventions; it makes financial sense; it can be easy to implement and to understand. Arguably it’s not happening because energy is too cheap. So price energy properly. But in the context of SA, this could be very destructive. Catch 22: how do you drive EE uptake without putting stress on wealth distribution and economic development? The next few years will be very interesting.” Although this was an important response it is critical to understand that EE implementation would not put stress on economic development, EE uptake simply reduces the amount of energy being used with the same rate of production, it is increasing the price of electricity without EE implementation that could put stress on economic development.

4.3.3 Barriers to energy-efficiency uptake

Besides the already-mentioned barriers, Group Y was asked to identify the main barriers to successful EE implementation from a programmatic perspective. The following barriers were identified and discussed:

- Lack of knowledge;
- Access to reliable technology.

As one participant explained:

“Actually, making that decision to optimise what they have instead of growing more is not difficult. Ultimately finance is overrated and it’s an excuse to not go through with implementation. Why? 1) Knowledge: he’s spent 30 years in the baking business; he doesn’t understand next generation motors. He’s going to favour what he knows. It’s about knowing the kit, supplier and the CapEx. Knowledge does not exist in-house. Lack of knowledge is a major concern; most of the clients, as soon as they become exposed to what it is, they try to go for it—take that information and go for it. We don’t have the same access to technology

options; ESCOs have created problems in the market. The companies don't want to take another risk because of trust issues.”

What the Group Y member is trying to express here is that financial barriers do not cause clients' lack of uptake. This is a very interesting contrast to the responses in Group X. According to Group X, *six of the seven* participants identified financial restraints as a main barrier to energy efficiency uptake. This clearly epitomises disconnect between energy efficiency programmes or hosts and the participants or clients. This specific contrast embodies the very reason for this research and why it is critical to understand the barriers at client or participant-specific level. At the end of the day, it is the client/participant that is responsible for making the decision for the uptake of energy efficiency and if their barriers are not addressed than uptake will continue to come to a standstill. Group Y felt that a lack of knowledge surrounding energy efficiency and technology prevents successful implementation. This response also highlights a behavioural barrier, to the extent that company owners are not willing to gain new information. Furthermore, Group Y has highlighted that there is a need for a standardised quality of technology because some dishonest ESCOs have flooded the market with unreliable technologies, giving “energy efficiency technology” a bad name.

4.3.4 Participant-driven recommendations

Group Y was asked to identify opportunities to improve or alleviate the existing barriers:

- “Tax breaks like 12L need to be more accessible.”
- “MCEP [is] discontinued now and this incentive needs to be supported by government.”
- “Carbon tax policy paper for discussion: that's going to start driving EE, but it needs to fit with the minister's budget.”
- “EE potential data is so old; we don't have a helicopter view of EE opportunities in SA. This needs to be updated.”

5 Summarised discussion and recommendation

The following discussion and recommendations are taken from this research and combined with global findings such as Table 3, and adapted for the South African Context.

Financial restraints

From this research, it can be inferred that key role-players to EE, such as government and financial institutions, need to address and manage the financial barriers that exist for companies, by introducing the following measures:

- Lower payback periods through further incentives (12L is not adequate enough, and there is a need for more financial incentives)
- Provide easily *accessible* funding and subsidies
- Ensure the continuation and *longevity* of successful programmes
- Consider cost alternatives for specific SMEs who are season-dependent (i.e., wine farms)

While the payback periods found in this research are acceptably low, these SME's do not have the capital to fund the recommended projects up front. Incentives such as tax rebates are an "after the fact" enticement, which does not allow or ensure the participant a stable platform from the beginning to go through with implementation. Further up front incentives such as the MCEP the capital and comfort with EE uptake. Funding and subsidies must be simple, to the point, accessible and readily available to companies. Given that none of the participants have a dedicated or allocated employee who addresses energy management, it is essential that financial processes are efficient and accessible.

Level of detail around opportunities

With regard to this specific barrier, identified mainly by Participant A, it would appear that there is a level of miscommunication between the participant and ESCO E and the level of detail given for the opportunities presented in the report. The participant was adamant that the numbers and data be more visible.

To ensure this visibility, the researcher suggests that the report include hard or final cost estimates from multiple contractors to ensure cost stability and ease participants' worries that the stated costs cannot actually be derived. Being transparent with the energy savings opportunities (ESO) calculations is a critical point for all further energy audits, if a trust-worthy relationship between client and consultant or client and programme is to be maintained.

Human resource capacity/time

The researcher found that, in addition to finance, the main existing barrier was *limited human resource capacity and time*. To address this barrier, the researcher suggests that any further incentive scheme ensures that there is at least one management-level, fully trained staff member who understands the importance of energy efficiency, to ensure follow through of the recommended projects (similar to that in the IEE). The researcher gathered that often the energy reports were sitting at the admin level, either ignored or forgotten. The "free audit" opportunity should include a policy or an agreement in place specifying that there is one specific person dedicated to the project for its entirety. While the PSEE, or any incentive scheme, cannot force uptake of recommended measures, it should be the case that, if there is no uptake, a formal follow-up meeting will take place, and further that the participant should have to provide formal reasoning about why the company has decided not to follow through with implementation. Furthermore, it is highly critical to include the cost of this measure in the payback period, as this work is time consuming and intensive in order to derive successful implementation and monitoring of EE uptake.

Knowledge

For the sake of efficiency, no incentive programme should be carried out without a full and detailed educational seminar. The researcher suggests that a seminar take place with all employees of the company, explaining the basic levels and concepts of energy efficiency. Further knowledge and skills-set-development should be provided at the management level. These suggestions should

organically become part of the programme. Fully engaging with programme participants, and the entire staff of the company, would hopefully address the *behavioural* barriers currently in place. Furthermore, change will not happen unless the opportunities are fully understood.

Furthermore, to address the lack of EE potential in South Africa highlighted by Group Y, the researcher suggests that government, support local academic research to further explore the extent and potential opportunities and barriers across *all* sectors. Without actually having a relevant baseline, programmes do not know what goals or targets to make. Energy-efficiency technology is constantly improving, hence the constant increase in potential.

Lack of government support and resources

Energy efficiency should be a bigger elephant in the room when the minister's budget is debated. Government and the South African economy will see major negative consequences if load-shedding and tariff increases continue. As previously mentioned, tax breaks like 12L need to be made more accessible and furthermore, attractive and reliable. Programmes such as the MCEP create havoc when they are suddenly dismantled; the "threat" of carbon tax alone is not going to drive uptake in regards to this research. This is validated throughout the responses, or there lack of, surrounding CO₂; Group X did not acknowledge CO₂ as an incentive for uptake and Group Y stated that CO₂ target reductions had not been found throughout the entirety of the PSEE programme.

As mentioned, the researcher strongly recommends the development of a physical and virtual *Energy Hub* where all energy efficiency information can be easily accessed by the commercial and industrial sectors in South Africa. Ideally this hub would include members from public and private sectors, academics and energy experts, accredited ESCO's, reliable contractors and technology suppliers. The hub would provide assistance and access to auditing organisations such as PSEE and the NBI IEE, assistance and access to government incentives and subsidies such as the 12L and MCEP, and direct

contact with financial institutions for both small, medium and large businesses that are eager to implement energy efficiency uptake.

The energy hub would be of utmost importance to meet both government and private sector goals, and would create a space that hopes to achieve sustainable energy development from the point of awareness and energy audits to monitoring and accessing the savings achieved.

Report misalignment

More consideration and rigorous alignment should be implemented from the beginning stages of any incentive scheme. Without this crucial step, the programmes are wasting time and resources for both parties. Implying false opportunities or un-catered recommendations will further discourage the potential of energy efficiency uptake and encourage the scepticism that exist in South Africa. Reports cannot be a carbon copy, they must be reliable and the participating company must feel that the opportunities and savings are trusted and genuine in order to proceed with implementation.

5.1 Summary of opportunities and barriers

The quantitative results show low CO_2 savings, as verified by Group Y in section 4.3.2 of the qualitative interview, despite significant energy-efficiency opportunities and significant kWh and Rand savings. Table 17 again highlights the total significant savings of all seven participants.

Table 17: Significant savings opportunities

<i>kWh</i>	<i>Rand</i>	<i>tCO₂</i>
2,768,536	3,359, 353	3064

Qualitative results show a high interest in EE uptake, all seven of the participants expressed an appetite for energy efficiency within the company thus demonstrating strong opportunity for energy efficiency uptake within the given specific data set. The identified barriers hindering the appetite for uptake, which

emerged through the semi-structured, one-on-one interviews, are presented in Table 18 below.

Table 18: Identified barriers

Identified barriers
Financial restraints
Level of detail around opportunities
Limited human-resource capacity/time
Other/ property management
Knowledge
Behaviour
Lack of understanding of the PSEE report
Lack of government support and resources
Report misalignment
Limited programme resources
Reliable technology

Each barrier identified from this research was also identified as a global barrier as outlined in Table 2: Global Barriers. While the context may be slightly different, the same problems regarding implementation exist. Since identified both globally and at participant level, these barriers are perhaps the most notable problems to uptake of energy efficiency measures. The researcher discussed and strongly encourages the following recommendations:

- Lower payback periods through further incentives;
- Accessible funding and subsidies;

- Ensured continuation and longevity of successful incentive programmes;
- Client-specific cost alternatives;
- Extensive and supported detail around each identified energy savings; opportunity to ensure positive outcomes;
- Human resource and energy management support;
- Knowledge and skills training;
- Stable energy platforms with standardised, efficiency, readily available information for anything energy related;
- More stringent technological standards.

Addressing perceptions and barriers to energy-efficiency uptake should be noted as highly critical in order to alleviate the energy challenges faced today in South Africa.

5.2 Summary

The above-noted discussion and recommendations have been suggested from (but are not limited to) a participant point of view, via those who were involved in the PSEE programme. The research from this thesis helped identify barriers and potential opportunities to energy-efficiency uptake through participation in incentive schemes. This data can play an important role for continuing and new incentive schemes, government, and energy-efficiency consultancies. If the appropriate measures are implemented to address the identified barriers and provide better support for the existing incentive schemes, significant improvements in uptake might materialise, which would in return alleviate the energy crisis in South Africa. The barriers identified in this research could also be useful in the global context, where little research at the participant level has been conducted. Future and more extensive research is highly suggested in order to properly overcome the barriers.

6 Conclusion

From the onset, the primary objective of this research was to identify company and participant-level perceptions of and barriers to energy-efficiency uptake through current incentive schemes in South Africa. There is strong theoretical and empirical evidence, which suggest that energy efficiency is widely acknowledged to alleviate numerous energy-derived challenges such as mitigate climate change, improve energy insecurities and increase energy savings. Historically low priced electricity, as a result of the abundant amount of easily accessible coal, coupled with other abundant resources, a monopoly coal-fired dependent utility provider and the politically and socially intense history of South Africa, all contribute to the current energy crisis and thus the importance to identify the perceptions and barriers of energy efficient uptake in South Africa to allow energy efficiency technologies and behaviours to better alleviate the current energy crisis.

To do this, the researcher hoped to identify holistic, participant-specific barriers for seven companies who had recently partaken in a local energy-efficiency incentive scheme: the Private Sector Energy Efficiency Programme. As shown in the quantitative data, all the participants were delivered substantial opportunities to reduce their energy consumption. The overall impact of implementing the recommended measures would have been a significant reduction in direct annual energy costs. However, there was no forward motion in the implementation. The researcher extracted the quantitative data from the PSEE reports, analysed it, and then conducted qualitative interviews to further understand the lack of implementation. *These savings vindicated the importance of understanding the barriers at participant-specific levels, furthermore the utmost brutality of addressing these barriers so that energy efficiency can meet its full potential thus addressing many challenges, which contribute to the current energy crisis.* This research has only scratched the surface of each barrier and has an enormous amount of potential to further explore the barriers and how to overcome them. The researcher strongly feels that if the participant size was increased, that similar opportunities and barriers would be identified. It

is critical to highlight that research regarding behavioural aspects should be explored to then explain the qualitative data and perceptions of the participants lack of implementation. In essence, if South Africa is committed to relieving the current energy crisis and all that it entails, more commitment, strengthening, and expansion of energy efficiency initiatives is required.

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Appendices

Appendix 1

Group X: Consent form



INFORMATION SHEET & CONSENT FORM

Incentives and barriers to energy-efficiency implementation: A study of the uptake of energy-efficiency initiatives offered through incentive schemes in South Africa

Hello, my name is Victoria Daniela Parker and I am conducting research towards a Master's degree at the University of Cape Town's Energy Research Centre. I am researching energy-efficiency uptake in South African industries and would like to invite you to participate in this research project, which is in partnership with ESCO E.

Despite a growing awareness of climate change, the need for carbon reduction, the increase in electricity tariffs and the current shortages of state-utility power in South Africa, the energy-intensive economy/industries that exist in SA are still thought to encounter many barriers to the uptake of more energy-efficient measures. The implementation of energy-efficiency measures in this historically, energy-intensive economy would help resolve the above-mentioned issues—mainly energy savings and consumption for growing companies.

The central research problem is to *identify and understand what the energy-efficiency implementation barriers are* in South Africa and how role-players in the energy-efficient field can become more effective and beneficial in implementing the changes that are needed.

I am interested in finding out [Company Name's] thoughts on energy-efficiency initiatives and I want to understand how energy-efficiency companies (such as

ESCO E) can upsurge energy-efficiency implementation in South Africa. I would like to interview companies that have been given energy audits through incentive schemes like the Private Sector Energy Efficiency Programme (PSEE), such as the report that [Company Name] was given by ESCO E. With your permission, ESCO E will provide this researcher with [Company Name's] energy audit, as the information will be a useful quantifiable tool.

Please understand that you do not have to participate. [Company Name's] participation is voluntary. The choice to participate is [Company Name's] alone. If you choose not to participate, there will be no negative consequences. If you choose to participate, but wish to withdraw at any time, you will be free to do so without any negative consequences. However, I would be grateful if you would assist me by allowing me to interview [Company Name]. [Company Name's] information will be kept private, and the name of the company will not be released, nor will the energy-audit information be linked to [Company Name] whatsoever.

There is no direct benefit or risk or harm whatsoever for the company, but you will have access to the full, published report. Again, anonymity will be preserved. Neither the company name nor a specific description of the company will be referred to at any time and the anonymity of [Company Name] will be protected and maintained by using an alias.

Name of Company:

Signature of Interview:

Name of Interviewer:

Signature of respondent:

Date:

Appendix 2

Group Y: Consent form



Energy-efficiency uptake incentive scheme survey

Name of interviewer: Victoria Daniela Parker

Name of programme: Private Sector Energy Efficiency Programme (PSEE)

Incentives and barriers to energy-efficiency implementation: A study of the uptake of energy-efficiency initiatives offered through incentive schemes in South Africa

Hello, my name is Victoria Daniela Parker and I am conducting research towards a Master's degree at the University of Cape Town's Energy Research Centre. I am researching energy-efficiency uptake in South African industries and would like to invite you to participate in this research project, which is in partnership with ESCO E.

Despite a growing awareness of climate change, the need for carbon reduction, the increase in electricity tariffs and the current shortages of state-utility power in South Africa, the energy-intensive economy/industries that exist in SA are still thought to encounter many barriers to the uptake of more energy-efficient measures. The implementation of energy-efficiency measures in this historically, energy-intensive economy would help resolve the above-mentioned issues—mainly energy savings and consumption for growing companies.

The central research problem is to *identify and understand what the energy-efficiency implementation barriers are* in South Africa and how role-players in the energy-efficient field can become more effective and beneficial in implementing the changes that are needed.

I am interested in knowing and understanding your perceptions about this programme, as I feel it is currently plays a big role in the uptake of energy efficiency in South Africa.

Please understand that you do not have to participate. PSEE's participation is voluntary. The choice to participate is yours alone. If you choose not to participate, there will be no negative consequences. If you choose to participate, but wish to withdraw at any time, you will be free to do so without any negative consequences. However, I would be grateful if you would assist me by allowing me to interview you.

The anonymity of those who participate in the interview will be preserved.

Signature of respondent:

Date:

Appendix 3

Group X: Quantitative data results

Participant A Recommendations	Annual savings			Economics	
	kWh	Rand	tCO ₂	Cost	Payback period
Implement a comprehensive energy-monitoring and targeting system	20307	24, 368	21	10, 000	0.41
Instigate a comprehensive staff awareness and motivation resource-efficiency campaign	20307	24, 368	21	15, 000	0.62
Replace inefficient luminaires with next-generation efficient lighting	20444	19, 488	21	77, 000	3.95
Retrofit pots for steam cooking and implement a fuel switch from electrical energy to paraffin energy	-	29,024	102	75,000	2.60
Total	69001	106, 290	172	206, 050	1.94

Participant B Recommendations	Annual savings Electricity			Annual savings Gas			Economics	
	kWh	Rand	tCO ₂	kWh	R	tCO ₂	Cost	Payback period
Implement a comprehensive energy monitoring and targeting system	116,086	171,477	52	27,008	12,202	5	300,000	1.6
Install a site-wide energy management system (EMS) to exercise optimised time and temperature control over HVAC systems	49,760	73,504	22	225,063	101,684	41	450,000	2.6
Instigate a comprehensive staff awareness and motivation resource efficiency campaign	43,532	64,304	19	-	-	-	60,000	0.9

Replace inefficient luminaires in areas of high usage with modern alternatives and deploy lighting controls for absence detection	175,210	258,814	78	-	-	-	1,258,470	4.9
Replace aging LPHW boilers modern high efficiency boilers to provide optimised heating requirements	-	-	-	147,799	66,776	27	540,000	8.1
Implement a planned maintenance schedule for detecting and repairing compressed air leaks	5,850	8,641	3	-	-	-	7,500	0.9
Total	390,439	576,741	174	399,870	180,661	74	2,615,970	3.45

Participant C Recommendations	Annual savings				Economics	
	kWh	kVa	Rand	tCO ₂	Cost	Payback period
Implement a comprehensive energy monitoring and targeting system	21026	-	25,721	21	3,500	0.14
Instigate a comprehensive staff awareness and motivation resource efficiency campaign	21026	-	25,721	21	15,000	0.58
Replace inefficient luminaires in areas of high usage with modern alternative and deploy lighting controls for occupancy and daylight harvesting	84693	-	93,804	86	193,667	2.06
Install Power Factor Correction Equipment	0	20	41,760	0	33,335	0.80

Install 100 kWp PV plant	3153 91	100	478, 331	319	1, 800, 000	3.76
Total	4421 36	120	665, 337	447	2, 045, 502	3.07

Participant D Recommen- dations	Annual savings			Economics	
	kWh	Rand	tCO ₂	Cost	Payback period
Measurement, monitoring and targeting system	165,540	171, 996	167	15, 000	0.09
Awareness and motivation resource efficiency campaign	110,360	114,664	112	15, 000	0.13
Replace inefficient luminaires with energy efficient lighting and sensors	275,346	286, 085	279	364, 921	1.28
Install VSD of fan motor and repair	91,599	95, 171	93	177, 200	1.86
Implement a planned maintenance compressed air	23,970	24, 905	24	20, 000	0.80

leaks					
Total	666, 815	692, 821	674	592, 121	0.85

Participant E Recommendations	Annual Savings			Economics	
	kWh	Rand	tCO ₂	Cost	Payback period
Implement a comprehensive energy monitoring and targeting system	20,981	14, 802	21	10, 000	0.68
Instigate a comprehensive staff awareness and motivation resource efficiency campaign	48,957	34, 539	50	15, 000	0.43
Deploy lighting controls for occupancy and daylight harvesting & replace refrigeration display lighting with efficient	13, 572	9, 575	14	39, 723	4.15

LED alternatives					
Instigate a temperature optimisation program for display refrigeration	12, 630	8,910	13	0	0.00
Total	96, 140	67, 827	97	64, 723	0.95

Participant F Recommendations	Annual savings			Economics	
	kWh	Rand	tCO ₂	Cost	Payback period
Implement a comprehensive energy monitoring and targeting system	54, 758	46, 639	55	0	0.00
Instigate a comprehensive staff awareness and motivation resource efficiency campaign	54, 758	46, 638	55	15, 000	0.32

Replace inefficient luminaires with modern energy efficiency alternatives	33,904	28,876	34.3	54,000	1.87
Install VSD's on refrigeration pumps and fans	36,990	31,504	37	194,000	6.16
Implement a maintenance schedule for detecting and repairing compressed air leaks	11,894	10,130	12	20,000	1.97
Replace existing air compressor with more appropriately sized VSD compressor	113,400	96,583	115	180,000	1.86
Introduce water treatment regime to chilled water refrigeration system	31,968	27,227	32	55,250	2.03
Insulate chilled water pipes	84,139	71,661	85	52,650	0.73

Total	42, 811	359, 257	427	570, 900	1.59
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Participant G Recommendations	Annual savings			Economics	
	kWh	Rand	tCO ₂	Cost	Payback period
Implement a comprehensive energy monitoring and targeting system	150, 093	94, 242	152	10, 000	0.11
Instigate a comprehensive staff awareness and motivation resource efficiency campaign	150, 093	94, 242	152	30, 000	0.32
Replace inefficient luminaires in areas of high usage with modern alternative	199, 067	185, 871	201	331, 879	1.79
Install VSD's on circulation pumps	82, 820	66, 456	84	117, 125	1.76

Implement a planned maintenance schedule for detecting and repairing compressed air leaks	18,011	11,309	18	20,000	1.77
Replace existing small u/s air compressor with new vsd compressor	92,150	71,437	94	81,695	1.14
Upgrade power factor correction equipment	46,611	163,245	47	264,000	1.62
Insulate chilled water pipes	321,348	204,305	325	392,185	1.92
Total	1,061,194	891,107	1073	1,246,884	1.40

Appendix 4

Group X: Participant survey



Energy-efficiency uptake participant survey

Name of interviewer: Victoria Daniela Parker

Name of employee:

Name of company:

1. Is there an appetite for energy efficiency?
2. If not, why, considering the significant energy-price increases?
3. Do you have an energy-management plan in place? If yes, can you elaborate?
 - 3.1 Do you have a metering, monitoring and targeting system in place?
 - 3.1.2 Do you measure energy per unit cost?
4. Has company or production growth stayed in line with the tariff increases?
5. What % of monthly overheads does your energy spending represent?
6. Has your energy proposal been discussed at the management level?
7. Was the proposal understood or are there further questions?
8. Have any of the recommendations been implemented?
9. If so, how were they funded?
10. If no, what are the incentives for and barriers to proceeding with implementation?
 - Financial restraints/benefits?
 - Energy policy guiding decisions (or lack thereof)?
 - Lack of open lines of communication?
 - Human resource capacity?
 - Time?
 - Other?

11. Is there a need for further feasibility studies, such as an M&V exercise?
12. What is your investment criterion for capital projects in general? Do you rate your energy projects on the same scale, and if not, why not? What must your payback period be for projects?
13. PSEE/12L tax rebate opportunities?
14. Further comments?

Appendix 5

Group Y: Participant survey



Energy Efficiency Uptake Incentive Scheme Survey

Name of Interviewer: Victoria Daniela Parker

Name of Programme: Private Sector Energy Efficiency Programme

Name of Interviewee:

Incentives and barriers to Energy Efficiency Implementation: A Study of the Uptake of Energy Efficiency Initiatives Offered Through Incentive Schemes in South Africa

1. Is there an appetite for energy efficiency in the participants you approach?
2. How do you reach the participants?
3. Where are the consultants?
 - 3.1 And how did you get the consultants?
4. What are the criteria for the participants to take advantage of the programme?
5. Who carries out the reports for the programme?
6. How successful do you feel the programme is?
7. After the programme, do you follow up with the participants?
8. Do the participants fully understand the report?
9. What do you feel the barriers are for energy efficiency uptake in South Africa?
10. How could South African key role players better assess the uptake and implementation of energy efficiency in South Africa?
11. Do you have any further comments about the uptake of energy efficiency in South Africa or this programme?

Appendix 6

EBE Faculty: Assessment of Ethics in Research Projects

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zulpha Geyer (Zulpha.Geyer@uct.ac.za; Chem Eng Building, Ph 021 650 4791). Students must include a copy of the completed form with the thesis when it is submitted for examination.

Name of Principal Researcher/Student: Victoria Daniela PARKER Department: Energy Research Centre

If a Student: Degree: MPhil Energy Development Studies Supervisor: Andrew Hlabard

If a Research Contract indicate source of funding/sponsorship:

Research Project Title: "Incentives and Barriers to Energy Efficiency Implementation: A Study of the uptake of EE initiatives offered through incentive schemes"

Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	YES	<input type="radio"/> NO
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	<input checked="" type="radio"/> YES	<input type="radio"/> NO
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	YES	<input type="radio"/> NO
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	YES	<input type="radio"/> NO

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate.

I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student: <u>Victoria Daniela Parker</u>	Signed	<u>Feb 16, 2015</u>
This application is approved by: Supervisor (if applicable):		<u>16/2/2015</u>
HOD (or delegated nominee): Final authority for all assessments with NO to all questions and for all undergraduate research.		<u>23/02/15</u>
Chair: Faculty EIR Committee: For applicants other than undergraduate students who have answered YES to any of the above questions.		

ADDENDUM 1:

Please append a copy of the research proposal here, as well as any interview schedules or questionnaires.

ADDENDUM 2: To be completed if you answered YES to Question 2:

It is assumed that you have read the UCT Code for Research Involving Human Subjects (available at <http://web.uct.ac.za/depts/educate/download/uctcodeforresearchinvolvinghumansubjects.pdf>) in order to be able to answer the questions in this addendum.

2.1 Does the research discriminate against participation by individuals, or differentiate between participants, on the grounds of gender, race or ethnic group, age range, religion, income, handicap, illness or any similar classification?	YES	<input checked="" type="radio"/> NO
2.2 Does the research require the participation of socially or physically vulnerable people (children, aged, disabled, etc) or legally restricted groups?	YES	<input checked="" type="radio"/> NO
2.3 Will you not be able to secure the informed consent of all participants in the research? (In the case of children, will you not be able to obtain the consent of their guardians or parents?)	YES	<input checked="" type="radio"/> NO
2.4 Will any confidential data be collected or will identifiable records of individuals be kept?	YES	<input checked="" type="radio"/> NO
2.5 In reporting on this research is there any possibility that you will not be able to keep the identities of the individuals involved anonymous?	YES	<input checked="" type="radio"/> NO
2.6 Are there any foreseeable risks of physical, psychological or social harm to participants that might occur in the course of the research?	YES	<input checked="" type="radio"/> NO
2.7 Does the research include making payments or giving gifts to any participants?	YES	<input checked="" type="radio"/> NO

If you have answered YES to any of these questions, please describe how you plan to address these issues (append to form)

ADDENDUM 3: To be completed if you answered YES to Question 3:

3.1 Is the community expected to make decisions for, during or based on the research?	YES	<input checked="" type="radio"/> NO
3.2 At the end of the research will any economic or social process be terminated or left unsupported, or equipment or facilities used in the research be recovered from the participants or community?	YES	<input checked="" type="radio"/> NO
3.3 Will any service be provided at a level below the generally accepted standards?	YES	<input checked="" type="radio"/> NO

If you have answered YES to any of these questions, please describe how you plan to address these issues (append to form)

ADDENDUM 4: To be completed if you answered YES to Question 4

4.1 Is there any existing or potential conflict of interest between a research sponsor, academic supervisor, other researchers or participants?	YES	<input checked="" type="radio"/> NO
4.2 Will information that reveals the identity of participants be supplied to a research sponsor, other than with the permission of the individuals?	YES	<input checked="" type="radio"/> NO
4.3 Does the proposed research potentially conflict with the research of any other individual or group within the University?	YES	<input checked="" type="radio"/> NO

If you have answered YES to any of these questions, please describe how you plan to address these issues (append to form)