Evaluating
By
ANDILE MAHLATI

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Promoter: Prof W. Fox
DECLARATION

DEPARTMENT OF ACADEMIC ADMINISTRATION
EXAMINATION SECTION
SUMMERSTRAND NORTH CAMPUS
PO Box 77000
Nelson Mandela Metropolitan University
Port Elizabeth
6013
Enquiries: Postgraduate Examination Officer

DECLARATION BY CANDIDATE

NAME: Andile Mahlati
STUDENT NUMBER: 9929373
QUALIFICATION: Master in Business Administration
TITLE OF PROJECT: Evaluate current Energy management strategy: Case Study of an automotive manufacture in Eastern Cape

DECLARATION:

In accordance with Rule G4.6.3, I hereby declare that the above-mentioned treatise is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

SIGNATURE: ________________________________________________________

DATE: _____________________________________________________________
ACKNOWLEDGEMENTS

Thanks to God for blessing and giving me strength and courage throughout my studies.

- I dedicate this treatise to my parents for their love, support and courage,
- A special thanks to Miss Nombulelo Mbanzi and Sazi Mahlati for their emotional support throughout this project,
- Big thanks to Prof. William Fox (promoter) for his guidance and support with respect to this dissertation,
- Big thanks Dr M. L. Crowley (editor) for her professional editing skills
- I would also like to take this opportunity to thank my organisation for its financial support,
- And last but not least, special thanks to my respondents for their time.
EXECUTIVE SUMMARY

Historically, the most frequently used energy sources have been those nearest and easiest to consume. Unfortunately, society’s reliance on fossil fuel for power generation has occurred at the expense of the environment, coal being a major contribution to carbon dioxide (CO\textsubscript{2}) emission. Carbon dioxide is classified as a greenhouse gas (GHG); it contributes to the phenomenon of climate change (Haw & Hughes, 2007, p.1).

According to Worrell (2011), industry uses nearly 40 percent of worldwide energy on economic activities. Value chain activities alone contribute almost 37 percent to global GHG. Organisations are socially and ethically required to minimise the carbon footprint of their operations. Reducing energy use makes perfect business sense; it saves money, enhances corporate reputations and helps everyone participate the fight against climate change (Carbon Trust, 2011). Gielen, Newman, and Patel (2008) strongly believe the overall energy and emissions trends can be mitigated through additional energy efficiency measures. However, implementing EnMS will enable organisations to establish systematic approaches and the processes necessary to improve energy performance, including energy efficiency, use and consumption (SANS 50001, 2011).

The objective of this paper was to evaluate the current energy management strategy adopted by selected automotive manufacture in Eastern Cape. The research was motivated by the fact that previous researchers have focused more on technological aspects and less of management functions. The research paradigm followed in this paper was qualitative because a case study is used to gain an insight and understanding about more and less successful energy management strategies.

In this report, background about the global energy outlook and its significant to economic development, factors behind energy demands, the link to climate change and providing effective energy management principles are covered. The energy management principles covered key elements for delivering successful energy management. Literature highlighted that, senior management commitment is the
foundation of good energy management, which is delivered through a formal energy policy and a supporting energy strategy with action plan. High level commitment will provide:

- Advocacy from senior managers
- Visibility of the issues across your organisation
- Impetus for the organisation to implement energy management
- Resources, both human and financial.

It will also demonstrate that good energy management is part of your organisation’s mission and as relevant as other management aspects.

The empirical study is focused on the characteristics of the current management system and organisational structure employed with its relevant functions. Based on these reference points the paper concludes with recommendations for the case study organisation.
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<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAU</td>
<td>Business as usual</td>
</tr>
<tr>
<td>BRICS</td>
<td>Brazil, Russian Federation, India, China and South Africa</td>
</tr>
<tr>
<td>Btu</td>
<td>British thermal unit</td>
</tr>
<tr>
<td>CCL</td>
<td>Climate change levy</td>
</tr>
<tr>
<td>CCS</td>
<td>Capture and storage</td>
</tr>
<tr>
<td>CCS</td>
<td>Carbon capture and storage</td>
</tr>
<tr>
<td>CH₄</td>
<td>Methane</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>DoE</td>
<td>Department of Energy</td>
</tr>
<tr>
<td>EnMS</td>
<td>Energy management system</td>
</tr>
<tr>
<td>EnPI</td>
<td>Energy performance indicator</td>
</tr>
<tr>
<td>FBU</td>
<td>Fully built up vehicles</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross domestic product</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse gases</td>
</tr>
<tr>
<td>GW</td>
<td>Giga watt</td>
</tr>
<tr>
<td>GWH</td>
<td>Giga watt hour</td>
</tr>
<tr>
<td>HFO</td>
<td>Heavy fuel oil</td>
</tr>
<tr>
<td>IEA</td>
<td>International Energy Agency</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>KPI</td>
<td>Key performance indicator</td>
</tr>
<tr>
<td>kWh</td>
<td>Kilo watt hour</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquid petroleum gas.</td>
</tr>
<tr>
<td>MWH</td>
<td>Megawatt hour</td>
</tr>
<tr>
<td>N₂O</td>
<td>Nitrous oxide</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation of Economic Cooperation and Development</td>
</tr>
<tr>
<td>OHSE</td>
<td>Occupational health, safety and Environment.</td>
</tr>
<tr>
<td>P&amp;A</td>
<td>Parts and accessories</td>
</tr>
<tr>
<td>RO</td>
<td>Research objective</td>
</tr>
<tr>
<td>RQ</td>
<td>Research question</td>
</tr>
<tr>
<td>SANS</td>
<td>South African National Standard</td>
</tr>
<tr>
<td>SHEQ</td>
<td>Safety, Health, Environmental and Quality</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>TPES</td>
<td>Total primary energy supply</td>
</tr>
<tr>
<td>TWH</td>
<td>Terawatt hour</td>
</tr>
<tr>
<td>VDA</td>
<td>Verband der Automobilindustrie</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile organic compounds</td>
</tr>
<tr>
<td>WEO</td>
<td>World Energy Outlook</td>
</tr>
</tbody>
</table>
CHAPTER 1: PROBLEM STATEMENT

1.1 BACKGROUND
Industrialisation, urbanisation and increasing free trade globally have led to production efficiency, that is, the ability to meet the demands of the modern age. Increasing production has led to major environmental challenges due to the extraction and consumption of natural resources because production requires significant energy to meet corresponding economic activities, from the burning of wood, to coal, oil, etcetera (Zailani, 2010). The South African economy, for example, relies heavily on mineral extraction and processing, which involve very high energy-intensive processes (Department of Minerals and Energy, 2009). At the same time, South Africa has the reputation for less expensive electricity, coal and liquid fuels, a factor that has been used strategically to attract foreign direct investment (FDI) with little incentive to save energy. In January 2008, the demand for electricity in South Africa outstripped the supply, and load shedding occurred. That was a reminder to consumers to use energy optimally. As a result, various organisations countrywide embarked on the process of optimisation in order to better use energy and natural resources (Zailani, 2010).

South Africa introduced a White Paper Energy Policy in 1998. This policy identified the first measures for implementing energy efficiency. Prescriptive-type measures provided the framework for an energy efficiency strategy. The strategy involved setting up a national long-term target for an energy efficiency improvement of 12 percent by 2015. This target was expressed in relation to the forecasted national energy demand at that time, and therefore allows for current expectations of economic growth (Department of Minerals and Energy, 2009).

According to National Cleaner Production Centre South Africa (2008), there are no legal instruments used to enforce the reduction wastage of electricity. However, the Constitution of the Republic of South Africa (1996) states people of South Africa have the right to an environment that is not detrimental to human health. The South African government has recently engaged in significant environmental law
formulations to set a tone for an environmental legal framework. These developments of legislation and regulations are there to restrict and control polluting activities in order to slow and decrease environmental influence both locally and globally. Carbon tax has been under discussion, and it is expected to come into force during the 2013/14 budgetary year (Lewis, 2012). Lewis noted carbon tax liabilities are likely to be limited in scope to one emission: The direct release of gases into the atmosphere through burning fuel or other industrial activities. Although Scope 2 emissions, which cover indirect energy use from electricity, are exempted, the main utility provider is likely to be taxed on emissions from its power stations and the belief is the utility provider will pass these costs onto business and consumers in the form of higher prices.

In response to the above developments, the selected organisation under study has rolled out an energy management strategy. This strategy forms part of cooperative efforts to become the greenest automaker and address individual mobility and sustainable action. This organisation’s leaders believe business of today should not be directed only toward developing eco-friendly products and technologies but also have resource-efficient production methods. The ultimate, objectives of the strategy are to enable energy efficient production processes and change the mind-set of the industry beyond products and technologies. This strategy will serve as a reminder to all the organisations’ customers and employees to act in an even more environmentally compatible way.

1.2 PRIMARY OBJECTIVES
The purpose of this research is to evaluate the current energy management strategy employed by the selected automotive organisation and to make recommendations for the improvement of that strategy.

1.2.1 Secondary Objectives
The secondary objectives of the research conducted were the following:
- Highlight the significance of the energy sector in the world and in South Africa
- Define the characteristics of effective energy management
- Identify areas of success and shortfalls in current energy management strategies
• Highlight and recommend areas of improvement.

1.3 RESEARCH QUESTION
The research question motivating the research conducted was the following: How can the current energy management strategy be improved for sustainable business in the future?

1.3.1 Sub-Foci
The following are sub-foci of the research:
• What role does energy management play in sustainable development?
• What are the characteristics of effective energy management?
• Where are current energy management strategies the most effective and least effective?
• Does the organisation have a sustainable energy management strategy?

1.4 RESEARCH METHODOLOGY
1.4.1 Research Paradigm
The paradigm chosen for this study was a case study methodology. Case study was a methodology of choice because the aim of this study seeks to gain a better understanding of the current energy management strategies employed in one particular organisation, an automotive manufacturer in the Eastern Cape.

1.4.2 Research Design
According to Collis and Hussey (2003), there are various forms of sampling methods; however, for the purpose of this study, the option taken was a sample based on convenience and judgement.

Wergner (2010) defines judgement sampling occurs when personal judgement is used to select the most appropriate sampling units to include in the study. Judgemental sampling was a choice because the research is focused on relevant departments that deal with the implementation of the energy management strategy in the case study organisation.
1.4.3 Sampling

The sample was limited to those individuals who had a direct influence on the implementation of the energy management process in the case study organisation. A sample of five relevant business units where evaluated as a sample group for this study.

The sampling was conducted as following:

- The semi-structure questionnaire was utilized mainly in Central plant engineering in order to gain overall implementation of energy management.
- Document review and relevant sections of the semi-structure questionnaire was utilized in the following business units as indicated below:
  - Purchasing was evaluated in terms of procurement,
  - Environmental department was evaluated on how they evaluate applicable legislation, formulation of Environmental policy and objectives,
  - Process planning was only evaluated on how the organisation introduce equipment and machinery that can have an significant impact on energy,
  - And lastly the one production business unit was evaluated on how they manage and conduct their energy reviews.

1.4.4 Measuring Instrument

According to Collis and Hussey (2003), collecting data in a quantitative study is an attempt to measure variables or count occurrences of a phenomenon and the qualitative study evaluate meaning and understanding. Qualitative methodology was used in this paper because this study seeks to gain a better understanding of the current energy management strategy and how it was implemented by the selected organisation. The data was collected by means of a semi-structured questionnaire (Annexure A) and document reviews within relevant business units. The measuring instrument was constructed base on energy management literature.

1.4.5 Data Analysis

The data analysis was conducted by means of gap analysis methodology based on management practises adopted by the case study organisation for its energy management.
1.5 DELIMITATION OF THE RESEARCH
Delimiting the research makes it manageable from a research point of view. The case study will be limited to one automotive manufacturer in the Eastern Cape.

1.6 ASSUMPTIONS
In pursuit of this research, the assumptions made were the following:

- The current energy management strategy is inefficient;
- Improving the current strategy will yield favourable results towards effective energy management.

1.7 PREVIOUS RESEARCH
Previous researches have tended to focus more on the technological aspects and less on management functions of energy management. To support the above statement Brown (n.d.) highlighted most experts who believe and argue the energy management is a technical problem that must be addressed with technological solutions. However, Brown strongly argues that whatever the technology identified by an organisation to address its energy needs, the technology must still be implemented by people and the selected people’s performances need to be managed.

In the same vein, Hansen and Lund (2002) support the above statement by highlighting the following elements in order to achieve optimal energy efficiency:

- Change agents must exist, specifically to coordinate energy management implementation activities
- Managerial commitment must be practised towards energy efficiency as a legitimate part of the business, establishing communication channels with employees, and realistically allocating time and money to energy efficiency measures
- Effective structural responsibility towards energy management should be incorporated in such a way that horizontal networks, delegation production groups and line management are created
• Through skills and development activities, acceptance of change and internal liaison channels, organisations will realise a sustainable energy management system.

Industrial Energy Management (n.d.) highlights cases demonstrating significant achievement and sustainable savings on energy based solely on people’s awareness of corporate values that change their attitudes towards energy use. The combination of these two approaches, technological and human resources typically yields the best results. Many cases can be found to demonstrate the wisdom of addressing the three dimensions of energy management which are technical, behavioural and organisational.

Based on the literate reviewed, it is clear technological solutions cannot achieve the desired results; without involvement of the management function, achieving effective energy management remains elusive for organisations.

1.8 SIGNIFICANCE OF THIS STUDY
According to South Africa Department of Minerals and Energy (2004), developing economies worldwide, like South Africa, are faced by challenges of sustainable energy, meaning they need to find ways of using their energy efficiently so that the environment, society and economy can exist in harmony. South Africa is a typical developing nation that relies on its energy intensive industry as a driving force for the development of the economy. The economy relies mainly on indigenous coal reserves as a source of energy. In recent years, energy efficiency has gained stature and been recognised as one of the most cost-effective ways of meeting the demands of sustainable development.

The Department of Minerals and Energy (n.d) further highlights that South Africa remains one of the highest emitters of the greenhouse gas CO₂ per capita in the world. At a local level, the problems of sulphur dioxide (SO₂) and smoke emissions have been the focus of concern for many communities living adjacent to heavily industrialised areas. Go Green Consult (2009) highlighted organisations driving a continuous improvement on effective energy management can achieve better
efficiency and lower costs due to skyrocketing energy prices, power factor penalties, time of use penalties, demand charges, energy caps and costs.

1.10 TERMS AND DEFINITIONS

Annex I: The following countries are classified as industrialised countries and/or countries in transition*: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia*, Czech Republic*, Denmark, the European Union, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein*, Lithuania, Luxembourg, Monaco*, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, the Slovak Republic*, Slovenia*, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom, Northern Ireland and the United States of America.

Annex II: These countries are classified as developed countries that pay for costs of developing countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States of America.

Energy baseline: Quantitative reference(s) providing a basis for comparison of energy performance

Energy consumption: Quantity of energy applied

Energy efficiency: Ratio or other quantitative relationship between an output of performance, service, goods or energy and an input of energy

Energy management system (EnMS): Set of interrelated or interacting elements to establish an energy policy and energy objectives and processes and procedures to achieve those objectives

Energy management team: Person(s) responsible for effective implementation of system activities for energy management and for delivering energy performance improvements

Energy objective: Specified outcome or achievement set to meet the organisation’s energy policy related to improved energy performance

Energy performance indicator (EnPI): Quantitative value or measure of energy performance, as defined by the organisation

Energy performance: Measurable results related to energy efficiency, energy use and energy consumption
Energy policy: Statement by the organisation of its overall intentions and direction of an organisation related to its energy performance, as formally expressed by top management.

Energy review: Determination of the organisation's energy performance based on data and other information, leading to identification of opportunities for improvement profile, are included in the concept of energy review.

Energy services: Activities and their results related to the provision and/or use of energy.

Energy target: Detailed and quantifiable energy performance requirement, applicable to the organisation or parts thereof, that arises from the energy objective and that needs to be set and met in order to achieve this objective.

Energy: Electricity, fuels, steam, heat, compressed air, and other like media.

G-20: Group of 20 includes the following countries: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, México, Russia, Saudi Arabia, South Africa, Korea, Turkey, the United Kingdom, the United States and the European Union.

OECD: The organisation of Economic Cooperation and Development includes the following countries: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

Scope 1: CO₂ emission emitted by all activities contained within the immediate business operations.

Scope 2: CO₂ emission emitted, taking into account all forms of purchased electricity providing power to the sites being audited.

Scope 3: Indirect emissions of the organisation including air travel, water consumption and waste generated.

Significant energy use: Energy use accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement.
1.11 ENERGY CONVERSION FACTORS

This section seeks to give readers terms of reference between different energy sources because through the study various forms of energy source are being mentioned. Electricity in kWh was used as a reference point to the equivalent energy requires producing the same energy from different energy sources (Table 1). This gives a better picture in terms of energy mix and its impact on natural resources. For example compressed air is 8-10 times more expensive than Electricity for the same useful power because of the high percentage of heat losses during processing. Only 10 – 3 percent of energy reaches the point of end-use, and balance 70 – 90 percent of energy of the power of the prime mover being converted to unusable heat energy and to a lesser extent lost in form of friction, misuse and noise. (Bureau of Energy Efficiency, 2004)

Table 1. Energy Conversion Factors

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Measured units</th>
<th>To get kWh multiply by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>kWh</td>
<td>1</td>
</tr>
<tr>
<td>Natural gas</td>
<td>m³</td>
<td>10.7</td>
</tr>
<tr>
<td>Natural gas</td>
<td>100 cubic feet</td>
<td>30.3</td>
</tr>
<tr>
<td>Natural gas</td>
<td>therm</td>
<td>29.31</td>
</tr>
<tr>
<td>Diesel or 35-second gas oil</td>
<td>litre</td>
<td>10.6</td>
</tr>
<tr>
<td>Heavy fuel oil</td>
<td>litre</td>
<td>11.4</td>
</tr>
<tr>
<td>Propane</td>
<td>kg</td>
<td>13.78</td>
</tr>
<tr>
<td>Coal</td>
<td>kg</td>
<td>9</td>
</tr>
<tr>
<td>Steam</td>
<td>tonne</td>
<td>630</td>
</tr>
</tbody>
</table>

Source: Industrial Energy Management (n.d.)
1.12 OUTLINE OF THE STUDY

This section indicate the outline of the study with reference to research questions and relevant chapters that where covered on this paper (Table 2).

Table 2. Study Outline

<table>
<thead>
<tr>
<th>Research question</th>
<th>Research objective</th>
<th>Chapter</th>
<th>Deliverable</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ0</td>
<td>RO0</td>
<td>Chapter 1</td>
<td>This chapter was focused on problem statement, the motivation for the research, the methodology and the outline of the research project.</td>
</tr>
<tr>
<td>RQ1</td>
<td>QO1</td>
<td>Chapter 2</td>
<td>The emphasis of this chapter was to highlight the role energy management towards sustainable development</td>
</tr>
<tr>
<td>RQ2</td>
<td>QO2</td>
<td>Chapter 3</td>
<td>Highlights the characteristics of effective energy management</td>
</tr>
<tr>
<td>RQ3</td>
<td>RO3</td>
<td>Chapter 6</td>
<td>Identifies areas of success and shortfalls towards effective energy management</td>
</tr>
<tr>
<td>RQ1</td>
<td>RO1</td>
<td>Chapter 7</td>
<td>Highlights where current energy management strategies can be improved for a sustainable business and future</td>
</tr>
</tbody>
</table>
CHAPTER 2: GLOBAL ENERGY OUTLOOK

2.1 INTRODUCTION

World Energy Outlook (WEO, 2010) raised the following fundamental questions about today’s global economy:

- The global economic crisis is far from over, is the world heading towards a sustainable future?
- Oil supply and demand are becoming inelastic to price; does this raise concerns?
- Natural gas markets are rising sharply; does this mean there is a new revolution in energy?
- Will Copenhagen Accord and G-20 subsidies achieve their main objectives?
- What is the future of emerging economies with regard to global energy? (Tanaka, 2010)

In this chapter, the intention is to provide a background that makes the links between energy production and climate change explicit. This chapter closes with a description of global trends on energy conservation to address the increasingly urgent global issue.

2.2 GLOBAL ENERGY SECTOR

The first great wave of industrialisation was fuelled entirely by unsustainable energy systems, like the steam engine, coal and oil. Coal remains the primary source of power generation; it is being replaced gradually by natural gas and renewable energy sources (Dudley, 2011). Historically, the most used energy sources have been those nearest and easiest to consume. This has resulted in a global reliance on fossil fuels (Haw & Hughes, 2007, p.1).

Due to world reliance on unsustainable energy systems, over the last 100 years, the earth has experienced an approximate 6 degrees Celsius increase in global mean annual temperatures. This global mean temperature is projected to rise by 1.4 to 5.8 degrees Celsius between 1990 and 2100 (IPCC, 2001). The rise in temperatures was discovered to have a strong link on natural and human causes. Natural causes are water vapour in the atmosphere and other greenhouse gases such as carbon
dioxide, methane (CH₄), and chlorofluorocarbon (CFC). Water vapour contributes a significant amount to greenhouse warming. The greenhouse gas effect traps radiated heat energy from the earth’s surface, reradiating it back to the earth’s surface (Schneider, 1989). This trapped energy effectively creates an enclosure around the earth’s atmosphere similar to a greenhouse, which not only traps heat, but also restricts air circulation that would otherwise cause cooling (Botkin & Keller, 2000).

Prior to the IPCC’s report in 2001, there was still uncertainty about human beings’ contribution to global warming. Many scientists believed natural global cooling mechanisms would offset warming (EcoPlanIT Madison, n.d.). However, the IPCC’s (2001) Third Assessment Report confirmed a scientific link between greenhouse gas emissions and global climate change. Energy production and use have various environmental implications because energy represents about 65 percent of global greenhouse-gas emissions (International Energy Agency [IEA] 2011b, p. 19). The IEA argues that, among many human activities that produce greenhouse gases, the use of energy represents by far the largest source of emissions. Energy accounts for over 80 percent of greenhouse gases in Annex I countries, with emissions resulting from the production, transformation, and handling and consumption of all kinds of energy commodities (see Figure 1).

**Figure 1. Shares of greenhouse-gas emissions in Annex I countries: 2009.**

![diagram showing energy emissions](image)

Source: IEA (2011b)
Smaller shares correspond to agriculture, which produces mainly Methane (CH₄) and nitrous oxide (N₂O) from domestic livestock and rice cultivation, and to industrial processes not related to energy, which produce mainly fluorinated gases and N₂O (IEA, 2011b, p.19). EcoPlanIT Madison (n.d.) highlights that, over the past 50 years, there was a significant contribution by human’s activities, mostly from burning fossil fuels that emit more carbon dioxide into the atmosphere, approximately 5.4 billion tons annually.

**Figure 2. Human influence on the atmosphere during industrial era.**

Source: UNEP/GRID-Arendal (2011)

Global total primary energy supply (TPES) doubled between 1971 and 2009 (IEA, 2011b). According to ExxonMobil (2012), population and economic growth are the key variables behind the increasing demand for energy. ExxonMobil strongly believes that without access to affordable energy, long-term development cannot take place. In support of ExxonMobil, Dudley (2011) highlighted that since 1900, the world population increased significantly, real income has grown by a factor of 25, and primary energy consumption by a factor of 22.5. Dudley predicts the world’s population will rise by more than 25 percent from 2010 to 2040, reaching nearly 9 billion people.
According to ExxonMobil (2012) population growth is slowing down in some places, mainly OECD countries plus China, and will change little by 2040. This global deceleration, coupled with gains in energy efficiency, will further the significant slowdown in energy demand growth that has been under way for decades in those countries. In contrast, non-OECD economies will grow much faster, at almost 4.5 percent a year (see Figure 3).

**Figure 3. Relationships between global population, energy and GDP.**

There is great concern about the growing energy demand from non-OECD regions because these regions depend mainly on fossils fuels. One of the most important recent developments in the world economy is the increasing economic integration of large non-OECD countries, in particular Brazil, the Russian Federation, India, China and South Africa, the so-called BRICS countries (IEA, 2011b, p.19). Already, the BRICS represent almost one-third of the world GDP, up from 18 percent in 1990. In 2009, these five countries represented 33 percent of global energy use and 37 percent of CO₂ emissions from fuel combustion.

The IEA (2011b, p.21) believes the share is likely to rise further in coming years if the strong economic performance currently occurring in most of these countries continues, as many commentators expect. In fact, China, the Russian Federation and India are already three of the four countries that emit the most CO₂ emissions in absolute terms.
2.3 BRICS ENERGY SECTOR

Each of BRICS countries has very different and widespread resources, energy supply constraints and sectorial consumption patterns. Consequently, the issues relating to CO₂ emissions facing these five countries are quite different (IEA, 2011b, p.22).

2.3.1 Energy in Brazil

Brazil is the third largest emitter of total greenhouse gases in the world, with the particularity that the country's energy system has a relatively minor impact on greenhouse gas emissions, namely, 15 percent. The bulk of greenhouse gas emissions in Brazil, about 85 percent, come from agriculture, land-use and forestry activities, mainly through the expansion of agricultural frontiers in the Amazon region (IEA, 2011b, p.22).

Figure 4. Brazil CO₂ emission by sector.

![Diagram showing CO₂ emission by sector in Brazil](image)

Source: IEA (2011b, p.22)

Compared to the Russian Federation, China and India, CO₂ emissions from fuel combustion in Brazil are small, representing only 1.2 percent of global CO₂ emissions from fuel combustion. Brazil’s energy matrix is one of the cleanest in the world, with renewables accounting for 46 percent of TPES. Brazil is also one of the world’s largest producers of hydropower. Within the energy sector, the sub sectors that contribute the most to total greenhouse gas emissions transport 44 percent in 2009 and industry 28 percent, These emissions are likely to grow most over the next years (IEA, 2011b, p.22).
Electricity generation in Brazil relies heavily on hydropower. Over the last three decades, the number of major dams has grown steadily and hydropower accounted for 84 percent of total electricity generation in 2009. Many of Brazil's hydropower generating facilities are located far away from the main demand centres, resulting in high transmission and distribution losses. Droughts in recent years have led to a wider diversification in the electricity production mix, increasing the use of natural gas (IEA, 2011b, p.22).

2.3.2 Energy in India

India emits more than 5 percent of global CO₂ emissions, and emissions continue to grow. CO₂ emissions have almost tripled between 1990 and 2009. According to WEO (2010, as cited by IEA, 2011b, p.25), the new policies scenario projects that CO₂ emissions in India will increase by almost 2.5 times between 2008 and 2035. Large shares of these emissions are produced by the electricity and heat sector, which represented 54 percent of CO₂ in 2009, up from 40 percent in 1990. CO₂ emissions in the transport sector accounted for only 9 percent of total emissions in 2009, but transport is one of the fastest growing sectors.
In 2009, 69 percent of electricity in India came from coal, another 12 percent from natural gas and 3 percent from oil. The share of fossil fuels in the generation mix grew from 73 percent in 1990 to 85 percent in 2002. The share of fossil fuels has declined steadily since then, falling to 81 percent in 2006, although increasing back up to 84 percent in 2009 (IEA, 2011b, p.25).

Although electricity produced from hydro has actually risen during this period, the share fell from 25 percent in 1990 to 12 percent in 2009. India is promoting the addition of other renewable power sources into its generation mix and had an installed capacity of 17 GW of renewable energy sources on 30 June 2010. Under its National Action Plan on Climate Change, India plans to install 20 GW of solar power by 2020. With an installed wind capacity of 12 GW in June 2010, India has the world’s fifth largest installed capacity of wind power (IEA, 2011b, p.25).

Of the BRICS countries, India has the lowest CO₂ emissions per capita (1.4 t CO₂ in 2009), about one third of the world average. However, because of the recent large increases in emissions, the Indian ratio is more than two times that of its ratio in 1990 and will continue to grow. India’s per capita emissions in 2035 will still be well below those of the OECD member countries today (IEA, 2011b, p.25).
Figure 7. India CO2 emission by sector.

![India CO2 emission by sector](image.jpg)

Source: Source: IEA (2011b, p. 25)

In terms of CO$_2$/GDP, India has continuously improved the efficiency of its economy, and reduced CO$_2$ emissions per unit of GDP by 16 percent between 1990 and 2009. India aims to reduce emissions by 20-25 percent by 2020 compared with the 2005 level (IEA, 2011b).

2.3.3 Energy in Russia

The Russian Federation is the only BRICS country where CO$_2$ emissions fell between 1990 and 2009, with a 30 percent drop over the period. The economic downturn after the breakup of the former Soviet Union caused emissions to fall by 34 percent between 1990 and 1998. Nonetheless, CO$_2$ emissions grew in 1999 and 2000 (2 percent and 3 percent a year, respectively) due to the Russian Federation’s strong economic recovery, stimulated by the increase in world energy prices. CO$_2$ emissions have remained constant for the last five years. After a 4 percent increase in 2006, the CO$_2$ emissions were stable in 2007 and increased by 1 percent in 2008 before falling 4 percent in 2009, largely due to the global financial crisis (IEA, 2011b, p.24).
According to WEO (2010, as cited by IEA, 2011b, p.26) a new policies scenario projects the Russian Federation CO₂ emissions will continue to increase steadily, and in 2035, will represent around 75 percent of the estimated 1990 level. CO₂ emissions from fuel combustion in the Russian Federation stabilised in 2000. However, other sources of greenhouse gases (in particular CH₄ emissions from leaks in the oil and gas transmission/distribution system and CO₂ emissions from flaring of associated gas) represent an important share of the Russian greenhouse gas emissions. To reduce greenhouse gas emissions from energy effectively, these two problems would also need to be addressed.

2.3.4 Energy in China

With almost 7 billion tons of CO₂ in 2009 (24 percent of global emissions), Chinese emissions far surpass those of the other BRICS countries. In fact, China overtook the United States in 2007 as the world’s largest annual emitter of energy-related CO₂, although in cumulative and per capita terms the United States remains the largest. Chinese CO₂ emissions tripled between 1990 and 2009. According to WEO (2010, as cited by IEA, 2011b), the new policies scenario projects the growth in Chinese emissions could slow down to 1.5 percent per year between 2009 and 2035 (p. 26).
Even with this further slowed growth, emissions in 2035 would be 1.5 times current levels. Since 1990, the electricity and heat generation sector grew the most, representing 48 percent of Chinese CO₂ emissions in 2009. The transport sector also grew rapidly, but from a much smaller base, representing 7 percent of CO₂ emissions in 2009. According to WEO (2010, cited by IEA, 2011b), the new policies scenario projects the transport sector will continue to grow, rising to an estimated 13 percent in 2035, as switching to low- or zero carbon energy sources is much more difficult in transport than in other sectors.

**Figure 9. China CO₂ emissions by sector.**

Source: IEA (2011b)

Chinese demand for electricity was the largest driver of the rise in emissions. The rate of capacity additions peaked in 2006, but in 2009 China’s installed capacity rose by a net 81 GW (China Electricity Council, 2010), slightly more than the total installed capacity of South Korea. At the same time, it closed over 26 GW of small, inefficient fossil fuel-fired plants about the size of Ireland and Switzerland’s combined installed capacity. Coal played a major role in supporting the growing demand for electricity generation.
Nearly all of the 1990-2009 emissions growth from power generation were derived from coal, although the emissions performance of coal-fired power generation has improved significantly, and China has started to add some natural gas, for example, electricity generated from natural gas increased by 64 percent in 2009 (IEA, 2011b, p.26).

2.3.5 Energy in South Africa

According to Department of Minerals and Energy (2009), South Africa has abundant coal reserves and some oil and gas. As a result, coal is used as primary energy source for electricity generation and synfuel production. In 2009, South Africa generated 94 percent of its electricity using coal. Although South Africa accounted for 40 percent of CO₂ emissions from fuel combustion in Africa in 2009, it represented only 1 percent of the global total (IEA, 2011b, p.27).

The Department of Minerals and Energy (2009) further characterises South African as an energy intensive economy due to its extraction and processing of raw materials such aluminium, iron and steel. The electricity and heat sector produced 62 percent of South Africa’s CO₂ emissions (IEA, 2011b, p.27). As an emerging economy, development and poverty alleviation are still the primary objectives. Informal settlements rely on ‘dirty’ fuels to meet their daily energy needs (Department of Minerals and Energy, 2009).
Figure 11. South Africa CO$_2$ emission by sector.

Source: IEA (2011b)

A major challenge facing South Africa is reducing its reliance on coal as a primary energy source. South Africa has already taken strides to expand the use of both renewable and nuclear energy, explored the use of carbon capture and storage (CCS) technologies, and reduced energy demand through a nationwide energy efficiency programme. South Africa’s public utility, Eskom, also has a target to reduce dependence on conventional coal to 70 percent by 2025 and reduce greenhouse gas emissions in absolute terms by 2050, which includes increasing capacity from renewables. South Africa’s current target is to have 1 000 MW of renewable capacity by 2013 and 3 800 MW by 2016 (IEA, 2011b).

South Africa signed the Kyoto protocol as an Annex 3 country in 2002. As such, South Africa does not yet have an obligation to reduce carbon emissions under the Kyoto Protocol but it is believed that after 2012, during the second commitment period, South Africa may be required to actively reduce her GHG emissions (Department of Minerals and Energy, 2009). Further, South Africa has various activities in terms of policy implementation like SANS 204 (2011), focusing on energy efficiency in buildings, the Energy Efficiency Strategy, and the Electricity Regulation Act that ensures stability of the network and minimising load shedding and blackouts. Regional initiatives have been rolled out in the major cities like Cape Town, with Solar Water By-laws, and Gauteng, with the Integrated Energy Strategy.
Energy Efficiency Demand Side Management (EEDSM) is driven by Eskom (Mathekgana, 2012).

2.3 GLOBAL INDUSTRY TRENDS
Rising population and increasing wealth are fuelling growing global demand for products, services, buildings and public infrastructure (Gielen, Newman & Patel, 2008). Industry uses nearly 40 percent of worldwide energy on economic activities. Value chain activities alone contribute almost 37 percent of global GHG (Worrell, 2011). According to Sharma (2010), three major sectors responsible for nearly 70 percent of the direct industrial emissions are iron and steel, non-metallic minerals (notably cement), and chemicals and petrochemicals excluding freight transportation.

Figure 12. Direct industrial CO₂ emissions: 2004

Source: Gielen et al., (2008)

On the other hand, Worrell (2011) indicated a steady energy decline from the industry in most countries since the oil price crisis in 1970s. Gielen et al. (2008) explain the energy decline is due to some energy efficiency improvements in all sectors worldwide. However, these efficiency gains have not been geographically
uniform. The rapid growth of production in less-efficient developing countries has contributed significantly to poverty alleviation, but it has also limited the average efficiency gains worldwide.

Gielen et al. (2008) strongly believes the overall energy and emissions trends can be mitigated through additional energy efficiency measures. Even though energy cost is significantly high in manufacturing, there is minimal effort to manage and control it like other costs. Citing an International Energy Agency study, Gielen et al. suggest technical efficiency improvement has a potential of reducing energy consumption 18–26 percent for the manufacturing industry worldwide if the best available technologies were applied. These savings would equal 5–7 percent of total worldwide energy use and reduce CO₂ emissions by 7–12 percent worldwide (see Table 3). These were conservative estimates based on proven technology.

Table 3. Energy Efficiency Opportunities in Industry

<table>
<thead>
<tr>
<th></th>
<th>Energy Efficiency (EJ/year)</th>
<th>CO₂ Emissions (Mt of CO₂/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector process improvements</td>
<td>12–17</td>
<td>1150–1550</td>
</tr>
<tr>
<td>Systems options</td>
<td>13–20</td>
<td>750–1650</td>
</tr>
<tr>
<td>Total</td>
<td>25–37</td>
<td>1900–3200</td>
</tr>
<tr>
<td>Industrial improvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>potential</td>
<td>18–26 %</td>
<td>19–32 %</td>
</tr>
<tr>
<td>World improvement potential</td>
<td>5–7 %</td>
<td>7–12 %</td>
</tr>
</tbody>
</table>

Source: Gielen et al. (2008)

Carbon Trust (2004) indicated energy and environmental management are issues already on the agenda for many leading global businesses. The international community agreed to reduce the environmental impact from their economic activities as per the Kyoto Protocol that set targets to cut overall greenhouse gas emissions by 5.2 percent below the 1990 baseline by 2008-2012.

Legislative and regulatory policies, research and technology development and fiscal measures were developed in various countries (Sivill, 2011). For example, the
United Kingdom (UK) has set a domestic goal to cut emissions of carbon dioxide by 20 percent below 1990 levels by 2010. In order to encourage businesses to take up this challenge, the UK government introduced the Climate Change Programme in April 2001 (Carbon Trust, 2004). The Climate Change Programme includes:

- The Climate Change Levy (CCL), which typically adds around 15 percent to the non-domestic fuel bills of all businesses
- Climate change agreements, where eligible businesses (e.g., in energy-intensive industries) can secure an 80 percent discount from the levy if they agree to meet challenging targets for improving their energy efficiency or reducing carbon emissions (targets are set through negotiations between government and trade bodies)
- A greenhouse gas trading scheme, which enables successful savers to gain financial reward for their efforts by selling their 'surplus allowance', while expanding businesses can purchase an additional allowance
- An Enhanced Capital Allowances (ECA) scheme that helps promote energy-saving technologies. (Carbon Trust, 2004)

In addition, Sivill (2011) highlighted that rising public awareness put pressure on sustainable development in business. At the same time, the cost of materials and energy continues to rise as the world economy expands, resulting in heavy demands on natural resources.

2.4 CONCLUSION

It is clear business cannot carry on with traditional unsustainable strategies. In the last half of the century, human’s activities, mostly from burning fossil fuels that emit more carbon dioxide into the atmosphere, have had a significant effect on the environment. At the same time, the global total primary energy demand doubled between 1971 and 2009 due to population and economic growth. That means without access to affordable energy, long-term development cannot take place. In the next chapter characteristics of effective energy management that can enable an organisation to implement an effective energy management strategy is presented.
CHAPTER 3: PRINCIPLES OF EFFECTIVE ENERGY MANAGEMENT

3.1 INTRODUCTION
According to Sivill (2011), a growing body of evidence exists indicating energy use is not managed as effectively as it should be in firms today. A lack of energy management often leads to inefficient use of energy and improper allocation of energy resources (Chee Wai, Patrick, Hui Xian, Tobias, Ruisheng, Fatida, Yeo, Zhiquan, Song., 2012).

In this chapter, the aim is to identify and highlight the characteristics of effective energy management, with a primary focus on system management rather than technological solutions.

3.2 ENERGY MANAGEMENT DEFINITION
Barney, Wayne and William (2008) define energy management as an efficient and effective use of energy to maximize profits (minimize costs) and enhance competitive positions. SANS 50001 (2011) defines it as a set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes and procedures to achieve energy objectives of maximize profits (minimize costs). According to Capehart, Turner and Kennedy (1997), energy management is the careful and effective use of energy to maximize profits (minimize costs) and enhance competitive positions.

Among the above definitions, one can deduce that energy management is about optimising energy consumption by using systems and procedures to reduce energy inefficiency while maintaining or reducing total costs of energy.

3.3 ENERGY MANAGEMENT OBJECTIVES
Reducing energy use makes perfect business sense; it saves money, enhances corporate reputations and helps everyone participate in the fight against climate
change (Carbon Trust, 2011). According to Mohammad (n.d.), there are many reasons for adapting energy management programs in facilities. These reasons are summarised as follows:

3.3.1 The Principle of Saving Natural Resources
Usable resources are made available to humankind to be used for their benefit and well being. Every individual bears responsibility for not wasting or misusing usable resources. Therefore, every individual should be educated and trained to become part of the management of resources for the benefit of generations to come (Mohammad, n.d.).

3.3.2 Economic Benefits
The objective of commercial organisations is to maximise profit while the objective of noncommercial organisations is to allocate savings in one area to other important tasks. An energy cost is an operating cost, and savings in this area could be continuously put to use. Many measures can be employed to save energy, some of which involve nothing more than wise use and operation of energy systems within a facility. Others might require capital investment but would bring long-term benefits. Studies on energy conservation have shown much potential for great energy savings in various projects. As much as 5-15 percent savings can be achieved with little or no capital expenditure, 15-30 percent is a common energy saving and 30-50 percent savings can be obtained with capital investment.

3.3.3 Protection of the Environment
In a world with serious environmental safety concerns, the need is growing for more technical, political, and management activities to use clean, safe and economically feasible energy as well as contributing to lessened production of environmentally damaging products such as acid rain and ozone depleting products. Energy management is the first step towards achieving such objectives.

3.3.4 Customer Satisfaction and National Good
Energy management results in wise use of available energy resources that will reflect well on the individuals concerned as well as society as a whole. The outcome
of the implementation of effective energy management programs will result in the following:
  
  - Making energy available to others,
  - Decreased customer costs,
  - Fewer interruptions (better service),
  - Savings in electricity generation costs,
  - A reduction of costs required to install new power generating plants to meet increased demand,
  - An extension of the life of finite energy resources, and
  - Conservation of resources for future generations.

An important ingredient of energy management is the human dimension and its involvement in the overall scheme of things. Employees and end users' participation in managing energy sources in a facility is crucial in determining the success of energy management activities. Involvement in management behaviour is a basic principle of the newly introduced approach of total productive energy management (Mohammad, n.d.).

3.4 DIMENSIONS OF ENERGY MANAGEMENT

Most experts believe and argue energy management is a technical problem that must be addressed with technological solutions. However, Industrial Energy Management, (n.d.) believes technological solutions alone do not achieve maximum energy savings and are less likely to have long, sustainable terms. Rather, energy management has the greatest effect when organisations address three dimensions: technical, organisational and human behavioural.

Industrial Energy Management (n.d.) further highlights cases that exist to demonstrate significant achievement and sustainable savings on energy just with people being aware of corporate values that change their attitudes towards energy use. The combination of these two approaches, technological and human resources, typically yields the best results. Many cases can be found to demonstrate the wisdom of addressing the three dimensions of energy management, namely, technical, organisational and human (see Figure 13).
3.4.1 Technical
According to Brown et al. (2012), there is no one size to fit all solution when it comes energy efficient technology. Organisations can maximise their energy efficiency potential by replacing older, inefficient processes with current best available technologies and best practice technologies. They can demonstrate and deploy fuel switching to low carbon energy sources. They can accelerate research into industrial CO₂ capture and rapidly demonstrate integrated industrial CO₂ capture and storage (CCS) plants. They can alter product design and waste protocols to facilitate reuse and recycling in order to close the materials loop.

3.4.2 Organisational
According Carbon Trust (2011), energy management is only one small element of any organisation, and there are many influences determining how an organisation is structured. It is not possible or indeed appropriate to prescribe a particular solution; only the organisation’s senior management can decide what is best for their specific circumstances. There are a number of characteristics that should be put in place to facilitate effective energy management and ensure key decisionmakers consider the consequences for energy. To name a few, there should be a clear reporting structure from the energy manager and team through to the senior management.
team via the responsible senior manager. Second, particularly strong relationships are necessary between the energy management function and those responsible for the operation of buildings (e.g. facilities managers) or processes. Third, Hansen and Lund (2002) indicate effective structural responsibility towards energy management should be incorporated in such way that horizontal networks, delegation production groups and line management are created. Last, through skills and development, acceptance of change and internal liaison channels, organisations will realise a sustainable energy management system.

3.4.3 Human Behavioural
Brown (n.d.) argues whatever the technology identified by an organisation to address energy needs, it must still be implemented by people, and people’s performances still need to be managed. To support the above views, Hansen and Lund (2002) indicate that to achieve maximum energy efficiency, change agents must exist, specifically to coordinate activities for energy management implementation. Second, managerial commitment must be practised towards energy efficiency as a legitimate part of the business, establishing communication channels with employees and realistically allocating time and money to energy efficiency measures.

3.5 DRIVERS OF ENERGY MANAGEMENT
AVEVA Solutions Limited (2012) viewed drivers of energy management in two ways, which are costs and regulation. Costs can be a significant element in process intensive facilities, such as refineries, chemicals plants or pulp and paper mills; energy costs often account about 25 percent of a plant’s total operating costs. Implementing an energy management system is just good business management. Its scope includes identifying and eliminating inefficiencies, saving energy through the adoption of best practices, participating in incentive programmes, and adhering to applicable standards such as the ISO 14000 (environmental management system) and ISO 50001 (energy management systems).

AVEVA Solutions (2012) argues it is difficult to quantify regulatory and corporate social responsibility (CSR) drivers for efficiency improvements, but various international regulations and policies are always aiming at reducing greenhouse gas emissions and reducing dependency on increasingly costly, often imported fossil fuel
supplies. Increasingly, these policies are being implemented through financial ‘carrot and stick’ incentives to make compliance more easily justified on the balance sheet. In support of AVEVA Solutions, Industrial Energy Management (n.d.) believe industry competitiveness, restructuring of energy supply sector, limited energy supply, environmental management and climate change are the key drivers for energy management:

3.5.1 Industry Competitiveness
Energy may be a relatively small component of total operating costs in some industries, but many organisations see energy as the most manageable components because reducing it energy costs flows directly to the bottom line.

3.5.2 Restructuring of the Energy Supply Sector
There is an international movement towards the introduction of competition into the energy supply sector. For example, South Africa’s electrical utility sector is being restructured and commercialised, while natural gas from Mozambique will soon be available in Gauteng, Kwazulu-Natal and parts of Mpumalanga and the Free State that were previously served by SASOL gas. The implication for industry is growing consumer awareness towards sustainable energy sources (when and where energy is used) in order to maximise energy supply.

3.5.3 Energy Supply Limitations
Some industries in South Africa experience power supply problems in terms of reliability and quality due to limitations in the power supply infrastructure. More significantly, the continued growth in the economy, coupled with the expansion of electrical service to new areas and users has led to serious energy supply shortages. Conservation energy programmes from ESKOM can alleviate these supply shortages to some extent, but it is clear that much greater efforts are required to reduce energy demand from industries.

3.5.4 Environmental Management
The ISO 14001 standard on environmental management is increasingly becoming a requirement for trade in certain parts of the world, especially Europe. As South Africa grows its trade markets with Europe, South African products will have to meet
this standard to remain competitive. Compliance with this standard, as with the other ISO standards, leads to tangible savings due to the reduction of waste like water, energy and materials. Energy management and waste reduction strategies are very important component of environmental management and feature significantly in ISO14001.

3.5.5 Climate Change
There is a large body of evidence to support the view the global climate is changing because of human activity, and one of the major causes of climate change is the emission of GHG, principally from CO₂ emissions from fossil fuels. The Kyoto Protocol of 2005 has taken on the weight of international law because of heavy reliance on coal for both power generation and industrial energy.

3.6 MARKET ENERGY BARRIERS
Worrell (2011) defines energy barriers as forces observed in the markets that inhibit behaviours or investments that would increase the efficiency of energy use. Sorrell, Mallett and Nye (2004) define barriers to energy efficiency as “a postulated mechanism that prevents a decision or behaviour that appears to be energy and economically efficient” (p.4).

There is considerable technical potential for improving industrial energy efficiency and the economics appear favourable, even without putting a price on carbon emissions. Such improvements frequently involve the adoption of established technologies whose performance is well proven and which involve relatively little technical risk. However, it has long been recognised that numerous ‘barriers’ inhibit the adoption of such technologies, such as lack of information, shortage of trained personnel and limited access to capital. In particular, the adoption of such technologies may be associated with various ‘hidden costs’ that are difficult to capture within energy-economic models. However, while there is a general consensus that an energy efficiency ‘gap’ exists and policy options to overcome this gap need to be identified and acted upon, there is considerable debate over the most effective approach (Sorrell et al., 2011).
Sorrell et al. (2011) argue that the concept of a barrier to energy efficiency is both confused and contested. Although the term is widely used, little consensus exists on how barriers should be understood, how important they are in different contexts, and how (if at all) they should be addressed. Sorrel et al. further highlight that many authors distinguish between barriers and market failures and recognise that some provide no grounds for policy intervention while others may prove too costly to overcome. However, Sorrel et al. view this as an element that tends to treat market failures as absolute, whereas in practice, market failures are relative. As a result, organisations tend to ignore internal barriers and adopt an unrealistic model of individual rationality.

In the context of traditional economics, barriers fail the market by preventing actions that would increase both energy efficiency and economic efficiency. Worrell (2011) emphasised market failures occur when an energy efficiency invention policy is viewed as economically efficient only if its benefits outweigh the costs of intervention. Sorrell et al. (2011) argue the barriers are to some extent interdependent and may manifest themselves in a number of different ways (e.g., technical versus market risk). Sorrell et al. classify energy efficiency barriers as paybacks, imperfect information, hidden costs, access to capital, split incentives and bounded rationality.

3.6.1 Payback Risk
The short paybacks required for energy efficiency investments may represent a rational response to risk. This could be because energy efficiency investments represent a higher technical or financial risk than other types of investment or business and market uncertainty encourage short-term horizons.

3.6.2 Imperfect Information
Lack of information on energy efficiency opportunities may lead to cost-effective opportunities being missed. In some cases, imperfect information may lead to inefficient products driving efficient products out of the market.

3.6.3 Hidden Costs
Engineering-economic analyses may fail to account for either the reduction in either utility associated with energy efficient technologies or the additional costs associated
with them. Consequently, studies may overestimate energy efficiency potential. Examples of hidden costs include overhead costs for management, disruptions to production, staff replacement and training, and the costs associated with gathering, analysing and applying information.

### 3.6.4 Access to Capital
If an organisation has insufficient capital through internal funds and has difficulty raising additional funds through borrowing or share issues, energy efficient investments may be prevented from progressing. Investment could also be inhibited by internal capital budgeting procedures, investment appraisal rules and the short-term incentives of energy management staff.

### 3.6.5 Split Incentives
Energy efficiency opportunities are likely to be foregone if actors cannot appropriate the benefits of the investment. For example, if individual departments within an organisation are not accountable for their energy use, they will have no incentive to improve energy efficiency.

### 3.6.6 Bounded Rationality
Owing to constraints on time, attention, and the ability to process information, individuals do not make decisions in the manner assumed in economic models. Consequently, they may neglect opportunities for improving energy efficiency, even when given good information and appropriate incentives.

### 3.7 ORGANISATIONAL ENERGY BARRIERS
Energy barriers occur because they are perceived as a tool to reduce operating costs but often not important enough to justify a financial investment. Unfortunately, without a management commitment or a comprehensively planned and adequately funded management programme, energy management efforts are doomed to fail and become ineffective; they end up discarded and forgotten shortly after initiation until the next energy crisis occurs (Brown, n.d.).
Common energy efficient barriers stated by Brown (n.d) are lack of organisational commitment, insufficient resources, lack of energy data, shifting priorities, results are not sustained, correcting symptoms instead of problems, and a narrow focus.

### 3.7.1 Lack of Organisational Commitment

A fundamental aspect of effective energy management is management commitment. Bottom-up support may influence executive management only if there is a perceived positive impact towards productivity. However, energy management lacks such a recognized link. Too often energy management is treated as a crisis management tool to solve problems that can be fixed and forgotten while core business issues require constant attention. Energy management also requires constant attention to be effective. Once energy is removed from the primary focus of attention, the organisation will slip back into unsound management practices.

### 3.7.2 Insufficient Resources

Energy, like any other management discipline, requires a commitment of resources to be effective. Resources are required to cover the cost of daily operations (oversight) as well as the cost of energy management projects. In most organisations, capital resources are reserved for core business functions and energy management becomes a secondary objective. This means not only are there no funds for energy projects, but also, the resources to manage energy do not exist.

### 3.7.3 Lack of Energy Data

Due to widespread energy activities in an organisation, no one is responsible for its management, and no one has accurate data regarding the consumption, cost, and organisational energy efficiency. If it cannot be measured, it cannot be improved upon.

### 3.7.4 Shifting Priorities

Effective management requires a sustained commitment to achieve measurable results. Too often, energy management is a passing fancy. When shortages occur or prices spike unexpectedly, energy becomes the crisis *de jour* and receives the full attention of the organisation. When market conditions change, energy management is once again deemed a minor concern. Because energy is used every day, it must...
be managed every day. Employing a crisis approach to energy, or any other organisational concern, produces no sustained improvement and often results in resentment as organisational priorities are constantly changed.

3.7.5 Results Not Sustained
Sustaining the effort in energy management faces the same concerns as the shifting priorities described above. Too often, energy problems are handled with a crisis approach. After the perceived crisis passes or is superseded by other concerns, the effort devoted to managing energy is placed elsewhere.

3.7.6 Correcting Symptoms Instead of Problems
Many times, a crisis approach to manage resources results in a focus on easy solutions and quick results. This can often cause a reliance on correcting symptoms instead of identifying and addressing the root causes of problems.

3.7.7 Narrow Focus
In most cases, the responsibility for energy management is centralized in a single functional area, such as engineering or maintenance. The centralization creates tunnel vision, which limits the range of opportunities that could be identified from a different department. While the organisation’s technical expertise may exist primarily in one department, energy opportunities are not limited to technological improvements and can include improved purchasing, operating practices and maintenance.

3.8 OVERCOMING ORGANISATIONAL ENERGY BARRIERS
According to Brown (n.d.), the barriers discussed above present a serious impediment towards effective energy management. However, an organisation can implement a structured approach to overcome these barriers by attending to the following:

3.8.1 Organisational Commitment
It is important executive management formulate, communicate and embrace the energy policy. The policy serves to sets a tone for the entire organisation and establishes a firm commitment towards sustained energy management systems.
The policy involves setting goals, targets and projects aligned with energy management programme. The management review should include management system performance, energy indicators, projects completed and planned, resource needs, and future directions (Brown, n.d.).

3.8.2 Resource Allocation
It is very important for an organisation to show commitment towards energy management systems by delegating human and capital resources. Like any other project or system implementation, reasonable time and financial resources are paramount. Management should allow energy teams to attend training events and planning meetings. After an energy assessment identifies viable projects, funds to cover low investment projects should be allocated (Brown, n.d.).

3.8.3 Energy Data
Capturing and analysing energy data is an essential element of energy management. To achieve proper management, data on use, demand, utility rates, average price, marginal price, and energy consumption per unit of output must be made available and used to influence organisational decisions. Someone in the organisation must be assigned responsibility for collecting, analysing and reporting energy costs, consumption and efficiency information. Tracking this data on a monthly basis facilitates comparisons between different months, seasons and years. Changing trends quickly become apparent and root causes can be investigated. As part of their measurement system, plants must install meters for significant users (Brown, n.d.).

3.8.4 Shifting Priorities
Effective energy management requires a stable, committed staff to provide command and control, collect and analyse energy data, and implement energy management projects. A firm commitment to energy management must be demonstrated by providing adequate resources and following a carefully planned strategy. This system employs a team approach and uses energy and production data to identify baseline operating conditions and potential improvement opportunities. The plant energy assessment team provides a list of energy saving opportunities complete with projected energy and cost savings, estimated investment and simple payback. The energy team can use the assessment report as a planning
document to complete a feasibility study and prioritize the projects for implementation order. Management reviews should be used to oversee the planning process and project implementation and to track project savings (Brown, n.d.).

3.8.5 Sustaining Effort
Many facilities embark on an energy management programme that is successful at the beginning yet dies due to lack of interest after the easy improvements have been exhausted. The trick is to sustain a programme over the long term. According to Brown (n.d.), the management structure is critical to achieving this objective. Organising a programme that has the full support of executive management that can carefully plan and execute, quantify results, track progress and has a team to provide momentum will ensure success. The energy policy is a statement approved by management that expresses the organisation’s commitment to managing energy. Regular management reviews to sustain the management system are required. These reviews serve as a feedback mechanism to evaluate the results of the system and move the programme forward based on the results discovered. When problem areas are identified, corrections are implemented by revising system procedures. Permanent improvement is sustained by incorporating revised procedures into training (Brown, n.d.).

3.8.6 Preventive Action
Processes increase the robustness of the management system by adding an element of flexibility. Concentrating on problems instead of symptoms can be achieved by tracking the results of energy management efforts and using measurement to determine if the correction employed yielded sustained improvement. A proper administrative system that identifies root cause instead of correcting symptoms should be in place. When management or technical problems are identified, this process should give a solution that addresses the root cause and successful solutions should be incorporated into the organisation’s procedures (Brown, n.d.).

3.8.7 Narrow Focus
Broadening the focus of energy management efforts is accomplished through the selection of an energy management team and through formal written communication procedures. By requiring the energy team to have members from each functional
area concerned with energy, the focus of energy management is widened. Effective communication requires the energy team to share information about the impact of energy use within the facility and the results of energy management efforts. Sharing the results of the energy management programme improves the perception of energy in the organisation (Brown, n.d.).

3.9 ENERGY MANAGEMENT SYSTEM

The purpose of energy management systems is to enable organisations to establish a systematic approach and the processes necessary to improve energy performance, including energy efficiency, use and consumption. Implementation of an energy management system leads to reductions of greenhouse gas emissions and other related environmental impacts and energy costs. An EnMS enables an organisation to achieve its policy commitments, take action as needed to improve its energy performance and demonstrate conformity of the system to the requirements of this International Standard (SANS 50001, 2011).

In this section, a structured approach is provided that businesses can adopt to manage their energy use based on the ISO 50001. The ISO 50001, also known as the International Standard on Energy Management System (EnMS), is a set of guidelines and requirements intended to help all kinds of organisations regardless of size, industry, geography, and culture with the goal of minimizing energy costs and reducing greenhouse gas emissions (Energenz, 2011, p.1).

According to Energenz (2011, p. 1), development of this standard was a response of the International Organisation for Standardization (ISO) to the global challenge to reduce greenhouse gas emissions and to the ever increasing cost of energy. In June 2011, the first edition of this standard was released and is expected to “influence up to 60 percent of the world’s energy use”. Energenz highlights that the broad conceptual framework of ISO 50001 gives each organisation the flexibility to tailor-make an energy management system. Like other ISO standards, ISO 50001 employs the plan-do-check-act (PDCA) approach in laying out an organisation’s Energy Management System. This approach is essential for a continuous cycle of improving organisation’s’ energy performance.
Figure 14. Energy management (PDCA) approach.

McKane (2009) highlights those companies that adopt an energy management system are able to reduce energy use and improve operations, even if they are already complying with ISO 14001. Meffert and McKane (2009) support the above statements by emphasizing this standard does not state specific performance criteria with respect to energy but gives guidance in the field of energy management, including energy supply, procurement practices for energy using equipment and systems, energy use and any use-related disposal issues.

According to McKane (2009) the ISO 50001 will have a greater impact on international trade than did the ISO 9001. This is because implementing the ISO 50001 will be driven by companies seeking international recognition and responses to international climate agreements, national caps and trade programmes, carbon or energy taxes, corporate sustainability programmes, increasing market value of “green manufacturing,” a reduced carbon footprint and carbon trading schemes, as is the case in Europe.
3.10 STEPS TO EFFECTIVE ENERGY MANAGEMENT

According to Harding (2010) energy management is not a once off exercise; to be effective, it needs to be an ongoing process. In order to be successful in energy management, organisations need to have the commitment of the senior management team, a clear shared vision and essential resources such as time and finance, as well as monitor performance and keep the firm’s communication channels open.

3.10.1 Top Management Commitment

Organisations must have some kind of commitment towards improved energy efficiency and reduce carbon emissions to agreed upon set targets or objectives. A simple policy statement as part of an organisation’s environmental policy will demonstrate senior management's commitment to energy efficiency and helping to reduce or negate the organisation’s contribution to climate change. Once senior management decide to adopt energy efficiency as a corporate policy, it is important to appoint 'energy champions' as key drivers of this policy. Energy champions should have the support of top management and be given the necessary resources to be effective (Harding, 2010).

Harding further highlights that the appointed energy champion should act as eyes and ears of the organisation on energy waste; monitor energy performance; and include an energy action team is necessary to assist with reporting on progress and problems that inhibit action.

3.10.2 Establish the Facts

The statement, “If you cannot measure it, you cannot improve it”, is very relevant to energy management. Invoices alone will not provide sufficient information to take full control over energy costs (Harding, 2010). Organisations need to monitor energy consumption at regular and frequent intervals. This will enable organisation to achieve the following:

- Identify exceptional consumption and attend to the causes quickly,
- Ensure organisations pay only for the fuel actually used,
- Compare current costs and performance with previous years,
• Compare several sites, processes or buildings in the company with each other,
• Compare organisational performance against typical standards for similar businesses, and
• Assess the seasonal pattern of consumption.

Making these comparisons will help an organisation to set improvement targets and identify where the greatest scope for saving energy exists in the business (Harding, 2010). As a rule of thumb, meters should be monitored monthly if invoicing is quarterly or else weekly if invoicing is monthly. Harding emphasizes meter readings should be done constantly at fixed time intervals in order to develop fixed monitoring trends. These readings can be displayed graphically, which is useful for detecting trends and giving warning of exceptional consumption.

Harding (2010) also indicated several ways of paying less for each unit of electricity exist, for example:

• Maximize the use of cheaper units during off-peak periods, for example, night time,
• Minimise the use of peak rate winter units by reducing peak demand where possible,
• Check the tariffs to ensure the organisation is paying the minimum amount for availability and maximum demand against the agreed upon structure,
• Monitor and correct power factors (inefficient), and
• Consider diversifying energy sources into energy sources that have less climate change levy liability.

3.10.3 Energy Planning
According to U.S. Department of Energy (2011), once organisational objectives and targets are set and agreed upon, action plans must be drawn up in conjunction with ISO 50001 planning sub elements. ISO 50001 sub elements prescribe the following activities:

• The organisation must identify legal and other requirements applicable to the organisation’s energy uses.
• The organisation must analyse energy data, identify significant energy uses, and prioritise the organisation’s opportunities for energy performance improvement.

• It is recommended a standard time interval be defined that will serve as a basis for comparison of energy performance.

• Energy performance indicators (EnPIs) serve as a quantitative measures.

• Like any management function, targets and objectives serve to steer the organisation into energy performance improvement and goals achievement.

• The organisation needs to set up energy management action plans that will highlight the methods needed and corresponding responsibilities to assist with achieving and verifying the improvements stated in the energy objectives and targets.

**Figure 15. Energy planning process concept diagram.**

![Energy Planning Process Diagram](image)

Source: SANS 50001 (2011, p.24)

Harding (2010) indicated accountability as a key success factor towards an effective energy management programme. An effective programme can be achieved by
implementing small business units or cost centres within the organisation. On a regular basis, these cost centres should account to senior management for their energy consumption and carbon emissions in their operations. At the same time, the cost centres should be recognised and incentivised with regard to implementing good energy saving measures in order to maintain high energy performance levels.

Harding (2010) identifies employees awareness as a critical element for the success of this system. Although organisations may make one individual responsible for energy efficiency, the involvement and commitment of all staff is crucial to achieve success and ensure people and the teams they work in accountable for the energy they use. All staff should be encouraged to participate. Incentive schemes can help ensure actions are taken and all staff contribute to energy efficiency measures.

3.10.4 Implementation

3.10.4.1 Competence, training and awareness

According to SANS 50001 (2011) the organisation should ensure significant energy users have appropriate training, skills or experience. This can be achieved by using training needs analyses associated with the controls implemented within significant energy users’ sections. The organisation must provide training or take other actions to meet these needs. Energy training awareness should cover or address the following minimum content:

- The importance of conformity with the energy policy, procedures and the requirements of the EnMS;
- The roles, responsibilities and authorities responsible for achieving the requirements of the EnMS;
- The benefits of improved energy performance;
- The impact, actual or potential, of energy use and consumption, activities and the contribution of activities and behaviour to the achievement of energy objectives and targets, as well as the potential consequences of departure from specified procedures.
3.10.4.2 Communication
SANS 50001 (2011) finds it necessary to establish communication strategies internally and externally with respect to energy performance and EnMS strategies and as appropriate to the size of the organisation. SANS 50001 further recommends that once an organisation decides to communicate with interested parties external to the organisation, it is advisable to establish and implement a method for external communication. An external communication framework should include the organisation’s energy policy, EnMS and energy performance, as well as its objectives.

3.10.4.3 Documentation requirements
SANS 5001 (2011) encourages document control be implemented by organisations: hard copy, electronic or any other mediums to describe the core elements of the EnMS and their interaction are essential. The EnMS documentation should cover the following minimum content: The scope and boundaries of the EnMS; the energy policy; and the energy objectives, targets, and action plans. At the same time, the EnMS document should be controlled or else integrated into the ISO 9001 system. This includes technical documentation where appropriate.

3.10.5 Operational Control
The SANS 50001 (2011) suggests organisations should identify and plan operations and maintenance activities related to significant energy uses in such a way that operations and maintenance activities are consistent with its energy policy, objectives, targets and action plans, as well as ensure operations and maintenance activities are carried out under specified conditions by means of the following:

- Establishing and setting criteria for the effective operation and maintenance of significant energy uses where their absence could lead to a significant deviation from effective energy performance;
- Operating and maintaining facilities, processes, systems and equipment in accordance with operational criteria; and
- Appropriately communicating operational controls to personnel working for or on behalf of the organisation.
3.10.5.1 Design
Where possible, the organisation should consider energy performance improvement opportunities and operational control in the design phase of new, modified and renovated facilities, equipment, systems and processes that can have a significant impact on the organisation’s energy performance. The results of the energy performance evaluation should be incorporated where appropriate into the specification, design and procurement activities of the relevant project(s). The results of the design activity should be recorded (SANS 50001, 201).

3.10.5.2 Green procurement of energy services
When procuring energy services, products and equipment that have or can have an impact on significant energy use, the organisation should inform suppliers that procurement is partly evaluated based on energy performance. Ideally, organisations should establish and implement the criteria for assessing energy use, consumption and efficiency over the planned or expected operating lifetime when procuring energy using products, equipment and services that are expected to have a significant impact on the organisation’s energy performance (SANS 50001, 2011). Furthermore SANS 50001 (2011) recommends organisations define and document energy purchasing specifications, as applicable, for effective energy use.

3.10.6 Measurement and Evaluation
According to Energy Conservation Act, 2001 cited by BEE (2011, p.2), an energy audit is defined as "The verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

BEE (2011) indicates an energy audit is meant to identify all the energy streams in a facility. It quantifies energy use according to its discrete functions. It is an effective tool to define and pursue a comprehensive energy management programme. An energy audit gives a positive orientation to the energy cost structure, preventative maintenance and quality control programme. Such an audit programme assists with keeping the focus on variations that directly influence energy costs. This should
highlight the availability and reliability of the energy supply, appropriate energy mix, energy conservation technologies, etcetera.

The primary objective of an energy audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. An energy audit is a reference point for managing energy in the organisation and provides the basis for planning the more effective use of energy in the organisation (BEE, 2011).

3.10.6.1 Monitoring, measurement and analysis

SANS 50001 (2011) specifies an organisation should ensure key characteristics of its operations that determine energy performance are monitored, measured and analysed at planned intervals. These key characteristics should include the following:

- Significant energy uses and other outputs of the energy review,
- The relevant variables related to significant energy uses,
- Energy performance indicators (EnPIs),
- The effectiveness of the action plans in achieving objectives and targets, and
- Evaluation of actual versus expected energy consumption.

SANS 50001 (2011) emphasizes the organisation should ensure the equipment used for monitoring and measurement of key characteristics provides data that are accurate and repeatable by means of calibrated instruments and/or other means of establishing accuracy. With monitoring, the organisation should investigate and respond to significant deviations in energy performance.

3.10.6.2 Internal audit of the EnMS

At planned intervals, the organisation should evaluate compliance with legal and other requirements to which it subscribes related to its energy use and consumption. These planned evaluations can be conducted in a form of internal audits in order to ensure that the programme:

- Conforms to planned arrangements for energy management system,
- Conforms with the energy objectives and targets established,
- Is effectively implemented and maintained, and
• Improves energy performance.

Audit results should be maintained and reported to top management. Organisations must address actual and potential non-conformities by making corrections and taking corrective action and preventive action. Corrective actions and preventive actions should be appropriate to the magnitude of the actual or potential problems and the energy performance consequences encountered.

3.10.7 Management Review

According to Harding (2010), energy management should be a process of continuous control and improvement, not a once-off effort. Organisations should periodically have planned management reviews in order to check if targets are being met and to identify further cost reduction opportunities that offer attractive returns on investment. The lessons learnt should be used as a feedback in planning to ensure continuing suitability and effectiveness.

Harding (2010) emphasises that once companies stop monitoring their energy use on a regular basis, waste starts to occur, often at least 10 percent, in a relatively short space of time. This could be due to a lack of controls and/or procedures that have changed, resulting in a negative effect on the energy management system. If an organisation implements and continually monitors set targets religiously, it is likely to achieve significant energy savings and protect the environment (Harding, 2010).

3.11 CONCLUSION

The literature reviewed in Chapter 3 has provided insight about the principles of an effective energy management system. Energy management was defined, drivers of energy management discussed, barriers hindering successful implementation explained and the means to overcome organisational barriers outlined. The commitment of senior management was highlighted as an important element for a successful energy management programme. Various authors confirm that energy management requires the commitment of senior management and clear organisational objectives in order to be successful.

In the next chapter, the research methodology applied for collecting primary data, as well as the type of analysis used, will be discussed.
CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

The past two decades have seen dramatic changes in the business environment. Emerging from what is, historically, an economic role, business organisations have evolved in response to the social and political mandates of national public policy, explosive technology growth and continuing innovations in global communications. These changes have created a new knowledge need for the managers and new publics that should be considered when evaluating any decision, meaning that it is more important than ever to have sound information for decision making (Blumberg, Cooper, & Schindler, 2008).

Research provides managers with the knowledge and skills they need to solve problems and meet the challenges of a fast-paced decision-making environment. This chapter focused on the research strategy used to explore the research problem which is, how can the current energy management strategy be improved for sustainable business in the future? The focus was on the research design, research objectives, methodological approach and procedure appropriate to answer the research question.

4.2 THE CONCEPT OF RESEARCH

Blumberg et al. (2008) defines business research as systematic inquiry, the objective of which is to provide information that will allow managerial problems to be solved. Blumberg et al. indicate three factors have stimulated interest in a scientific approach to decision making:

- The need to for more and better information as decisions become complex,
- The availability of improved techniques and tools to meet these needs,
- The resulting information overload if discipline in not employed in the process.

In order to make sound decisions, managers need to know how to identify high quality information and how to recognise solid, reliable research on which high risk
decisions can be based. While the decision-making environment has become more complicated, business research tools have been developed that serve to streamline the research process (Blumberg et al., 2008).

According to Blumberg et al. (2008), three different classifications of research studies are reporting, descriptive, explanatory or predictive:

- Reporting studies may be produced simply by providing an account or summation of data or to generate statistics. The task may be quite simple and the data readily available. According to Purists cited by Blumberg et al, reporting studies do not qualify as research, although data gathered carefully can have great value. Others argue at least one form, namely, investigative reporting, has a great deal in common with widely accepted qualitative and clinical research.

- Descriptive studies try to discover answers to the questions who, what, when, where and, sometimes, how. An attempt is made to describe or define a subject, often by creating profiles of groups of problems, people or events. Such studies may involve the collection of data and an examination of distribution or number of times a single event or characteristics (known as research variables) are observed. Descriptive studies may also involve an assessment of the interaction of two or more variables.

- Explanatory studies go beyond descriptive and attempt to explain the reasons for the phenomenon that the descriptive study has observed. The focus is on relationships between two or more variables. In explanatory studies, theories, or at least hypotheses, to account for the forces that cause certain phenomenon to occur are tested.

4.3 RESEARCH METHODOLOGIES

According to Collis and Hussey (2003), there are different types of research methodologies that can be employed. The basic research paradigm types are the following:

- Quantitative research, conducted by positivists, is research that relies primarily on the collection of quantitative data.

- Qualitative research, for example, a phenomenological approach, is research that relies on the collection of qualitative data.
Mixed methodologies involve mixing quantitative and qualitative methods or paradigm characteristics.

To answer the research question, qualitative methodology was applied as this study seeks to understand how and why current energy management was implemented.

4.3.1 THE QUANTITATIVE METHODOLOGY
According to Burken and Larry (2007), the basic building blocks of quantitative research are variables. Variables are classified into independent and dependent objects. Independent variables are the presumed cause effects on dependent variables. Dependent variables are influenced by one or more independent variables.

A positivist or quantitative paradigm attends to the facts with little regard to the subjective state of the individual. Logical reasoning is applied to the research so that precision, objectivity and rigour replace hunches, experiences and intuition as the means of investigating research problems (Collis & Hussey, 2003).

The two major types of quantitative research are experimental and non-experimental research (Burken & Larry, 2007).

4.3.1.1 Experimental research
According to Burken and Larry (2007), the purpose of experimental research is to study cause and effect relationships. This research methodology is characterised by active manipulation of an independent variable; it is only in experimental research that “manipulation” of variables is performed. In addition, random assignment, which creates "equivalent" groups, is used in the strongest experimental research designs.

Experimental studies are conducted either in a laboratory or in a natural setting in a systematic way. The methodology permits casual relationships to be identified, the aim being to manipulate the independent variable in order to observe the effects on the dependent variable (Collis & Hussey, 2003).
4.3.3.2 Non-experimental research

Burken and Larry (2007) explain non-experimental research as there being no active manipulation of the independent variable and no random assignment of participants to groups. Relationships between two variables in non-experimental research cannot be concluded to have cause and effect relationships because alternative explanations for the relationship between the variables are possible.

Non-experimental research is needed because there are many independent variables that we cannot manipulate for one reason or the other (e.g., for ethical reasons, for practical reasons, and for literal reasons such as it is impossible to manipulate some variables). Here’s an example of an experiment where you could not manipulate the independent variable (smoking) for ethical and practical reasons: Randomly assign 500 new-borns to experimental and control groups (250 in each group), where the experimental group new-borns must smoke cigarettes and the controls do not smoke (South alabama, n.d.).

4.3.2 Qualitative approach

A qualitative approach, as an example of a methodology based on a qualitative paradigm is concerned with understanding human perceptions and perspectives from the researchers own frame of reference (Collis & Hussey, 2003). According to Burken and Larry (2007), there are five major types of qualitative research: phenomenology, ethnography, case study research, grounded theory, and historical research. Each approach has distinct characteristics and its own roots and following.

4.3.2.1 Phenomenology

Phenomenological research is a form of qualitative research in which an attempt is made to understand how one or more individuals experience a phenomenon (Burken & Larry, 2007). The purpose of the phenomenological approach is to illuminate the specific and identify phenomena through how they are perceived by the actors in a situation. In the human sphere, this normally translates into gathering ‘deep’ information and perceptions through inductive, qualitative methods such as interviews, discussions and participant observation, and representing the data from the perspective of the research participant(s). Phenomenology is concerned with the
study of experience from the perspective of the individual, ‘bracketing’ taken-for-granted assumptions and usual ways of perceiving (Stan, 1999).

4.3.2.2 Ethnography
According to Collis and Hussey (2003), ethnography stems from anthropology and is an approach that uses socially acquired and shared knowledge to understand the observed patterns of human activity.

This form of qualitative research is focused on describing the culture of a group of people by participating in that culture. Note that a culture is defined as the shared attitudes, values, norms, practices, language, and material things of a group of people (Burken & Larry, 2007).

This method was employed to observe and understand the culture of the selected organisation in term of energy management.

4.3.2.3 Case study research
According to Burken and Larry (2007), case study is a form of qualitative research that is focused on providing detailed accounts of one or more cases. Collis and Hussey (2003) define a case study as an extensive examination of a single instance of a phenomenon of interest that focuses on understanding the dynamics present within a single setting.

Case study is the methodology of choice for the purpose of answering the research question motivating this study because the purpose was to try to understand the current energy management strategy adopted in the selected automotive manufacturer.

4.3.2.4 Grounded theory
Grounded theory is a qualitative approach for generating and developing a theory from data collected (Burken & Larry, 2007). The theory is generated by observations rather than being decided upon before the study, in contrast to a positivist study where speculation and reflection lead to the development of the hypotheses. The purpose of grounded theory is to build theory that is faithful to and illuminates the
area under investigation; the intention is to arrive at prescriptions and recommendations with the theory that are likely to be intelligible and usable in the situation being studied (Collis & Hussey, 2003).

The primary objective of this study seeks to prescribe and recommend the elements that can be employed to enhance the current energy management within the selected organisation.

4.3.2.5 Historical research
According to Burken and Larry (2007), historical research is the process of systematically examining what has happened in the past. Historical research is not a mere accumulation of facts and dates or even a description of past events. It is a flowing, dynamic account of past events that involves interpretation of the events in an attempt to recall the nuances, personalities, and ideas that influenced the events. One of the goals of historical research is to communicate understanding of past events.

4.3.3 Mixed Methodologies
Mixed methodology is a research in which the qualitative research paradigm is used for one phase of a research study and the quantitative research paradigm for another phase of the study. For example, a researcher might conduct an experiment (quantitative), and after the experiment, ask participants about their experience of the experiment (qualitative) to see if the result confirm and deepen understanding of a phenomenon. Mixed method research is like conducting two mini-studies within one overall research study (Burken & Larry, 2007).

4.4 RESEARCH DESIGN
Research design is the systematic process of collecting, analysing, and interpreting information (data) in order to understand a phenomenon better. People often use a systematic approach when they collect and interpret information to solve the small problems of daily living (Leedy & Ormro, 2010). In this study, the focus is on formal research or research that is designed to enhance understanding of the current energy management strategy employed in a selected organisation in Eastern Cape.
4.4.1 Data Collection Methods

According to Sage (2006), qualitative research relies on four methods for gathering information: Participating in the setting, observing directly, analysing documents and material culture, and interviewing in depth.

Developed primarily from cultural anthropology and qualitative sociology, participant observation (as this method is called) is both an overall approach to inquiry and a data-gathering method. To some degree, it is an essential element of all qualitative studies. As its name suggests, participant observation demands first-hand involvement in the social world chosen for study (Sage, 2006).

Observation entails the systematic noting and recording of events, behaviours, and artefacts (objects) in the social setting chosen for study. The observational record is referred to as field notes, which are detailed, non-judgmental, concrete descriptions of what has been observed. For studies relying exclusively on observation, no special effort is made to have a particular role in the setting; to be an unobtrusive observer is enough (Sage, 2006).

Knowledge of the history and context surrounding a specific setting comes, in part, from reviewing documents. Participant observation is supplemented with interviewing and observation as well as gathering and analysing documents produced in the course of everyday events or constructed specifically for the research at hand. The review of documents is an unobtrusive data gathering method, rich in portraying the values and beliefs of participants in the setting (Sage 2006).

According to Sage (2006), in-depth interviews typically are much more like conversations than formal events with predetermined response categories. A few general topics are explored to help uncover participants’ views, but how the participant frames and structures the responses is respected and emphasized. In-depth interviews are based on an assumption fundamental to qualitative research: The participant’s perspective about the phenomenon is of interest should be presented as the participant views the phenomenon, not as the researcher views it.
For the purpose of this study, semi-structured interview questionnaire was utilized data together with document review. The instrument used is contained in Annexure A.

4.4.1.1 The research sample

According to Collis and Hussey (2003), various sampling methods exist. Wergner (2010) defines sampling methods as convenience and judgement sampling. A convenience sample implies the sampling units are selected to suit the convenience of the researcher, whereas judgement sampling is when the researcher used personal judgement to select whom he or she considers the most appropriate sampling units to include in the research.

In this research, convenience sampling was the appropriate choice. The selected organisation was a convenient place to do the study because the researcher is employed currently in the case study organisation. Judgemental sampling was applied because the researcher chose participants from only those departments that deal with implementation energy management.

The sample for this study was limited to those individuals who had a direct influence on implementing the energy management process at the company; for example, process planning, purchasing, environmental departments, manufacturing planning (central plant engineering) and three production business units were included.

4.4.1.2 The measuring instrument

According to Collis and Hussey (2003), collecting data in a quantitative and/or qualitative study is an attempt to measure variables or count occurrences of a phenomenon. This kind of data can be collected by means of questionnaire. The questions are categorised as open-ended or closed. In response to open-ended questions, each respondent can give a personal response or opinion in his or her own words. Responses to closed questions are where respondents select answers from a number of predetermined alternatives.

Collis and Hussey (2003) argue that open-ended questions offer respondents freedom to express their opinions as precisely as possible in their own words but can
be difficult to analyse. In a survey questionnaire, open-ended questions may deter busy respondents from replying to the questionnaire. Collis and Hussey maintain closed questions are convenient for collecting factual data and easy to analyse because the range of potential answers is limited.

For the purpose of this research, an interview with open-ended questions was used as the tool for data collection. The questionnaire was used to obtain an understanding of the current energy management practices employed by selected organisation. Interview questions were self-constructed based on the energy management literature reviewed. The questionnaire is contained in Annexure B.

The questionnaire was subdivided into the following parts: Section A was designed to extract information about the respondent and the respondent's company designation and qualification. Section B was focused on energy management principles. The questions in the section were aimed to determine how current energy management are integrated in daily business.

4.4.2 Credibility of Findings

According to Collis and Hussey (2003), there two measures exist to describe the credibility of research findings, namely, reliability and validity.

4.4.2.1 Reliability

According to Leedy and Ormro (2010), reliability is the consistency with which a measuring instrument yields a certain result when the entity being measured has not changed. Reliability errors reflect the use of the instrument and are apt to vary unpredictably from one occasion to the next. Collis and Hussey (2003) state three common ways exist for estimating the reliability of the responses to questions in questionnaires or interview:

- The re-test method: In this method, questions are asked of the same people on two separate occasions. Responses for the two occasions are correlated and the correlation coefficient of the two sets of data computed, thus providing an index of reliability.
• Split halves method: Here the questionnaires or interview record sheets are divided into two equal halves by putting the responses to the first half of the questions in a separate pile from the answers to the remainder. The two piles are correlated, and the correlation coefficients of the two sets of data are computed.

• Internal consistency method: Cronbach’s coefficient alpha is a measure of the internal consistency of a measurement test. The index shows the degree to which all the items in a measurement test measure the same attribute.

For the purpose of this study retesting method was a method of choice because this paper was evaluating the understanding and how this strategy was implemented.

4.4.2.2 Validity
According to Leedy and Ormro (2010), the validity of a measurement instrument is the extent to which the instrument measures what it is intended to measure. Validity errors reflect biases in the instrument itself and are relatively constant sources of error. The different ways that the validity of a research can be assessed, according to Collis and Hussey (2003), are the following:

• Face validity involves ensuring that the tests or measures used do actually measure or represent what they are supposed to measure or represent.
• Construct validity refers to the degree to which a measuring instrument measures the are not directly observable.

According to Golafshani (2003), reliability and validity are conceptualized as trustworthiness, rigor and quality in the qualitative paradigm. Triangulation assists with achieving validity and reliability in qualitative research, helping eliminate bias and increasing the truthfulness of results. Golafshani defines triangulation as a validity procedure where convergence is sought among multiple and different sources of information to form themes or categories in a study.

In this study, in-depth interviewing using a semi-structured survey questionnaire, observation, and document analysis were used as sources of data collection in order
for the design to qualify as a triangulated method and ensure sufficiently trustworthy results.

4.5 CONCLUSION

In this chapter, the concept of research was defined, the research methodology explained and the research design discussed. The chapter was used to introduce the methods for data collection, namely, in-depth interviewing using a semi-structured a survey questionnaire, observation, and document analysis. The nature of the questionnaire constructed was discussed as well as the reasons for the choice of particular types of questions. In the next chapter, the data collection for the empirical study, response rate, and document review are described.
CHAPTER 5: DATA COLLECTION

5.1 INTRODUCTION
In this chapter, the data collected for the empirical study are presented.

5.2 THE RESPONSE RATE
The sample was limited to those individuals who had a direct influence on the implementation of the energy management process in the case study organisation. A sample of five relevant business units where evaluated as a sample group for this study.

The sampling was conducted as following:
• The semi-structure questionnaire was utilized mainly in Central plant engineering in order to gain overall implementation of energy management.
• Document review and relevant sections of the semi-structure questionnaire was utilized in the following business units:
   ➢ Purchasing was evaluated in terms of procurement,
   ➢ Environmental department was evaluated on how they evaluate applicable legislation, formulation of Environmental policy and objectives,
   ➢ Process planning was only evaluated on how the organisation introduce equipment and machinery that can have an significant impact on energy,
   ➢ The three production business unit were evaluated on how they manage and conduct their energy reviews.
   ➢ And lastly Communication department was consulted in terms of communicating the strategy.

5.3 DATA COLLECTION
Data was collected by means of a semi-structured interview questionnaire with central plant engineering, planning department, OHSE department, Purchasing and one production business unit. Various document reviews conducted with in these selected business units.
5.3.1 Data Transcript

The interview transcript followed the questionnaire structure. In Section A the profile of respondents was obtained from the biographical information in Section A of the questionnaire. In this section, a respondent was asked to provide information about his or her title, gender, first language; highest qualification, job title and the nature of his position with regard to energy management (see Annexure A).

The organisational name was omitted and replaced by “Company A” for ethical reasons. Participants were also assigned code names to protect their confidentiality:

- Central plant Engineering – IC001
- Purchasing – IC002,
- Environmental department – IC003,
- Process planning – IC004,
- Production business – IC005.
- Communication department – IC006

Face-to- face interviews were introduced with a preamble to ensure the respondent understood the conditions of his or her participation, for example:

> OK, before we begin the interview itself, I’d like to confirm that you have read and that you understand that your participation in this study is entirely voluntary, and I will be recording this interview instead of writing. And lastly, this questionnaire has been ethically cleared by the Ethics Committee of NMMU.

Once the participants responded with confirmation of the conditions, the questions constructed for the purposes of establishing participants biographical details were asked.

**SECTION B** was designed to gain insight on how the current energy management strategy is being implemented or integrated into the daily business process. Respondents were interviewed by following the semi-structured interview questions constructed in order to gain insight about the current energy management strategy (see Annexure A).
The first part of Section B was focused on top management commitment. In response to the question, “Has top management demonstrated its commitment to support the EnMS and to continually improve its effectiveness?” Participant IC001 responded as follows:

The chairman or chief executive officer of the parent company declared, publicly, [the] organisation’s commitment to reduce energy consumption by 25 percent in 2018 in all group plants. On [the] other hand, South African plants have demonstrated their commitment by advertising in the public domain the new strategic direction. These plants have been branded accordingly to show case the new strategic direction.

To a more detailed question about defining, establishing, implementing and maintaining an energy policy, Participant IC001 and IC003 responded as follows:

[The] organisation has an environmental policy which encompasses the energy policy. This policy is guided by ISO 14001 environmental management system. Environmental policy sets yearly objectives that must be attained by all business units that are in [the] ISO 14001 scope. These objectives are being set by central plant engineering, director of production and occupational health, safety and environmental department.

Participant IC001 and IC003 responded as follows about a question about appointing a management representative and approving the formation of an energy management team:

There is one head allocated purely for energy management. The job is split for energy champion; probably 70 percent is dedicated on production and 30 percent on energy management. The energy champion stand-in, probably 80 percent for manufacturing planning and 20 percent for energy management; and for head of central plant, 50 percent plant duties and 50 percent on energy management. And lastly, there is a fulltime German student who assists the energy champion with regard to energy migration workshops.

Participant IC001 responded as follows to a question about providing the resources needed to establish, implement, maintain and improve the EnMS and the resulting energy performance:

The organisation has provided human capital, in this case, [an] energy core team. Time resource is as per job split cited above. There are challenges when it comes to financial resources, when it comes to equipment upgrade, as they can cost a lot of money. But, the organisation does look at return of investments (ROI). At this stage,
[the] finance director does not accept at ROI longer than 5 years. In some cases, it comes done to cooperate responsibility and brand image.

Participant IC001 responded as follows to a question about whether top management appointed management representatives with appropriate skills and competence, who, irrespective of other responsibilities, have the responsibility and authority to (a) identify person(s), authorized by an appropriate level of management, to work with the management representative in support of energy management activities and (b) report to top management on energy performance:

Yes, the organisation has appointed a senior manager of the paint shop as an energy champion and plant engineer as a stand-in. The paint shop was viewed as a key energy consumer when comparing to other business units. Therefore, it was found necessary to appoint [the] senior manager of this business unit simply because the paint shop carries significant responsibility when it comes to energy consumption. [The] plant engineer was appointed on base of his technical knowledge in the field of electrical engineering.

The energy champion has significant authority because he is reporting directly to board of management regarding plant performance and to the parent company in terms of energy management implementation.

The second part of Section B was focused on energy planning. The first question in Part 2 asked, “Does the organisation have systematically procedure to review tariff structures?” Participant IC001 responded as follows:

Yes, the organisation does consider [the] tariff structure when it comes to production scheduling. One of the reasons these organisation decided to have morning and night shift patterns was to take advantage of the cheap tariff between 10:00 – 06:00 a.m. However, there are a number of challenges that the organisation came across:
First, there were people’s issues with regard working night shifts instead of afternoon shifts, and [the] organisation had to revise the decision and go back to morning and afternoon shift pattern. Secondly, when the plant runs on its full capacity, meaning three shift patterns, the organisation cannot take advantage of cheap tariff. Thirdly, the organisation is running a pull system; if [the] body shop stops due to breakdown or line supply shortage then the paint shop would not be able to run. That means the organisation cannot run one business unit alone to offset the demand.

Now that the organisation has moved back to [the] morning and night shift pattern, the production director requested central plant engineering to do an analysis of the cost impact. And the analysis revealed that the impact for the rest of the year is about R980 000 in
labour saving to run afternoon compare to night shift if 5 (Afternoon is 10 percent and 15 percent for nightshift). That means 5 percent represents R 4 million.

Other opportunities that the organisation has not explored are to move day one production to start on Sunday and last day on Thursdays, which is in line with labour. This will enable the organisation take advantage of Sunday off peak tariffs, which central planning engineering is considering. Lastly, from the energy management steering committee, it was decided the training material should incorporate the tariff structure in order to raise awareness of employees about why the organisation is reviewing shift patterns because currently, the union does not understand to move from afternoon to night shift.

Participant IC001 responded as follows to the question, “Has the organisation established an energy baseline(s) using the information in the initial energy review, considering a data period suitable to the organisation's energy use and consumption?”

Not all business units are aware of their baseline consumption because the organisation is still rolling out key performance indicator (KPI) to all business units including base load consumption. At the same time, exceptional consumption is seasonally affected, meaning the organisation is still developing data to establish accurate parameters, for example, the base load is different between summer and winter, as can observed in paint shop because they use more fuel for heating in winter and more energy to chill. The paint shop is fully aware of their seasonal consumption as compared to other business units. These were observed from excessive consumption between summer and winter on their energy demands.

Participant IC001 and IC003 responded as follows to the question, “Has the organisation identified and implemented the applicable legal requirements and other requirements to which the organisation subscribes related to its energy use, consumption and efficiency, and does it have access to these?”

Since this organisation is ISO 14001 and Verband der Automobilindustrie (VDA) certified, it does take into consideration applicable legislation in terms of environmental laws or to meet minimum required emission standards. But, the current environmental legislation are there to restrict and control pollution activities in order to slow and decrease environmental [damage. It does] not pay much attention on energy efficiency. This organisation reports on LPG and paraffin emission that is being burned off. However, the new sustainable strategy requires each and every plant to report on CO₂ and Volatile organic compound (VOC ) emissions. The organisation is currently uncertain about the new proposed carbon tax legislation due
indirect CO₂ emission from Eskom. Energy load of this organisation is approx. 70 percent from industrial motors, which are driven by Eskom power generated from coal.

Participant IC001 responded as follows to the question, “Is the energy use and consumption analysed based on measurement and other data (i.e., identification of current energy sources and evaluation of past and present energy uses and consumption)?”

Yes, the organisation has an extensive measuring system in place. These are networked electrical meters installed per shop to measure end-user consumption. These smart meters can give live data per hour, so they give energy consumption profile per shop. The metering is not just for electricity but fuel too, because production processes do use fuel like liquid petroleum gas (LPG) and paraffin. The organisation used to use heavy fuel oil (HFO) before to power up the boiler for old the paint shop, but it was discontinued due to the newer paint shop facility that was recent build. LPG and paraffin is not networked into the same system of metering because they are consumed by dedicated processes; hence, there was no need for a separate meter. If organisation buys bulk kilograms of LPG, it’s only used in paint shop. In fact, the paint shop processes have a metering facility that can measure gas consumption. And paraffin is purely used for waxing production units in the old paint shop.

These meters are monitored on monthly bases and are reviewed in terms of consumption absolute to the rate of production. In order [know] how much energy [is] consumed per vehicle produced for example, kilowatt hour per unit or kilolitres per unit produced [is measured]. There are KPI that are going to be rolled out to each business unit in order to report on their consumption during plant day. Plant day is a board of management meeting within the business units.

Participant IC001 and IC003 responded to the question, "Has the organisation established, implemented and maintained documented energy objectives and targets at the relevant functions, levels, processes or facilities within the organisation?" with, "[It is] part of the role out in the KPI report on plant day. Each business unit report their energy consumption and their base load. This is method is to assign responsibility."

The third part of Section B was focused on implementation. Participant IC001 and IC003 responded to the question, “Does the organisation ensure that any person(s) working for or on its behalf, related to significant energy uses, are competent on the
basis of appropriate education, training, skills or experience?” with “The paint shop has appropriate skills due to the nature of the business units but other business units no, due to a lack of engineering skills not just in the organisation, but in South Africa as whole.”

Participant IC001 and IC006 responded as follows to the question, “Does the organisation communicate internally with regard to its energy performance and EnMS, as appropriate to the size of the organisation?”

Energy core team have a communication representative whose job is to communicate the targets, where the organisation is. The communication strategy is divided into four themes according to four the KPI of the strategy. These four themes are divided into quarters of the year. The first campaign was about waste; secondly, energy, thirdly, water and lastly, is VOC. These campaigns are being promoted by means of management competition to raise awareness. Communication was involved from the beginning of the programme.

Participant IC001 responded as follows to the question, “Does the organisation establish, implement and maintain procedure(s) to periodically review and update documents as necessary?”

The organisation has only base load management related documentation, for example, the Switch Off action document which is to tell stakeholders where to switch on and off the equipment after production. These documents are not fully rolled out to all business units because they must still understand which equipment they can switch on or off. The organisation only reviews the switch off action as the model changes.

The fourth part of Section B was focused on operational control. Participant IC001 responded as follows to the question, “Does the organisation identify and plan those operations and maintenance activities which are related to its significant energy uses and that are consistent with its energy policy, objectives, targets and action plans?”

Central plant engineer do have switch off action activities for all main users during non-production hours, and there are roles and responsibilities assigned to each main energy user and smart meter do verify if the main energy user was indeed switched off. The switch off actions are developed consultation with central plant engineering and production. The steps that the organisation follows are to identify the key energy user, then quantify the saving, implement switch off action and last, verify if these activities are happening.
Deviation can be picked up from monthly reviews if the business units are not implementing required activities on their base load. Awareness for the main energy user during energy management workshops and maintenance are the key people to implement switch off action.

Participant IC001 responded to the question, “How high performing business been recognised and rewarded?” with “At the moment, the energy core team is still discussing energy management awards. These awards will inspire competition among business units.”

The fifth part of Section B was focused on green procurement and design. Participant IC001 responded as follows to the question, “Does the organisation consider energy performance improvement opportunities and operational control in the design of new, modified and renovated facilities, equipment, systems and processes that can have a significant impact on its energy performance?”

Yes, the organisation has a very strong drive to implement energy efficient facilities from intelligent lighting systems to robotic processes that are highly energy efficient. The organisation has just installed the greenest press plant in the Southern Hemisphere. From the planning side, the organisation is already planning new facilities for the run out models with relevant energy efficient plants. For any replacement motors and machinery, we ensure energy efficient products.

Participant IC002 responded the question, “Has the organisation defined and documented energy purchasing specifications, as applicable, for effective energy use?”

“At the present moment, there is no formal purchasing specification; the process owner must give the buyer a product specification.”

The sixth part of Section B was focused on measurement and evaluation. Participant IC001 responded as follows to the question, “Does the organisation ensure that the key characteristics of its operations that determine energy performance are monitored, measured and analysed at planned intervals?”

Yes, all main energy users monitor their energy consumption on monthly bases against the set energy targets. And going forward, divisional heads will also present on business day as part of their KPIs. If any deviation or negative trends looming, they would have to explain why there is a negative trend on their energy consumption.

Participant IC001 responded as follows to the question, “Does the organisation investigate and respond to significant deviations in energy performance?”
Yes, central plant level investigates all significant energy deviations from the set targets and informs the relevant business units about excessive use of energy. In most cases, these deviations occur over weekends when there was maintenance activity with no production or during short time days where employees were being laid off and machinery were left running. And this affected significantly base load energy consumption.

Participant IC001 responded as follows to the question, “Does the organisation ensure that the equipment used in monitoring and measurement of key characteristics provides accurate data?”

No, we don’t calibrate our electrical meters because they come with certain level of tolerance like any other electrical appliance. And we don’t even have gas meter (LPG); as I said earlier on, LPG is used by one department, and there, whatever is used that month is accounted for by the paint shop. Even if we had a fuel meter, the accuracy level deteriorates with the amount of fuel volume going through per minute because of its mechanical structure.

The seventh part of Section B was focused on management review. Participant IC001 and IC003 responded as follows to the question, “Does top management review the organisation’s EnMS to ensure its continuing suitability, adequacy and effectiveness?”

Yes, the organisation has two main reviews: the first one is the implementation of energy management strategy in various business units, which is on executive level. In this level, the energy champion presents strategy implementation status and plant performance. The plant performance and implementation is then relayed to the parent plant where the plant performance is being compared against other group plants.

The next management review happens on plant level where all business units’ performances are compared against each other with the energy champion and central plants’ inputs.

The last level happens at business unit level; this level meets on a monthly basis to review strategy implementation status and quarterly to review energy performance. But some business units review their energy performance daily, some monthly.

The interview was completed by asking the participant if there was anything else he or she would like to add and thanking him or her for his or her cooperation.
5.3.2 Document Reviews
Apart from semi-structured interviews, a document review was conducted in order to understand standardised processes employed by the organisation to achieve an effective energy management. The organisational name was omitted and replaced by “Company A” for ethical reasons.

5.3.2.1 Safety and environmental policy
As a manufacturer of passenger vehicles and components for the local and export market, Company A has committed to a legal and moral obligation towards the environment and the prevention of injuries and ill health of all employees, contractors, service providers and the public. The management recognize occupational health, safety and environmental awareness and compliance is imperative to the success of operations and will therefore ensure the policy statement is communicated to and lived by all persons working for or on behalf of the organisation.

Management at Company A acknowledges that occupational health, safety and environmental protection is a fundamental responsibility of everyone in the organisation and has therefore committed to ensuring adequate resources and facilities are available and supported by training, to ensure effective occupational health, safety and environmental performance.

Management at Company A is committed to the following:

- Ensuring compliance to applicable occupational health, safety and environmental legislation, as well as any other occupational health, safety and environmental related requirements,
- Continually improving the occupational health, safety and environmental management system through regular benchmarking of industry best practice and the implementation of innovative and practicable control measures,
- Establishing measurable objectives and regular monitoring of the achievements thereof,
- Periodically reviewing the occupational health, safety and environmental policy to ensure alignment with the company’s vision and values, and
- Maintaining sustainable environmental management.

The Board of Directors takes full responsibility for the occupational health, safety and environmental performance of Company A and asserts adherence to this occupational health, safety and environmental policy statement is mandatory.

5.3.2.2 Group sustainability report

The parent company aspires by 2018 to be the world’s most successful and fascinating automobile manufacturer and the leading light when it comes to sustainability. Because the organisation is already thinking of tomorrow, its main objective is to lower the environmental impact of all its production plants by 25 percent base on 2010 base line values. The group believes responsible business management and commercial success are two sides of the same coin. Sustainability is and will remain the foundation of corporate policy.

Figure 16. Group objectives.

Source: Company A Sustainable Report (2011)

The group focuses on “green” mobility. A green mobility focus is dictated by both social responsibility and sound business thinking. In the last five years, the group has reduced its fleet’s CO₂ emissions by 15 percent to 144 grams per kilometre. The group’s portfolio already includes 20 model variants with emissions of less than 100 grams of CO₂ per km.
The group is making great efforts to improve resource efficiency at its 62 production facilities. At Hannover Messe’s conference, the organisation showcased the systematic implementation of its sustainability strategy by giving visitors an insight into responsible mobility today and for the future with its thematic blocks of low-consumption vehicles, sustainable production and technologies.

The organisation believes its sustainable strategy goes beyond purely technical or product related aspects from resource efficient and environmentally friendly production through energy efficient vehicles to new sustainable employment fields.

5.3.2.3 Energy marshal duties
The objective of this document review was to understand duties and responsibilities of the energy champion and/or energy marshals. Energy marshals are meant to assist energy champions in various business units by carrying out the following duties and responsibilities. These duties and responsibilities were extracted from energy marshal’s appointment letter.

Energy marshals are there to ensure the following:
- Communication of the division’s energy use for the month to compare with other months
- Appointment of people to switch off equipment in their areas,
- Liaison with central plant engineering about Sunday use, which should be 30 percentage less of the running use, and
- Assistance with and driving energy awareness in their areas and further assist the Occupational Health, Safety and Environmental Department and Manufacturing Planning with such initiatives.

5.3.2.4 Training and awareness provided for year 2012
The objective of this review was to understand the training and awareness provided in order to change the mind-sets of stakeholders.
• Conservation of natural resources (water, electricity and gas) is targeted at employees, namely, Safety, Health, Environmental and Quality (SHEQ) coordinators, office personnel, group leaders, and operators in production.
• Energy marshal training is targeted as appointed energy marshals.

5.3.2.5 Environmental management review guideline
The objective of this review was to understand, how energy management reviews are documented and reviewed.
The management review team is comprised of those managers responsible for particular aspects of the system being reviewed. The entire management team conducts the annual review and are informed of the review by the occupational health, safety and environmental (OHSE) manager.
A management review takes place in the following instances:
• An annual review of the entire OHSE management system,
• At the discretion of the OHSE manager when a serious non-conformance that could have dire consequences is identified or when the system did not anticipate a non-conformance or incident has occurred, and
• When an audit takes place and the OHSE manager believes the findings are of such a nature that a management review is necessary.

5.3.2.6 Guideline for planning and introduction of new facilities
The guideline for the planning and introduction of new facilities was reviewed in order to understand the processes followed by the planning division when they design and introduce or modify machinery, equipment and facilities.

5.4 CONCLUSIONS
In this chapter, the data collected for the empirical study were presented. Questions and answers were used as a guideline to illustrate the responses from the respondents. Document reviews were presented to understand the standardised process employed by the organisation under study.

In the next chapter an analysis, interpretation and integration of the data collected and the literature reviewed will be presented.
CHAPTER 6: ANALYSIS AND INTERPRETATION

6.1 INTRODUCTION

In the previous chapter, the data collected for the empirical study was presented. In this chapter, analysis, interpretation and integration of the empirical study and the literature review will be conducted. The analysis of the data is focused on addressing the following sub-problems, as defined in Chapter 1:

- What role does energy management play on sustainable development?
- What are the characteristics of effective energy management?
- Where are current energy management strategies most effective and least effective?
- Does the organisation have a sustainable energy management strategy?

Once the findings of the literature study and empirical study are integrated, recommendations about other areas of research and the problems encountered in this study will follow.

6.2 ANSWERING THE RESEARCH QUESTIONS

6.2.1 What Role Does Energy Management Play on Sustainable Development?

The main objective of this question involved reviewing the literature and highlighting the role that can be played by energy management towards sustainable development. The literature emphasized that during the last half of the century, human activities made a significant attribution to climate change, mostly from burning fossil fuels that emit carbon dioxide into the atmosphere. At the same time, the global total primary energy supply doubled between 1971 and 2009, and only population and economic growth can explain this. It means that without access to affordable energy, long-term development cannot take place. The findings raised concern about the growing energy demand from non-OECD regions because these regions depend mainly on fossil fuels.
In spite of a sharp growth in the global energy demand, a steady decline in energy demand from industry in most countries was noted since the oil price crisis in 1970s. The decline was explained better as the result of energy efficiency improvements in all sectors worldwide. However, these efficiency gains have not been geographically uniform because production in less efficient in developing countries due to socio-economic conditions. A strong belief the overall energy and emissions trends can be mitigated through effective energy management measures is apparent.

Energy and environmental management are issues already on the agenda for many leading global businesses. As the literature suggested, growing evidence the overall energy and emissions trends can be mitigated through additional energy efficiency measures is apparent. Even though energy cost is high in manufacturing, minimal effort to manage and control it like other costs exists. Technical efficiency improvement has a potential to reduce energy consumption 18–26 percent for the manufacturing industry worldwide if the best available technology can be applied. These savings would equal 5–7 percent of total worldwide energy use and reduce CO₂ emissions 7–12 percent worldwide. In closing, business needs to have a paradigm shift when it comes to energy use.

6.2.2 What are the Characteristics of Effective Energy Management?
The main objective of effective energy management seeks to understand the main characteristics of effective energy management. The literature reviewed in Chapter 3 provided insight into the principles of an effective energy management system.

In the literature, energy management is defined as a tool to optimise energy consumption by using systems and procedures to reduce energy inefficiency while maintaining or reducing total cost. Reducing energy use makes perfect business sense; it saves money, enhances a corporation’s reputation and helps everyone lead the fight against climate change. However, energy management fails due to organisational mind-sets that perceive it as a tool to reduce operating costs but often not important enough to justify financial investment. Unfortunately, without managements’ commitments or comprehensively planned programmes and adequate resources, energy management efforts are doom to fail.
In the literature that organisations need to implement a structured approach to overcome barriers was indicated. A systematic approach and the processes necessary to improve energy performance, including energy efficiency, use and consumption, can be achieved by adopting the ISO 50001 energy management system. The system enables an organisation to achieve its policy commitments and take action as needed to improve its energy performance. Like other ISO standards, ISO 50001 employs the plan-do-check-act (PDCA) approach in laying out an organisation’s energy management system. The PDCA approach is essential to a continuous cycle of improving an organisation’s energy performance. Various authors argue energy management is not a once off exercise; to be effective it needs to be an on-going process. A successful energy management system relies on the commitment of the senior management team, a clear, shared vision, the provision of essential resources such as time and finance, and the monitoring of performance and keeping the firm’s communication channels open.

6.2.3 Where are Current Energy Strategies Most and Least Effective?
The above question was designed to facilitate investigating of the current energy management strategy employed by a chosen automotive manufacturer in the Eastern Cape and show how its energy management strategy is integrated into the daily business process. Data was collected by means semi-structured interview questions.

6.2.3.1 Management commitment
The first part of SECTION B of the questionnaire was focused on top management commitment; the questions were focused on whether top management had demonstrated its commitment to support the EnMS and to improve its effectiveness continually. According to Harding (2010), it is essential organisations have some kind of commitment towards improving energy efficiency and reducing carbon emissions to agreed upon set targets or objectives. A simple policy statement of objectives, perhaps as part of an organisation’s environmental policy, will demonstrate senior management’s commitment to energy efficiency and help reduce or negate the organisation's contribution to climate change.
The chairman or chief executive officer of the parent publicly company declared the organisation’s commitment to reduce energy consumption by 25 percent by 2018 in all the group’s plants. South African plants have demonstrated their commitment by advertising the new strategic direction in the public domain. These plants have been branded to showcase the new strategic direction.

The case study organisation used the public domain to showcase its commitment, an ambitious strategy. At the same time, the organisation used the public domain to take advantage of environmentally conscious consumers. This sends a very strong signal to its competitors and stakeholders like operational managers and employees.

This organisation will make use of this marketing strategy as a competitive advantage because to realign each plant in the world means capital intensive resources that can be hard to duplicate.

A related question was focused on defining, establishing, implementing and maintaining an energy policy. Executive management must formulate, communicate and embrace the energy policy. The policy serves to sets a tone for the entire organisation and establishes a firm commitment towards a sustained energy management system. The policy should be used to set goals, targets and projects aligned to the energy management programme. The management review should include management system performance, energy indicators, projects completed and planned, resource needs, and future directions (Brown, n.d.).

The case study organisation has an environmental policy that encompasses the energy policy. This policy is guided by ISO 14001 environmental management system. Environmental policy is used to set yearly objectives that must be attained by all business units that are within the ISO 14001 scope. The Central Plant Engineering together with OHSE department formulates the Plant energy objectives.

The organisation did not set a standalone energy policy but rather, integrated the energy and environmental management system. In the policy, it states the Board of Directors takes full responsibility for the occupational health, safety and
environmental performance of the organisation and asserts adherence to occupational health, safety and environmental policy statement is mandatory.

A second related question was focused on issues associated with appointing a management representative and approving the formation of an energy management team. According to Harding (2010), once senior management decide to adopt energy efficiency as a corporate policy, it is important to appoint an energy champion as a key driver of the policy. The energy champion should have the support of top management and be given the necessary resources to be effective. Harding further highlights the appointed energy champion should act as eyes and ears of the organisation on energy waste, monitor energy performance, and include an energy action team to assist with and report on progress and problems that inhibit action.

There is one manager allocated purely for energy management in manufacturing planning, one senior manager appointed as an energy champion, one energy champion stand-in, and a core team from various business units, which includes the head of Central Plant Engineering. The job split for the energy champion is probably 70 percent dedicated to production and 30 percent dedicated to energy management. The energy champion stand-in works 80 percent for manufacturing planning and 20 percent for energy management, and the head of Central Plant Engineering works 50 percent on plant duties and 50 percent on energy management. Finally, a fulltime German student assists the energy champion with respect to energy migration workshops.

This ties in with the system requirements for all appointees except the fulltime employee, but the job split lies more with production than energy management. That may indicate production takes precedence, with energy management taking second place to production.

A third related question was focused on the issue of providing the resources needed to establish, implement, maintain and improve the EnMS and the resulting energy performance. According to Brown (n.d.), it is very important for organisations to show commitment towards energy management systems by delegating human and capital resources. Like any other project or system implementation, reasonable time
and financial resources are paramount. Management should allow the energy team to attend training events and planning meetings. After an energy assessment identifies viable projects, funds to cover low investment projects should be allocated.

The case study organisation has provided human capital, in this case, the energy core team. Time resources are allocated as per the job split cited above. There are challenges when it comes to financial resources because equipment upgrades may be expensive. While the organisation does look at ROI, at this stage, the finance director does not accept projects with a ROI longer than five years. Some longer term ROIs are judged by impact on brand image.

ROI is a classic example of a market barrier as explained by Brown (n.d.). Brown said the short paybacks required for energy efficiency investments may represent a rational response to risk. This could be because energy efficiency investments represent a higher technical or financial risk than other types of investments or that business and market uncertainty encourages short-term horizons (Brown, n.d.).

A fourth related question was focused on whether top management has appointed management representative(s) with appropriate skills and competence, who, irrespective of other responsibilities, have the responsibility and authority to identify person(s) authorized by an appropriate level of management to work with the management representative in support of energy management activities. As Harding (2010) mentioned, the energy champion should have the support of top management and be given the necessary resources to be effective.

The case study organisation has appointed a senior manager of the paint shop as an energy champion and the plant engineer as a stand-in. The paint shop was viewed as a key energy consumer compared to other business units. It was found necessary to appoint the senior manager of this business unit because the paint shop carries significant responsibility when it comes to energy consumption. The plant engineer was appointed based on his technical knowledge in the field of electrical engineering.
The energy champion has significant authority because he reports directly to the board of management with respect to plant performance and to the parent company in terms of energy management implementation.

Any appointment level with responsibility requires relevant authority in order for a system to succeed. Sufficient authority can be viewed as a core ingredient to success. Full management involvement means this system has less chance of failure and the best chance of achieving the desire goals by 2018.

6.2.3.2 Energy planning

The first question about energy planning was focused on whether the organisation has a systematic procedure to review tariff structures. According to Barney et al. (2008) managers should know what electricity rate schedule they are under and how much they are charged for the various components of the electricity bill, including demand, consumption, power factor, sales tax, etcetera.

The case study organisation does consider tariff structures when it comes to production scheduling. One of the reasons the organisation decided to have a morning and night shift pattern was to take advantage of the cheap tariff between 10:00 p.m. and 06:00 a.m. However, a number of challenges were apparent.

First, people’s issues with regard to working night shift instead of afternoon shift became an issue, and the organisation had to revise the decision and go back to the morning and afternoon shift pattern. Second, when the plant runs at its full capacity, meaning a three-shift pattern, the organisation cannot take advantage of the cheap tariff. Third, the organisation is running a pull system; if the body shop stops due to a breakdown or line supply shortage, the paint shop would not be able to continue. That means the organisation cannot run one business unit alone to offset the demand.

After the organisation moved back to the morning and night shift pattern, the production director requested central plant engineering to conduct an analysis of the cost impact. The analysis revealed the impact for the rest of the year is about R980 000 and labour saving to run afternoon compared to night shift if 5 percent (the
afternoon is 10 percent and 15 percent for nightshift), representing ZAR 4 million (IC001).

Other opportunities the organisation has not explored are to move day one production to start on Sunday with the last day of production for the week being Thursdays, which is in line with labour. This will enable the organisation to take advantage of Sunday off-peak tariffs, an aspect central planning engineering is considering. Finally, the energy management steering committee decided the training materials should incorporate the tariff structure in order to raise the awareness of employees about why the organisation is reviewing shift pattern because currently, the union does not understand the need to move from afternoon to night shift.

The findings show the organisation is aware of its energy tariff. However, the organisation focuses more on daily tariff structures and ignores seasonal tariff structures that may affect paint shop operations. The paint shop consumes a great deal of gas in winter and less in summer and consumes more electricity in summer for air-conditioning as compared to winter.

A related question was focused on whether the organisation has established energy baselines using the information in the initial energy review, considering a data period suitable to the organisation's energy use and consumption. According to Harding (2010), invoices alone will not provide sufficient information to take full control of energy costs. Organisations need to monitor energy consumption at regular and frequent intervals.

In the case study organisation, not all business units are aware of their baseline consumption because the organisation is still rolling out KPI. At the same time, exceptional consumption is seasonally affected, meaning the organisation is still developing data to establish accurate parameters; for example, the base load is different between summer and winter, as observed in the paint shop because the paint shop uses more fuel for heating in winter and more energy to chill. The paint shop is fully aware of its seasonal consumption as compared to other business units.
These were observed from excessive consumption between summer and winter on their energy demands.

According to Brown (n.d.), capturing and analysing energy data is an essential element of energy management. To achieve proper management, data on use, demand, utility rates, average price, marginal price, and energy consumption per unit of output must be available and used to influence organisational decisions. Someone in the organisation must be assigned responsibility to collect, analyse and report energy costs, consumption and efficiency information. Tracking this data on a monthly basis facilitates comparisons between different months, seasons and years. Changing trends quickly become apparent, so root causes can be investigated. As part of their measurement system, the plant must install meters for several significant users.

Further, Harding (2010) highlighted accountability is a key success factor towards effective energy management programme. This can be achieved by implementing small business units or cost centres within the organisation. On a regular basis, these cost centres should account to senior management for the energy consumption and carbon emissions in their operations.

A related question was focused on whether the organisation identified and implemented the applicable legal requirements and other requirements to which the organisation subscribes related to its energy use, consumption and efficiency.

According to U.S. Department of Energy (2011), once organisational objectives and targets are set and agreed upon, action plans must be drawn up in conjunction with the ISO 50001 planning sub elements. The ISO 50001 prescribes that organisation must identify legal and other requirements applicable to the organisation’s energy uses.

Since the case study organisation is ISO 14001 and VDA certified, it does take into consideration applicable legislation in terms of environmental laws to meet minimum required emission standards. However, the current environmental legislation is there to restrict and control pollution activities in order to slow and decrease environmental
damage rather than promote energy efficiency. The case study organisation reports on LPG and paraffin emissions that are being burned off. However, the new sustainable strategy requires each plant to report on CO₂ and VOC emissions. The organisation is currently uncertain about the proposed carbon tax legislation pertaining to indirect CO₂ emissions from Eskom. The energy load of the cases study organisation is approximately 70 percent from industrial motors, which are driven by Eskom power, which is generated from coal.

This integrates this element with existing ISO 14001 and VDA certification requirements and can be viewed as one of the advantages built into the ISO management system.

A related question asked if energy use and consumption was analysed based on measurement and other data (i.e., identification of current energy sources and evaluation of past and present energy uses and consumption). The case study organisation has an extensive measuring system in place. Networked electrical metering is installed per shop to measure end-user consumption. These smart meters can give live data per hour, so they provide the energy consumption profile per shop. The metering is not just for electricity but fuel because the production process uses fuel, like LPG and paraffin. The organisation used to use heavy fuel oil (HFO) to power up the boiler for the paint shop, but it was discontinued with the newer paint shop facility. LPG and paraffin are not networked into the same system of metering because dedicated processes consume them; hence, there was no need for a separate meter. If the organisation buys bulk kilograms of LPG, it is only used in the paint shop. In fact, the paint shop processes have a metering facility that can measure gas consumption. Paraffin is used for waxing production units in the old paint shop.

These meters are monitored on a monthly basis and are reviewed in terms the absolute rate of consumption the rate of production to measure how much energy is consumed per vehicle produced, for example, kilowatt hour per unit or kilolitres per unit produced. There are KPI that are going to be rolled out to each business unit in order to report on their consumption during plant day, which is a board of management meeting among the business units.
The organisation is focused more on energy consumption due to a lack of skill and knowledge about how to manipulate the data provided by smart meters. The meters provide real-time opportunities to manage and optimise energy use in the plant. As indicated by Harding (2010), several ways of paying less for each unit of electricity exist:

- Make maximum use of cheaper units during off-peak periods, for example, at night,
- Minimise the use of peak rate winter units by reducing peak demand where possible,
- Check the tariffs to ensure the organisation is paying the minimum amount for availability for maximum demand against the agreed upon structure,
- Monitor and correct power factors (inefficiencies), and
- Consider diversifying energy sources into energy sources that have less of a climate change levy liability.

A related question asked if was has organisation established, implemented and maintained documented energy objectives and targets at the relevant functions, levels, processes or facilities. Brown (n.d.) mentioned capturing and analysing energy data is an essential element of energy management. To achieve proper management, data on use, demand, utility rates, average price, marginal price and energy consumption per unit of output must be available and used to influence organisational decisions.

Part of the role out is a KPI report on plant day. Each business unit reports its energy consumption and base load. This method is used to assign responsibility.

6.2.3.3 Implementation
The first question about implementation was focused on whether the organisation ensures that any person(s) working for or on its behalf, as related to significant energy uses, are competent in terms of appropriate education, training, skills or experience. The paint shop has the appropriate skills due to the nature of the business units it encompasses, but other business units do not due to a lack of
engineering skills not just in the case study organisation but also South Africa as whole.

According to the SANS 50001 (2011) the organisation should ensure significant energy users have appropriate training, skills or experience. This can be achieved by using training needs analyses associated with the controls implemented within significant energy users’ sections. The case study organisation must provide training or take other actions to meet these needs. The skills shortage is a key issue in South Africa.

A related question asked whether the organisation communicates internally with respect to its energy performance and EnMS, as appropriate to the size of the organisation. The core energy team have a communication representative whose job is to communicate the targets and where the organisation is with respect to those targets. The communication strategy is divided into four themes according to the four KPI of the strategy. These four themes are divided into quarters of the year. The first campaign was about waste, the second about energy, the third about water and the last about VOC. These campaigns are promoted by means of management competition to raise awareness. Communication was involved from the beginning of the programme.

This activity seems to be in line with SANS 50001 (2011). However, one of the objectives of the strategy is to change the mind-set of the stakeholders. As an observer, the communication strategy fails to clarify why the organisation decided to take the direction it did. The communication strategy is focused more on what the organisation seeks to achieve by 2018. In order to win the minds of the stakeholders, the stakeholders must be able to understand the bigger picture.

A related question asked whether the organisation has established, implemented and maintained procedure(s) to periodically review and update documents as necessary. The case study organisation has only base load management related documentation, for example, a switch off action document that tells stakeholders where to switch the equipment on and off after production. These documents are not rolled out fully to all business units because employees in the business units must still understand
which equipment they can switch on or off. The organisation only reviews its switch off action as the model changes.

Base on observation, in spite of VDA certification, the bulk of energy document is not integrated into existing process documents. This process is also in line with VDA and ISO 14001 (2004) requirements.

6.2.3.4 Operational control
The first question about operational control was focused on whether the organisation identifies and plans those operations and maintenance activities related to its significant energy uses and consistent with its energy policy, objectives, targets and action plans. Central plant engineering does have switch off action activities for all main users during non-production hours, there are roles and responsibilities assigned to each main energy user, and the smart meter verifies if the main energy user was switched off. The switches off actions are developed in consultation with central plant engineering and production. The steps the organisation follows are identify the key energy user, quantify the saving, implement switch off action and verify if switch off actions are happening.

Deviation can be picked up from monthly reviews as well as if the business units are not implementing the required activities. Awareness for main energy users during energy management workshops and maintenance are the key to implementing switch off action.

A related question asked whether high performing business has been recognised and rewarded. Currently, the core energy team is still discussing energy management awards. These awards will inspire competition among business units. As it suggested by Genovese (2008), any behaviour that is followed by a reward is more likely to occur again. Rewards help to foster sustainable behaviours and provide motivation for engaging in particular behaviours.

6.2.3.5 Green procurement and design
The first question about green procurement and design was focused on whether the organisation considers energy performance improvement opportunities and
operational control in the design of new, modified and renovated facilities, equipment, systems and processes that can have a significant impact on its energy performance. The case study organisation has a very strong drive to implement energy efficient facilities, from intelligent lighting system to robotic processes that are energy efficient. The organisation has just installed the greenest press plant in the Southern hemisphere. From the planning side, the organisation is already planning new facilities for the run out models for relevant energy efficient plants. For any replacement motors and machinery, the organisation ensures energy efficient products.

A related question asked whether the organisation had defined and documented energy purchasing specifications, as applicable, for effective energy use. At the time the research was conducted, no formal purchasing specification was apparent; the process owner gives the buyer a product specification.

According to SANS 50001 (2011) organisations should establish and implement criteria for assessing energy use, consumption and efficiency over the planned or expected operating lifetime when procuring energy using products, equipment and services expected to have a significant impact on the organisation's energy performance. It is recommended the organisation define and document energy purchasing specifications, as applicable, for effective energy use.

6.2.3.6 Measurement and evaluation

The first question about measurement and evaluation was focused on whether the organisation ensures the key characteristics of its operations determining energy performances are monitored, measured and analysed at planned intervals. Based on the data collected, all main energy users monitor their energy consumption on monthly basis against the set energy targets. Going forward, divisional heads will also present on business day as part of their KPIs. If any deviation or negative trends are looming, divisional heads would have to explain why negative trend on their energy consumption exists.

A related question asked whether the organisation investigates and responds to significant deviations in its energy performance. At the central plant level, all
significant energy deviations from the set targets are investigated and the relevant business units informed about excessive use of energy. In most case, these deviations occur over weekends when there was maintenance activity with no production and/or during short-time days where employees were being laid off and machinery was left running. This significantly affected base load energy consumption.

The procedure does not give full responsibility to the business units because it appears the central plant engineer acts as a watchdog to any deviation. Ideally, the units should evaluate themselves constantly against the set targets and if any deviation occurs, central plant engineering can be invited to provide input on ad hoc bases because central plant is subject matter experienced. That would ensure accountability and responsibility on the part of business units.

A related question asked whether the organisation ensures the equipment used in monitoring and measurement of key characteristics provides accurate data. The organisation does not calibrate its electrical meters because the meters come with certain level of tolerance like any other electrical appliance. There is no gas meter because only one department uses gas. That means the business unit is solely accountable for the consumption of LPG.

It is understandable that if one department uses LPG, it should account for LPG consumption by means of an invoice. An opportunity cost associated with this practice exists because the organisation cannot optimise its consumption of LPG or any other form of energy that it does not measure. This means the organisation must rely on service provider’s invoice. Harding (2010) suggests, “If you cannot measure it, you cannot improve it” and argues invoices alone will not provide sufficient information to take full control of energy costs.

6.2.3.7 Management reviews

The first question about management reviews was focused on whether top management reviews the organisation's EnMS to ensure its continuing suitability, adequacy and effectiveness. The case study organisation has two main reviews: first, the implementation of energy management strategy in various business units,
which is on the executive level. At this level, the energy champion presents the strategy implementation status and plant performance. The plant performance and implementation is relayed to the parent plant where the plant performance is compared against other group plants. The second management review happens on plant level where the energy champion and head of central plant compare all business units’ performances against each other and give input. The third level happens at business unit level; this level meets on a monthly basis to review strategy implementation status and quarterly to review energy performance. However, some business units review their energy performance daily and others monthly.

It seems the organisation does not have fixed monitoring standards because various business units monitor their energy consumption differently, for example the three business units that were consulted review their energy consumption differently (see Annexure E to G). This practice leads to different monitoring standards. According to Harding (2010), energy management should be a process of continuous control and improvement, not a once-off effort. Organisations should have planned management reviews periodically in order to check if targets are being met and to identify further cost reduction opportunities that offer attractive ROIs. The lessons learnt should be used as feedback in planning to ensure continuing suitability and effectiveness.

Harding (2020) emphasized that once companies stop monitoring their energy use on a regular basis, waste starts to occur, often at least 10 percent more waste, in relatively short space of time. This is could be due to a lack of controls and/or procedures that have changed, resulting in negative effects on the energy management system. If the organisation is to implement and continually monitor the set targets religiously, it is likely to achieve significant energy savings and protect the environment (Harding, 2010).

6.3 CONCLUSIONS

In this chapter, an analysis, interpretation and integration of the data collected for the empirical study and the literature review were achieved. In the next chapter, the findings from the empirical study and literature review will be discussed, recommendations suggested and the study concluded.
CHAPTER 7 - RECOMMENDATIONS AND CONCLUSIONS

7.1 INTRODUCTION
In the previous chapter the data analysis and interpretation of the empirical study was presented. The aim of this chapter is to provide answers to the original research question:

- How can current energy management strategies be improved for a sustainable business and future?

7.2 RESEARCH QUESTION

7.2.1 Top Management Commitment
It is understood the case study organisation makes use of an environmental policy that encompasses sustainability issues. According to the Genovese (2008), commitment is an oral or written pledge or promise to change a specific behaviour. The act of committing to a particular action appears to alter one’s attitude on the topic and the way in which one views oneself. In this case, the organisation did have the environmental policy long before the organisation decided to adopt an energy efficiency strategy.

Like any other new strategic direction, the organisation should rebrand itself according to the new strategy to give a sense of change and direction to stockholders. The same applies to environmental policy; it needs to be reviewed and revised to be in line with the new strategic direction. The environmental policy should encompass water, waste, and volatile organic compounds (VOC) as the main KPI to be attained by 2018 and sustained beyond 2018.

According to ISO 50001 (2011), the energy policy should state the organisation’s commitment to achieving energy performance improvement and ensure the following:

- It is appropriate to the nature and scale of the organisation's energy use and consumption;
• It includes a commitment to continual improvement in energy performance;
• It includes a commitment to ensure the availability of information and necessary resources to achieve objectives and targets;
• It includes a commitment to comply with applicable legal requirements and other requirements to which the organisation subscribes related to its energy use, consumption and efficiency;
• It provides the framework for setting and reviewing energy objectives and targets;
• It supports the purchase of energy-efficient products, services, and designs for energy performance improvement;
• It documents and communicates at all levels within the organisation;
• It regularly reviews and updates the strategy as necessary.

The current environmental policy of the case study organisation meets five out of eight of the above points, meaning revision is necessary.

7.2.2 Core Energy Management Team
Looking at the job split for the core energy team, the split favours production. It is recommended the organisation calculate the savings to be achieved by adjusting the job split in favour of energy functions rather than production. As the literature suggests, lucrative savings can be achieved if the energy strategy is properly managed. Proper management of the energy strategy is linked to management commitment towards effective energy management.

In terms of responsibility Carbon Trust (2011) suggested that the Energy Management Team, as a whole, should encompass the following functions:
• On-going monitoring and reporting on energy use, energy cost and related carbon emissions through the use of appropriate energy metering, monitoring and analysis tools and systems. Benchmarking performance, identifying exceptions and instigating corrective actions.
• Communicating with staff to encourage all employees to be energy aware and play their part. Providing support and advice to staff.
• Identifying and implementing opportunities for reducing energy consumption and for using alternative lower carbon sources of energy.
• Keeping abreast of and managing relevant regulatory requirements, new technical developments and identifying sources of external funding for energy efficiency investment and support.
• Specifying energy efficient features in maintenance operations, plant replacements, building refurbishments and in new builds. Approval of equipment purchases from an energy efficiency perspective.

7.2.3 Tariff Structures Review
The case study organisation is focused more on daily energy tariffs than seasonal tariffs. Annual production schedules are spread out evenly throughout the year, even during market down turns. The peak season tariffs have a considerable negative impact on production costs, and this remains a significant opportunity area for the production plant. Little can be done about the price of the tariff, but electricity consumption and demand need to be tightly controlled over the peak season. This can be exercised more effectively by reviewing the annual production schedule, especially at a time of economic downturn within motor industry because of the Eurozone crisis.

7.2.4 Measure and Monitoring
It is understood a large quantity of energy sub-metering has been placed within the plant for monitoring purposes as it was depicted on Annexure E to F by different business units consulted, but the focus should on converting energy monitoring into energy management Real-time management provides an opportunity to optimise energy use in the plant. Optimisation should be driven by a benchmarking strategy with other group plants where similar operations should benchmark with each other in terms energy efficiency. Second, hourly energy consumption per part produced can be analysed and investigated for better energy efficiency only one business unit out of three that monitor energy hour by hour (Annexure G) the rest monitor monthly. That means, there was a lack of standardisation when it comes to energy review or monitoring. Third, converting energy from a fixed cost position to more of a variable cost by making use of energy produced per vehicle kWh per vehicle could be
implemented. At least all three business units that were consulted monitor their energy consumption per unit produced.

To effectively measure and monitor each business unit, a relevant budget must be allocated instead of an energy target alone. This will ensure business units use their budgets sparsely and encourage self-governing measures because if business units do not meet their targets, the cause must be investigated. Every year, the budget must be adjusted according to the desired target.

7.2.5 Monitor Other Forms of Energy
It is understandable that one department uses LPG; therefore, that department should account for LPG consumption by means of an invoice. There is an opportunity cost associated with this practice because the organisation cannot optimise its consumption of LPG or any other form of energy that is not measured. This means the organisation must rely on the service provider’s invoice. Harding (2010) suggests, “If you cannot measure it, you cannot improve it” and argues that invoices alone will not provide sufficient information to take full control over the energy costs. The company must monitor all forms of energy at regular and frequent intervals in order to enable organisation to do the following:

- Identify exceptional consumption and attend to the causes quickly;
- Ensure the organisation pays only for the fuel actually used;
- Compare current costs and performance with previous years;
- Compare several sites, processes or buildings in the company with each other;
- Compare organisational performance against typical standards for similar businesses; and
- Assess the seasonal pattern of consumption.

7.2.6 Goal Setting/Targets
Research indicates providing goals or targets for individuals, households or communities to work toward are effective for changing behaviour. A goal ideally includes the steps to reach the target in the chosen timeframe. A supporting strategy also needs to be developed to reach long-term goals or take large steps. Goal setting is most effective when coupled with feedback or forms part of a
commitment strategy. Observations suggest the organisation does not have a feedback strategy to stakeholders.

The organisation has a quarterly review meeting with union member where the managing director presents market trends and plant performance and production related KPIs. The organisation can make use of this forum to give feedback about performance on the energy strategy, which will show organisational commitment to conserve energy and other related KPIs.

It is important goals and targets be linked to rewards and recognition as suggested in the section Measure and Monitoring. Currently, the case study organisation does not recognise high performing business units. As suggested by Genovese (2008), any behaviour that is followed by a reward is more likely to occur again. Rewards not only help foster sustainable behaviours but also provide motivation for engaging in particular behaviours. Rewards are most effective when they are

- used to reward people immediately after engaging in particular eco-friendly behaviours and/or achieving their goals,
- individualised, and
- made visible.

Rewards do not have to be material objects, for example, money, food and stickers. Some people will find it rewarding to receive a compliment or some praise.

7.2.7 Competence and Skills for Significant Energy Uses

The environmental department only provided two training and awareness programs in the year 2012, and the human resource department does not have any energy-related training and awareness for the new strategic direction. According to Carbon Trust (2011), a lack of understanding and appreciation, or a lack of appropriate training can lead to unsatisfactory staff engagement outside of the core Energy Management Team. This can be overcome by ensuring formal responsibilities are assigned as above and through wider staff awareness programmes.

As Genovese (2008) suggests, aligning staff with the fundamentals of sustainability and the rationale behind what the case study organisation is doing on the
environmental front makes all the difference between a successful and unsuccessful program. Development of a functional and aligned green team can ensure progress along the organisational green path. A mix of varying levels of staff is crucial to successful implementation; likewise, awareness among significant energy users is crucial.

In support Carbon Trust (2011) indicated that a common issue is that the Energy Management Team may just expect a culture of energy efficiency to develop because they have written a newsletter and put up some posters. While both of these actions can be of value, there needs to be an understanding about what makes the organisation tick and what will drive people to do what you want.

In addition to top-level commitment, the strategy must include engagement with staff at all levels. Any effort to engage the workforce must include everyone from the Chief Executive to the part-time worker. This means making employees aware of the importance of saving energy, both for the organisation and for their own working conditions. People are more likely to change their own habits if they understand how their actions affect consumption. Staff should feel confident about making suggestions and be informed enough to take action. Workforce engagement brings energy savings in two ways: when people change their day-to-day behaviour and by the ideas that staff generate. Workforce engagement can be a low-cost activity, but it still needs to be carefully managed. Time and care spent in planning an awareness campaign will be rewarded (Carbon Trust, 2011).

The following behavioural change principles were suggested by Genovese (2008) to be considered when implementing an energy management strategy: Social norms, Feedback and prompts strategies

7.2.7.1 Social norms

When a new idea arises, most people look to others, particularly higher status peers, for guidance and clues about how to behave. When doing this, they are looking to see what the social norm is. Norms can be used effectively in a program by:

- Involving people who the audience perceive as high status individuals like union members;
• Increasing the status of people who already exhibit the sustainable behaviour, which can be achieved by featuring them in news stories and giving them prizes and awards; and
• Making the norm noticeable, for example, publicly modelling the desired behaviour.

7.2.7.2 Feedback
Feedback helps to reduce audience members’ anxiety, provides reinforcement, and gives participants an opportunity to see if they are moving in the right direction and/or ways they can improve. This strategy works best when feedback is given frequently and follows the behaviour as closely as possible.

7.2.7.3 Prompts
How many times have people gone shopping and left their green bags in the car or at home? The problem was not that the person lacked motivation, but his or her memory failed him or her. Prompts are a simple strategy to help individuals remember to perform specific actions such as turning off a light, recycling paper and taking shorter showers. For prompts to be effective, they should
• be eye-catching;
• be self-explanatory, for example, contain a simple picture and/or text that explains what the person needs to do;
• be placed close to where the desired behaviour is to occur;
• encourage people to engage in positive behaviour, rather than tell them to avoid environmentally harmful behaviours; and
• be combined with a commitment strategy to help people act on the prompt.

7.2.8 Green Procurement Policy
An energy and waste audit should be undertaken from the occurrence of the waste back to the source in order to understand the how, why, and at what stage of the life cycle the product entered the waste stream. Suppliers should be “encouraged” to provide a waste/packaging take-back service. A green procurement policy would ensure measures are in place to reduce the amount of primary and secondary packaging the plant has to deal with on a daily basis. Like other purchase decisions,
decisions are based upon initial costs, quality, delivery time and back-up service; other issues such as energy efficiency and environmental impact demand closer attention.

According to Carbon Trust (2011), the energy performance of the organisation is influenced by the choices made regarding the procurement of both equipment and services that consume energy. It is best practice in energy management to have procedures in place that ensure that the energy performance of such items is taken duly into account when procurement decisions are being made. The following represent best practice:

- An energy efficiency/low carbon procurement policy is in place, possibly as an element of a wider sustainable procurement policy. The principal responsibility for developing and implementing this policy should be with the procurement department, with strong involvement from the Energy Management Team.
- The procurement policy and its related procedures should ensure that service provision agreements incorporate terms and conditions that ensure energy efficiency is taken fully into account in line with the objectives of the organisation’s energy policy.
- The procurement policy and procedures should include reference to particular standards, such as Energy Star for IT equipment, or guidance provided by the Energy Management Team.
- Under the policy and its related procedures, the Energy Manager has a formal role in the procurement decision-making process for strategic items or service contracts, with a sign-off requirement that the procurement is consistent with the objectives of the organisation’s energy policy.

7.2.9 KVP: Continuous Improvement Process

Because the case study organisation uses a production system encompassing lean principles, energy management can use the value stream mapping process to identify opportunities to increase efficiency and develop a plan for implementing improvements. Value stream maps serve as critical tools during the review process and can reveal substantial opportunities to reduce costs, improve production flow, save time, reduce inventory, and improve environmental performance.
Conventional value stream mapping overlooks environmental wastes, such as energy, water, or raw materials used in excess of what is needed to meet consumer needs. Incorporating “lean and clean” elements into its mapping techniques will help with the following:

- Recognising where environmental effects occur in a product line
- Quantifying raw materials used by processes and comparing it to materials actually needed to produce the product
- Identifying pollution and wastes generated by the production activities
- Identifying root causes of wastes and inefficiencies.

The current verses desired value stream mapping is depicted on Annexure C and D.

7.2.10 Energy Audit

To ensure success of the system, the organisation should consider energy audits as integral to the review process. As highlighted by Bureau of Energy Efficiency (2004), energy audits are a means to identify all the energy streams in a facility. The audit quantifies energy use according to its discrete functions. It is an effective tool to define and pursue comprehensive energy management programmes. Energy audits give a positive orientation to the energy cost structure, preventive maintenance and quality control programme. Such an audit programme would assist in keeping the focus on variations having direct influences on energy costs. Audits should highlight the availability and reliability of the energy supply, appropriate energy mix, energy conservation technologies, etcetera.

The primary objective of the energy audit is to determine ways to reduce energy consumption per unit of product output or lower operating costs. An energy audit is a reference point for managing energy in the organisation and provides the basis for planning effective use of energy throughout the organisation.

7.3 CONCLUSIONS

Reducing energy use makes perfect business sense; it saves money, enhances corporate reputation and helps everyone lead the fight against climate change. Energy costs are often treated as a fixed overhead by organisations. But, by taking the right approach to energy management it is possible to make considerable
savings. Successful energy management must combine an effective strategy with the right practical interventions. Many organisations would like to save energy, but they need to make energy management an integral part of running the organisation to ensure success.

The case study organisation’s state of readiness to achieve effective energy management is relatively high, but the strategy requires some minor adjustments as recommended above. Leaders of the organisation need to develop a very robust integrated waste management policy that encompasses energy, water, VOC and CO₂ that is in line with 2018 key performance indicators. What was found missing

The case study organisation can integrate most of the energy management elements into VDA process and ISO 14001 systems to ensure a sustainable energy management system.
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ANNEXURE A MEASURING INSTRUMENT

SECTION A

Please make a cross (X) or enter the relevant information in the blocks provided.

Please Indicate Your Title
(Mr, Miss, Dr, Prof, etc.):

Gender: Male [ ] Female [ ]

Age Group: 20 – 29 [ ] 30 – 39 [ ] 40 – 49 [ ] 50 – 59 [ ] 60+ [ ]

Please Indicate Your First Language:

Please Indicate Your Highest Educational Qualification:

Please indicate your Job Title:
(Director, Deputy-director, Senior Manager, etc.)

Nature of their position:

For HOW LONG have you been working for your institution (in years?)

LESS THAN 5 YEARS [ ] 5 – 9 [ ] 10 – 14 [ ] 15 – 19 [ ] 20 + [ ]

How many years of EXPERIENCE have you got in your job or profession?

LESS THAN 5 YEARS [ ] 5 – 9 [ ] 10 – 14 [ ] 15 – 19 [ ] 20 + [ ]
SECTION B

ENERGY MANAGEMENT SYSTEM REQUIREMENTS:

TOP MANAGEMENT COMMITMENT

Has top management demonstrated its commitment to support the EnMS and to continually improve its effectiveness by?

a) Defining, establishing, implementing and maintaining an energy policy

___________________________________________________________________

___________________________________________________________________

b) Appointing a management representative and approving the formation of an energy management team

___________________________________________________________________

___________________________________________________________________

c) Providing the resources needed to establish, implement, maintain and improve the EnMS and the resulting energy performance?

___________________________________________________________________

___________________________________________________________________

Has top management appointed a management representative(s) with appropriate skills and competence, who, irrespective of other responsibilities, has the responsibility and authority to?

a) Identify person(s), authorized by an appropriate level of management, to work with the management representative in support of energy management activities;

___________________________________________________________________

___________________________________________________________________

b) Report to top management on energy performance;

___________________________________________________________________

ENERGY PLANNING

Does the organisation have systematically procedure to review tariff structures?

___________________________________________________________________

Has the organisation established an energy baseline(s) using the information in the
initial energy review, considering a data period suitable to the organisation's energy use and consumption?

________________________________________________________________________________

Has the organisation identified and implemented the applicable legal requirements and other requirements to which the organisation subscribes related to its energy use, consumption and efficiency implement, and does it have access to these?

________________________________________________________________________________

Is the energy use and consumption analysed based on measurement and other data (i.e. Identification of current energy sources and evaluation of past and present energy uses and consumption)?

________________________________________________________________________________

Are other relevant variables affecting significant energy uses identified?

________________________________________________________________________________

Has the organisation established, implemented and maintained documented energy objectives and targets at the relevant functions, levels, processes or facilities within the organisation?

________________________________________________________________________________

**IMPLEMENT**

Does the organisation ensure that any person(s) working for or on its behalf, related to significant energy uses, are competent on the basis of appropriate education, training, skills or experience?

________________________________________________________________________________

Does the organisation communicate internally with regard to its energy performance and EnMS, as appropriate to the size of the organisation?

________________________________________________________________________________

Does the organisation establish, implement and maintain procedure(s) to periodically review and update documents as necessary?
OPERATIONAL CONTROL
Does the organisation identify and plan those operations and maintenance activities which are related to its significant energy uses and that are consistent with its energy policy, objectives, targets and action plans?

To what extent planned operational and maintenance activities consistent with organisational energy policy, objectives, targets and action plans?

Does the organisation communicate internally with regard to its energy performance and EnMS, as appropriate to the size of the organisation?

GREEN PROCUREMENT AND DESIGN
Does the organisation consider energy performance improvement opportunities and operational control in the design of new, modified and renovated facilities, equipment, systems and processes that can have a significant impact on its energy performance?

Has the organisation defined and documented energy purchasing specifications, as applicable, for effective energy use?

CHECK
Does the organisation ensure that the key characteristics of its operations that determine energy performance are monitored, measured and analysed at planned intervals.
Does the organisation investigate and respond to significant deviations in energy performance?

Does the organisation ensure that the equipment used in monitoring and measurement of key characteristics provides data which are accurate and repeatable?

MANAGEMENT REVIEW
Does top management review the organisation's EnMS to ensure its continuing suitability, adequacy and effectiveness?

THANK YOU VERY MUCH FOR YOUR KIND CO-OPERATION!

This questionnaire has been ethically cleared by the Ethics Committee of Nelson Mandela Municipality University.
ANNEXURE B THE QUESTIONNAIRE COVERING LETTER

Dear Respondent

I am a post-graduate student studying towards my MBA (Masters in Business Administration) at the Nelson Mandela Metropolitan University Business School. The research project topic, “Evaluate current energy management strategy: Case Study of an automotive manufacture in Eastern Cape”. Reducing energy use makes perfect business sense; it saves money, enhances corporate reputation and helps everyone lead the fight against climate change.

You are part of our selected sample of respondents whose views we seek on the above-mentioned matter. We would therefore appreciate it if you could answer a few questions in this regard, which should not take more than twenty minutes of your time. Please note that the information gathered will not be used against any organisation in any way and that all your responses will be strictly confidential. We would like to complete all necessary interviews by the 15th October 2012. The empirical results of the study will be made available to the participants on request.

On attachment you will find interview questions which will be used to get the insight of the current energy management practice employed in your organisation. There are no correct or incorrect answers. We thank you in advance for your highly appreciated contribution towards this study

Thank you very much.
Mr Andile Mahlati
ANNEXURE C CONVENTIONAL VALUE STREAM MAPPING

Figure 17. Current Value stream Mapping

Source: (Green Suppliers, n.d.)
Figure 18. Value stream mapping incorporating environmental waste.

Source: (Green Suppliers, n.d.)
Figure 19. Value stream mapping incorporating energy.

Source: (Green Suppliers, n.d.)
ANNEXURE E FINAL ASSEMBLY ENERGY REVIEW

Figure 20 Final Assembly Business Unit energy review

ELECTRICITY Usage

GOAL: Energy reduction through continuous improvement

Target: 3% Reduction

WEEKLY ACTIVITIES

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Rsp.
1 Nominate champion
3 Weekly walkabout audit
4 Identify improvements
5 Weekly tracking to be visualised to established process
6 Communication to the shop floor in morning meeting
7 Develop energy saving culture
8 Timer switches on hydroboils & pie warmers
9 Switch all lights off during tea & lunch times (Interim)
10 - GL confirmation that lights switched off
11 - SV to do random checks and highlight failures
12 - Failures discussed in morning meetings
13 Monitor Compliance

STRUGGLE POINTS

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Source: Company A - final Assembly Business unit energy review
ANNEXURE F BODY SHOP ENERGY REVIEW

Figure 21 Body Shop Business unit energy review

Source: Company A - Body Shop Business unit energy review
ANNEXURE G PAINT SHOP ENERGY REVIEW

Figure 22 Paint Shop Business unit energy review

Source: Company A – Paint Shop Business unit energy review