Management Standards: Alternative Approaches to Energy Management?

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DECLARATION

I declare that this thesis is entirely my own work, except where otherwise stated and has not been previously submitted to any Institute or University.

Signed:

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30 May 2010

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

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ABSTRACT

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Due to the interrelationship between the energy and carbon standards, the large overlap in energy data and increasing pressure on organisations to reduce their environmental impacts, this dissertation focuses on energy and carbon management standards, relative to Ireland, in order to assess the different approaches outlined for managing energy in an organisation. The research methods consisted of a review of literature to compare energy and carbon standards, coupled with the collection and analysis of empirical energy and carbon data from a service organisation case study. This provided a meaningful comparison between research and practice.

It is evident from the research that there is a large energy data overlap between both standards and these standards, at an organisation level, have different approaches to the assessment and management of energy use and carbon emissions. These individual approaches have their own advantages and disadvantages. The energy standard 'process' driven approach ensures the organisation identifies and manages energy reduction opportunities. While the carbon standard, through is 'scientific' driven approach, ensures that the carbon emission assessment is clear, transparent and accurate, as far as practical.

The main conclusion drawn from this study is that an Irish organisation, when deciding to establish and implement an energy or carbon standard, should design a system that will comply with both standards, to maximise the benefit to the organisation through energy and carbon savings, financial savings and promote the corporate 'green' image of the organisation.

This study recommends a move towards integrating the Government's White Paper on Energy and the National Climate Change Strategy to reinforce the interrelationship between energy and carbon management and lead to combined objectives and targets to tackle Irelands' key environmental challenges. The integration of national and international energy and carbon standards, at an organisation level, is also recommended. This will maximise the benefits to an organisation, energy resources and climate change without entailing the duplication of an organisation's time and financial resources.

Keywords: *energy, carbon, standard, organisation, approach*

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Climate change and energy management have become key environmental challenges globally. Irish energy policy is set firmly in the global and EU context therefore Ireland has set out actions to be taken in response to the energy challenges in *Government White Paper: Delivering a Sustainable Energy Future for Ireland, the Energy Policy Framework 2007-2020* (DEPARTMENT OF COMMUNCIATIONS, Marine and Natural Resources, 2007).

The objective of this *White Paper* is to deliver a sustainable energy future, while tackling climate change and ensuring economic and social growth based on secure, diverse and affordable energy supply. Without policy change, International Energy Agency (IEA) predicts that global energy demand is likely to increase by over 50% between now and 2030 (DEPARTMENT OF COMMUNCIATIONS, Marine and Natural Resources, 2007, p.10). Fossil fuel energy remains the dominant source of energy today and this is likely to continue in the short term. However, fossil fuels are non-renewable resources therefore; government policies need to encourage efficient supply and use of energy and the growth in renewable energy sector.

A number of Irish and European policies have been proposed for the achievement of these energy objectives which include (DEPARTMENT OF COMMUNCIATIONS, Marine and Natural Resources, 2007):

- 20% savings in energy across the electricity, transport and heating sectors by 2020
- 15% of electricity consumption from renewable sources by 2010 to 33% of electricity consumption from renewable sources by 2020
- Limit Ireland's relative dependence on natural gas for power generation to approximately 50% by 2020

- Irish Energy Efficiency Action Plan - deliver 20% reduction in energy demand by 2020
- *EU Biofuels Directive (2003/30/EC)* has set a target of 2% use of biofuels by 2005, 5.75% by 2010 and 10% by 2020
- 130 g CO_2/km to be reached by car manufacturers by 2012

Plan and policies have also been outlined to reduce greenhouse gas (GHG) emissions to minimise climate change. The Kyoto Protocol was the first step to achieve this and this Protocol was agreed in 1997. The aim of the Kyoto Protocol was to show that developed countries, which have the responsibility for current GHG levels in the atmosphere, would take a lead in reducing their emissions. This Protocol sets emission reduction targets for many industrialised countries, including most European Union (EU) Member States by at least 5 per cent below 1990 levels over a five-year period from 2008 to 2012. The Protocol also limits the emission increases of the remaining countries. The United States of America, which have high greenhouse gas emissions, have not endorsed the Protocol (AGENCY, European Environment, 2010).

The IPCC calls for global emission reductions of about 50% by the middle of the 21st century. This implies 60–80% reduction of emissions by developed countries. Developing countries with large emissions, such as China, India and Brazil, will have to limit their emission growth (AGENCY, European Environment, 2010).

In December 2009, the 15th Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) was held in Copenhagen (COP15) - the Copenhagen Accord. This Accord is the first one to involve all major nations including the US and China since 1997. The Accord failed to agree reduction targets or plans for either the developed or developing nations. However, a number of key points were recognised and one of these was an agreement on international monitoring, reporting and verification. Many governments will be joining the UK and EU to ensure a legally binding deal is concluded by the next global climate change conference in Mexico at the end of November 2010 (TRUST, Carbon, 2009).

Under the Kyoto Protocol, the EU have committed to reduce GHG emissions by 8% below 1990 levels between 2008-2012. The EU has shared this reduction over each

EU country, depending on their development status. Ireland was allowed to increase its emission levels by 13% above 1990 levels in order to allow for industrial development (AGENCY, Envrionmental Protection, 2008). In 2004, Ireland GHG emissions were 23% greater than 1990 levels. Provisional data on Ireland greenhouse gas emissions for 2007 was published in October 2008 and data in this report Ireland's GHG emissions is 38% above 1990 levels (AGENCY, Envrionmental Protection, 2008).

The Kyoto Protocol however, is just the first step in reducing GHG emissions and addressing climate change. In January 2008, the EU Commission set a target of 20% reduction in total EU GHG emissions compared with 1990 levels by 2020 (AGENCY, Envrionmental Protection, 2008).

Many European countries have adopted national programmes aimed at reducing emissions. In Ireland, the Department of Environment, Heritage and Local Government (DEHLG) published the *National Climate Change Strategy (2007).* In this strategy the Government has set out measures to achieve Ireland's Kyoto Protocol commitments. This strategy includes measures for all sectors, energy supply, transport, residential, industrial, commercial and services, agriculture, landuse and forestry, waste and public sector (DEPARTMENT OF THE ENVIRONMENT, Heritage and Local Government, 2007).

The Government's energy policy and climate change goals are closely aligned and are reflected in both the Government White Paper on Energy and in the Climate Change Strategy. The goals set out in these policies are challenging and will involve systematic and innovative energy and carbon management and reduction plans by all stakeholders; individuals, organisations, local and national bodies.

1.2 Research Focus

All organisations contribute to environmental impact, energy usage and climate change in some way. Organisations are being driven to reduce their impacts by their customers, stakeholders and increasingly by their governments. Organisation's therefore, need to integrate environmental, energy and carbon management into the overall management structure of the organisation. The establishment and implementation of a management system to incorporate these aspects into business offers considerable benefits for an organisation.

First of all, the establishment of an energy and/or carbon management system will benefit the corporate 'green' image of the organisation by proving it is proactive in its approach towards minimising environmental issues and contributing towards sustainable development. This is positive publicity to customers, the local community and regulatory agencies. Management systems can also help increase market share by providing competitive advantage over competitors, especially on obtaining an independently certified standard and by fulfilling specific customer requirements on management systems.

Financial rewards will also be evident with improved operational efficiencies and management, decreasing operational costs. Industries currently in GHG programmes will save on the cost of GHG allowances through emission reduction and may financially benefit from the trade of excess GHG allowances. With ever increasing energy and climate change regulations, policies, taxes being introduced, it is beneficial for all organisations, to be proactive now and reduce the future corporate risk of the company. Management standards also improve the credibility of environmental monitoring and reporting, ensures compliance with environmental legislation and helps with mandatory national reporting requirements.

However, energy consumption and climate change are highly interrelated. In simple terms, if we reduce energy use, we will also reduce GHG emissions. Therefore, critical to the value and reason of the research in this study is the question– is there considerable overlap between environmental, energy and carbon management systems?

From Figure 1-1, it is evident that there is significant overlap in the aspects (i.e. energy and transport fuel) associated with each management standard. Assessing and understanding this overlap is therefore an area worthy of study and one that would contribute knowledge to organisations, energy and carbon management consultants and standards authorities. The importance of research in this field becomes even more apparent when a gap in comparison research in this area is identified.

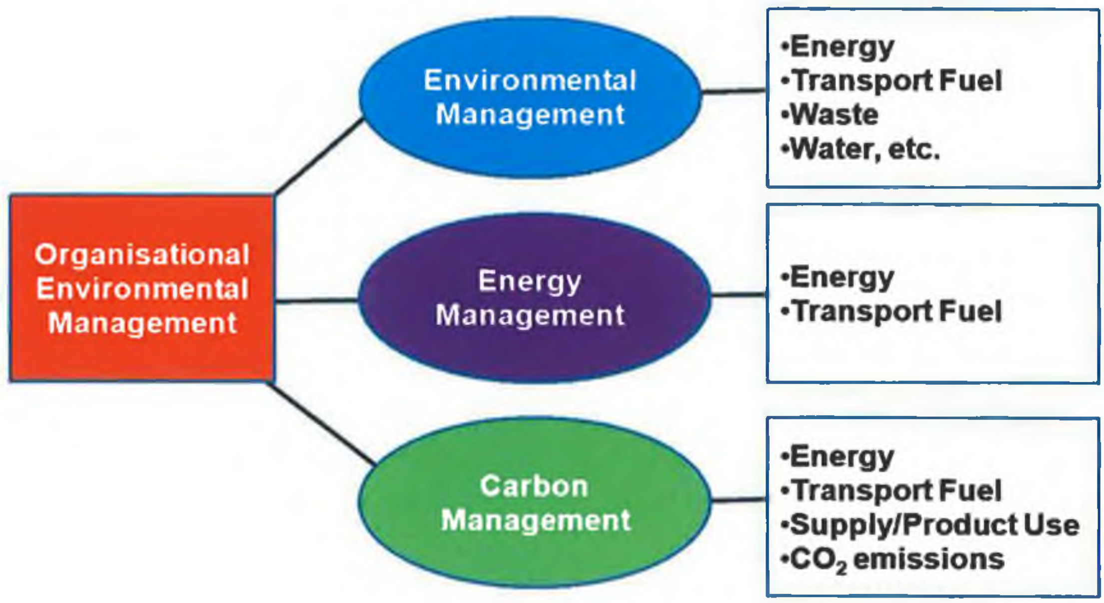


Figure 1-1: Organisational Environmental Management and Associated Aspects (Source: Clearstream Solutions Presentations)

The lack of available research can be attributed to the fact that the development of energy management and carbon management standards themselves are only a recent phenomenon and are currently only being developed in individual countries, regions and internationally. Also the fact that such standards are voluntary in nature and are not regulated by governments suggests that research into such areas is not critical. However, with the current drive in climate change and energy management the need for research into the overlap of methodologies and approaches outlined energy and carbon standards is required. This will determine if either energy or carbon management standards can be applied to an organisation to mutually benefit the organisation, as well as energy resources and climate change.

A major focus of this research will be on the examination of energy and carbon management standards in order to assess the overlap, if any, in methodologies and approaches. To gain an understanding of these issues, two main activities will be undertaken; firstly a review of literature to compare the standards themselves and ascertain current research findings on energy and carbon management standards comparisons. Secondly, empirical data analysis will be undertaken on a sample case study, in order to provide a meaningful comparison between research and practice. This will provide an improved understanding of the overlap of energy and carbon management standards.

1.3 Overall Research Aim and Research Objectives

The overall aim of this research is to examine energy and carbon management standards, relative to Ireland, in order to assess the different approaches outlined for managing energy in an organisation.

Specifically, the objectives of this research are:

1. To examine energy and carbon management standards at an organisational level to assess how energy management is approached within these standards
2. To critically evaluate energy and carbon management standards to assess the overlap in each standards requirements, if any, in managing energy
3. To appraise energy and carbon management standards to assess the accuracy and completeness of the standards
4. To outline the advantages and disadvantages of implementing an energy or carbon management standard
5. To explore if either an energy or a carbon standard can be applied to an organisation and will mutually benefit the organisation as well as energy resources and climate change
6. To formulate recommendations for Irish organisations when implementing energy or carbon standards

These objectives are not seen as independent of each other, but rather as all linked to in order to assess the overlap in energy and carbon management standards. Objective 1 will assess how energy management is undertaken within each standard type. Objectives 2, 3 and 4 provide an opportunity to gain valuable insight into overlaps in requirements within standards and the differing accuracies, advantages and disadvantages of such standards. Finally Objectives 5 and 6 will, as a result of both the literature review and collection and discussion of empirical data, allow conclusions to be drawn on if an energy or carbon management standards are more suitable to an organisation and make recommendations to organisations when implementing such standards.

The next chapter – Literature Review – examines literature applicable to the objectives of this research, beginning with an enquiry into what is meant by the term *standard.*

1.4 Scope of the Study

The scope of the study will include energy and carbon management standards that are applicable to Ireland only. This focuses on an assessment of standards which would be most beneficial for Irish organisations.

The scope of this study is also focused at an 'organisational' level rather than a 'project' level as the scope of energy or carbon projects is too broad to incorporate within the constraints or the timeline of this study.

The scope of an energy or carbon standards is also very broad therefore the methodology and analysis sections of this study will focus only on the technical 'planning' aspects of the standards such as the energy and carbon measurement.

1.5 Outline of Research Structure

This study is structured in six chapters as outlined below:

Chapter 1 Introduction

This chapter provides the reader with the background to energy and carbon management and the need for the assessment of these standards to determine energy management overlaps. The *focus* of the research is discussed and justified and the *overall research aim*, *individual research objectives* and the *scope* of the study are identified.

Chapter 2 Literature Review

Chapter 2 reviews the literature in relation to energy and carbon management standards and outlined the advantages, disadvantages and differences between such standards. This initiates the comparison and assessment of such standards, focuses the remaining of the study on specific aspects for detailed comparison and justifies the need for empirical data for the comparison of energy and carbon standards.

Chapter 3 Research Methodology

This chapter discusses and justifies the research strategy (case study) and data collection and analysis techniques (centred on specific standard requirements) to be adopted in the empirical collection of data in this study. The framework for data analysis and the limitations of this research is also outlined.

Chapter 4 Data Analysis and Results

This chapter presents the data collected, analysis undertaken and results of the case study. The results are analysed in a structured way under the headings of the specific research objectives. This chapter also synthesizes the findings of the Literature Review and empirical findings, in order to examine the research objectives as a whole.

Chapter 5 Conclusions and Recommendations

This chapter presents a summary of the findings of this research work and puts forward conclusions based on these findings. Recommendations will then be made on these conclusions.

Chapter 6 Bibliography

This chapter contains the alphabetical listing of the sources referred to in this study. The Harvard system of referencing (author-date system) is used.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Introduction

This literature review will compare energy and carbon management standards in order to assess the overlap, if any, on energy management. The study within this review of literature focuses on the first two research objectives as set out in Section 1.3 of the Introduction chapter.

1. To examine energy and carbon management standards to assess how energy management is approached within these standards
2. To critically evaluate energy and carbon management standards to assess the overlap in standard requirements, if any, in managing energy

The remaining objectives will be assessed in more detail in the data collection and analysis section of this study.

By exploring the above areas of literature, a significant contribution will be made into the comparison of energy and carbon standards. Firstly, energy and carbon management standards relevant to Ireland will be identified. Differences between standards are identified and each standard's approach to energy management is evaluated. A comparison of international energy management standards is also undertaken to assess if the requirements of other international standards are significantly different to that which is relevant to Ireland. The value in studying these standards in this structured way will facilitate a critical understanding of the standards, their requirements and the differences between them. It is hoped that a clear focus on the issues and overlaps between standards will emerge through this literature review and the need for empirical research will evolve. In the first instance, a sensible starting point is to investigate what is meant by the term *standard*.

2.2 What is a Standard?

A standard is defined as "*a technical document designed to be used as a rule, guideline or definition. It is a consensus-built, repeatable way of doing something*". Standards are created by bringing together all interested parties such as manufacturers, consumers and regulators of a particular material, product, process or service and all contributors will benefit from standardization (CEN, 2010).

2.3 The Requirement for Standards

Standards are necessary to ensure products and services we buy are of good quality, are environmentally friendly, safe, dependable, efficient and is available at a good cost. Standards contribute to:

- making the development, manufacturing and supply of products and services more efficient, safer and cleaner
- facilitating trade between countries and making it fairer
- providing governments with a technical base for health, safety and environmental legislation, and conformity assessment
- sharing technological advances and good management practice
- propagating innovation
- safeguarding consumers
- providing technological, economic and societal benefits.

Standards address quality, efficiency and best practice. These are vital for both small and larger companies. They create competitive advantage, inspire trust and reduce business cost whilst opening markets (ISO, 2009).

2.4 Standard Authorities

Ireland's official standard body is *National Standards Authority of Ireland (NSAI)*. NSAI provides a certification service which allows companies to demonstrate that their goods and services conform to recognised national or international standards. This removes barriers to business development on a global scale. NSAI also represents Ireland at national and international level to ensure published standards are best practice and reflect developments in science and technology (NSAI, 2009).

The *European Committee for Standardization (CEN (Comité Européen de Normalisation))* is an international non-profit organization which aims to facilitate a single market across the European economy. CEN is a major provider of European Standards (ENs) and technical specifications (CEN, 2010). CEN has 31 national members, of which Ireland is one, which work together to develop voluntary European Standards (ENs). Once an EN standard is developed this automatically becomes the national standard in each member country. This removes conflicting individual national standards and allows freer trade between these countries. CEN also ensures co-operation with its international counterpart the International Organization for Standardization (ISO) and ISO Standards are adopted as a European standards, once introduced (CEN, 2010).

International Organization for Standardization (ISO) is the world's largest developer and publisher of International Standards with more than 17,500 International Standards published. ISO is a non-governmental organisation where a representative from each of the 163 participant countries is part of organisation. Each country has equal influence on the direction of ISO's work, as well as the technical content of individual standards (ISO, 2009). As a non-governmental organization, ISO cannot enforce the implementation of its standards therefore, the adoption of these standards are voluntary. However, countries may decide to adopt ISO standards as regulations or refer to them in legislation. ISO standards may also become a market requirement, which provides evidence that products, services and organisations are compliant with recognised standards. ISO standards are technical agreements which provide a reference framework between suppliers and their customers. This facilitates trade and the transfer of technology (ISO, 2009).

2.5 Management Standards

Standards are designed for a number of different activities ranging from agriculture, engineering, communication technologies and good management practice (ISO, 2009). Management standards provide guidance and good management best practice. Good management can encompass quality systems, environmental systems, health and safety systems, etc. and a number of management standards have been developed to cover these areas.

From an energy and carbon management perspective, management standards and protocols that govern Irish energy and carbon management include:

National

- I.S 393: 2005 Energy Management System (superseded by EN 16001 (see below) in January 2010)

European

- EN 16001:2009 – Energy Management Systems – Requirements with guidance for use
- European Union – Emission Trading Scheme (EU-ETS) - Regulated Standard

International

- ISO 14001: 2004 – Environmental Management System (EMS)
- ISO 50001 – Energy Management Standard – Currently under development
- ISO 14064 series - for the quantification, reporting and verification of greenhouse gas (GHG) emissions
- World Resources Institute Greenhouse Gas Protocol World Business Council for Sustainable Development (WBCSD)/World Resources Institute's (WRI) *'Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard'*

Each of these energy and carbon management standards and protocols are discussed below under the relevant section heading.

2.6 Energy Management Standards

2.6.1 ISO 14001 - Environmental Management System

The ISO 14000 family addresses various aspects of environmental management. ISO 14001 and ISO 14004 deal with environmental management systems (EMS). These standards were first published in 1996 and were later revised and updated in 2004. These standards are now named as ISO 14001:2004 and ISO 14004:2004.

Companies who establish, implement and maintain an EMS strive to operate its business in an environmentally sustainable manner. ISO 14001:2004 provides the requirements for an EMS. These requirements are auditable in order to demonstrate that a company's environmental management system is compliant with the standard. ISO 14004:2004 is the technical guidance document for ISO 14001 and provides guidelines EMS implementation (ISO, 2009).

An EMS is a management tool which provides a systematic approach to identifying the environmental aspects of a company, setting environmental objectives and targets and continually improving the company's environmental performance. An environmental aspect is defined in the standard as '*an element of an organisations activities, products or services that interact with the environment*' (NSAI, 2004).

This standard outlines the generic requirements for an EMS. It is deliberately kept generic in order to ensure that whatever a company's activity – a successful EMS can be established. The Standard does not stipulate a specific level of environmental performance that is required. This also ensures that the standard can be implemented in a wide range of companies no matter what scale of environmental management currently occurs. However, the commitment for continual improvement is required for all companies which inherently demands better environmental performance over time (ISO, 2009).

ISO 14001 is a voluntary standard which only requires the Companies Environmental Policy to be published publically. In Ireland as of December 2008, 515 companies have accreditation to ISO 14001 (SECRETARIAT, ISO Central, 2009) . Up to the end of December 2008, worldwide at least 188,815 certificates had been issued in 155 countries and economies. The 2008 total represents an increase of 34,243 (+ 22%) over 2007, when the total was 154,572 in 148 countries and economies (SECRETARIAT, ISO Central, 2009). China, Japan, Spain, Italy, UK, Korea, Germany, USA, Sweden and Romania are in the top ten in terms of greatest numbers of certifications.

2.6.1.1 *Benefits of Implementing ISO 14001*

- Ensures the management of a company while minimising its impact on the environment and ensures continual improvement on this baseline.
- Good for staff morale, in the motivation that their company is environmentally responsible.
- Benefits the corporate image of the company for external stakeholders; such as customers, the community and regulatory agencies
- Complies with customer requirements
- Provide competitive advantage over competitors
- Ensures compliance with environmental legislation
- Provides a framework for demonstrating compliance by an independent certification body to all third parties.
- Can ensure financial benefits such as cost saving in waste management, resource consumption, reduction in distribution costs, saving in insurance costs, etc (ISO, 2009).

2.6.1.2 *Disadvantages of Implementing ISO 14001*

- Does not identify the nature of progress in continual improvement
- Does not require any form of independent verified environmental statement
- The standard can be achieved by companies who just meet the requirements and by class leaders
- Identification of environmental impacts are difficult for service companies/SME's

2.6.1.3 *Requirements of the ISO 14001:2004 Standard*

The ISO 14001 standard and the ISO 9001 Quality standard usually act as the basic structure for the development of any other ISO standards. The core elements of the ISO 14001 standard are outlined showing how continuous improvement is achieved through the Plan, Do, Check, Act (PDCA) cycle as shown below.

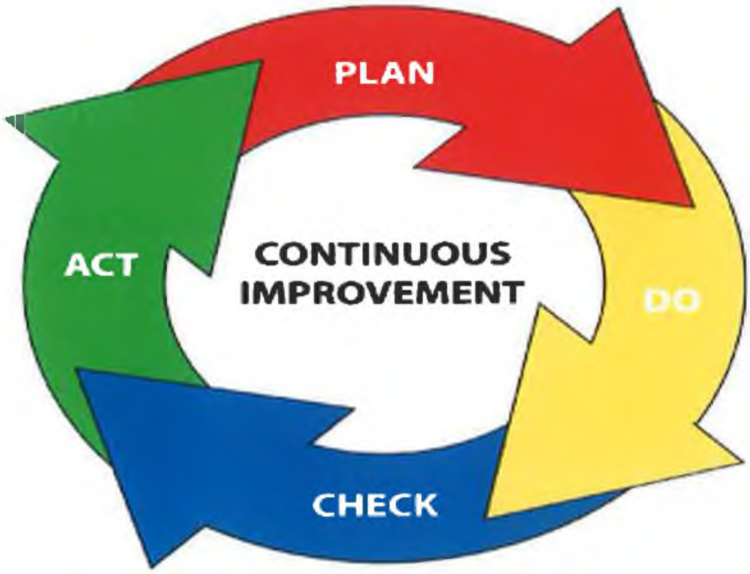


Figure 2.1: Plan, Do, Check, Act (PDCA) Cycle

An Environmental Policy is drawn up which ensures commitment to the EMS. The requirements of the standard are outlined below under the cycle headings (NSAI, 2004, p.vi).

Plan – includes:

4.3.1 Identification of Environmental Aspects

4.3.2 Identification of legal and other requirements

4.3.3 Sets out environmental objectives, targets and programmes

Do – Implementation and Operation

4.4.1 Resources, Roles and Responsibility

4.4.2 Competence, awareness and training

4.4.3 Communication

4.4.4 Documentation

4.4.5 Control of Documents

4.4.6 Operational Control

4.4.7 Emergency Preparedness and Response

Check

4.5.1 Monitoring and Measurement

4.5.2 Evaluation of compliance

4.5.3 Nonconformity, corrective action and preventative action

4.5.4 Control of records

4.5.5 Internal audit

Act

4.6 Management Review.

2.6.1.4 *Energy Management in ISO 14001:2004*

The management of energy in this standard is undertaken by identifying the environmental aspects of the company; one of which is energy usage. Legal compliance requirements related to energy are also identified, if applicable. If the energy usage aspect of a company is deemed significant then objectives and targets will be outlined to ensure improvement in the reduction or efficient use of energy.

The objective, target and programme for energy reduction is put in place and implemented by resources, training, altering operational controls, etc. Energy usage can be monitored and measured in order to ensure a reduction is being achieved and internal audits are undertaken of energy management in order to assess compliance with the management system.

As energy usage is one environmental aspect of a company. Other environmental aspects include, but are not limited to, resource use of water and raw materials, waste generation, water, noise, air emissions, etc. Therefore, depending on the nature of the company energy usage may not be a significant environmental impact and therefore, energy management will not be a high priority in the management system.

2.6.2 I.S EN 16001:2009 – Energy Management Systems – Requirements with guidance for use

The aim of this standard is to establish a management system to improve energy efficiency and enable more sustainable energy use. The management of energy aims to reduce energy costs and reduce greenhouse gas emission which contributes to climate change (STANDARDS, BSI British, 2009, p.4).

The standard is based on the ISO 14001 Plan-Do-Check-Act cycle and it is intended that this standard can apply to all organisations. It does not establish absolute requirements of energy performance for an organisation, only the commitment for continuous improvement and compliance with relevant legislation (STANDARDS, BSI British, 2009, p.4). It is a voluntary standard and the above commitments are similar to the level required for ISO 14001.

2.6.2.1 *Benefits of implementing EN 16001*

Direct benefits include:

- energy cost savings
- reduced greenhouse-gas emissions
- reduced carbon footprint
- increased energy awareness among staff
- greater knowledge of equipment efficiencies
- informed decision-making processes

Indirect benefits include:

- positive publicity
- improved corporate image
- improved operational efficiencies
- improved maintenance practices

(SEI, 2009)

2.6.2.2 *Difference between ISO 14004 and EN 16001*

The scope of EN 16001 as an energy management system focuses solely on energy. This narrows the scope from ISO 14001 to one environmental aspect – energy. The standard includes energy efficiency and the use of sustainable energy. An important difference between ISO 14001 and EN 16001 is that EN 16001 only covers '*activities under the control of an organisation*' (STANDARDS, BSI British, 2009, p.4) while ISO 14001 covers those aspects which it can control and which it can influence (NSAI, 2004, p.1).

In EN 16001, an energy aspect is defined as '*an element of the organisation activities, goods or services that can affect energy use or energy consumption'*. It also defines a significant energy aspect as that which: (STANDARDS, BSI British, 2009, p.6):

> '*accounts for a high proportion of the total energy consumption and has the potential for one or more of the following:*
> *-more efficient energy use*
> *- increased use of embedded renewable energy*
> *- increased energy exchange with the rest of society*'

In contrast the determination of a 'significant environmental impact' in ISO 14001 is left to the organisations discretion (NSAI, 2004, p.2).

Energy efficiency is also defined in EN16001 as '*the ratio between an output of an organisations activities, goods or services, and an input of energy'*. Therefore, this definition requires an organisation to produce energy performance indicators (EPI's) which relate energy inputs to organisation outputs, in order to show improvement. These definitions in EN 16001 are more exact in their requirements than those necessary in ISO 14001.

Planning

In the Planning stage of the EN 16001 standard, there is no reference to establishing, implementing and maintaining a procedure for aspect identification however, energy aspect reviews are required to be documented. The standard outlined specific steps to be undertaken in the identification of aspects such as:

a) Past and present energy consumption
b) Identification of areas of significant energy consumption
c) Estimate expected energy consumption over the following period
d) Identification of persons whose actions may lead to significant energy consumption
e) Identify and prioritise opportunities – in a register for opportunities for energy saving.

Both standards require legal and other requirements identified however, EN 16001 again removed the requirement for a specific procedure. In the development of objectives, targets and programmes the same requirements are outlined however, in EN 16001 these objectives and targets are energy related only and deals solely with those aspects under the organisations control (STANDARDS, BSI British, 2009, pp.9-10).

Implementation and Operation

In the implementation and operation requirements of the standards, the training, awareness and competence requirement in EN 16001 specifically references the competence and qualification of the management representative or energy manager. Each level of management is also required to be informed and appropriately trained in energy management. This is above what is required in ISO 14001 (STANDARDS, BSI British, 2009, pp.10-11).

EN 16001 again does not require communication procedures and external communication, unless the organisation decides to communicate externally. Under documentation, the requirements of the EN 16001 standard is reduced, with reference to procedures being removed however the control of documents and associated records still need to be maintained.

Under operational control, ISO 14001 requires specific procedures to be outlined where operations are associated with significant environmental impacts in order to prevent an environmental aspect from occurring. In EN 16001 while a procedure is not referenced, operations associated with significant energy aspects must be identified and planned. EN 16001 specifically references:

- outlining criteria for operation and maintenance,
- evaluation of energy efficiency when purchasing equipment, raw material or services from suppliers. Contractors are not included as EN 16001 only deals with aspects under direct control.
- evaluation of energy consumption in design, change or restoration
- communication of operational controls to personnel

The requirement for emergency preparedness and response is removed from EN 16001 (STANDARDS, BSI British, 2009, pp.11-12).

Checking

The monitoring and measurement section of EN 16001 is more specific in its outline of requirements. It explicitly requires an energy metering plan to record significant energy consumption and associated energy factors and develop energy performance indicators (EPI's). Where possible, these EPI's should be benchmarked against similar organisations or situations. Any deviation from expected energy usage should be recorded and causes and preventative measures outlined.

The non-conformity, corrective action and preventative action section of EN 16001 seems to be reduced compared with ISO 14001 and the word procedure is replaced by 'identify and manage'. However, it should be noted that in Annex 1 more detail is outlined under this requirement. EN 16001 also limits action required to actual rather than potential non-conformance and allows the organisation to determine when a non-conformance requires and action (STANDARDS, BSI British, 2009, p.12). In ISO 14001 the standards allows the organisation to define the criteria for identifying a non-conformance however, once it is identified as a non-conformance or a potential non-conformance action is required (NSAI, 2004, p.8).

Internal audit requirements in both standards are similar however; EN 16001 ensures compliance with legal obligations is included in internal audits. This standard also removes the requirement for a specific audit procedure. EN 16001 also links internal audits with corrective and preventative actions in the requirement that management of the area being audited are responsible for eliminating non-conformances and ensure preventative action is taken to prevent re-occurrence.

Management Review

Management review requirements are similar in both standards. However; EN 16001 management review inputs and outputs are broken down clearly.

Annex A – Guidance Document

In Annex A of the Standards, the determination of the scope and boundary of the management system is discussed in more detail.

EN 16001 in the determination of energy aspects in Annex A can also include aspects with the most potential for energy saving. The Annex also details how each opportunity should be broken down within the register of energy opportunities. One division is the determination of the opportunity in financial and/or carbon dioxide terms (STANDARDS, BSI British, 2009, pp.16-17).

Annex A also provides additional information on the identification of energy aspects, operational control, corrective and preventative action, monitoring and measurement. Under Annex A guidance, a training programme should be established and reviewed and contractors working on behalf of an organisation should have appropriate competence and training (STANDARDS, BSI British, 2009, p.20). This is additional to the requirements of the standard and the inclusion of contractors, borders on the insertion of aspects that are not within the organisations direct control.

Annex A also specifically requires an internal audit procedure which is not outlined in the standard and outlines the benefit of producing a performance statement detailing the organisations energy performance and how it is achieving continual improvement (STANDARDS, BSI British, 2009, p.27).

In conclusion, EN 16001 is more specific than ISO 14001 by virtue of the fact that EN 16001 focuses entirely on energy management, which is one environmental aspect in ISO 14001. This also allows the standard to be written more specifically stating details to be included in the identification of energy aspects, operational control, monitoring and measurement, etc. EN 16001 also moves away from the typical onerous management system documentation by predominantly removing the word 'procedure'. While the system is still required to be documented, an organisation has the opportunity to simplify the documentation system by using the energy manual, process maps, flow diagrams, etc.

EN 16001 limits the scope of the system to those aspects which it can control and does not include those which it can influence. It also only incorporates actual non-conformances rather than actual and potential non-conformances. It is more onerous from a training perspective requiring a competent and qualified energy manager. The Annex to the Standard provides a more detailed guidance to the implementation of the standard. In some requirements, the Annex actually increases the detail of the requirements from that of the standard, for example the production a performance statement for the organisation.

2.6.3 Sustainable Energy Ireland (SEI) Guidelines for I.S EN 16001:2009

Sustainable Energy Ireland (SEI) has published a number of documents to help Irish organisations with the implementation of EN 16001.

- Technical Guideline- I.S. EN 16001:2009 Energy management systems – Requirements with guidance for use
- Implementation Guide - I.S. EN 16001:2009 Energy management systems – Requirements with guidance for use, November 2009.
- Internal Audit Guide - - I.S. EN 16001:2009 Energy management systems – Requirements with guidance for use, November 2009.

The technical guidance document aims to provide technical information only, that companies could include in an energy management system. The technical focus provides a range of possible methodologies and approaches for the development of an effective energy management system.

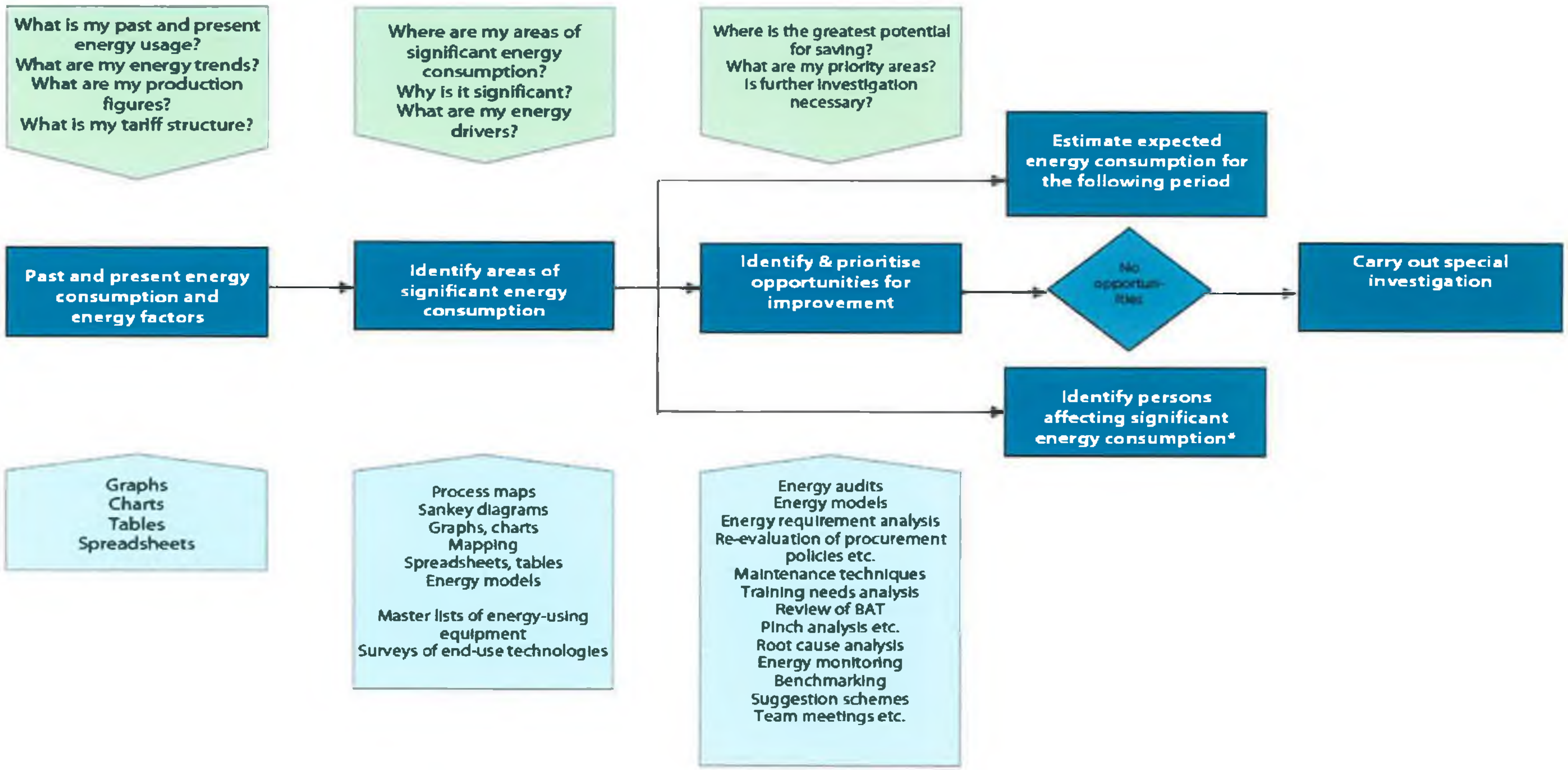
The first technical aspect of this guideline examines the review of energy aspects and it outlines that past energy data for a minimum of three years should be examined in graphs or tables. To examine significant energy aspects a number of top-down and bottom-up approaches are listed such as process maps, sankey diagrams, energy models, lists of equipment and energy surveys. Options for the technical assessment of opportunities for improvement include: energy audits, energy models, benchmarking, root-cause analysis, league tables, etc. This guidance document also introduces a new concept of ‘Special investigations’ where if no opportunities for improvement are identified at least one special investigation into an area that may offer potential savings is carried out (SEI, 2009, p.7). A diagram taken from the technical guideline illustrating the steps in the Review of Energy aspects is provided in Figure 2-2.

For setting objectives and targets a number of techniques are listed such as regression analysis, CUSUM analysis, base load analysis, etc. Under structure and responsibility, the guideline states that in complicated energy systems, management and control should be broken down into business unit management teams (SEI, 2009, p.11).

Operational control including design, specification and procurement, installation and operation and maintenance is discussed and options for assessment are provided such as whole-system design, life-cycle assessment, specific procurement guidelines, preventative maintenance, etc. The inclusion of 'Installation' under operational control is additional to the EN 16001 standard and incorporates the proper commissioning of new facilities, plant, equipment, etc and ensures sufficient training is provided during commissioning, to operational staff (SEI, 2009, p.12).

This guideline also references a Performance Statement in Annex A of EN 16001 and states that an organisation shall produce an energy performance statement to be reviewed by the certification body (SEI, 2009, p.15). It should be noted that while this guideline list options for technical analysis of energy aspects of an organisation the process for carrying out such options is not provided. Therefore, an energy specialist may be required to undertake the technical analysis.

Figure 1: Review of energy aspects



Note This diagram is for illustrative purposes only, and merely provides a synopsis of the guidance on the Review of energy aspects

Figure 2-2: Overview of Review of Energy Aspects for EN 16001 from SEI Technical Guideline Document

2.6.4 I.S 393: 2005 - Energy Management System

This standard was developed by the National Standards of Ireland (NSAI) in August 2005 to ensure energy management is integrated into organisational business. This standard has now been replaced by EN 16001 (NSAI, 2005, p.4). Similarities between I.S 393 and EN 16001 are numerous however; this section will highlight the differences between the two standards. This is significant to any of the approximately 50 Irish companies that are already certified to I.S 393, as these existing systems may need to be altered in order to comply with EN 16001, within this audit year.

In I.S. 393 an energy aspect is an element that can affect energy usage and an aspect is significant if the potential for energy performance improvement is available. However, in EN 16001 an energy aspect also includes energy consumption and has a much more detailed definition of '*significant*'. The definition of energy efficiency and energy performance indicators also varies.

I.S. 393 required to establish, implement and maintain 'procedures' for the system however, EN 16001 has removed the word 'procedures' from the standard which give a company more flexibility in system set-up. In EN 16001, the identification of energy aspects additionally requires expected energy consumption and a register of opportunities to be established for an organisation. EN 16001 specifically references targets for what is controllable by the organisation while I.S 393 is broader stating parameters that affect energy performance (NSAI, 2005, p.11).

In the implementation and operation section, I.S 393 is more flexible in structure and training allowing senior management to appoint a management representative rather than top management in EN 16001. I.S 393 does not require a competent and qualified energy manager as in EN 16001. This may prove difficult for companies to achieve, in the transition to EN 16001. I.S. 393 does not reference external communication while this is provided as an option in EN 16001 (NSAI, 2005, p.12). In operational control, EN 16001 is more specific in its requirements especially for company purchases or design of assets while I.S. 393 also incorporates installation of plant under operational control.

While I.S. 393 requires monitoring and measurement, EN 16001 is more specific in its requirements – specifying an energy metering plan and the measurement of energy consumption and energy factors to develop energy performance indicators (NSAI, 2005, p.13). In EN 16001, management are required to undertake actions from internal audits, as soon as possible, in order to avoid non-conformities and projected energy consumption is also included in EN 16001 Management review (NSAI, 2005, p.14).

Annex A of both standards are similar however, I.S. 393 does specify details on purchasing and design under operational control therefore the requirements are similar to EN 16001. In I.S 393 monitoring and measuring should be undertaken to assess against targets however, EN 16001 assesses against expected energy consumption. Annex A of EN 16001 also includes an option of producing a performance statement for the organisation. This is not referenced in I.S. 393 (NSAI, 2005, pp.15-26).

In conclusion, I.S. 393 requires a more 'procedural' system and this is eliminated in EN 16001, allowing energy mangers to focus on energy rather than documentation. It appears that the EN 16001 is much more specific and detailed in its requirements therefore; a significant degree of work will be required by companies to changeover to EN 16001. One significant factor in EN 16001 is the requirement for a 'competent' energy manager. This may be difficult to comply with in medium to small organisations. The definition of 'competent' is not provided in the standard and flexibility in this definition will need to be outlined by the standards authority.

2.6.5 Development of ISO 50001 – Energy Management Standard

While national energy standards have been developed and are in use in various countries and regional standards are also underway in Europe, China and USA, there have been requests to ISO to develop an international standard to promote energy efficiency and reduce carbon emissions.

ISO set up a new committee (PC 242) consisting of 90 participants from 25 countries as well as the United Nations Industrial Development Organisation (UNIDO) to develop this standard. The timeline for issue of this standard is currently late 2010-early 2011. It has been decided that the standard will be based on the common elements found in all ISO management standards to ensure compatibility and the specification will include a practical approach to improving energy efficiency, reducing costs and improvements in environmental footprint of organisations by combining technical aspects of energy management and strategic management aspects (PINERO, Edwin, 2009).

Before the ISO committee began work on the international standard, the UNIDO and the China Standards Certification Committee (CSC) sponsored a working group in Beijing to discuss the harmonisation of national standards for energy management. A document entitled '*Summary Comparison of National Energy Management Standards*' was prepared by the Georgia Institute of Technology in Atlanta, USA. This document will be abbreviated to the 'Summary Comparison Report' in the following discussion. This report highlights major differences among energy standards of seven countries and it was used to facilitate discussion at the working group meeting (DESAI, Deann et al., 2008). The Irish I.S. 393:2005 standard and the draft European EN 16001 standard (CEN/CLC BT/TF 189/PT Energy Management Systems) were included in this comparison.

In the Summary Comparison Report, the standards were compared across generic requirement elements of a management system (Plan-Do-Check-Act) and the standard agreement was graded high if agreement was good, medium if agreement was average and low if agreement was poor. This review will focus on those aspects of the standards that have medium and low agreement, to highlight the differences between various national standards. As the CEN standard (EN 16001) has been finalised since the publication of the Summary Comparison Report, specific reference is made to the finalised standard in the discussion on medium and low agreement below.

2.6.5.1 *Medium Agreement of National Energy Management Standards*

Scope and definitions

Firstly, the purpose of energy standards seems to vary. The purpose of the CEN, Irish and Danish standard is to improve energy efficiency. While the CEN, Swedish and Irish standard also includes the sustainable use of energy, use of renewable energy or increased energy exchange. The purpose of the US standard (MSE 200:2005) is to control and reduce costs and energy related environmental impacts (DESAI, Deann et al., 2008, p.8). The new draft US standard (MSE 2000: 200X_April 2008) broadens the scope to improved energy intensity, increased use of renewable energy and reduced expenditures for energy (TECHNOLOGY, Georgia Institute of, 2008, p.1). The boundary or the scope of a standard also varies with some standards including aspects directly under their control and other standards incorporate that which it can influence (DESAI, Deann et al., 2008, p.8).

The definition of energy also varies across standards. The USA definition is the most comprehensive and includes both primary and secondary energy. In the draft US standard, a primary energy source is defined as:

> "*Raw resources that enter the facility from an internal or external energy supplier. Primary energy resources may include electricity, natural gas, petroleum products, solid fuels, and water*".

A secondary energy resource is "*converted form of primary energy resource. This may include steam, compressed air, chilled water and hot water*" (TECHNOLOGY, Georgia Institute of, 2008, pp.4-5).

The definition of primary and secondary energy internationally is not consistent. In September 2008, an issue paper for preparing Standard International Energy Classification (SIEC) in the International Recommendation on Energy Statistics (IRES) defines primary energy as:

> "*energy embodied in sources which involve human induced extraction or capture, that may include separation from contiguous material, cleaning or grading, to make the energy available for trade, use or transformation*"

Secondary energy is defined as: "*energy embodied in commodities that comes from human induced energy transformation*" (ØVERGAARD, Sara, 2008, p.7). The main differences between these definitions and the USA definitions are that the USA considers electricity to be a primary source and it also includes water as a primary source.

This Summary Comparison Report states that secondary energy is not addressed by the CEN, Swedish, Irish or Danish standards. The CEN standard defines energy as – "*electricity, fuel, steam, heat, compressed air and other like media*" and the Irish standard defines energy as "*oil, gas, coal, bioenergy, wind, solar and other kinds of fuel, electricity and heat*". Therefore, while there are differences between the CEN and Irish definitions – aspects of both primary and secondary energy are included in both standards.

Definition of significant energy usage also varies across standards with the US standard basing it on the energy profile, CEN on total energy use, and in Ireland it is significant if it is a large portion and offers considerable potential for conservation (DESAI, Deann et al., 2008, p.12).

<u>Equipment, Systems and Process Control</u>

This section requirement has considerable variation across the standards. Mainly due to the overlap through a number of different sections of the standards for example, purchasing, design, operation control, monitoring and measuring, etc. A standard may have a specific individual requirement for a specific operational control or include all operations under the one heading (DESAI, Deann et al., 2008, p.29).

Calibration

Again, the requirement for calibration can stand as a separate requirement or be merged into the operational control or monitoring and measurement sections of standards. Variations in standard's wording include - acquire or retain appropriate equipment, ensure valid results, calibrate against traceable standards. Therefore, the level of detail required in the calibration process varies significantly (DESAI, Deann et al., 2008, p.31).

Monitoring and Measurement

The variation in the information that should be monitored and measured across standards is large. The draft US standard requires standard measurement and verification protocols to be used and the CEN standard states that "*the organization shall ensure that the accuracy and repeatability of monitoring and measuring equipment used is appropriate to the task*". China's standard requires the measurement, collection, cleaning and use of energy data to be carried out in accordance with the calculation of total production energy consumption, energy balances, use of surveillance technologies, etc (DESAI, Deann et al., 2008, pp.33-34). The variance in the requirements raises the question of whether specific standard measurement or verification protocols should be incorporated in an energy management standard.

Internal Audits

While all standards agree that internal audits should be undertaken, the focus of the audits varies. In the draft US standards, internal audits should be undertaken to determine compliance with the standard and should be planned based on energy status and importance and the results of past audits (TECHNOLOGY, Georgia Institute of, 2008, p.14). In the CEN standard, the audit schedule shall be planned, taking into consideration the significance of the parts of the management system to be audited, as well as the results of previous audits (STANDARDS, BSI British, 2009, p.13). In the Danish and Irish standards, the audit schedule should be planned, taking into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits. There is no specific reference to energy in these Standards. In order to harmonise standards, the focus of an internal audit should be clearly outlined in the standard requirement.

2.6.5.2 *Low Agreement of National Energy Management Standards*

Management Commitment

The ISO 9001 Quality standard includes a separate requirement on Management Commitment while ISO 14001 address this in the Roles, Responsibilities and Authorities section. The Summary Comparison Report raises the question of whether a separate section for management commitment is required for energy management standards.

Strategic Planning

Two out of standards compared in the Summary Comparison Report includes a requirement for strategic planning. One of these is the US standard which requires that top management ensure that the results of energy planning are considered in organizational strategic planning (TECHNOLOGY, Georgia Institute of, 2008, p.8). From a general web search, the idea of strategic planning is outlined as a sustainable approach to long term planning to achieve the organisations energy goals. Strategic planning will assess a number of different overall energy options to find the best path to energy reduction/energy efficiency.

Energy Data Management and Identifying Energy Aspects

From the examination of the standards in the Summary Comparison Report, two basic approaches emerge for the identification of energy usage and the energy opportunities. The US standard is very specific in terms of outlining specific items that need to be included in the energy profile for the organisation (DESAI, Deann et al., 2008, p.20). An energy profile is defined in the USA standard as a "*regularly updated overview of the organization's energy status, which serves as a means to connect an organisations energy use to its primary business output*" (TECHNOLOGY, Georgia Institute of, 2008, p.3). The US standard also encourages the use of baseline data as a benchmark for future energy management.

The second approach uses operational controls for significant energy aspects and programmes chosen to consider significant energy users (DESAI, Deann et al., 2008, p.20). While the CEN standard is not specific on what is to be monitored, it does incorporate past and present energy consumption, identification of areas of significant energy consumption, etc. Therefore, a data driven approach is required in order identify energy use areas. This data driven approach is outlined in detail in Annex A of the standard and in further detail in the SEI Technical Guidance document for EN 16001. The Summary Comparison Report raises the issue of whether a minimum list of energy data should be specified in the actual standard in order enable a data driven approach and ensure consistency across the standards.

Purchasing

In the Irish and CEN standard purchasing is included under the operational control requirement while the US and China Standards include 'Purchasing' as a separate requirement. In the US standard, the purchasing of energy products and services, energy supply purchasing and the evaluation of energy suppliers, energy equipment and systems is considered. In the CEN and Irish standard, energy efficiency should be considered in the purchase of equipment, raw materials and services. Therefore, the scope of purchasing in the US standards is more detailed. Other standards include the requirement for the review of suppliers based on criteria and also address the purchasing of bids and contracts (DESAI, Deann et al., 2008, p.23).

Design

Design - similar to purchasing above is included under the operational control requirement or as a separate requirement in various standards. All standards have the concept of design included. The US standard states that energy should be considered in the design of new facilities and major modifications, major upgrades and expansions (TECHNOLOGY, Georgia Institute of, 2008, p.12). The CEN standard references the design, change and restoration of all assets while the Irish just states the need to address energy efficiency in a design process. Therefore, there is no agreement between standards on what should be included in design considerations.

Energy Project Implementation

This requirement is not widely included in standards. In the US standard this requirement is included and an energy management project is defined as "*a course of action with a definite beginning and end used by an organisation to achieve energy goals and targets*" (TECHNOLOGY, Georgia Institute of, 2008, p.3). While an energy project is not specific to other standards, an energy management programme is referenced in the Irish and CEN standards. It is considered that an energy management programme is equivalent to the energy project referenced in the US standard.

Contingency Planning

Contingency planning is not included in the majority of energy management standards. The UK PAS 99:2006 standard for the specification of common management system requirements as a framework for integration is the only standard with specific reference to contingency planning (DESAI, Deann et al., 2008, p.32).

In conclusion, of the 26 section requirements assessed in the Summary Comparison Report, 10 out the 26 requirements were in high agreement, 8 out of the 26 requirements were in medium agreement and 7 out of the 26 requirements are in low agreement. All of the low agreement requirements are focused in the 'Planning' and 'Doing' sections of the standards which are the more technical aspects of the management system. This report highlights the areas that will require greater attention and debate when developing the ISO international standard. It also indicates possible changes that will be incorporated into the new ISO standard such specific requirements under purchasing, design and strategic planning. Also, the inclusion of more specific and clear requirements in the technical aspects of the standard such as scope and definitions, energy data management, monitoring and measuring and internal audits must be considered in order to ensure complete harmonisation and implementation consistency in all counties.

2.7 Carbon Management Standards

2.7.1 Emission Trading System (EU ETS)

In January 2005, the European Union Greenhouse Gas Emission Trading System (EU ETS) commenced operation as the largest multi-country, multi-sector Greenhouse Gas Emission Trading System world-wide. The scheme is based on Directive 2003/87/EC, which entered into force on 25 October 2003 (AGENCY, European Environmental, 2010). This system will help to achieve GHG emissions targets especially in large industries.

Following a review of this Directive, the European Commission adopted a proposal to amend the current EU ETS Directive (Directive 2003/87/EC) in January 2008. The revised Directive was published on 5 June 2009 - Directive 2009/29/EC. This revised Directive containing measures to fight climate change and promote renewable energy and is designed to achieve the EU's overall environmental target of a 20 % reduction in greenhouse gases and a 20 % share of renewable energy in the EU's total energy consumption by 2020 (AGENCY, European Environmental, 2010).

The 2003 Directive has been transposed into Irish law by the European Communities (Greenhouse Gas Emissions Trading) Regulations 2004 (S.I. 437 of 2004). The revised Directive (2009/29/EC) is currently in stakeholder consultation by the Department of the Environment, Heritage and Local Government before its transposition in to Irish legislation.

The EU ETS scheme works on a "Cap and Trade" basis. This means that all 27 EU governments are required to set an emission limit for all installations covered by the scheme. Each installation is allocated emission allowances and the number of allowances allocated to each installation for any given period is determined on the basis of the National Allocation Plan (AGENCY, Environmental Protection, 2010)

This Scheme creates a price for carbon 'a carbon allowance' which is equivalent to one tonnes of CO_2. The limit or 'cap' on the total number of allowances at a facility creates the shortage needed for trading. Companies that keep their emissions below the level of their allocated allowances can sell their excess allowances at a price determined by supply and demand at that time. Those companies exceeding their allowance limit can reduce their emissions, purchase additional allowances or invest in *Clean Developing Mechanism (CDM)/ Joint Implementation (JI)* projects (AGENCY, Environmental Protection, 2010). *CDM* was set up to allow countries to meet part of their emission reduction targets by investing in emission reducing projects in developing countries. Financing emission reduction projects in developed countries is covered under the *Joint Implementation (JI)* (AGENCY, European Environment, 2010).

The Environmental Protection Agency (EPA) has the responsibility for the implementation of the EU ETS legislation in Ireland. The EPA outlines the National Allocation Plan as well as the National Emissions Trading Registry to track the holding and transfer of allowances. The EPA also issues greenhouse gas emissions permits and supervises the monitoring, reporting and verification of emissions from participating companies (AGENCY, Environmental Protection, 2010).

Currently, the ETS is mandatory for stationary installations. In Ireland over 100 installations are covered by the scheme which includes energy activities, production and processing of ferrous metals, mineral industry and pulp and paper activities (AGENCY, Environmental Protection, 2010). From 2012, under the revised Directive, the ETS will also include emissions from air flights to and from European airports, chemical processing facilities and GHG transport or geological storage. (UNION, European Parliment and Council of the European, 2009).

2.7.2 European Pollutant Release and Transfer Register (E-PRTR)

The European Pollutant Release and Transfer Register (E-PRTR) is another scheme which is mandatory for all Integrated Prevention and Pollution Control (IPPC)/Waste Licensed facilities. Under this scheme each facility, provides information on the amounts of pollutant releases to air, water and land as well as off-site transfers of waste and of pollutants in waste water, from a list of 91 key pollutants, including greenhouse gases.

The facility has to report data if the facility falls under at least one of the 65 E-PRTR economic activities listed in Annex I of the E-PRTR Regulation and exceeds at least one of the E-PRTR capacity thresholds for waste or pollutants. This register contains data reported annually by approximately 24,000 industrial facilities covering 65 economic activities across Europe.

Most activities falling under the EU ETS are subject to the E-PRTR Regulation except for the combustion of fuels in installation with a total rated thermal input between 20 and 50 MW. However, data from the EU ETS and the E-PRTR is not directly comparable as activity descriptions vary and the reporting boundaries vary e.g. facility or installation.

2.7.3 ISO 14064 series - for the quantification, reporting and verification of greenhouse gas (GHG) emissions

The ISO 14064 series was published in March 2006 with an aim to reduce greenhouse gas (GHG) concentrations being released to the atmosphere. This standard aims to provide clarity and consistency for quantifying, monitoring, reporting and validating or verifying GHG emissions. The series consists of three parts:

- Part 1: Specification with Guidance at the organisation level for the quantification and reporting of greenhouse gas emissions and removals
- Part 2: Specification with Guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.
- Part 3: Specification with Guidance for the validation and verification of greenhouse gas assertions

Part 1- ISO 14064-1is focused on organisation or company level and outlines the principals and requirements for designing, developing, managing and reporting organisation or company level GHG inventories. Part 2 – ISO 14064-2 focuses on GHG projects which are project based activities especially intended to reduce GHG emissions and increase GHG removals. Part 3 – ISO 14064-3 – describes the process of GHG validation and verification that can be used for organisations or independent parties to validate or verify GHG statements.

Benefits of ISO 14064

The benefits of ISO 14064 are outlined below:

- Improve the credibility, consistency and transparency of GHG quantification, monitoring and reporting
- Streamline the development and implementation of GHG management and plans and GHG projects
- Improve the progress/performance tracking in GHG reductions
- Facilitate crediting or trade of GHG emission reductions i.e. the buying and selling of GHG allowances or credits.
- Corporate risk management – identification and management of risks and opportunities for a business
- Participation in voluntary initiatives for GHG reporting enhancing the corporate environmental image
- Benefit from early action from possible future regulatory/governmental policies such as emission trading programmes, carbon or energy taxes, regulations and standards on energy efficiency and emissions.
- Aids companies with mandatory GHG agreements or national reporting requirements under for example the EU ETS to use standard reporting procedures (STANDARDS, BSI British, 2006, p.v)
- Allows comparison with similar organisations that use the same standard.

Part 1: Specification with Guidance at the organisation level for the quantification and reporting of greenhouse gas emissions and removals

This study will examine Part 1 of this series in detail as it focuses on the organisation level rather than a project level. This standard like all the energy standards discussed above is a voluntary standard. GHG emissions are not reported to ISO for verification. The standard provides clarity and consistency for quantifying, monitoring, reporting and validating or verifying an organisation's GHG emissions.

It therefore outlines an auditable process to reduce GHG emissions. Unlike the other standards discussed, this standard does not specifically follow the typical standard heading requirements or the Plan-Do-Check-Act cycle.

This standard is also unique in the fact that it supports the use of the World Business Council for Sustainable Development (WBCSD)/World Resources Institute's (WRI) '*Greenhouse Gas Protocol – A Corporate accounting and Reporting Standard*' for guidance when implementing the requirements of the standard. This ensures consistency with existing international standards and protocols. The standard also defines what is required when the verbs 'explain' and 'justify' are used in the standard. 'Explain' should include – how approaches were used or decisions taken and why approaches where chosen and decisions made? To 'justify' means an organisation will document the requirements under 'explain' and in addition why alternative approaches were not chosen. This standard therefore, requires documented detail on decisions made during the implementation of this standard (STANDARDS, BSI British, 2006, pp.vi-vii).

The terms and definitions section of the standard defines a greenhouse gas and includes for six GHG's - carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). Global warming potentials for these gases are provided in Annex C of the Standard. Other definitions include but are not limited to: greenhouse gas source, sink, reservoir, emission, removal, assertion and inventory.

The standard also has a 'Principles' section to reflect its aim of clarity and consistency and the 5 principles of the standard are: (STANDARDS, BSI British, 2006, p.6)

1. Relevance – data appropriate to the needs of the user
2. Completeness – include all relevant GHG emission/removals
3. Consistency – meaningful comparisons across the GHG information
4. Accuracy – reduce bias and uncertainty as far as possible
5. Transparency – release sufficient and appropriate GHG information

The standard is then broken into 5 major steps. These steps are listed and explained below.

1. GHG inventory design and development
2. GHG Inventory Components
3. GHG Inventory quality management
4. Reporting of GHG
5. Organisations role in verification activities

GHG inventory design and development

Under this section organisational and operational boundaries are outlined. Organisational boundaries can be defined either by control i.e. GHG emission/removals over which a facility has financial or operation control or equity share where an organisation accounts for its share of GHG emission from a facility (STANDARDS, BSI British, 2006, p.6). Operational boundaries are defined by direct, energy indirect and other indirect emissions. Direct emission is defined as '*GHG sources owned or controlled by an organisation - this would include direct GHG emissions from electricity, heat and steam generated and exported or distributed by the organisation'*. This emission is owned and controlled by the organisation, for example, the burning of fossil fuels to produce heat. Energy indirect emissions are defined as '*emissions from the generation of imported electricity, heat or steam consumed by the organisation*'. Indirect emission would include emissions from the use of electricity onsite from an offsite power generating station. Other indirect GHG emissions are ' *a consequence of a organisations activities, but arises from green house gas sources that are owned or controlled by other organisations'* for example, employee's commuting to work (STANDARDS, BSI British, 2006, p.8). Under this standard direct and energy indirect emissions must be accounted for however, other indirect emissions may only be accounted for if applicable. GHG emissions can be excluded if the emission is deemed not substantial or if the emission quantification is not technically feasible or cost effective.

The organisation will then identify the GHG sources and sinks within the operational boundary. A quantification methodology needs to be chosen. This is mainly either by calculation (using activity data and emission factors, models, mass balance or site specific factors) or direct measurement or a combination of the two. If calculation based on activity data an emission factors is chosen this data needs to be collated. Then the calculation of GHG emissions and removals will be undertaken (STANDARDS, BSI British, 2006, pp.8-10).

GHG Inventory Components

Under this section, GHG emissions and removals are documented as tonnes CO_2e separately in accordance with the type of emissions. The organisation can then plan and implement *'directed actions'* to reduce or prevent GHG emissions (STANDARDS, BSI British, 2006, p.10). This would be similar to targets in other management standards however; this is not a necessary requirement under this ISO 14064 standard.

A GHG emission base year will also be established for comparison purposes over future monitoring years. This will also show the progress towards emission reduction in the future. An assessment of uncertainty should be undertaken for emission/removals (STANDARDS, BSI British, 2006, pp.11-12).

GHG Inventory Quality Management

This section is more consistent with the previously discussed energy management standards where GHG information management procedures should be established and maintained. This incorporates operational controls like responsibilities, training, data collection, audits and reviews. Procedures to ensure conformance with the five principles of the standard, for the identification of emissions/removals, for the quantification methodologies etc. need to be outlined. Procedures for document retention and record keeping are also required (STANDARDS, BSI British, 2006, p.12).

Reporting of GHG

GHG reporting should be undertaken for verification, participation in a GHG programme or to inform external or internal users. This section outlines the planning and content of a GHG report (STANDARDS, BSI British, 2006, pp.13-14).

Organisations role in verification activities

Verification is an independent or objective review of reported GHG emissions/removals against the ISO 14064-3. This section outlines the preparation and the planning required for the verification process and the contents of a verification statement (STANDARDS, BSI British, 2006, pp.14-16).

2.7.4 World Business Council for Sustainable Development (WBCSD)/World Resources Institute's (WRI) *'Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard'*

The Greenhouse Gas Protocol Initiative is a multi-stakeholder partnership of businesses, non-governmental organisations, governments and others. The World Resources Institute's (WRI) is a US based environmental non-governmental organisation (NGO) and the World Business Council for Sustainable Development (WBCSD) is a Geneva based partnership of 170 international companies. The aim of the initiative is to develop internationally accepted GHG accounting and reporting standards for business and encourage its implementation (COUNCIL, World Resources Institute and World Business, 2004, p.2).

The WBCSD/WRI *Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard'* was first published in 2001. The standard was widely adopted around the world, mainly due to the fact that such a wide diversity of stakeholders was involved in its development. This standard has also been used as a basis for many industry, NGO and government GHG programmes. The Corporate Standard was revised in 2004 to build on experience and feedback gained from the first edition (COUNCIL, World Resources Institute and World Business, 2004, p.3).

The WBCSD/WRI has also published a project GHG Standard entitled '*GHG Protocol Project Quantification Standard*' similar to the project focus of ISO 14064-2. In addition to this, a number of cross-sector and sector specific calculation tools are available on the GHG Protocol website for the calculation of GHG emissions from specific sources and industries. These calculations are consistent with the Intergovernmental Panel on Climate Change (IPCC) calculation of emissions at a national level and are believed to be current 'best practice' (COUNCIL, World Resources Institute and World Business, 2004, p.4)

The aim of the WBCSD/WRI GHG Protocol is to give guidance to companies and other organisations preparing a GHG inventory. It also covers the six greenhouse gases included in the ISO 14064-1 and the Kyoto Protocol (COUNCIL, World Resources Institute and World Business, 2004, p.2). As stated earlier the ISO 14064-1 standard provides the requirements of the standard however, the WBCSD/WRI GHG Protocol should be used as the guidance document fro ISO 14064-1. The requirements of ISO 14064-1 and the WBCSD/WRI GHG Protocol are very similar. However, there are some slight differences and these differences are discussed herein.

Principals

The same five principles of accounting and reporting are included in the WBCSD/WRI GHG Protocol however, the principal of 'Relevance' in the WBCSD/WRI GHG Protocol references the boundary setting by including '*appropriately reflects the GHG emissions of the company*' and it specifically references '*the chosen inventory boundary*' in the 'Completeness' principle (COUNCIL, World Resources Institute and World Business, 2004, p.7). The WBCSD/WRI GHG Protocol also includes two pages of detailed explanations of the five principles and some examples.

Organisational and Operational boundaries

The WBCSD/WRI GHG Protocol also uses the control and equity share approach to organisational boundaries and while the operational boundaries is also divided into the same three classes of emission, the WBCSD/WRI GHG Protocol calls the Scope 1, Scope 2 and Scope 3 emissions.

- Scope 1 – direct emission
- Scope 2 – energy indirect emissions
- Scope 3 – other indirect emissions

Again, Scope 3 emissions are an optional accounting category in the WBCSD/WRI GHG Protocol (COUNCIL, World Resources Institute and World Business, 2004, p.25). The WBCSD/WRI GHG Protocol provides greater guidance on how and why to select emissions for inclusion.

Quantification of GHG Emissions and Removals

In this quantification section, each standard has a five step process however, in the WBCSD/WRI GHG Protocol, the identification of activity data and emission factors are merged as one and it includes an additional step to '*roll up GHG emissions to corporate level*'. The ISO 14064-1 is more explicit on selecting or developing calculation methodologies while the WBCSD/WRI GHG Protocol references the GHG calculation tools developed for specific and cross sectors. The roll up of GHG emissions to corporate level in the WBCSD/WRI GHG Protocol includes for the gathering and summarising of GHG data from multiple facilities in order to combine data in one corporate GHG inventory (COUNCIL, World Resources Institute and World Business, 2004, pp.42-45).

GHG Inventory Components

Both the ISO 14064-1 standard and WBCSD/WRI GHG Protocol have the same requirements for base year selection and establishment. However, where the ISO 14064-1 standard requires that base year data is adjusted if there is significant change in organisational boundaries, ownership and methodologies, the WBCSD/WRI GHG Protocol outlines the 'significant threshold' and gives more guidance on what would lead to adjustments and provides examples (COUNCIL, World Resources Institute and World Business, 2004, pp.37-38).

Emission Reductions

While the ISO 14064-1 does not directly describe methods for emission, the WBCSD/WRI GHG Protocol has separate section for 'Accounting for GHG

Reductions' which outlines why one should account for reductions (COUNCIL, World Resources Institute and World Business, 2004, pp.58-61) .

Assessing and Reducing Uncertainty

The ISO 1464-1 recommends that an uncertainty assessment should be undertaken and refers to a reference document for assessing uncertainty. The WBCSD/WRI GHG Protocol does not explicitly recommend undertaking an uncertainty assessment however; it provides a three page discussion on why it is a good thing to do.

GHG reporting

The ISO 14064-1 standard requires reporting to facilitate verification, participation in GHG programmes or to inform external or internal users. This standard provides eight steps required for planning a report (STANDARDS, BSI British, 2006, p.13). In the WBCSD/WRI GHG Protocol, reporting is focused on the five principals of the standard and does not outline planning steps (COUNCIL, World Resources Institute and World Business, 2004, p.63). The list of data that 'shall' or 'should' be included in a GHG report under both standards varies and interchanges between standards however, the majority of the reporting requirements are included in both standards.

Verification

The ISO 14064-1 standard recommends that verification should be undertaken and provides guidance on preparation and management of verifications. The WBCSD/WRI GHG Protocol also discussed and provides guidance on verification however, it does not explicitly recommend verification.

GHG Targets

The WBCSD/WRI GHG Protocol has a separate section which discusses and describes why and how to set targets for GHG emission reductions (COUNCIL, World Resources Institute and World Business, 2004, p.74). The ISO 14064-1 does not address targets. In fact the entire section requirements of objectives, targets and programmes in conventional management standards are not included in ISO 14064-1.

Emerging Issues and Need for Empirical Research

The study of literature and standards revealed that; while energy management is included in environmental management standards, such as ISO 14001, energy is only one aspect to be considered within this management system and if energy is not deemed significant there is no requirement for an organisation to manage energy as a priority. Energy management standards focus on the energy aspects of an organisation alone and therefore can be more specific in its requirements towards energy management. However, energy management systems for example, EN 16001, also incorporate the aim to reduce greenhouse gas emissions and provide guidelines to analyse energy opportunities for an organisation by assessing both financial and carbon dioxide emission terms. Therefore, both energy management and carbon management standards aim to reduce greenhouse gas emissions.

The literature review also highlighted that energy standards - the Irish, European and other national standards are significantly different in their requirements. The difference lies predominantly in the 'planning and doing' sections of the standards, where for example, the definition of energy varies, the identification of energy aspects, operational control and monitoring requirements are diverse. Therefore, the direct comparison of organisational energy management across nations is not possible. However, the development of an international energy standard, which is currently underway, may overcome this variance. In contrast, the carbon management standard ISO 14064 aims to ensure consistency and accuracy in the quantification of GHG emissions and this allows the comparison of emission across industries internationally.

From the comparison of energy and carbon management standards, it is evident that energy management standards are management focused and the requirements of the standards are very specific and technical in the how an organisation should manage energy. This is evident from the requirements for 'Implementation and operation' section of the standard with the inclusion of employee training and communication and operational control. Management is also fundamental in the 'Checking' section with monitoring and measurement and analysis and auditing of deviations from compliance. The carbon management standard 'ISO 14064' does not follow the typical 'Plan-Do-Check-Act' management structure and instead focuses in the 'Planning' section to ensure GHG emissions are quantified with clarity and consistency across organisations. Carbon management standards are therefore, most specific in its requirements in the 'Planning section' than energy management standards. This 'management' verses 'quantification' aspects is also iterated in that fact that energy reduction objectives, targets and programmes are a large part of the necessary requirements under energy management standards however, in carbon management standards - ISO 14064 – directed actions to reduce GHG emission are not a necessary requirement of this standard.

Energy management standards are focused only on energy aspects the organisation can 'control'. Carbon management standards also follow the 'control' organisational boundary however; it also incorporates the equity share option. Carbon management further breaks down the operational boundaries into direct, energy indirect and indirect GHG emissions. Reporting indirect GHG emission are optional in ISO 14064 as these emission are not in direct control by an organisation – they are emissions the organisation can influence. Therefore, if indirect emissions are eliminated from the carbon standard, it appears that energy and carbon management standards are reporting on the same organisational data.

The review of literature therefore identifies that there are overlaps in the requirements of energy and carbon management standards particularly in the 'planning' sections of the standards. Unfortunately, no substantial existing empirical data on the comparison of these standards is currently available. This may be due to the fact that the development of energy management and carbon management standards themselves are only a recent phenomenon and are currently only being developed in individual countries, regions and internationally. Also the fact that such standards are voluntary in nature and are not regulated by governments suggests that research into such areas is not critical. Therefore, to arrive at a deeper understanding of the overlap and requirements of energy and carbon standards, practical research will be implemented. The next stage of this research will detail the Research Methodology to be used to capture empirical data, including the research strategy to be adopted and data collection techniques.

CHAPTER THREE

3. RESEARCH METHODS

3.1 Introduction

This research study has a number of inter-related objectives which are re-iterated below:

1. To examine energy and carbon management standards to assess how energy management is approached
2. To critically evaluate energy and carbon management standards to assess the overlap in each standards requirements, if any, in managing energy
3. To appraise energy and carbon management standards to assess the accuracy and completeness of the standards
4. To outline the advantages and disadvantages of implementing an energy or carbon management standard
5. To explore if either an energy or a carbon standard can be applied to an organisation and will mutually benefit the organisation as well as energy resources and climate change
6. To formulate recommendations for Irish organisations when implementing energy or carbon standards

Objectives 2, 3, 4 and 5 are specifically related to this Research Methods Chapter as this chapter will outline how empirical research will be undertaken in order to evaluate any overlaps in energy and carbon management standards. Accuracy, completeness, advantages and disadvantages of standards will be assessed and how these standards will benefit an organisation.

In Chapter 2, the Literature Review, it identified that there are significant overlaps in energy and carbon management however there are no practical comparisons of energy and carbon management available in current literature. Undertaking empirical research to compare these standards will allow the comparison of theoretical and practical data to gain a deeper understanding of the overlap and requirements of energy and carbon standards.

This chapter will provide the details of the Research Strategy adopted to empirically assess these standards, the means of collecting data and the data analysis approach will be outlined. Additionally, potential limitations and problems with the research methods chosen will also be discussed.

3.2 Research Strategy

There are numerous tried and tested research strategies that have standing and credibility in the academic sector. Each research strategy has its own advantages and disadvantages and it is a case of examining the different research strategies available and identifying which one is more appropriate for this study. It should be noted that Yin (2009, p 3) outlines that a research study may not be limited to just one research strategy but may be a combination of a number strategies.

This study is interested in examining how energy and carbon management standards overlap by focussing on an individual real environment/organisation. There were a number of research strategies identified as being suitable for this assessment, such as experiments, surveys, action research and case studies. Firstly, experimental research is based in 'How' or 'Why' research questions and the researcher attempts to explain or develop a cause –effect relationship, in order to test if a research theory is correct or not. While this study is a 'How' question, experimental research aims to control variables or circumstances in order to test the theory (YIN, Robert K., 2009, pp.8-9). This study aims to examine the organisation in its natural state and does not aim to control circumstances therefore, experimental research is deemed unsustainable as a research strategy.

Survey research, while this research does not aim to control behavioural events its research questions are based on 'who, what, where, how many, how much' research questions and uses survey mechanisms such as questionnaires or interviews to obtain a representative sample of results to define its research theory (YIN, Robert K., 2009, p.8). Denscombe (2003, p 6) provides two views on survey strategy - '*to view comprehensively and in detail*' and to '*obtain data for mapping*'. This study initially was considered suitable to this strategy as the aim of the study was to focus on and study in detail the technical aspects of carbon and energy management standards and map out energy and carbon data for an organisation. This study is in line with two of the three characteristics outlined by Demscombe - in that it aims to collect *empirical research* and it is a study at a *specific point in time* as it outlines the present energy and carbon management of the organisation. However, the third characteristic is – *wide and inclusive coverage* and the use of questionnaires or interviews can achieve this (DENSCOMBE, Martyn, 2003, p.6). The aim of this study is focused on one organisation therefore this research method is not suitable for this study.

Action research is where a researcher identifies a particular problem that needs to be solved or understood better and this is usually within their own working environment. Therefore, the researcher is involved in the research, not just as an observer but as a participant, where the researcher can influence the findings of the research. As well as participation, other characteristics of action research are, *practical, change and cyclical process*. This strategy is practical in that it is dealing with real situations/problems. It aims to identify ways of changing the situation to solve a problem and then re-assess the situation for improvement – therefore it is a cyclical process (DENSCOMBE, Martyn, 2003).

While this study is practical and undertaken on the researcher work environment, the results of the study are typical of all service organisations and are relevant to all organisations involved in energy and carbon management. While energy and carbon management in an organisation can be seen as cyclical improvement process – this is not been focused on in this study. This research strategy may be inherently involved in the data collection in this study through the researchers own energy and carbon usage however, while applicable is not the predominant research strategy identified.

Case study research is defined by Yin (2009, p18) as:

> *'A case study is an empirical inquiry that*
> - *Investigates a contemporary phenomenon within its real life context, especially when*
> - *The boundaries between phenomenon and context are not clearly evident'*

Using this research strategy, the researcher examines a particular occurrence or fact in a particular environment. This allows the researcher to extensively investigate the chosen research topic. A simpler definition was outlined by Denscombe (2003, p32) as:

> *'Case studies focus on one instance (or a few instances) of a particular phenomenon with a view to providing an in-depth account of events, relationships, experiences, or processes occurring at that particular instance'*

Given the nature of this study as an in-depth study of energy and carbon management standards in a service organisation environment and the aim to examine energy and carbon management processes and their interrelationship, the case study research strategy most meets the needs of this study.

The case study research strategy however; as with all other strategies are not without criticism and limitations. Limitations on case study strategies are now outlined. A case study is a very popular research strategy however, it does not have specific systematic procedures to be followed like that of experiments or surveys therefore, the use of this strategy may become careless. Due to the fact that that this strategy is popular, there is an obvious increase in frequency where lack of attention is not overcome (YIN, Robert K., 2009, p.14). However, this study will overcome this by detailing systematic procedures for data collection, data analysis and how empirical research will be undertaken, in order to ensure adherence with reputable research strategies.

By choosing a case study strategy, the study is automatically limited in scale and scope and the results from a single case study cannot form scientific generalisation. However, limiting the scale and scope of a study also has the advantage of focusing on a particular aspect in more detail. As Yin (2009, p15) points out, scientific facts are rarely based on single experiments. They are usually based on multiple experiments replicated in different environments. This can be reiterated on case studies, as in this study any results will be typical of service organisations and can be applicable to all organisations involved in energy and carbon management. However, further case studies may need to be undertaken using this study methodology to prove generalisation.

3.3 Data Collection

Site and Sample Selection

The site chosen for this case study is an engineering and scientific service consultancy company based in Cork. The company has currently 54 employees based in Cork and has a total floor area of 1677 m^2 and has a total volume of 4792 m^3. Energy usage and carbon emissions from this company will be examined and compared in this study. This will be representative of service companies involved or choosing to be involved in energy and carbon management and will also identify overlaps in energy and carbon management aspects, relevant to all organisations.

Convenience sampling was used to select this company as the researcher works with this company. Convenience sampling was also used because of the time issues of the project and the ease of access to energy and carbon data from this company.

Data Sources and Collection Techniques

This case study is considered to be a quantitative study. The aim of this research is to examine energy and carbon management standards, relative to Ireland, in order to assess the different approaches outlined for managing energy in an organisation and evaluate any overlaps in these standards. The accuracy, completeness, advantages and disadvantages of standards and how these standards will benefit an organisation will also be assessed.

The energy and carbon management standard chosen for comparison in this empirical research is the European *CEN 16001:2009 Energy Management Systems –*

Requirements with Guidance for use ('the Energy Standard' going forward) and the international *ISO 14064-1:2006 Greenhouse gas – Part 1: Specification with Guidance at organisation level for the quantification and reporting of greenhouse gas emissions and removals* ('the Carbon Standard' going forward). These standards have been chosen, in the absence of an international energy management standard - CEN 16001:2009 is the current relevant standard to Irish organisations. Part 1 of ISO 14064:2009 was chosen as it is an international standard relative to an organisation level and it also is closely aligned with the World Business Council for Sustainable Development (WBCSD)/World Resources Institute's (WRI) '*Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard*'.

The literature review identified that the main overlaps in energy and carbon management standard occurs in the technical – planning stages, therefore this area is focused on in this empirical research.

Data Collection for Energy Management System

Data collection for energy management system is undertaken in accordance with the EN 16001 standard, its guidance notes and the SEI Technical guideline document.

The scope and boundaries of this management system is the organisations activities, goods and services provided from its Cork based office. Energy sources to be included are electricity usage, natural gas usage for heating and fuel use in organisation-owned vehicles. Electricity consumption is used in lighting, electrical appliances such as office equipment and kitchen/canteen appliances and water - heating. Approximately, half of the building has electric storage heaters and the other half uses gas energy for heating purposes.

Under requirement 3.3.1 of EN 16001 - the *identification and review of energy aspects* the following is required:

- Past and present energy consumption and energy factors based on measurement or other data
- Identification of areas of significant energy consumption, in particular of significant changes in energy use during the last period

- An estimate of the expected energy consumption during the following period
- Identification and prioritisation of opportunities for improving energy efficiency
- Identification of all persons working for and on behalf of the organisation whose actions may lead to significant changes in energy consumption

How these steps are undertaken are outlined below.

1. **Past and present energy consumption and energy factors based on measurement or other data**

Energy consumption for the previous three years (2007, 2008 and 2009) is compiled from available energy bills for electricity and natural gas. The electricity supply to the building is divided into four different sub-meters, each with a separate electricity meter and a separate bill. While this generates significant more data to analyse, this sub-metering allows for more detailed energy consumption analysis and comparisons across the four different sections.

Sub-Meter 1: Second floor of building
Sub-Meter 2: Ground and first floor of building
Sub-Meter 3: Landlord supply
Sub-Meter 4: Server room

Data on fuel usage from vehicles is only available from 2009. A written log book is kept of the mileage organisation-owned vehicles travels and an expenses database allows the mileage expenses claimed by staff to be analysed.

Energy factors that are considered suitable for the assessment of energy performance include heating degree days for the use of natural gas in heating the building. Heating degree days were downloaded for Cork Airport from a website - www.degreedays.net (LIMITED, BizEE Software, 2010). The most appropriate degree day base temperature was chosen though analysis of base temperatures of 15.5 °C +/- 3 °C.

For electricity usage the most appropriate energy factors considered are occupancy numbers or occupancy hours. While there is a base load energy usage within the building the occupancy of the building plays its part in energy consumption. The Human Resources section of the organisation provided employee numbers for the last three years. Occupancy hours are calculated from the year calendar and counting standard working days within each specific billing period.

2. **Identification of areas of significant energy consumption, in particular of significant changes in energy use during the last period**

Changes in energy use over the last period are identified by examining trends and patterns in past energy data. This analysis is outlined in more detail in the Data Analysis and Interpretation section. Significant energy aspects are identified by undertaking an energy survey using a 'bottom-up' approach. A master list of all energy using equipment onsite is created. This will record quantity, actual electricity usage, operational hours and estimated annual electricity consumption. Working hours will be estimated and the actual power usage will be measured where possible from individual appliances by a plug in power meter. A wireless smart electricity meter – the *Owl meter* – is also attached to each electricity meter in order to determine the base loads of electricity in each area.

The results of this energy survey will be tabulated and grouped into specific areas listed below and from this significant energy users will emerge.

- Electrical – Computers
- Electrical – Printers
- Other Electrical
- HVAC
- Lighting
- Water Heating
- Baseload Electricity

3. **An estimate of the expected energy consumption during the following period**

Using the past energy consumption from 2007, 2008 and 2009, an expected energy consumption trend is outlined for the coming year, taking into account and known planned operational changes.

4. **Identification of all persons working for and on behalf of the organisation whose actions may lead to significant changes in energy consumption**

All personnel who can have a significant impact on energy usage within the organisation are identified and their roles, responsibly and authority is outlined.

5. **Identification and prioritisation of opportunities for improving energy efficiency**

All areas of energy consumption are identified in Step 2 above. From this, energy opportunities are identified and prioritised. Opportunities can be identified as it accounts for the greatest energy use or that greater potential savings will be achieved. Opportunities are identified under the following headings:

- Energy aspect it relates to
- Value in financial terms
- Value in carbon dioxide terms
- Action required
- Estimated or actual cost
- Payback time

Data Collection for Carbon Management System

Data collection for carbon management system is undertaken in accordance with the ISO 14064-1:2006 standard and the WBCSD/ WRI Greenhouse Gas Protocol. The WRI has also published a document on '*Working 9 to 5 on Climate change: An Office Guide*' (PUTT DEL PINO, Samantha and Bhatia, Pankaj, 2002) which is directly applicable to the office/service case study under examination. This document is used in identifying GHG sources, the requirements for data collection and the calculation of emissions.

The organisational boundary defined for this study is GHG emissions from the operational control of the Cork based organisation. Under section 4.3 of ISO 14064-1:2006 *Quantification of GHG emissions and removals* the following is required:

- Identification of GHG sources and sinks
- Selection of quantification methodology
- Selection and collection of GHG activity data
- Selection or development of GHG emission or removal factors
- Calculation of GHG emissions and removals

How these steps are undertaken are outlined below.

1. **Identification of GHG sources and sinks**

Operational boundary emissions that can be included in the scope of the calculation are:

- **Direct GHG emissions (Scope 1) –**
    - natural gas usage for heating
    - fuel use in organisation-owned vehicles
    - fugitive emissions of refrigerant from equipment leaks from fridges and air conditioning units

- **Energy Indirect GHG emissions (Scope 2)** – electricity purchased and consumed by the organisation
- **Other Indirect GHG emissions (Scope 3) –** these emissions are outlined in Table 1.

Table 1 Possible Other Indirect GHG Emissions from the Organisation

Other Indirect Emission	Data Availability	Other Indirect Emission	Data Availability
Fuel use in privately owned vehicles used for work purposes	*Estimated data can be generated*	Emissions from outsourced activities – sub-consultant work	Data currently not available. Data would be difficult to generate
Fuel use in privately owned vehicles used for commuting to work	*Estimated data can be generated*	Emissions from waste generated at office – transport and recycling/ recovery/ disposal of waste.	Data currently not available. Data would be difficult to generate
Fuel use in business travel – public transport, flights etc.	*Estimated data can be generated*	Emissions from the construction, use of and decommissioning of services designed by the organisation.	Data currently not available. Data would be difficult to generate
Extraction, production and transportation of purchased materials – fuels, paper, toners, cleaning products, condiments, etc	Data currently not available. Data would be difficult to generate	Emissions from the transport of reports/services – An Post, Couriers etc.	Data currently not available. Data would be difficult to generate
Product use onsite – increased use of paper, toners, cleaning products, condiments, etc	Data currently not available. Data would be difficult to generate. *Use of printing paper can be estimated.*	Emissions from the generation of electricity consumed by the organisation lost in transmission and distribution losses	Data currently not available. Data would be difficult to generate

Emissions from fuel usage in privately owned vehicles for work purposes is debatably a 'direct' or 'other indirect' emission. While employees have the control over the type of vehicle used, the organisation is directly responsible for the distance travelled to undertake the work. In the *WRI Office Guide,* this emission is categorised as an 'Other indirect emission' therefore this study will also include it in this category.

In accordance with the carbon standard, direct emissions and energy indirect emissions are required to be reported while the reporting of 'Other indirect emissions' are optional. The WRI Greenhouse gas protocol provides further details on 'Other Indirect emissions' and state that these emissions may be relevant and reported on as: (COUNCIL, World Resources Institute and World Business, 2004, p.30)

- They are large relative to other emissions
- They contribute to a company's risk exposure
- They are important to stakeholders
- There are potential emission reductions that could be undertaken or influenced by the company

It is also acknowledged that data availability and reliability on 'Other indirect emissions' can be limited and accuracy is therefore reduced however; emission estimates are acceptable as long as the calculations are transparent. It may be important for an organisation to understand the magnitude of these emissions.

In this study, direct and energy indirect emissions will be included. This scope is the same as that included under the energy management system, with the exception of fugitive GHG emissions from equipment. In the 'other indirect emissions' category, it is likely that significant emissions would be calculated from fuel usage in commuting to work and business travel. Also, due to the nature of the service, as an engineering consultancy, paper usage is also considered significant. As data can be generated for fuel usage and paper usage, these emissions will be included in the calculation.

Emissions from outsourced activities and from the construction, operation and decommissioning of services designed by the organisation are also likely to be significant as considerable emission reductions can be achieved through sustainable design and operation of a facility. However, the lack of data and the time requirement to generate such data would be substantial and cannot be completed within the timeframe of this study.

2. **Selection of quantification methodology**

The quantification methodology is based on Section 4.3.3 of ISO 14064-1. This section references prescribed GHG programme methodologies. The GHG programme that is most applicable to Ireland is the EU *Emission Trading Scheme* quantification methodology. The '*European Commission Decision 2007/589/EC establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council*' is complied with, in this study (COMMISSION, The European, 2007). The quantification methodology chosen is calculation based on GHG activity data and GHG emission or removal factors.

3. **Selection and collection of GHG activity data**

The GHG sources and the source of activity data outlined in Table 2 below have been selected for inclusion in the organisations GHG emissions.

Table 2 GHG Activity Data and Sources

GHG Source	Source of Activity Data
Natural gas usage for heating	Metered gas usage from utility bills
Fuel use (diesel) in organisation-owned vehicles	Fuel quantities on fuel card statements
Fugitive emissions from equipment leaks, HFC use in refrigerant and air conditioning units	Refrigerant type and charge capacity – collated from equipment labels.
Electricity purchased and consumed by the organisation	Metered electricity usage from utility bills broken down by supplier – Airtricity, ESB and Bord Gais.
Fuel use in privately owned vehicles used for work purposes	Distance travelled will be collected in employee expense forms. Individual vehicle distance could not be broken down therefore total distance in privately owned vehicles was calculated.
Fuel use in privately owned	Survey of employees for distance travelled, type of

GHG Source	Source of Activity Data
vehicles used for commuting to work	fuel, fuel efficiency, frequency of travel, etc.
Fuel use in business travel – public transport, flights etc.	Business flights taken will be determined from credit card statements and booking confirmation details. Distance travelled estimated from Google Earth.
Use of printing paper	Papercut software monitors paper usage in each printer onsite. % paper recycled/ disposed estimated

4. Selection or development of GHG emission or removal factors

An emission factor is a measure of the average amount of a specific pollutant discharged into the atmosphere by a specific process, fuel, equipment, or source. Emission factors used should be appropriate, derived from a recognised origin and best available at the time of quantification. Specific emission factors used and their sources are outlined in Table 3 below.

Table 3 GHG Emission Factor and Sources

GHG Source	Chosen Emission Factor	Source
Natural gas usage for heating	NCV - 0.9028 57.112 - t CO2/TJ	EPA Emission Factors October 2009
Fuel use (diesel) in organisation-owned vehicles	73.3 t CO2/TJ CH_4 emission – 1.9 kg CO_2eq N_2O emission – 28.3 kg CO_2eq	SEAI Emission Factors (SEAI, 2010) Defra – Annex 6 Table 6A (AEA, 2009)
Fugitive emissions from equipment leaks, HFC use in refrigerant and air conditioning units	Estimated leakage rate	DEFRA – leakage Rate Annex 8 Table 8B and GWP of Refrigerant Annex 5 (AEA, 2009)
Electricity purchased and consumed by the organisation	Airtricity – 142 Bord Gais: 554 ESB: 565 g CO_2/kWh	CER: Fuel Mix and CO_2 Emission Factors Disclosure 2008 (CER, 2010)
Fuel use in privately owned vehicles used for work purposes	Diesel - 73.3 t CO_2/TJ CH_4 emission – 1.9 kg CO_2eq	SEAI Emission Factors (SEAI, 2010) Defra – Annex 6 Table

GHG Source	Chosen Emission Factor	Source
	N_2O emission – 28.3 kg CO_2eq	6A (AEA, 2009)
Fuel use in privately owned vehicles used for commuting to work	Petrol - 70.0 t CO_2/TJ CH_4 emission – 4.7 kg CO_2eq N_2O emission – 22.6 kg CO_2eq Diesel - 73.3 t CO_2/TJ CH_4 emission – 1.9 kg CO_2eq N_2O emission – 28.3 kg CO_2eq	SEAI Emission Factors (SEAI, 2010) Defra – Annex 6 Table 6A (AEA, 2009)
Fuel use in business travel – public transport, flights etc. Short flight: <463 km Medium flight:>463<3700 km Long flight: >3600 km	Uplift factor – 1.09 kg CO_2 per pkm **Short Flight** CO_2 - 0.17102 CH_4 - 0.00013 N_2O - 0.00168 **Medium Flight** CO_2 - 0.09826 CH_4 - 0.0001 N_2O - 0.00097 **Long Flight** CO_2 - 0.1122 CH_4 - 0.0001 N_2O - 0.0011	Defra – Annex 6 Table 6I (AEA, 2009)
Use of printing paper	Production – 1.2 kg CO2 per € 237 Net kg CO2 eq emitted per tonne for recycling of paper 1500 Net kg CO2 eq emitted per tonne for disposal of paper	Defra – Annex 13 Table 13 (AEA, 2009) Defra – Annex 9 Table 9b (AEA, 2009)

Where assumptions were required in the selection of activity data or emission factors they were conservative in approach, in order to ensure that no under-estimation of annual emissions occurs in accordance with *EC Decision 2007/589/EC.*

5. Calculation of GHG emissions and removals

All calculations of CO_2 emissions are based on the following generic formula:

CO_2 emissions = activity data * emission data * oxidation factor

However, specific formulas for different emissions are required as outlined below

Natural Gas Combustion emissions calculations:

CO_2 emissions = fuel used * net calorific value * emission factor * oxidation factor

(Oxidation factor = 1 for natural gas)

Process emissions =

CO_2 emissions = no. of units * equipment charge * period of use * leakage rate * Global Warming Potential (GWP)

Purchased Electricity Emissions:

CO_2 emissions = activity data (kWh electricity used) * emission factor

Car Travel Emissions:

CO_2 emissions = activity data (quantity of fuel used) * emission factor

Air Travel Emissions:

CO_2 emissions = activity data (passenger kilomteres) * uplift factor* emission factor

(Uplift factor – factor to include climb/cruise and decent fuel usage)

Paper Use Emissions:

CO_2 emissions = (activity data (no. of pages * weight of paper* cost of paper) * emission factor for production of paper)

+ (activity data (no. of pages * weight of paper) * emission factor for recycling/disposal of paper)

Appendix A contains a copy of the data collected as part of this study and the conversions and calculations undertaken to assess the technical aspects of these standards.

6. Assessing and reducing uncertainty

Requirement 5.4 of ISO 14064-1 states that an organisation should complete and document an uncertainty assessment for GHG emissions and removals. An uncertainty assessment was undertaken in accordance with this requirement and in line with the '*GHG protocol guidance on uncertainty assessment in GHG inventories and calculation statistical parameter uncertainty*' document and the GHG Protocol Uncertainty Calculation tool (OHNDORF, Mark and Gillenwater, Michael, 2010).

This calculation tool uses the first order error propagation method to collect parameter uncertainty information and aggregate it into one overall uncertainty value. Parameter uncertainty is uncertainty associated with quantifying the parameters used as inputs to the calculations included in activity data, emission factors and other conversion factors. Parameter uncertainties can be determined by a number of processes however in this research, statistical analysis is used.

The GHG Uncertainty Calculation tool requires activity data and the uncertainty associated with it and emission factors used and the uncertainty associated with them. To calculate the uncertainty associated with activity data the following procedure is undertaken:

1. Choose a confidence level – this determines the probability, that the true value of emission is situated within the identified uncertainty range. The IPCC suggests a confidence level of 95% as an appropriate level for range definition (OHNDORF, Mark and Gillenwater, Michael, 2010, p.9).
2. Determine the t-factor t – by using Annex 1 of the uncertainty guidance and using the number of sample measurements and the 95% confidence level (OHNDORF, Mark and Gillenwater, Michael, 2010, p.17).
3. The sample average x and the sample standard deviation s is calculated for each emission
4. The interval is calculated using this equation: (OHNDORF, Mark and Gillenwater, Michael, 2010, p.10)

$$\frac{s \cdot t}{\sqrt{n}}$$

The emission factors used are all published from a recognised origin. However, these published emission factors do not have associated published uncertainty intervals. Organisations that developed the emission factors used in this case study were emailed and uncertainty intervals were requested. Of those that responded, it was specific uncertainty intervals were not calculated.

The EPA's National Inventory Report (NIR) 2010, has uncertainty estimates published for 2008. The EPA estimates a 2.5% uncertainty for emission factors for energy –gas and transport -oil/gas (MCGETTIGAN, M. et al., 2007, p.29). These are not specific to the emission factors used in this case study however; an emission factor uncertainty of 2.5% is used across all activity data, in this case study as a best estimate.

In the EU ETS programme, *EC Decision 2007/589/EC* has a mechanism for increasing the accuracy of the calculation by using Tier approaches. Its approach is the higher the Tier number used the greater the accuracy of the data. Therefore, the highest numbered tier that is technically feasible and does not entail unreasonable costs should be used (COMMISSION, The European, 2007, p.14). Tier approaches are only relevant to stationary direct GHG emissions as this is the scope of *EC Decision 2007/589/EC* and therefore is not applicable to indirect and other indirect emissions. In this case study, natural gas usage is the only stationary direct emission and Tier 1 is chosen for the natural gas activity data. With regards to emission factors, Tier 2a – country specific factors were used.

3.4 Framework for Analysis

In order to focus the data analysis, the quantitative data collected is assessed and compared under a number of different headings. These headings are:

- Assess the overlap of energy and carbon standards, in managing energy
- Assess the accuracy and completeness of the standards, in managing energy
- Advantages and disadvantages of the implementation of energy and carbon standards
- Explore if either standard can be applied to an organisation and will mutually benefit the organisation, energy resources and climate change

The approach to be adopted for the analysis of this case study is outlined in Figure 3.1 below:

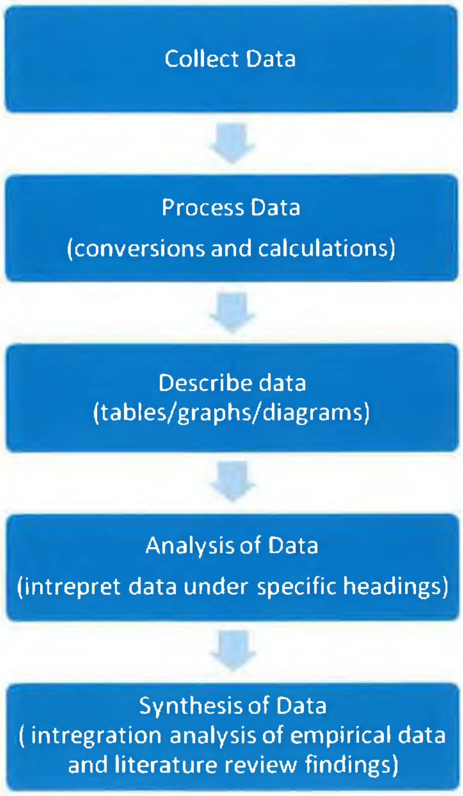


Figure 3.1: Framework for Data Analysis

All energy and carbon activity data is collected and processed in order to be able to fully understand and analyse it. All the data collected is summarised and described using tables, diagrams or graphs as appropriate. Trends and anomalies are highlighted and discussed. Then, the data is interpreted under specific headings in order to focus the analysis and achieve answers to the objectives laid out in this study. Finally, the findings of the literature review and the empirical analysis are combined to provide an integrated and deeper understanding of the study findings.

3.5 Potential Limitations and Problems

As stated earlier, when discussing the chosen research strategy in Section 3.2 the use of a case study, as a strategy, limits the interpretation of the results and conclusions of this study, as the results cannot be generalised across all Irish organisations. However, the results are directly applicable to service organisations particularly those that do not have significant process emissions and all organisation interested in energy and carbon management. This study layouts a research strategy than can be repeated in other organisations and with multiple case studies undertaken using the same strategy, the results of the assessment may then be proved as a generalisation.

The reliability of case study research is also questioned particularly those case studies that undertake empirical analysis using interviews or qualitative data. However, this case study is based entirely on quantitative data through the use of energy /activity data and carbon emission factors. Basing the study on quantitative data removes criticism on the objectivity of the study, with the study undertaken in the researcher's place of work. In this study, data collection, processing and interpretation is explained in detail to ensure transparency and reliability.

In the scoping of the emissions to be included in the carbon emission calculations, it was evident that there were limitations in the collection of data especially for 'other indirect' emissions. Significant time and resources are required to calculate such emissions and in reality, it would be very difficult to acquire certain activity data especially when depending on external sources. This limits the calculation of the carbon emissions from the organisation. Due to the time constraints of this study, the calculation of 'other indirect' emissions was only undertaken with activity data that was easily sourced.

In the energy standard data analysis, past and present energy consumption is required to be related to energy factors. In a service organisation it is difficult to relate energy use to a specific organisation activity. Energy factors examined in this case study included employee numbers, occupancy hours and heating degree days for natural gas usage. Employee numbers and occupancy hour energy factors should typically drive day-time electricity use and night time energy use should be minimal due to inactivity at the office however, this is not the case due to equipment being left on, unnecessarily. Day time energy usage related to occupancy hours provided the best regression value however, accurate trends were difficult to achieve. The case study organisation will need to examine such trends in greater detail in order to achieve a greater degree of accuracy.

The preparation of the Register of Energy Opportunities under the Energy Standard involved a detailed assessment of energy savings, financial savings, carbon savings and costs for each opportunity. Due to the time frame of this study, this assessment was limited to estimations of savings and costs. Therefore, the case study organisation should complete a more detailed assessment, before prioritising such opportunities.

In the carbon standard, an uncertainty assessment was undertaken. This assessment proved difficult to complete, with any accuracy, as uncertainty intervals for published national emissions factors were not available. This hindered the uncertainty assessment in this case study and made the uncertainty interval derived for the study even more uncertain. For clarity all published emission factors should be reported with their uncertainty intervals.

This chapter has outlined the data collection, processing and analysis to be used in this research strategy. It has also addressed the limitations of this research and the problems encountered during the study. The next chapter – Research Findings – discusses and analyses the results of the case study.

CHAPTER FOUR

4. EMPIRICAL FINDINGS –DESCRIPTION, ANALYSIS AND SYNTHESIS

4.1 Introduction

This chapter discusses the results of the case study described in Chapter 3 Research Methods. The case study research is focused on an in-depth data analysis of energy and carbon management standards in a service organisation environment, in order to examine a number of identified research objectives such as:

1. To critically evaluate energy and carbon management standards to assess the overlap in each standards requirements, if any, in managing energy
2. To appraise energy and carbon management standards to assess the accuracy and completeness of the standards
3. To outline the advantages and disadvantages of implementing an energy or carbon management standard
4. To explore if either an energy or a carbon standard can be applied to an organisation and will mutually benefit the organisation as well as energy resources and climate change

The data analysis is approached in a structured way. Firstly, the results of the empirical data on both the energy and carbon management are described under the specific requirements of the 'planning' sections of the individual standards. These results will then be assessed and analysed under a number of different headings in order to examine the specific research objectives. Lastly, this chapter will synthesize the findings of the Literature Review in Chapter 2 and the empirical finding of this chapter, in order to examine the research objectives as a whole.

As described in detail in Chapter 3, this research case study examines the energy usage and carbon emissions of an engineering and scientific service consultancy company based in Cork. The company building consists of three floors. On entering the building the main stairs and elevator to the upper floor can be accessed. Inside this is a common hall area which includes male and female sanitary facilities. This is replicated on each floor of the building.

The ground floor consists of a number of small to medium rooms, reception area, a meeting room, the main computer server room and a staff canteen. On the first floor there is a mixture of large open plan offices small individual offices. The second floor is similar to the first with large open plan offices and small number of individual offices. Currently, one area of this floor is the document archive and compiling area.

The main activities in the office would be the operation of personal computers, printing, photocopying and scanning. During break and lunch times the office canteen would also be utilised. Equipment in the canteen consists of the usual conveniences just as a fridge, hot water boiler, microwave, toaster etc. The core working hours are 8.30 – 5.00 Monday to Friday. Occasionally employees work times may extend beyond these hours due to work-loads.

The results of the energy usage and carbon emissions assessment of this company are outlined in summary in the followings sections of this chapter however, further detail on specific data and processing undertaken can be found in Appendix A and B of this document.

4.2 Data Description

Firstly, the results from the assessment undertaken, following the requirements of the energy management standard EN 16001 – requirement 3.3.1 - the *identification and review of energy aspects,* are outlined. These results are described under the heading of the requirements of the standard.

4.2.1 Past and present energy consumption and energy factors based on measurement or other data

Energy consumption in the organisation consists of electricity usage, natural gas for heating purposes and diesel fuel usage in organisation-owned vehicles. These energy usages are discussed individually below.

Electricity

Electricity consumption for the previous three years (2007, 2008 and 2009) was compiled and examined from electricity bills. As stated in Chapter 3, the electricity supply to the building is divided into four different sub-meters:

- Sub-Meter 1: Second floor
- Sub-Meter 2: Ground and first floor
- Sub-Meter 3: Landlord supply
- Sub-Meter 4: Server room

Sub-Meter 1: Second floor

Energy consumption on the Second floor from 2007-2009 is illustrated in Figure 4-1.

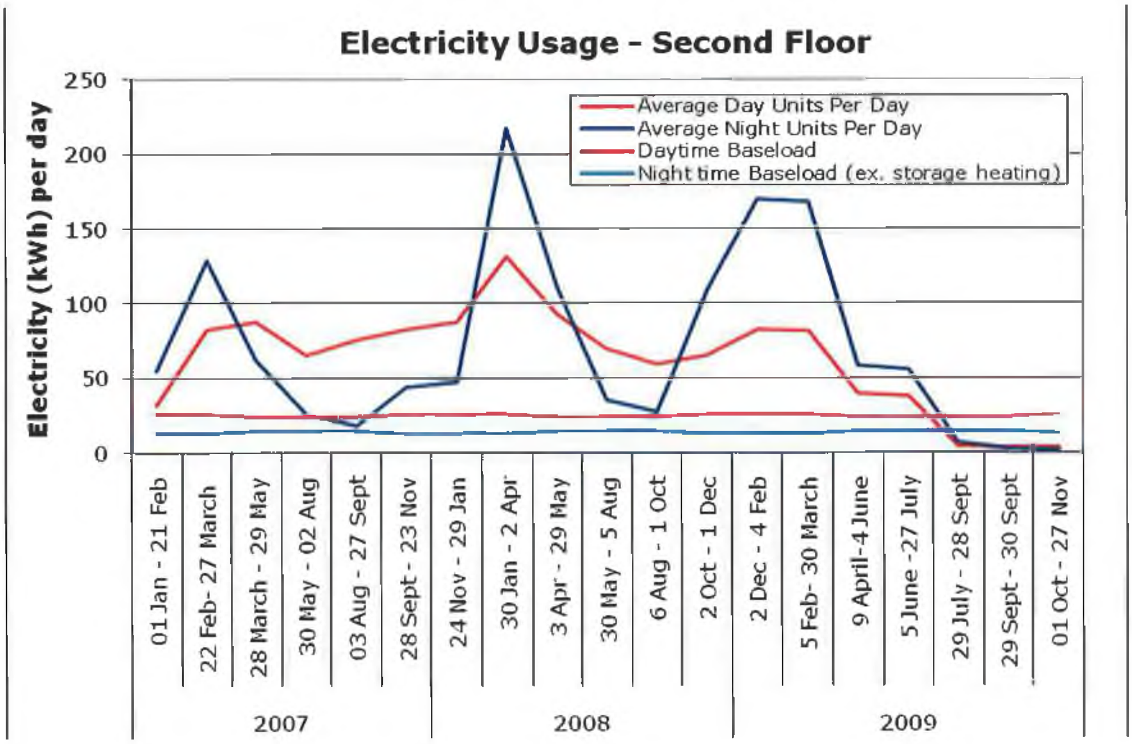


Figure 4-1: Electricity Usage on Second Floor of Organisation

This meter records both day-time and night-time units. Heating on this floor is electric convection heaters and night storage heaters. Due to this, night time units exceed day time units during the winter periods, with winter 2007-2008 recording the highest energy usage. However, daytime energy usage also increases during winter periods. This may be due to longer lighting hours and may also indicate incorrect usage of the storage heaters by boosting during daytime.

Average day and night time energy baseloads were also monitored for a short period during this assessment and are included in this figure for comparison. The night baseload does not include night time storage heating levels which peak between 22:30 and 3:30 am (See Figure 3 Appendix A). Examining the night time and night time baseload trend, it is evident that even during the summer months when the storage heating is off the baseload is not reached. This identifies that electric appliances are being left on overnight, unnecessarily.

In June-July 2009, the second floor was vacated and all employees were moved to the ground and first floor. A significant decrease in energy usage is evident at this time. Energy usage levels during this period are actually lower that the current estimated baseload which signifies that a reduction in the estimated baseload is achievable.

Energy factors which drive daytime energy usage in the second floor would include employee numbers and/or occupancy hours however; it was difficult to get an accurate trend using occupancy hour due to the fact that electrical heating causes significant variance in energy usage (See Figure 1 Appendix 1). Using degree days as the energy factor produces a more appropriate trend than occupancy hours however, there is still significant variance from the trend line with only a 0.3769 regression value.

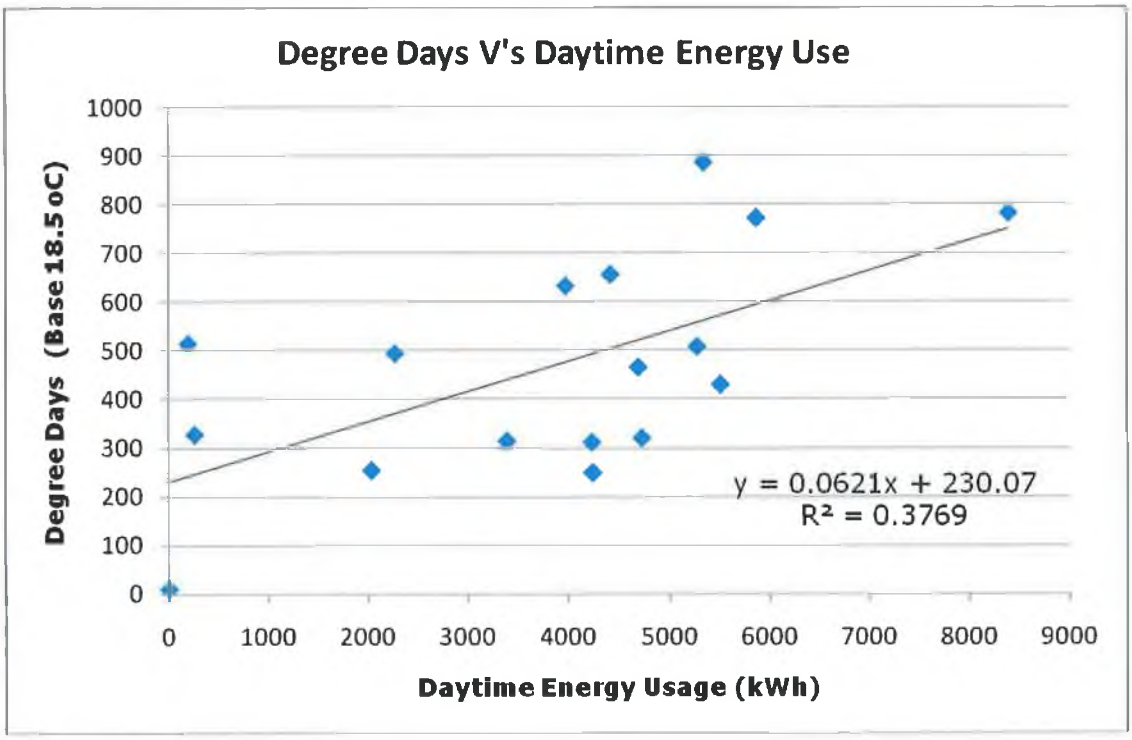


Figure 4-2: Degree Days V's Electricity Usage on Second Floor of Organisation

Sub-Meter 2: Ground and first floor

This meter also records day time and night time units. Energy consumption on this floor from 2007-2009 is illustrated in Figure 4-3.

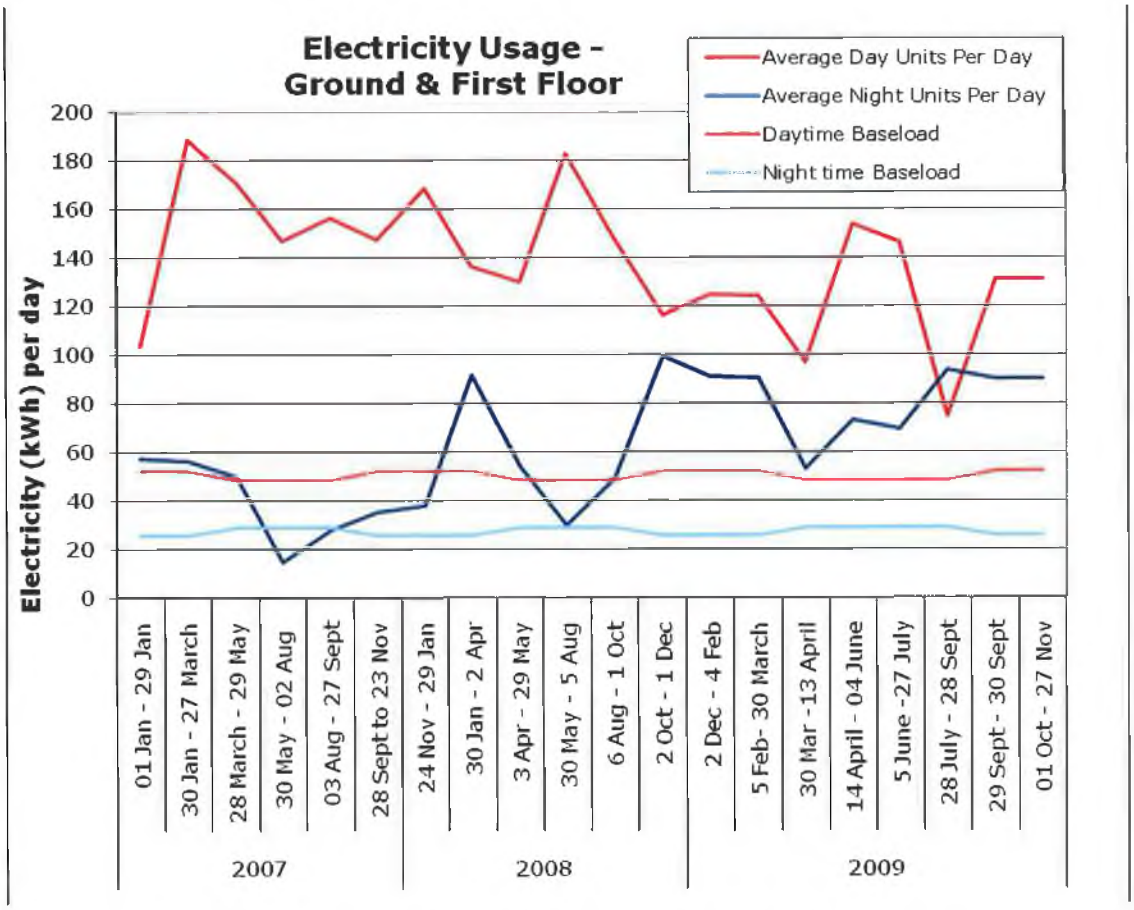


Figure 4-3: Electricity Usage on Ground & First Floor of Organisation

There is no obvious trend in energy use on these floors except that daytime energy use is overall decreasing and night-time energy use is overall increasing. Increases in day time energy is visible during winter months due to with longer lighting hours and decreasing consumption in April and May. However, consumption is increased again during the summer months and summer energy consumption exceeds winter energy consumption except for winter 2007. This is possibly due to the use of air conditioners and fans during the summer months. An unusual decrease in energy use was seen in July-September 2009, which was not typical of the trend.

Unlike the second floor night time units do not exceed the day time units in this graph. Night time units are elevated during the winter months and this is due to the use of electric storage heaters for heating in approximately 15% of this floor area.

Night time units have shown a decreasing trend during the 2007 and 2008 summer months however, this trend is not visible for summer 2009. This corresponded with the vacation of the second floor of the building and all employees were moved into the ground and first floor. However, night time energy use should have remained unaltered by this move and it suggests that electric appliances are being left on overnight, unnecessarily. Currently (end of 2009), night time energy usage is approximately 70% of the daytime usage, which is inefficient.

Energy factors which drive daytime energy usage on this is floor would include occupancy hours. Figure 4-4 outlines occupancy hour's verses daytime energy usage.

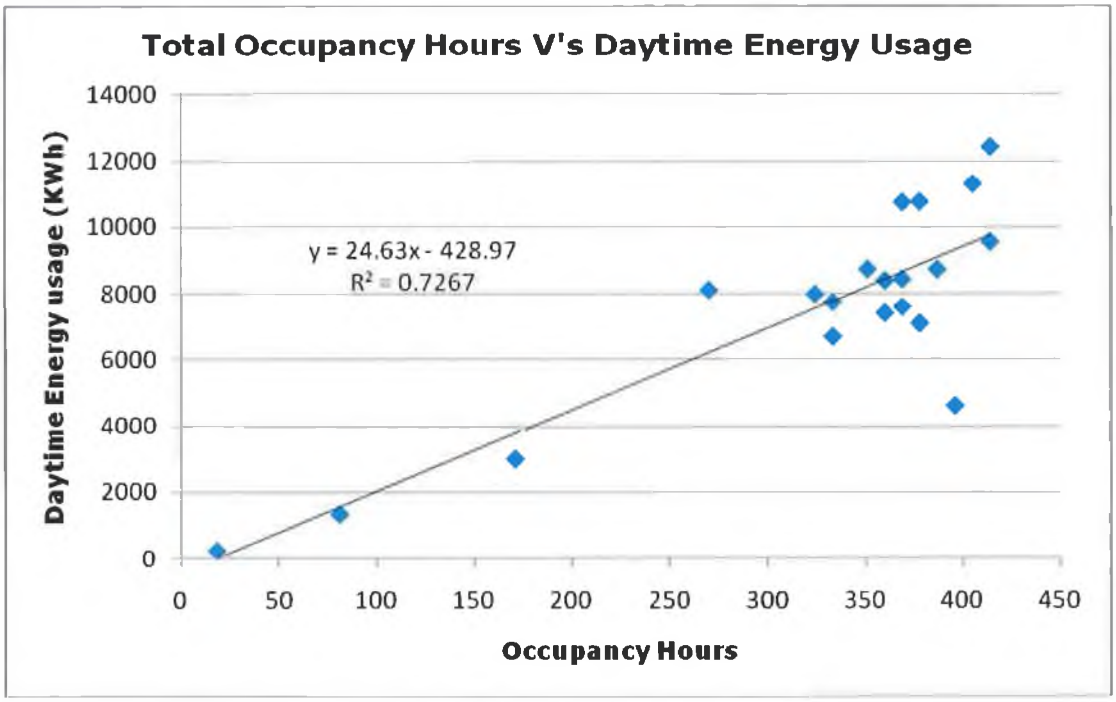


Figure 4-4: Total Occupancy Hours V's Electricity Usage on Ground & First Floor of Organisation

A reasonable trend is achieved on these floors verses occupancy hours, with a regression value of 0.7267. Variance is evident at the greater occupancy hours and this signifies that greater control of energy usage can be acquired.

Sub-Meter 3: Landlord supply

The landlord electricity supply covers the common areas of the building for example the lighting in the halls, stairs and toilets. It also covers the external building lighting and the operation of the electronic gate. The operation of the lift and electric water heating and ventilation in the toilets is also included in this bill. Baseload energy in this area would include the operation of the intruder alarm and fire alarm system and bathroom ventilation. Figure 4-5 below illustrates energy usage at this meter from 2007 to 2009.

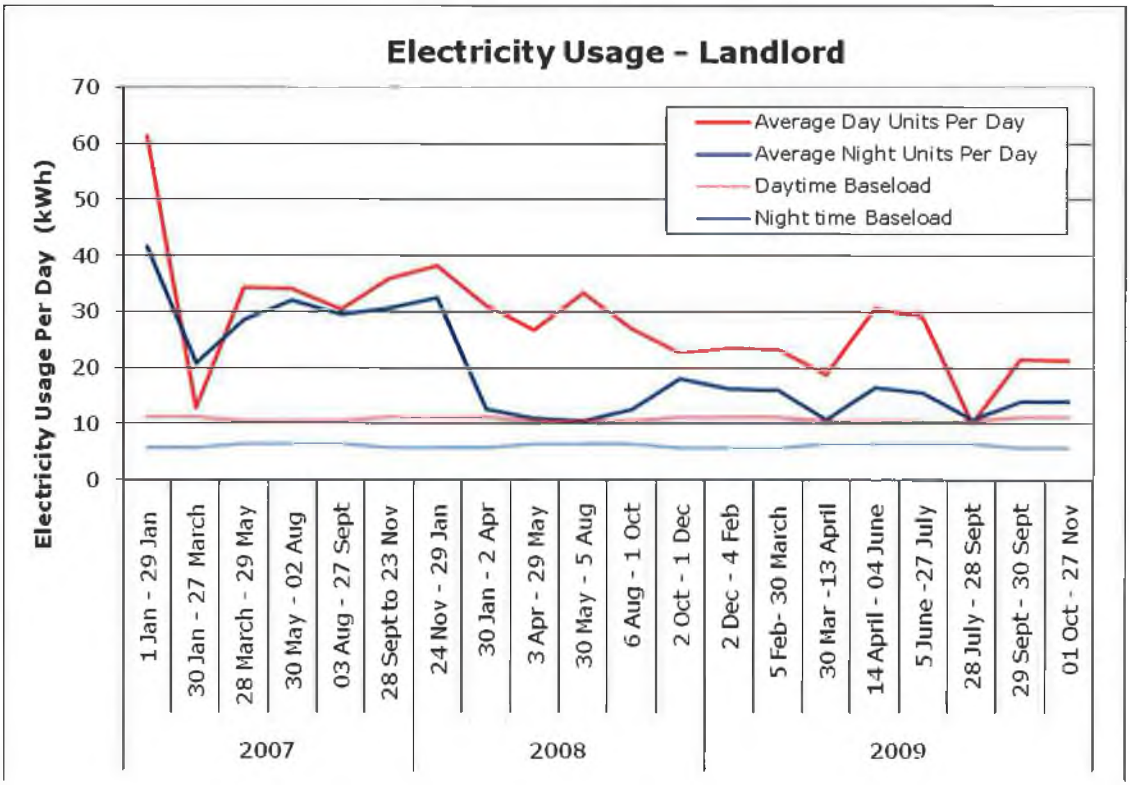


Figure 4-5: Electricity Usage on Landlord Meter of Organisation

An overall decreasing trend is evident in both day time and night time energy usage. It would be expected that daytime energy usage would increase in winter months with longer lighting hours however, with the exception of winter 2007/2008, this is not evident. Instead energy usage peaked in the summer months of 2008 and 2009. There is no discernable reason for this therefore it would need to be investigated further. Night time energy usage decreased significantly when the external lighting was switched off as an energy saving measure in early 2008. During 2008 and 2009 decreases in energy usage is seen during summer months and increases during winter months, which correspond with shorter and longer lighting hours. However, night time energy usage is still elevated over the estimated night time baseload energy therefore, additional energy savings may be identifiable.

Occupancy hours are currently the most suitable energy factor for the landlord supply, especially since switching off night time external lighting. Figure 4-6 below illustrates the trend verses daytime energy usage (excluding the July to September 2009 unusual energy dip).

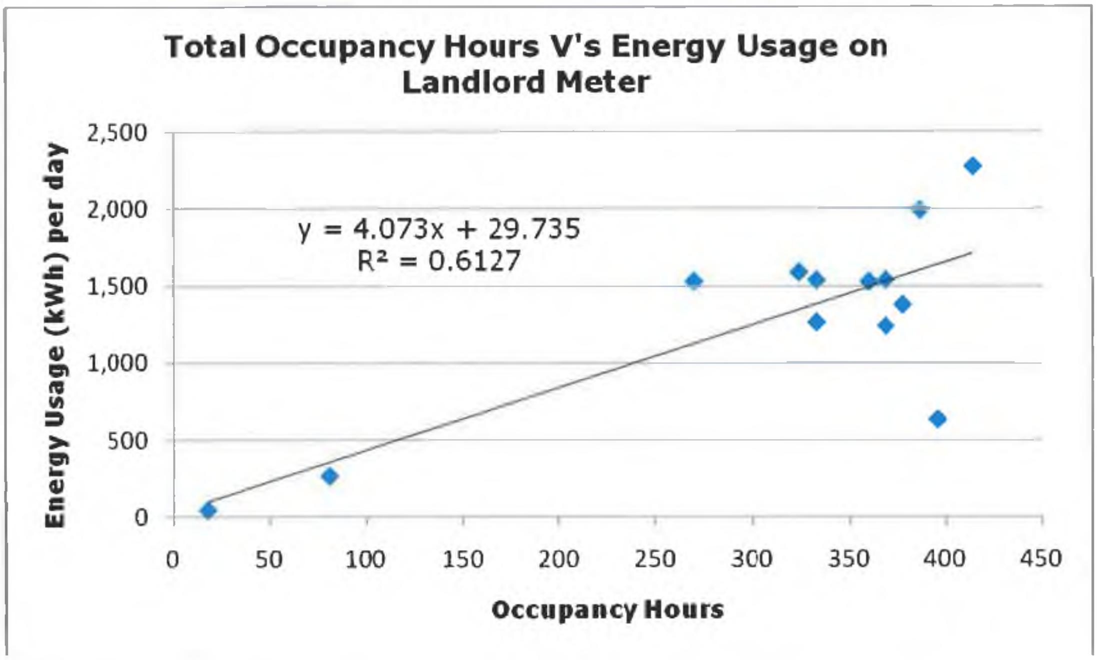


Figure 4-6: Occupancy Hours V's Electricity Usage on Landlord Meter of Organisation

A reasonable trend is achieved against occupancy hours with a regression value of 0.6127. Variance is evident at the greater occupancy hours and this signifies that greater control of energy usage can be acquired.

Sub Meter 4: Server Room

This meter covers the running of the servers and the operation of an air conditioner within the server room. This room is in operation 24 hours a day. This room has been separately metered since the beginning of 2008. The energy usage trend for 2008 and 2009 is provided in Figure 4-7 below. The energy data has been illustrated in energy use per day in order to accurately compare energy usage. Energy usage in this room is fairly consistent and is dependent on the number of servers that are operational. There is an unusual peak in electricity in July 2008 which was not recorded during the rest of the monitoring period. Energy usage decreased in March-May 2009 due to changes in server numbers. Overall energy use is consistent over 2009.

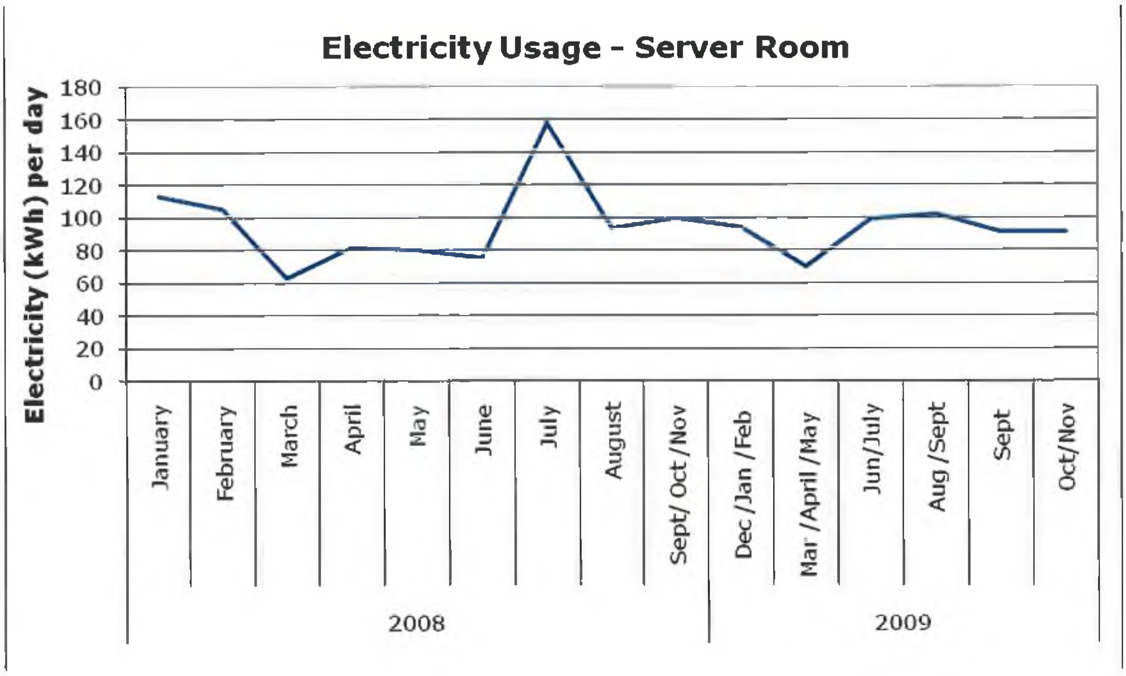


Figure 4-7: Electricity Usage on Server Meter of Organisation

Gas Usage

Approximately half of the building uses gas for heating purposes. This consists mainly of the ground and first floor. The annual consumption gas from 2007-2009 is outlined in Figure 4-8 below.

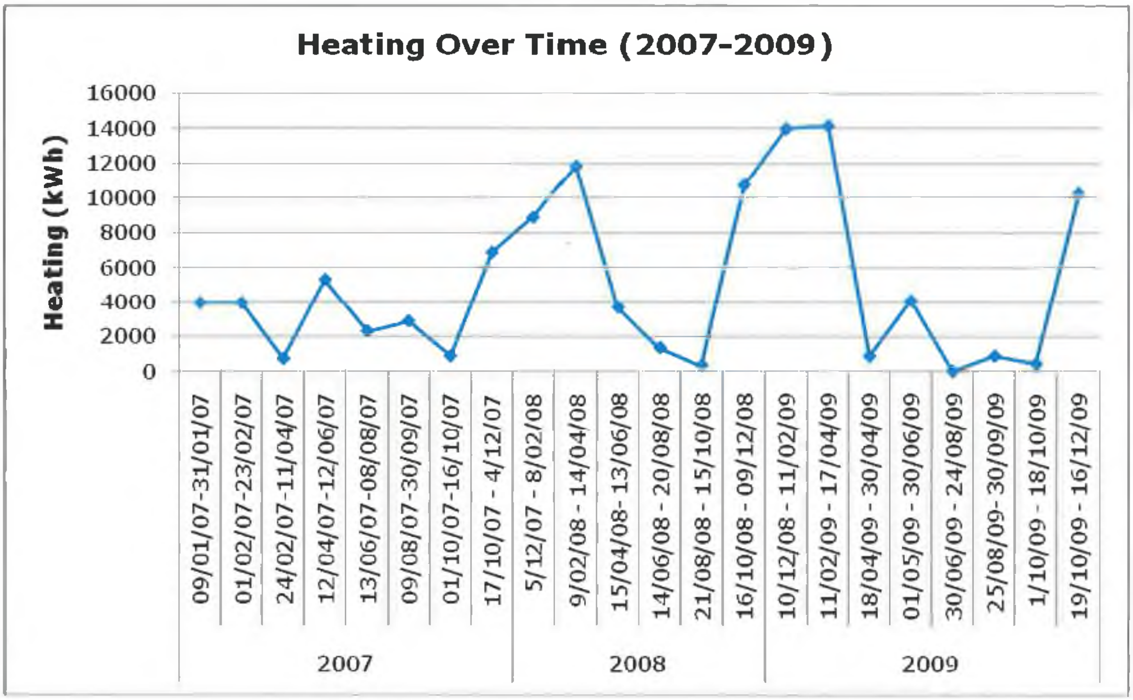


Figure 4-8: Natural Gas Usage of Organisation

Gas heating is timed to operate for 4 hours a day (3 hours in the morning and 1 hour in the afternoon) during the winter months from October to April. The gas heating is switched off during the summer months except when particularly cold weather was experienced. Gas is not used for water heating within the building. The highest levels of gas usage, as expected, are during the winter months December to April.

During the summer months, gas usage is low particularly from July to September. However, a peak in gas usage is evident in May-June 2007 and 2009. This peak is not evident in 2008 however, similar levels of gas usage is evident. Gas usage in the summer months of 2007 was elevated in comparison to other years.

The most appropriate energy factor for heating is heating degree days. A base temperature of 15.5 °C was the most appropriate in terms of regression value for the organisation. Heating verses degree days is illustrated in Figure 4-9 below.

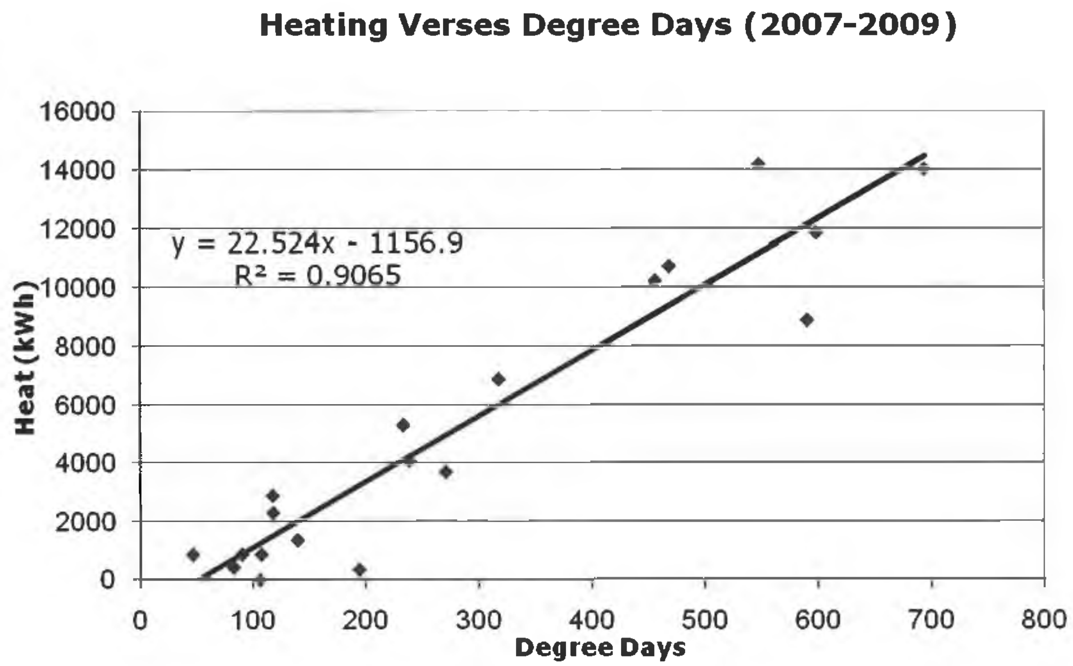


Figure 4-9: Degree Days V's Natural gas Usage of Organisation

This trendline gives a regression value of 0.9043 which is good however variance is evident at low and high degree day numbers therefore greater control can be achieved.

Transport Fuel Usage

The organisation also has two company owned vehicles; a Hyundai Santa Fe jeep and an Opel Combo van. The average theoretical fuel efficiency of this jeep is 14.3 km/L and the van is 18.5 km/L. The actual fuel usage and efficiency of these vehicles is outlined below.

The energy factor which is most appropriate for fuel usage is the corresponding distance travelled. However, while the distance travelled in recorded and fuel purchases can be extracted from fuel cards, the organisation currently does not have a data collection process to accurately match this data. An estimate can be made by totalling monthly distances and fuel usage.

Van

Figure 4-10 outlines the fuel usage and distance travelled in the van over 2009. Significant variation is found and an average fuel efficiency of 16.4 km/L was estimated. This is lower than the theoretical fuel efficiency of 18.5 km/L.

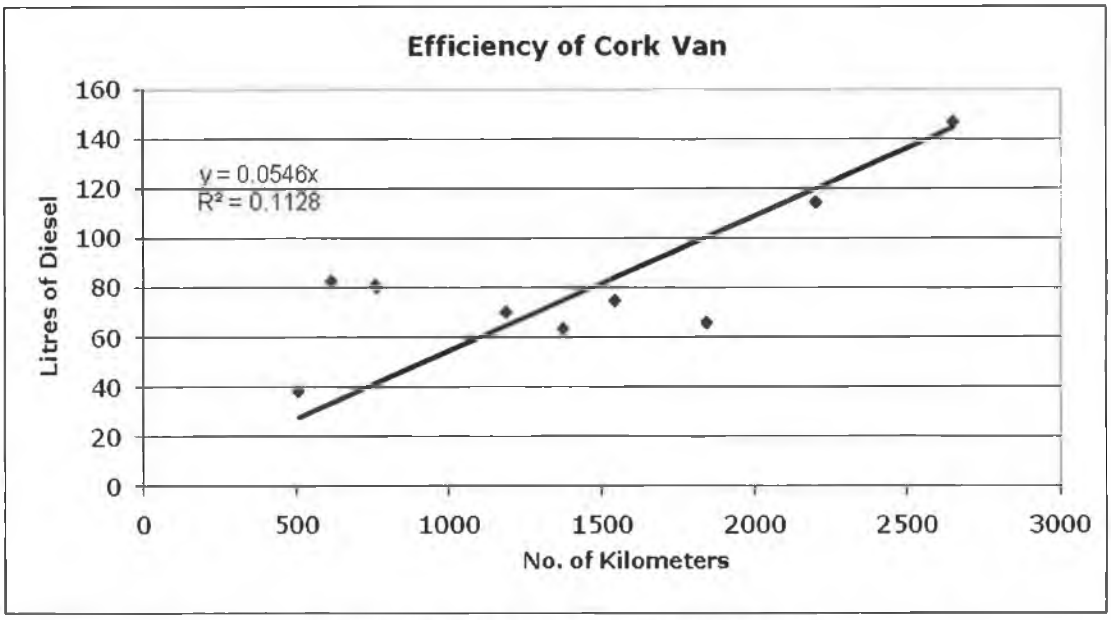


Figure 4-10: Efficiency of Organisation Van

On eliminating any outliers a better efficiency is estimated in Figure 4-11. This has a regression value of 0.9519. This provides an average fuel efficiency of 18.3 km/L which is only marginally lower than its theoretical fuel efficiency.

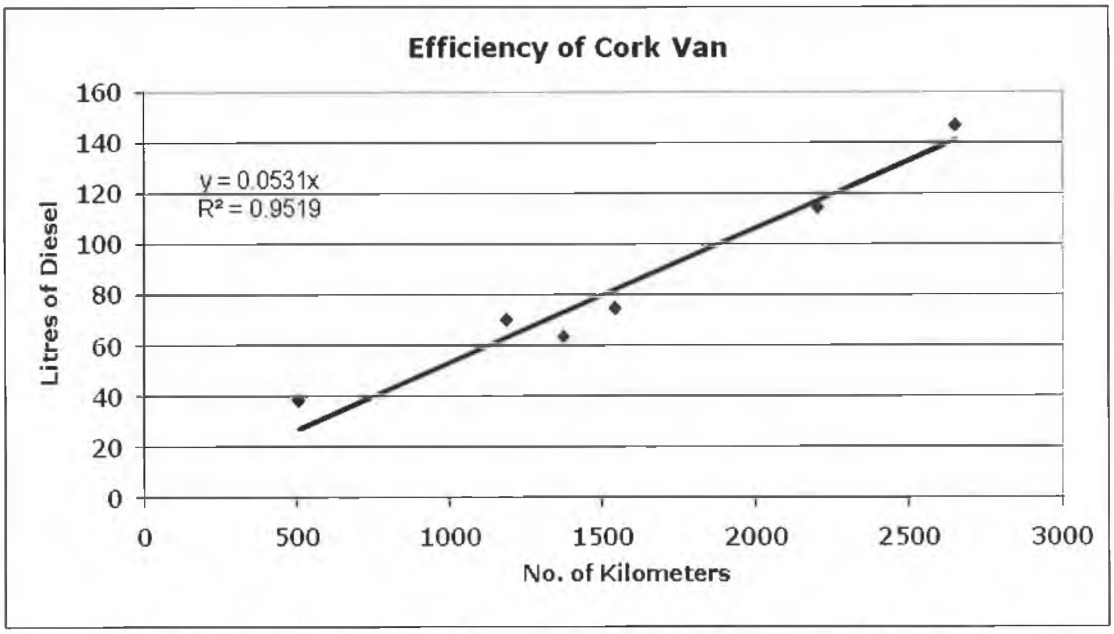


Figure 4-11: Efficiency of Organisation Van with removal of Outliers

Jeep

Figure 4-12 outlines the fuel usage and distance travelled in the jeep over 2009. Significant variation is found and an average fuel efficiency of 11.8 km/L was estimated. This is lower than the theoretical fuel efficiency of 14.3 km/L.

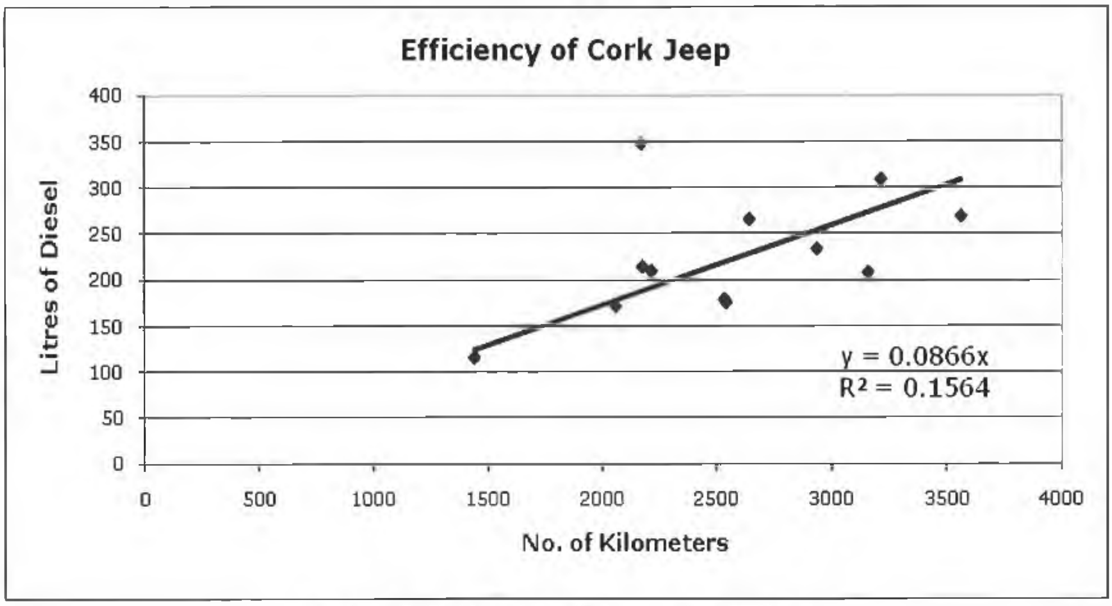


Figure 4-12: Efficiency of Organisation Jeep

On eliminating any outliers a better efficiency is estimated in Figure 4-13. This has a regression value of 0.6037. This provides an average fuel efficiency of 12.3 km/L. This is still lower than the theoretical fuel efficiency of 14.3 km/L.

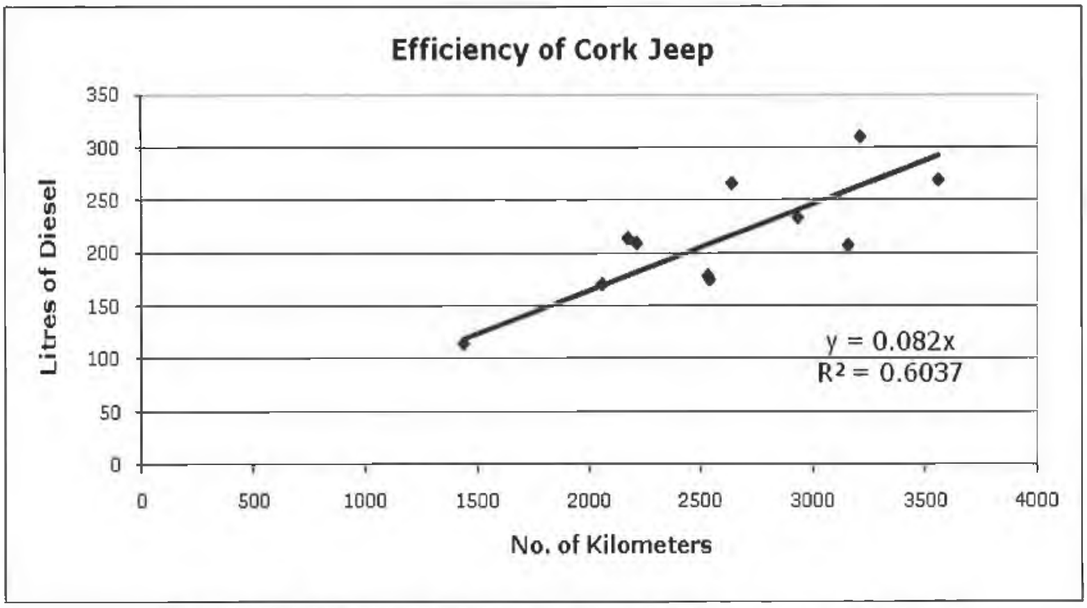


Figure 4-13: Efficiency of Organisation Jeep with removal of Outliers

4.2.2 Identification of areas of significant energy consumption, in particular of significant changes in energy use during the last period

Significant energy aspects were identified by undertaking an energy survey using a 'bottom-up' approach. A master list of all energy using equipment was formulated for each of the four sub-metered sections. Each list tabulated quantity, actual electricity usage, operational hours and estimated annual electricity consumption. Annual electricity consumption for each of the sub-metered areas and the overall company are represented on a pie chart and are discussed hereunder.

Second floor of building

Significant energy users on the second floor are illustrated in Figure 4-14.

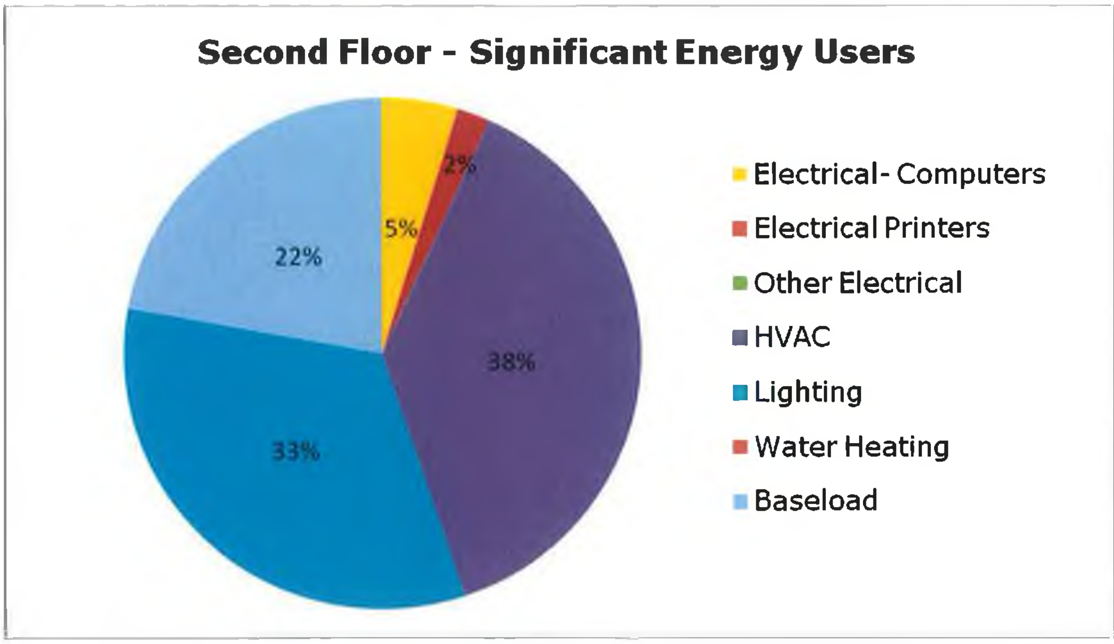


Figure 4-14: Significant Energy users on the Second Floor

The most significant energy user on the second floor is the heating and air conditioning, which is 38% of the total flow energy usage. Heating on the second floor is based on night storage heaters and the energy used in heating is a substantial part of this 38%. There are also air conditioners on this floor for use during warmer summer months. The next largest energy user is lighting at 33% of the total energy use. This assumes that all lighting is on during normal occupancy hours. The baseload excluding the night storage heating is approximately 22% of the total energy use. An Eircom server contributes to the baseload on this floor however, no other energy user is currently identifiable therefore significant saving may be achieved on reviewing baseload data. Computers and printers contribute only 7% to this floor energy usage however, currently only one section of this floor is occupied by employees.

Ground and first floor

Significant energy users on the ground and first floor are illustrated in Figure 4-14.

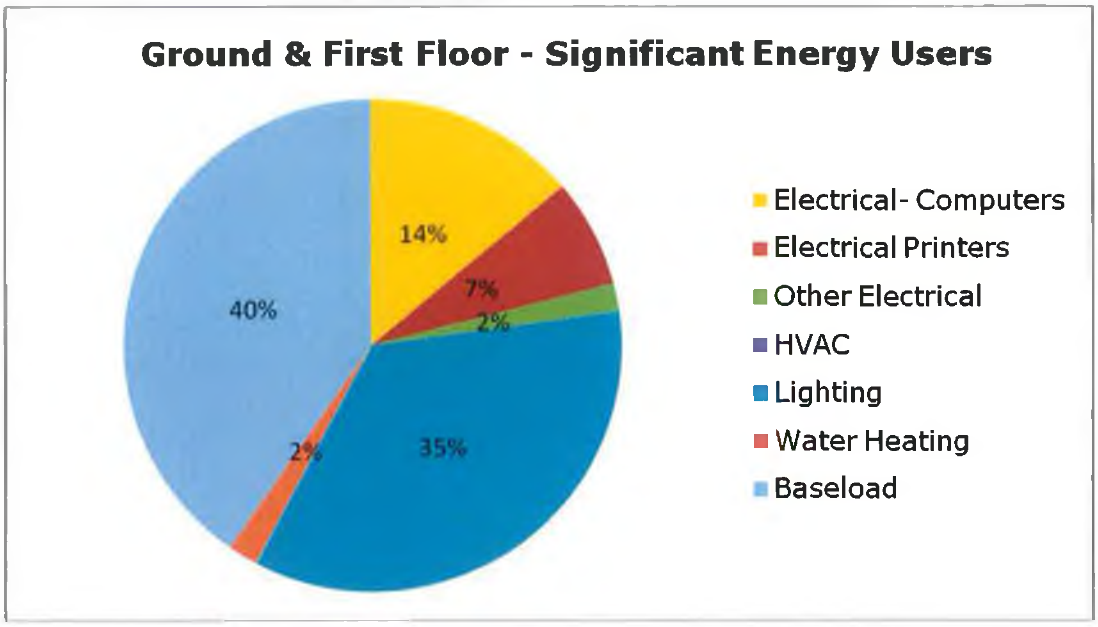


Figure 4-15: Significant Energy users on the Ground & First Floor

The baseload on these floors is estimated at 40% of the total energy use. An Eircom server and canteen fridges, water coolers and heaters currently contribute to the baseload on these floors however; no other energy user is currently identifiable. Significant savings may be achieved on reviewing baseload data. The second largest user on these floors is lighting at 35%. A larger percentage use is contributed by computers and printers than the second floor and this is due to a greater number of employees. Other electrical appliances such as kitchen appliances and water heat contribute 4% to the energy use of these floors.

Landlord supply

Significant landlord sub-meter energy users are illustrated in Figure 4-16.

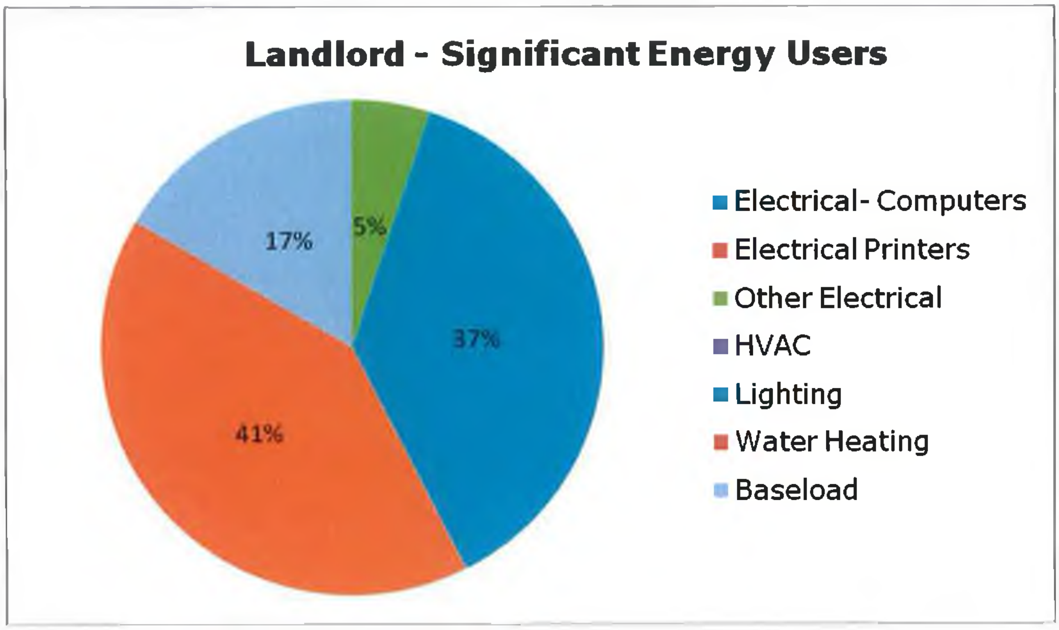


Figure 4-16: Significant Energy users in the Landlord Meter

In the landlord energy supply, electric water heaters in the bathrooms are the most significant energy user at 41% of the total energy usage. This is followed by lighting of the hall, bathrooms and common areas which uses 37% of the total energy usage. Baseload energy in this area would include the operation of the intruder alarm and fire alarm system and bathroom ventilation and consists of 17% of the total energy use. The remaining 5% energy usage is in the 'other electrical' category which incorporates electric hand dryers in bathrooms.

Total Organisation Supply (including Server room)

The overall energy usage across the entire organisation is summarised in the following pie chart (Figure 4-17). The server room has also been incorporated in here for comparison purposes.

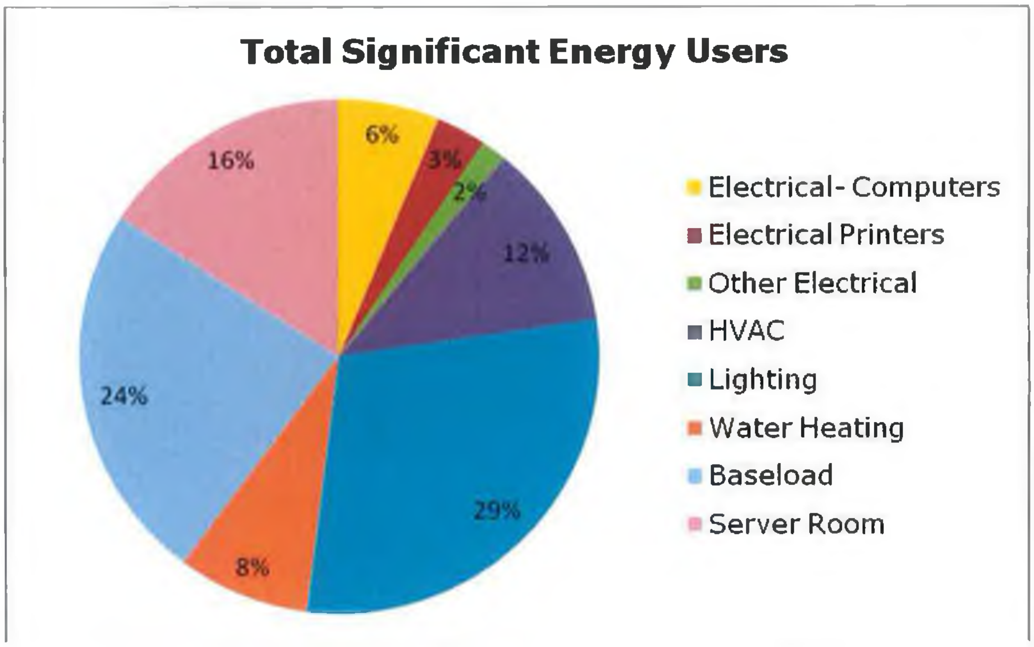


Figure 4-17: Total Significant Energy Users for the Organisation

The greatest overall energy user is lighting at 29% of the total energy. 24% of the total energy usage is estimated as baseload across the organisation. More detailed investigation is required to break this baseload down further. 16% of the buildings energy usage is attributed to the server room and 12% associated with storage heating and air conditioning on the second floor. The remaining 11% is associated with electrical appliances – computers, printers and canteen appliances.

4.2.3 An estimate of the expected energy consumption during the following period

An estimate of the expected energy consumption was undertaken taking into account and known planned operational changes. Planned operational changes include the re-occupation of the second floor of the building which will increase energy usage in the second floor over 2009 levels and slightly decrease energy usage in the ground and first floor. It is estimated that energy usage will be likely similar to that which was recorded in 2008 however, day and night energy levels on the ground and first floor will be more even. The server room energy levels are expected to remain similar to 2009 levels. Expected trends for each area are shown in Figure 4-18 and overall trends in Figure 4-19.

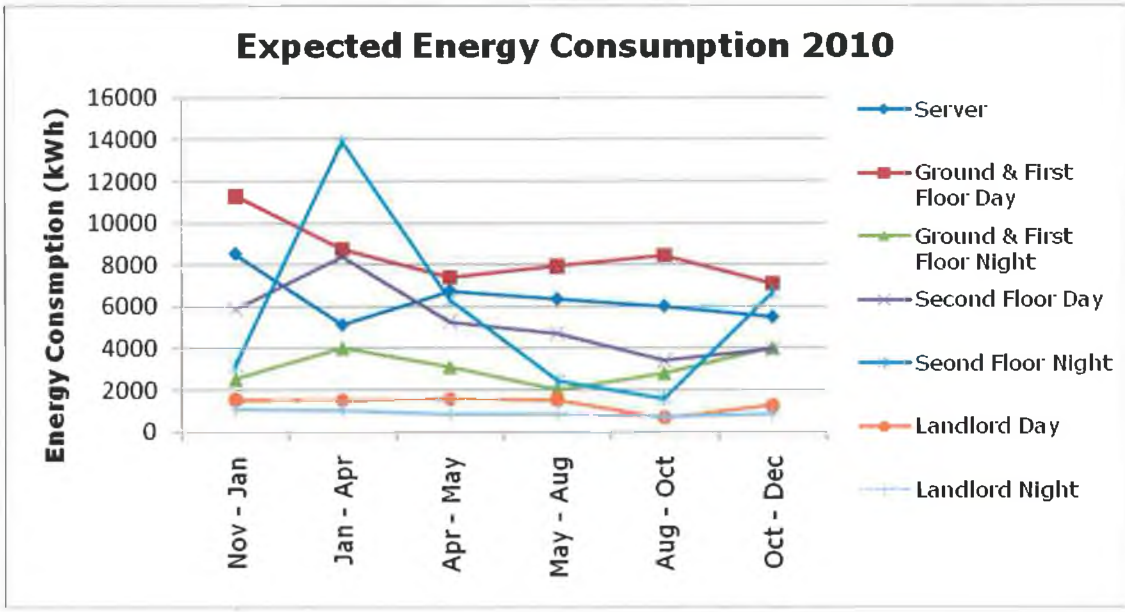


Figure 4-18: Expected Energy Consumption 2010

It is hoped that through ongoing energy management during 2010 that energy savings will be achieved and total energy consumption will be reduced on these trends.

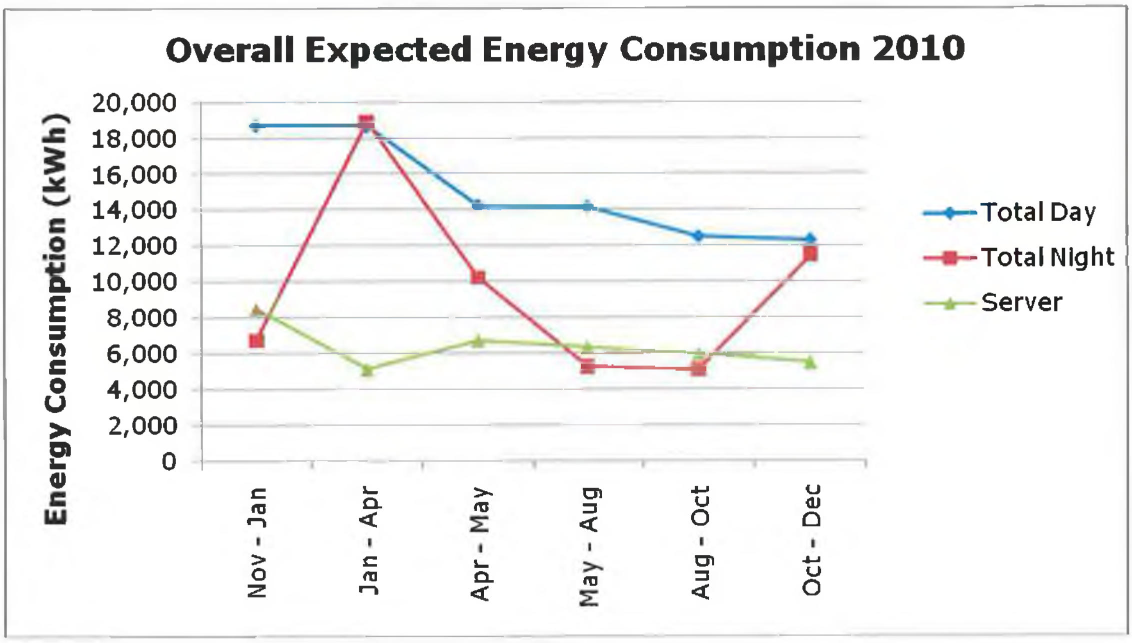


Figure 4-19: Overall Expected Energy Consumption 2010

4.2.4 Identification and prioritisation of opportunities for improving energy efficiency

Through the planning process undertaken in examining past and present energy consumption and in undertaking energy surveys to identify significant energy users, energy saving opportunities were highlighted. A register of energy saving opportunities has been devised for the organisation and this register summarises the opportunities under following headings:

- Energy aspect it relates to
- Action required
- Value in energy terms
- Value in financial terms
- Value in carbon dioxide terms
- Estimated or actual cost
- Payback in years

This register is outlined in Table 4. The register has been ordered from the largest to smallest in Column 3- energy savings, smallest to the largest in Column 4 - financial savings and largest to smallest Column 5 – CO_2 savings.

Energy Aspect	Energy Saving Action Required	Estimated Energy Savings	Estimated Financial Saving	Estimated CO_2 Saving	Estimated Cost	Payback	Assumptions/ Comments
		kWh/year	€ /year	kg CO_2/kWh	€	Years	
Lighting	Replace T8 Lamps with LED Replacements	19,000	€2,819.60	10,526	€37,700.00	13.37	11 years life span in bulbs - not economical unless lamps become cheaper.
Electrical	Switch off appliances policy	12,948	€989.22	7,173	€0.00	0.00	10% of equipment is not switched off. Used Night time rate
All	Energy Awareness	12,948	€989.22	7,173	€0.00	0.00	10% Saving. Used Night time rate
All	Energy Management System	12,948	€989.22	7,173	€0.00	0.00	10% Saving. Used Night time rate
HVAC	Install Room Thermostat controls	8,947	€382.40	0.00166	€400.00	1.05	Assume saving of 20% on heating
Lighting	Replace T8 lamps with T5 lamps	7,602	€1,128.14	4,212	€5,445.00	4.83	2.3 years life span in bulbs - not economical unless lamps become cheaper.
All	Monitoring and Targeting Programme	6,474	€494.61	3,587	€100.00	0.20	5 % Saving. Used Night time rate
Lighting	Replace Halogen spot lights with LED	4,900	€727.16	2,715	€750.00	1.03	Assumed 50% 12 V & 50% mains. Life span of LED lamp = 5.5 years
Lighting	De-lamping	4,532	€346.23	2,511	€100.00	0.29	35% Lighting - Reduce by 10%
HVAC	Annual gas burner service	3,512	€150.00	1,946	€80.00	0.53	8% saving on gas usage - SEI advice
Lighting	Lighting: install occupancy sensors in Bathrooms	3,119	€462.84	1,728	€500.00	1.08	60% saving in landlord lighting energy. Used daytime rate.
Electrical	Examine base load and reduce it	3,107	€237.41	1,722	€0.00	0.00	24% of total energy - save 10% of baseload
Lighting	Label light switches	2,266	€173.11	1,255	€0.00	0.00	35% Lighting - Reduce by 5%

Energy Aspect	Energy Saving Action Required	Estimated Energy Savings	Estimated Financial Saving	Estimated CO_2 Saving	Estimated Cost	Payback	Assumptions/ Comments
		kWh/year	€ /year	kg CO_2/kWh	€	Years	
Lighting	Maintenance and Cleaning of lighting	2,266	€173.11	1,255	€0.00	0.00	35% Lighting - Reduce by 5%
Lighting	Maximise use of blinds	2,266	€173.11	1,255	€0.00	0.00	35% Lighting - Reduce by 5%
HVAC	Keep doors between cold and warm areas closed	2,237	€95.60	0.00042	€0.00	0.00	Save 5 % on heating
HVAC	Seal Drafts in building	2,237	€95.60	0.00042	€150.00	1.57	Save 5% on heating
HVAC	Heat reflective foil behind radiators	2,237	€95.60	0.00042	€200.00	2.09	Save 5% on heating
HVAC	Staff awareness on storage heating & HVAC operation	1,813	€138.49	1,004	€100.00	0.72	HVAC 14% of total - save 10%
Electrical	New Equipment Purchase Policy	1,424	€108.81	789	€0.00	0.00	Approx. 11% Computer and printers of total energy. Save 10% with new energy saving equipment. Continuous replacement.
Electrical	Equipment energy saving devices	1,424	€211.36	789	€70.00	0.33	Approx. 11% Computer and printers of total energy. Save 10% with energy saving devices.
HVAC	Move office equipment out from radiators	895	€38.24	0.00017	€0.00	0.00	Save 2% on heating

Table 4 Register of Energy Saving Opportunities

This Register of Opportunities allows an organisation to identify and prioritise opportunities for implementation under the energy management system. It identifies opportunities for the most potential energy savings thereby reducing financial costs and CO_2 emissions for the organisation. As seen in Table 4 significant energy savings can be achieved by a number of no-cost housekeeping measures such as switching off appliances, energy awareness and management. Large energy savings can be achieved by the use of new energy saving technologies such as LED lighting however, while energy saving is achieved the financial cost of replacing existing lamps with LED's is not financially viable until the costs of such technologies reduce.

4.2.5 Identification of all persons working for and on behalf of the organisation whose actions may lead to significant changes in energy consumption

All persons working for and on behalf of the organisation will impact on energy consumption within the organisation. All employees have the responsibility of switching off their own electrical appliances, common electrical appliances and lighting in their areas. However, there are a number of persons that can significantly influence energy consumption. These persons are identified and their role and responsibilities outlined below:

- **Environmental/energy manager**: their responsibility is to implement the energy management system and provide training and awareness to staff.
- **Facility Manager**: their role is to ensure all energy use appliances is correctly serviced and maintained to ensure maximum energy efficiency is achieved – e.g. servicing of boiler, air conditioners etc.
- **Housekeeping person**: their role is to ensure electrical appliances especially lights are regularly cleaned in order to ensure maximum energy efficiency is achieved
- **Purchasing manager**: their role is to ensure that any electrical purchases are the most energy efficient available while balancing financial control and appropriateness for use.

4.2.6 GHG Emissions and Removal Inventory

Under section 4.3 of ISO 14064-1:2006 *Quantification of GHG emissions and removals,* the calculation of GHG emissions and removals was undertaken for the organisation. The GHG Inventory is reported in the form specified in requirement 5.1 of the standard. The GHG inventory for the organisation is provided in Table 5 and illustrated in Figure 4-20. The detailed calculation process undertaken is outlined in Appendix B.

GHG Emissions	Description	Sub- Total (kg CO_2eq)	Total (kg CO_2eq)
Direct	Natural Gas	8,304	18,119
	Organisation-owned vehicles	9,316	
	Refrigerant/air conditioners	499	
Energy Indirect	Electricity Purchased	95,160	95,160
Other Indirect	Private vehicles for work purposes	27,662	125,131
	Commuting	58,881	
	Business Travel - Flights	26,478	
	Printing paper	12,110	

Table 5 GHG Emission Inventory for the Organisation

Three sources of GHG emissions contributed to the direct GHG emission inventory. These included natural gas usage, diesel use in organisation owned vehicles and emissions from refrigerators and air conditioners onsite. Emissions from refrigerators and air conditioning are the smallest contribution to direct emissions followed by natural gas usage. Fuel use in organisation owned vehicles is the largest contributor to direct emissions. Electricity purchased emits over 95 tonnes of CO_2 emissions in 2009. Of the other indirect sources, employee commuting to work is the largest contributor to CO_2 emissions, followed by the use of private vehicles for work purposes, followed by business flights and paper usage.

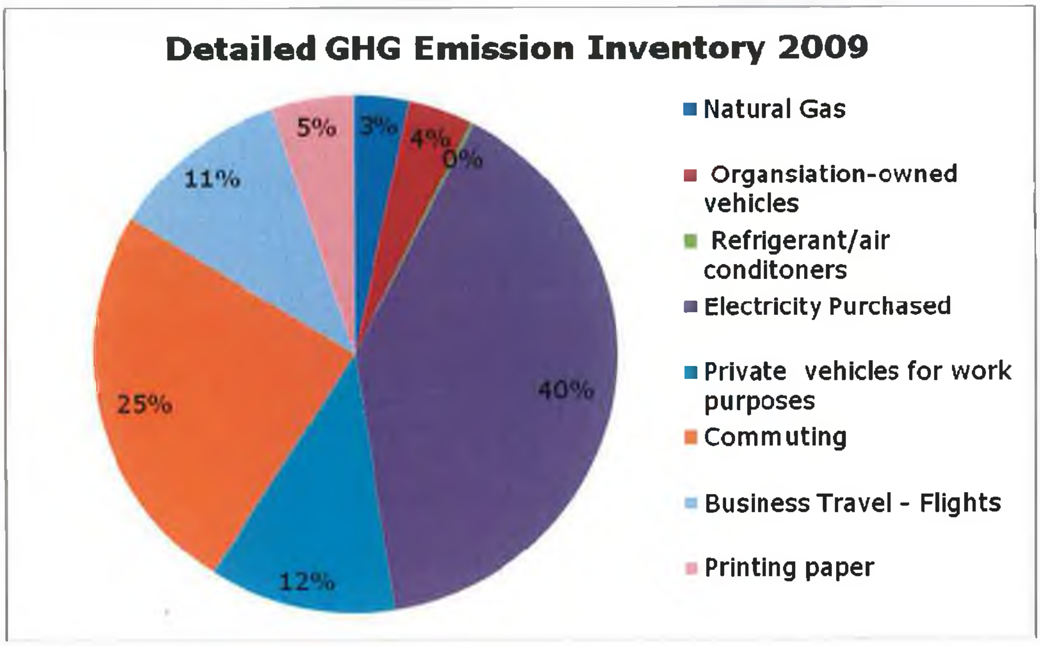


Figure 4-20: Detailed GHG Emission Inventory 2009

This pie chart illustrates the percentage contribution of these sub-categories to total CO_2 emissions. Electricity purchased is the largest single source contributor at 40% of total emissions. This is followed by employee commuting at 25%, use of private vehicles for work (12%) and business flights (11%).

Figure 4-21 illustrates the overall GHG inventory for the organisation.

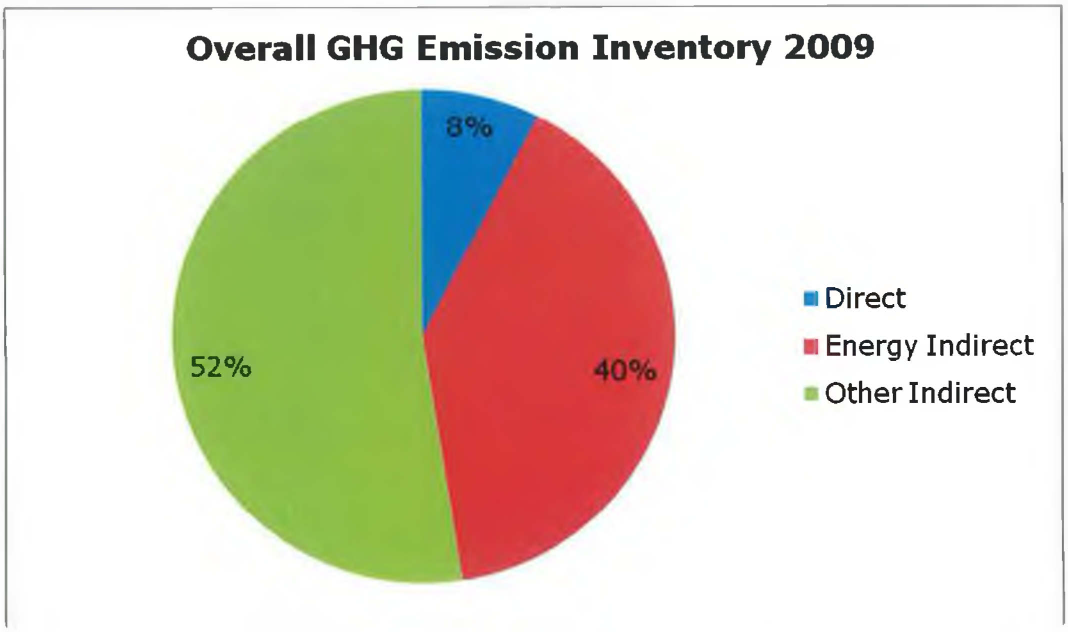


Figure 4-21: Overall GHG Emission Inventory 2009

It is evident from Figure 4-21 that the 'Other indirect' emission category is dominant at 52% of the total emissions. Purchased electricity contributes to 40% of total emissions and direct emissions contribute only 8% of total emissions.

4.2.7 Assessing and Reducing Uncertainty

An uncertainty assessment was undertaken in accordance with Requirement 5.4 of ISO 14064-1 and the GHG Protocol Uncertainty Calculation tool. Uncertainty assessments are undertaken for an organisation to understand the causes of uncertainty and help identify ways of improving GHG inventory quality by improving data sources and methodologies.

The assessment undertaken in this research resulted in an uncertainty of +/-18%. Therefore, the total GHG emission from the organisation is 238.4 +/-18% tonnes CO_2eq. This uncertainty interval is ranked as '*Fair*' data accuracy in accordance with the GHG Protocol Guidance (OHNDORF, Mark and Gillenwater, Michael, 2010, p.13). This uncertainty calculation is provided in Appendix B.

However, guidance on uncertainty in GHG protocol states that despite good efforts to estimate uncertainty, it is itself considered highly uncertain (OHNDORF, Mark and Gillenwater, Michael, 2010, p.3). This was evident during this assessment. The largest uncertainty intervals were calculated for metered gas or electricity, as there are large variations in data values (which would be an expected variance due to climatic factors and times of year) and where the number of measurements were less than 10. Therefore, while metered levels would be considered of reasonable accuracy this is not reflected in the uncertainty calculation. Another factor which contributed to the inaccuracy of the uncertainty calculation was the lack of uncertainty values for published national emissions factors. The organisation should further assess uncertainty calculation approaches to determine the most suitable to the organisations data.

4.3 Data Analysis

In order to focus the analysis of the empirical findings, this section is structured under a number of different headings. These headings are based on the research objectives of this study and are:

- Assess the overlap of energy and carbon standards, in managing energy
- Assess the accuracy and completeness of the standards
- Advantages and disadvantages of the implementation of energy and carbon standards
- Explore if either standard can be applied to an organisation and will mutually benefit the organisation, energy resources and climate change

4.3.1 Assess the overlap of energy and carbon standards, in managing energy

From the empirical analysis, it was evident that there is significant data overlap between energy and carbon standards. In the energy management standard, energy sources identified and reviewed included; electricity usage, natural gas usage for heating and fuel use in organisation-owned vehicles. In the carbon standard, all this energy data contributed to the GHG Inventory calculation. Natural gas usage and fuel usage in the organisation are direct GHG emissions (Scope 1) and energy indirect GHG emissions (Scope 2) incorporate the electricity purchased by the organisation. Therefore, the same data selection and collection is required for both standards.

However, process emissions are also identified as a direct emission in the carbon standard and this data is not included in the energy standard. In this case study, process emissions occurred from refrigerant and air conditioning systems during installation, operation, maintenance and disposal. This is relevant to service organisations and all organisations, as this scope includes the domestic type fridge in a canteen. From the empirical analysis undertaken in this study, the data collated for the energy standard contributed to 99.96% of the Scope 1 and 2 emissions, with refrigerant and air condition emissions contributing only 0.4%. Therefore, process emissions were not significant in this case study.

The carbon standard can also include 'Other indirect' emissions (Scope 3) which are GHG emissions that result as a consequence of an organisations activities. This data is not included in the energy standard as it is focused on activity under the control of an organisation. In this case study, 'other indirect' emissions contributed to 52% of the overall GHG emission inventory. This data was more difficult and more time consuming to collect as it was not based on metered data, such as electricity or natural gas usage. It involved extraction of information from the organisation's accounting system and obtaining specific data from staff. Therefore, including 'Other Indirect' emissions in the GHG Inventory will involve the collection of additional data that does not overlap with the data required in the energy standard.

The final step in the 'planning' stage of the energy standard is to identify and prioritise opportunities for improving energy efficiency. In this case study, a register was prepared to identify each opportunity and associated energy, financial, carbon dioxide savings, as well as, costs and payback periods. Therefore, in this register opportunities for CO_2 savings are identified. It was evident from the data that, when prioritised for the greatest energy saving, the greatest CO_2 saving was also achieved as energy saving is directly related to CO_2 saving. However, it was also evident that electricity savings achieved greater CO_2 saving than that of natural gas savings. Natural gas has a lower CO_2 emission rate that that of electricity therefore while energy savings can be achieved by increasing the efficiency of natural gas usage, an equivalent magnitude of reduction is not accomplished in CO_2 emission inventory. Therefore, energy savings focused on electricity usage would have a greater reduction impact on the GHG Inventory.

While the 'planning' section of the energy standard overlaps with the carbon standard in identification of CO_2 emissions related to energy activities and savings, the carbon standard itself does not identify carbon saving opportunities. It is only concerned with quantifying and reporting total GHG emissions.

While the data used in both the energy and carbon standard significantly overlaps the approach used to assess such data within the standards is different. In the energy standard, data collection and assessment is 'process' driven. The planning section of the standard requires past and present energy consumption to be examined and to be related to factors that drive energy consumption. This requires the organisation to examine energy processes and users, to identify usage patterns and trends. The identification of significant energy users also requires the organisation to examine in detail, energy use by equipment and processes. This requires detailed top-down or bottom- up process maps, surveys or master lists to be prepared which would entail specific measurement of energy use. These requirements are very specific and focus the organisation on the energy processes of the organisation where energy savings can be identified.

In the case of the carbon standard, the approach to data analysis is more 'scientific'. It requires a quantification methodology to be set out and calculations are undertaken in accordance with this chosen methodology. The methodology chosen in this case study included the use of activity data and emission factors. Therefore, for example, in the collection of electricity activity data – total electricity use within an uncertainty range was required and this involved totalling the organisation's electricity bills. The standard does not require any analysis of specific equipment or energy processes that contribute to the total electricity bill. However, a detailed explanation on the methodology used to integrate this activity data in the calculation of GHG emissions is required. Therefore, energy and carbon management standards have very different approaches in their assessment of relevant data.

With reference to the management of energy, as the energy standard is more process driven, as aforementioned, this helps the organisation to identify energy inefficiencies and improvements and therefore management energy. However in the carbon standard as details of energy process are not required these management opportunities are not identified. Therefore, the 'planning' section of the energy standard is designed to identify energy management opportunities while the carbon standard does not.

4.3.2 Assess the accuracy and completeness of the standards, in managing energy

As the energy standard is more process driven, it requires a detailed breakdown of energy users in order to determine their significance. This can be undertaken by a number of approaches including surveys of equipment and processes, etc. This level of detail provides a precise and accurate identification of significant energy users. However, this standard does not outline a specific procedure for undertaking such an assessment nor does it require the organisation to document the procedure undertaken. Therefore, the accuracy of the energy assessment cannot be examined externally unless the assessment procedure is questioned by an external auditor during certification.

Contrary to this, the carbon standard is very specific on the assessment of GHG emissions, requiring the organisation to explain and document GHG sources and sinks, quantification methodology selection, selection, collection and origin of activity data, emission factors and calculation processes. The reason for outlining specific methodologies is to minimise uncertainty and yield accurate, consistent and reproducible results. The requirement to document and explain decision choices during the process, makes the carbon standard more transparent and allows for greater external scrutiny and assessment.

As discussed previously, the energy standard is focused only on activities under the control of an organisation while the carbon standard can also include 'Other indirect' emissions (Scope 3) which are GHG emissions that results as a consequence of an organisations activities. The inclusion of energy usage or GHG emissions that occur as a consequence of an organisations activity is more complete. In the carbon standard the reporting of 'other indirect' emissions as an option, therefore if this option is not included from an energy perspective, the energy and carbon standard would consist of the same energy data and be equally inclusive.

The inclusion of 'other indirect' emissions can involve collecting and processing a wide range of data as was evident in this case study. The data availability and reliability limits the accuracy of the GHG inventory calculation.

A requirement of the carbon standard is that '*an organisation should complete and document an uncertainty assessment for GHG emissions and removals*'. The aim of this assessment is to identify data that is uncertain and inaccurate and identify ways of improving GHG inventory quality by improving data sources and methodologies. The inclusion of this assessment as a requirement (even though optional) will help overall improvement of GHG inventory accuracy over time. However, in undertaking the uncertainty assessment in this case study it was evident that uncertainty intervals associated with current published emission factors were not available. For clarity all published emission factors should be reported with their uncertainty intervals. The lack of uncertainty data hindered the uncertainty assessment in this case study and made the uncertainty interval derived for this study even more uncertain.

4.3.3 Advantages and disadvantages of implementing energy and carbon standards from the examination of empirical data

Advantages	Disadvantages
• Overlap of energy data in energy and carbon standard • Very specific with 'process' driven methodology to help identify opportunities for energy savings • Identifies energy and carbon saving opportunities	• 'planning' requirements are time consuming though detailed process driven energy use collection and analysis • Only includes energy aspects under the control of the organisation therefore is not a complete assessment • Quantification methodology and approach to identifying energy aspects is not transparent • No uncertainty or accuracy assessment as part of the stand requirements

Table 6 Empirical Data Analysis: Advantages and Disadvantages of the Energy Standard

Advantages	Disadvantages
• Overlap of energy data in energy and carbon standard • Inclusion of 'Other' indirect' emissions ensures a more complete assessment of carbon emissions • More scientific and transparent quantification approach • Inclusion of a uncertainty assessment to improve the accuracy and quality of GHG data	• Inclusion of 'Other' indirect' emissions are time consuming though data collection and analysis • Does not identify carbon saving opportunities • Inclusion of 'Other' indirect' emissions may decrease the accuracy of the assessment

Table 7 Empirical Data Analysis: Advantages and Disadvantages of the Carbon Standard

4.3.4 Explore if either standard can be applied to an organisation and will mutually benefit the organisation, energy resources and climate change

Energy and carbon standards can be applied to an organisation and benefit the organisation, energy use and climate change however, benefits will not be equal. The application of the energy standard due to its 'process' methodology opportunities for energy saving and financial saving for the organisation will be identified which will benefit the organisation. This standard also identified CO_2 saving opportunities however, under the standard energy opportunities will be prioritised. Energy saving will directly benefit a reduction on CO_2 emissions however; the magnitude of reduction is dependent on the correlation of energy use and associated CO_2 emission factors. The energy standard does not include 'Other Indirect' emissions which can be a significant portion of GHG emission inventory therefore no reduction will be achieved on these emissions when implementing the energy standard.

In the specific 'planning' requirements of the carbon standards examined in this case study; these requirements did not identify any carbon savings that can be achieved. The organisation benefits by knowing the total CO_2 emission related to the organisation however no carbon savings, financial or energy savings are identified.

4.4 Data Synthesis

The literature review undertaken in this study highlighted a number of outcomes which complement and augment the results of this empirical analysis. The synthesis of the literature and empirical results are discussed in the following section.

Firstly, the literature review highlighted the fact that the energy management standard can be very specific due to the exclusion of other environmental factors included in, for example, the environmental management standard ISO 14001. This allows the energy standard to be specific and process driven as was evident from the empirical results. A detailed review of the energy standard in the literature review also identified that this standard aims to 'lead to reductions in cost and greenhouse gas emissions' and the inclusion of CO_2 savings in the Register of Energy Saving Opportunities substantiates its support for these additional benefits. The energy standard therefore overlaps the carbon standard in this way.

From the review of the standards, it was evident that the energy standard was more management focused, as the requirements of the standard were very specific on how an organisation should manage energy – implementation, operation, checking etc. This was also evident in the energy standard 'planning' requirements through focussing the organisation to identify energy savings to be managed. The carbon standard does not follow the 'Plan-Do-Check-Act' structure which is typical of management standards and instead is focussed on the quantification of GHG emissions. Part of the planning section of the energy standard, includes the development of energy objectives, targets and programmes in order to manage and continually improve energy efficiency. In the carbon standard, the equivalent of objectives and targets are 'directed actions' and while directed actions are included as a requirement in the standard, it is not mandatory - '*The organisation may plan and implement directed actions to reduce or prevent GHG emissions.*' No significant detail is provided on their development within the standard. Therefore, the carbon standard, at an organisation level, assessed in this case study is not management focused.

In contrast, the *WRI GHG Protocol* provides greater detail in setting GHG targets with the aim to track company performance and initiate continual improvement. The other option for reducing GHG emissions from an organisation is to identify specific projects that will achieve this and follow Part 2 of the carbon standard which requires significant additional work, over what is identified in Part 1 of the standard.

The empirical data results confirm the literature review's conclusion that there are overlaps between energy and carbon management data. This is especially relevant if 'other indirect emissions' are eliminated from the carbon standard emissions and if process emissions are negligible, as in this case study. In this situation, energy and carbon standards are reporting on the same organisational data. This is relevant to all service organisations where process emissions are minimal. In the case of industrial organisations or organisations with larger refrigeration/air conditioning systems, the contribution of process emissions may be greater and more data collection and calculations are required in order to comply with the carbon standard.

It was evident from the energy standards examined in the literature review that they can significantly vary in their requirements and this limits the possibility of comparing energy use or management across nations. Through the empirical analysis, it was also evident that a number of approaches could be applied in the energy standard to assess energy aspects of an organisation. The development of an international energy management standard – ISO 50001 may overcome these inconsistencies by providing an overall international approach. However, this would require the inclusion of specific and clear requirements in the technical aspects of the standard in order to ensure complete harmonisation and implementation consistency in all counties.

The specific and clear requirements in the calculation of GHG emissions in the international carbon standard overcome what is absent in the energy standard. The overall guiding principles of the carbon standard are consistency, accuracy and transparency. This standard has been designed to purposely calculate GHG emissions from an organisation which can be assessed in detail and scrutinised. This allows the systematic and independent verification of the results against verification criteria and the comparison of emissions across other organisations.

It is this verification criteria that is the driving force towards the 'quantification' approach of the carbon standard. One such criterion is the mandatory European GHG programme – the Emission Trading Scheme. As this standard is used to determine emissions or emission reductions from an organisation and therefore, an appropriate payment for such emissions or emission reductions through CDM or JI projects – the need for clear and transparent calculation requirements are justified. With ever increasing climate change regulations, policies, taxes being introduced, this standard will be increasingly implemented by organisations.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The overall aim of this research was to examine energy and carbon management standards, relative to Ireland, in order to assess the different approaches outlined for managing energy in an organisation. The specific research objectives were:

1. To examine energy and carbon management standards at an organisational level to assess how energy management is approached within these standards
2. To critically evaluate energy and carbon management standards to assess the overlap in each standards requirements, if any, in managing energy
3. To appraise energy and carbon management standards to assess the accuracy and completeness of the standards
4. To outline the advantages and disadvantages of implementing an energy or carbon management standard
5. To explore if either an energy or a carbon standard can be applied to an organisation and will mutually benefit the organisation as well as energy resources and climate change
6. To formulate recommendations for the implementation of energy or carbon standards

This chapter will revisit these research objectives, summarise the findings of this research work and put forward conclusions based on these findings. Recommendations will then be made on a micro and macro level. On a micro level recommendations are provided for the case study organisation and service organisations with regards to the implementation of energy and carbon standards. On a macro level, recommendations are made that are relevant to all industries/organisations, nationally and internationally. Recommendations for future study are also provided.

5.2 Research Objectives: Summary of Findings and Conclusions

Each of the study's research objectives are individually discussed with regards to overall findings and conclusions, below.

5.2.1 To examine energy and carbon management standards at an organisational level to assess how energy management is approached within these standards

Due to the interrelationship between energy consumption, carbon emissions and climate change, energy and carbon standards are examined to assess how energy management is approached. In this study, the literature review identified that energy management is approached differently in each of the standards. The energy standard is 'management focused' and the requirements of the standard are very specific on how an organisation should manage energy – implementation, objectives, targets, operation, checking, etc. The carbon standard is 'quantification' focused designed to purposely calculate GHG emissions from an organisation so that the inventory can be assessed in detail.

When undertaking the empirical analysis, these different approaches were evident. The 'planning' requirements of the energy standard is very 'process' driven which requires a detailed examination of energy processes of an organisation to identify energy savings to be managed. In the case of the carbon standard, the approach to data analysis is more 'scientific'. It requires a quantification methodology to be set out and calculations undertaken in accordance with a chosen methodology. This standard does not require any analysis of specific equipment or energy processes that contribute to the total energy bill but is more concerned with the totalling of organisation's energy bills.

The main conclusion that can be drawn from this is that energy and carbon management standards have different approaches in their assessment of energy and carbon data. With regards to the management of energy, the energy standard is more appropriate as its requirements are designed to manage energy (implementation, objectives, targets, operation, checking, etc). The carbon standard (ISO 14064-1) as it is, does not contribute to the management of energy or even the management of carbon emissions. However, if the *WRI GHG Protocol* guidance on GHG targets is incorporated, then the management of carbon emissions and indirectly energy usage will be undertaken.

5.2.2 To critically evaluate energy and carbon management standards to assess the overlap, if any, in managing energy

The review of literature identified that there are overlaps in the requirements of energy and carbon management standards particularly in the 'planning' sections of the standards. This was substantiated in the empirical data analysis. All energy data collated for the energy standard is used in the carbon standard under Direct (Scope 1) and Energy Indirect (Scope 2) GHG emissions. These emissions are those which are required to be reported in the carbon standard.

In this case study, energy data contributed 99.96% of Scope 1 and 2 GHG emissions. The remaining 0.4% consisted of process emissions from small scale refrigerant and air conditioning systems. The contribution of process emissions to the GHG inventory of an organisation is dependent on the nature of the business. Overall, process emissions are not likely to be significant in service organisations however, in larger scale industrial plants or in the use of larger scale refrigerant and air conditioning systems – process emissions may a significant contribution to the GHG inventory.

The carbon standard also incorporates another category of 'Other indirect emissions' (Scope 3) which are an optional reporting requirement. From the case study results, these emissions contributed to 52% of the total organisation GHG emissions, therefore they can account for a significant majority of the total GHG emissions. The collection and inclusion of this data does not overlap with what is required in the energy standard.

In conclusion, energy and carbon standards are collecting and processing the same organisational energy data that are specifically required under each standard. Process emissions are incorporated in the carbon standard, in addition to energy data however, the contribution of such emissions is not significant in a service organisation and their significance will vary across other business types.

5.2.3 To appraise energy and carbon management standards to assess the accuracy and completeness of the standards

From the literature review it was evident that the carbon standard is more complete by including the option to incorporate carbon emissions which result as a consequence of the organisations activities - 'Other Indirect' (Scope 3) emissions. The energy standard only focuses on activities under the control of the organisation.

The approach taken by each of the standards contributes to the accuracy of the standards. The 'process' driven energy standard requires detailed breakdown on trends and energy users, thereby requiring very precise and accurate results. However, there are a number of options to undertake this and the standard does not outline specific procedures for undertaking such assessments or the required accuracy to be achieved. As identified in the literature review, the guiding principal of the carbon standard is – consistency, accuracy and transparency. This standard requires a more 'scientific' approach through the identification of a quantification methodology and calculation process, to be outlined clearly and transparently, to minimise uncertainty and yield accurate, consistent and reproducible results. This allows the systematic and independent verification of GHG emissions and allows for the comparison across different organisations.

The literature identified that an uncertainty assessment is included as part of the carbon standard albeit that it is an optional requirement. The assessment was undertaken as part of the empirical data analysis. This assessment aims to identify uncertainties and inaccuracies in data and identify opportunities for improvement of input GHG data. The inclusion of this assessment will improve the accuracy of inventory data over time. However in reality, undertaking this assessment is more difficult than expected due to the lack of published uncertainty interval for emission factors and lack of known uncertainty levels for metered readings at the organisation. However, the aim of the requirement was achieved as opportunities for accuracy improvement from the empirical analysis can be identified.

In conclusion, the carbon standard requires a more accurate and transparent assessment to be undertaken. The inclusion of an uncertainty assessment allows inaccuracy improvements to be identified and improved on. The opportunity to include carbon emissions that result as a consequence of an organisations activity - 'Other Indirect (Scope 3) emissions, allows the carbon standard to be more complete.

5.2.4 To outline the advantages and disadvantages of implementing an energy or carbon management standard

The literature review and the empirical analysis outlined a number of advantages and disadvantages of implementing each standard. These advantages and disadvantages are summarised in the Table 8 and Table 9.

Advantages	Disadvantages
• Focus on energy management alone for greater control • Overlap of energy data in energy and carbon standard • Very specific with 'process' driven methodology to help identify opportunities for energy savings • Identifies energy and carbon saving opportunities • 'management' focussed standard to continually improve energy efficiency • Identifies, objectives, targets and programmes to improve energy efficiency	• 'planning' requirements are time consuming though detailed process driven energy use collection and analysis • Only includes energy aspects under the control of the organisation therefore is not a complete assessment • Quantification methodology and approach to identifying energy aspects is not transparent • Comparison across organisations is not possible • No uncertainty or accuracy assessment as part of the standard requirements

Table 8 Overall Advantages and Disadvantages of Implementation of Energy Standard

Advantages	Disadvantages
• Overlap of energy data in energy and carbon standard • Inclusion of 'Other' indirect' emissions ensures a more complete assessment of carbon emissions • More scientific and transparent quantification approach • Comparison across organisations is possible • Inclusion of a uncertainty assessment to improve the accuracy and quality of GHG data	• Inclusion of 'Other' indirect' emissions are time consuming though data collection and analysis • Does not identify carbon saving opportunities • Is not 'management' focussed • Does not follow the typical ISO standard cycle – Plan-Do-Check-Act • Targets to reduce carbon emissions are not mandatory and limited detail is provided on 'directed actions' • Inclusion of 'Other' indirect' emissions may decrease the accuracy of the assessment

Table 9 Overall Advantages and Disadvantages of Implementation of Carbon Standard

Specific conclusions in relation to the advantages and disadvantages of energy and carbon standards have been outlined under the earlier research objectives.

5.2.5 To explore if either an energy or a carbon standard can be applied to an organisation and will mutually benefit the organisation as well as energy resources and climate change

The simple answer to this research objective is 'No'. While the energy standard will achieve savings and benefits from energy, financial and carbon emission perspective, the magnitude of the carbon saving is dependent on the correlation of energy use and associated CO_2 emission factors. The energy standard also does not identify any carbon savings from 'other indirect' emissions as this not covered within the scope of this standard. However, the carbon standard, in compliance with its mandatory requirements, does not identify any carbon savings or energy or financial savings.

In conclusion, the implementation of an energy or carbon standard at an organisation will not mutually benefit the organisation, energy resources and climate change. In compliance with the mandatory requirements of the standards, the energy standard would be most beneficial to an organisation as well as energy and carbon savings. However, if the additional requirements of the carbon standard are included such as inclusion of 'other indirect (Scope 3) emissions and the identification of directed actions to reduce carbon emissions – the net benefit of the carbon standard could potentially outweigh the benefits of the energy standard.

5.3 Recommendations

The final research objective of this study was to formulate recommendations for Irish organisations when implementing energy or carbon standards. These recommendations are outlined in this section in the context of the conclusions reached in Section 5.2 above.

Conclusion 1:

Energy and carbon management standards have different approaches in their assessment of energy and carbon data. With regards to the management of energy, the energy standard is more appropriate as its requirements are designed to manage energy (implementation, objectives, targets, operation, checking, etc). The carbon standard (ISO 14064-1) as it is, does not contribute to the management of energy or even the management of carbon emissions. However, if the *WRI GHG Protocol* guidance on GHG targets is incorporated, then the management of carbon emissions and indirectly energy usage will be undertaken.

Recommendation 1: If an organisation aims to become more energy efficient and continually improve energy usage, it is recommended that an energy standard is established and implemented.

Recommendation 2: If implementing the carbon standard at an organisational level, it is recommended that the WRI GHG Protocol guidance on GHG targets is incorporated. This will allow the management of carbon emissions to continually reduce such emissions.

Conclusion 2:

Energy and carbon standards are collecting and processing the same organisational energy data that are specifically required under each standard. Process emissions are incorporated in the carbon standard, in addition to energy data however, the contribution of such emissions is not significant in a service organisation and their significance will vary across other business types.

Recommendation 1: As the data overlap between energy and carbon standards for service organisations is large, it is recommended that following the implementation of the energy standard, a service organisation should calculate the GHG emissions for Scope 1 and 2 categories under the requirement of the carbon standard. This will benefit the organization as it can comply with two standards and can proactively manage and control both energy and carbon savings, without significant additional effort. This will reduce the future corporate risk of the company in the advent of future energy and climate change regulations, policies and taxes.

Recommendation 2: The above recommendation is applicable to all organisations however, depending on the nature of organisations process emissions, equivalent additional work will be required to incorporate process emissions. It is recommended that further study is undertaken, using the methodology approach undertaken in this case study, with regard to specific industrial sector areas, in order to substantiate this generalisation.

Conclusion 3:

The carbon standard requires a more accurate and transparent assessment to be undertaken. The inclusion of an uncertainty assessment allows inaccuracy improvements to be identified and improved on. The opportunity to include carbon emissions that result as a consequence of an organisations activity - 'Other Indirect (Scope 3) emissions, allows the carbon standard to be more complete.

Recommendation 1: It is recommended that when an organisation is establishing and implementing an energy standard that the requirements of the carbon standard are also complied with. This would involve clearly stating the quantification/assessment methodology undertaken, level of accuracy achieved, calculations undertaken, etc. While this may require additional resources initially, the organisation will benefit from this preparation, by demonstrating accuracy and transparency in its assessment process. This will also ensure the transition between energy and carbon standard implementation, if required, is simpler.

Recommendation 2: It is recommended, where possible, in the calculation of GHG emissions to include 'Other Indirect (Scope 3)' emissions. It is acknowledged that the accuracy of such data may be questionable however; the inclusion of these estimated emissions will provide the organisation with a greater understanding of its carbon footprint.

Recommendation 3: With regards to the specific case study in this research study, it is recommended that databases are set up to establish data collection and/or increase the accuracy of current data for 'Other Indirect (Scope 3)' emissions. To increase the accuracy of the uncertainty assessment, it is recommended to increase the frequency of data collection, if applicable, undertake an annual calibration of energy meters and undertake annual maintenance and leak testing of refrigerators/air conditioning systems.

Recommendation 4: In order to increase the accuracy of uncertainty assessments, public bodies developing country specific emission factors should also calculate and publish associated uncertainty intervals.

Recommendation 5: It is recommended that the new international energy management standard - ISO 50001- which is currently under development, includes specific and clear requirements for the assessment and quantification of the technical aspects of the standard, in order to ensure harmonisation and consistency across all countries. These requirements should be consistent with the carbon management quantification approach.

Conclusion 4:

The implementation of an energy or carbon standard at an organisation will not mutually benefit the organisation, energy resources and climate change. In compliance with the mandatory requirements of the standards, the energy standard would be most beneficial to an organisation as well as energy and carbon savings. However, if the additional requirements of the carbon standard are included such as the inclusion of 'other indirect' (Scope 3) emissions and the identification of directed actions to reduce carbon emissions – the net benefit of the carbon standard could potentially outweigh the benefits of the energy standard.

Recommendation 1: To maximise the benefits to an organisation, energy use and carbon reductions, it is recommended that the carbon standard plus its additional requirements are implemented. This standard is the most complete standard, with the inclusion of 'other indirect' (Scope 3) emissions and with the identification of specific carbon reduction actions. From this, an organisation will potentially benefit from both energy and carbon financial savings, carbon reduction and increased energy efficiency.

5.3.1 Overall Conclusion and Recommendation

The overall aim of this research was to examine energy and carbon management standards, relative to Ireland, in order to assess the different approaches outlined for managing energy in an organisation.

From the literature review undertaken and the practical empirical data analysis of a case study service organisation, it is evident that energy and carbon standards, at an organisation level, have different approaches to the assessment and management of energy use and carbon emissions. These individual approaches have their own advantages and disadvantages. The energy standard ‘process’ driven approach ensures the organisation identifies and manages energy reduction opportunities. While the carbon standard, through its ‘scientific’ driven approach, ensures that the carbon emission assessment is clear, transparent and accurate, as far as practical. However, the mandatory requirements of the carbon standard itself do not contribute to the management or reduction of emissions without the inclusion of supplementary ‘directed actions’ and support from the *WRI Greenhouse Gas Protocol.*

Due to the large overlap in energy data, the interrelationship between the energy and carbon standards and increasing pressure on organisations to reduce their environmental impacts, an Irish organisation, when deciding to establish and implement an energy or carbon standard, should design a system that will comply with both standards. This combined system will utilise the advantageous aspects of each standard, to maximise the benefit to the organisation through energy and carbon savings, financial savings and promote the corporate ‘green’ image of the organisation.

At a national level, in order to maximise the benefits of the Government’s energy policy and climate change policy, which are already closely aligned, the Government’s White Paper on Energy and the National Climate Change Strategy should be integrated into a single strategy. This would reinforce the interrelationship between energy and carbon management and lead to combined objectives and targets to tackle Irelands' key environmental challenges – sustainable use of energy resources and climate change.

At a national and international level, a move towards integrating energy and carbon management standards at an organisation level is also required. This will maximise the benefits to an organisation, energy resources and climate change without entailing the duplication of an organisation's time and financial resources.

CHAPTER SIX

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APPENDIX
A

Energy Standard
Data

Table 1 Second Floor Electricity Data

Year	Months	Day Units	Night Units	Days in Period	Average Day Units Per Day	Average Night Units Per Day	Base Load	Daytime Baseload	Night time Baseload (ex. storage heating)	Average No. of Employees	No. of working Days	Total Occupancy Hours	Degree Days	Supplier
		kWh	kWh		kWh	kWh	kW/min	kWh/day	kWh/night					
2007	01 Jan - 21 Feb	1672	2838	52	32	55	0.0265	25.44	12.72	34	36	324		ESB
	22 Feb- 27 Mar	2800	4372	34	82	129	0.0265	25.44	12.72	34	23	207		ESB
	28 Mar - 29 May	5510	3894	63	87	62	0.0265	23.85	14.31	34	42	378	430.6	ESB
	30 May - 02 Aug	4227	1667	65	65	26	0.0265	23.85	14.31	34	46	414	312	ESB
	03 Aug - 27 Sept	4235	1019	56	76	18	0.0265	23.85	14.31	34	39	351	249.2	ESB
	28 Sept - 23 Nov	4688	2521	57	82	44	0.0265	25.44	12.72	34	40	360	466.1	ESB
2008	24 Nov - 29 Jan	5,867	3,155	67	88	47	0.0265	25.44	12.72	34	45	405	772.7	ESB
	30 Jan - 2 Apr	8,384	13,872	64	131	217	0.0265	25.44	12.72	36	43	387	782.1	ESB
	3 Apr - 29 May	5,276	6,299	57	93	111	0.0265	23.85	14.31	38	40	360	508.6	ESB
	30 May - 5 Aug	4,723	2,409	68	69	35	0.0265	23.85	14.31	39	46	414	320.9	ESB
	6 Aug - 1 Oct	3,383	1,591	57	59	28	0.0265	23.85	14.31	39	41	369	314.6	ESB
	2 Oct - 1 Dec	3,967	6,673	61	65	109	0.0265	25.44	12.72	39	42	378	633.4	ESB
2009	2 Dec - 4 Feb	5345	11011	65	82	169	0.0265	25.44	12.72	33	30	270	886.9	ESB
	5 Feb- 30 March	4413	9091	54	82	168	0.0265	25.44	12.72	33	37	333	656.7	ESB
	9 April-4 June	2268	3331	57	40	58	0.0265	23.85	14.31	33	58	522	494.4	B. Gais
	5 June -27 July	2028	2979	53	38	56	0.0265	23.85	14.31	0	37	333	254.3	B. Gais
	29 July - 28 Sept	261	430	62	4	7	0.0265	23.85	14.31	0	44	396	328.1	B. Gais
	29 Sept 30 Sept	7	5	2	4	3	0.0265	23.85	14.31	0	2	18	10.9	B. Gais
	01 Oct - 27 Nov	196	131	58	3	2	0.0265	25.44	12.72	0	41	369	515.2	B. Gais

Figure 1 Second Floor Energy usage Verses Total Occupancy Hours

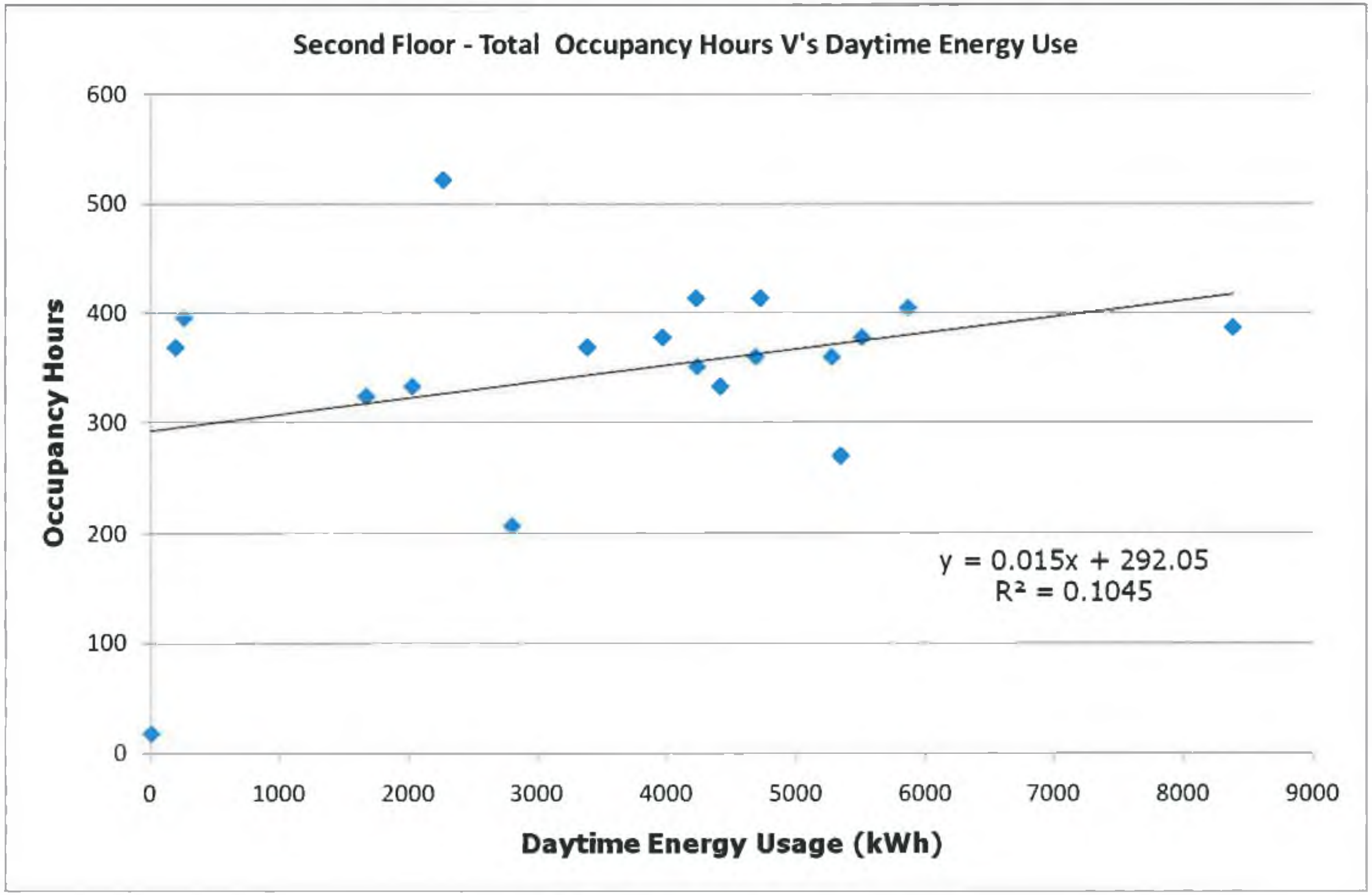


Table 2 Ground and First Floor Electricity Data

Year	Months	Day Units kWh	Night Units kWh	Days in Period	Average Day Units Per Day kWh	Average Night Units Per Day kWh	Base Load kW/min	Daytime Baseload kWh/day	Night time Baseload (ex. storage heating) kWh/night	Average No. of Employees	No. of working Days	Total Occupancy Hours	Degree Days	Supplier
2007	01 Jan - 21 Feb	1672	2838	52	32	55	0.0265	25.44	12.72	34	36	324		ESB
	22 Feb- 27 March	2800	4372	34	82	129	0.0265	25.44	12.72	34	23	207		ESB
	28 March - 29 May	5510	3894	63	87	62	0.0265	23.85	14.31	34	42	378	430.6	ESB
	30 May - 02 Aug	4227	1667	65	65	26	0.0265	23.85	14.31	34	46	414	312	ESB
	03 Aug - 27 Sept	4235	1019	56	76	18	0.0265	23.85	14.31	34	39	351	249.2	ESB
	28 Sept - 23 Nov	4688	2521	57	82	44	0.0265	25.44	12.72	34	40	360	466.1	ESB
2008	24 Nov - 29 Jan	5,867	3,155	67	88	47	0.0265	25.44	12.72	34	45	405	772.7	ESB
	30 Jan - 2 Apr	8,384	13,872	64	131	217	0.0265	25.44	12.72	36	43	387	782.1	ESB
	3 Apr - 29 May	5,276	6,299	57	93	111	0.0265	23.85	14.31	38	40	360	508.6	ESB
	30 May - 5 Aug	4,723	2,409	68	69	35	0.0265	23.85	14.31	39	46	414	320.9	ESB
	6 Aug - 1 Oct	3,383	1,591	57	59	28	0.0265	23.85	14.31	39	41	369	314.6	ESB
	2 Oct - 1 Dec	3,967	6,673	61	65	109	0.0265	25.44	12.72	39	42	378	633.4	ESB
2009	2 Dec - 4 Feb	5345	11011	65	82	169	0.0265	25.44	12.72	33	30	270	886.9	ESB
	5 Feb- 30 March	4413	9091	54	82	168	0.0265	25.44	12.72	33	37	333	656.7	ESB
	9 April-4 June	2268	3331	57	40	58	0.0265	23.85	14.31	33	58	522	494.4	B. Gais
	5 June -27 July	2028	2979	53	38	56	0.0265	23.85	14.31	0	37	333	254.3	B. Gais
	29 July - 28 Sept	261	430	62	4	7	0.0265	23.85	14.31	0	44	396	328.1	B. Gais
	29 Sept - 30 Sept	7	5	2	4	3	0.0265	23.85	14.31	0	2	18	10.9	B. Gais
	01 Oct - 27 Nov	196	131	58	3	2	0.0265	25.44	12.72	0	41	369	515.2	B. Gais

Table 3 Landlord Supply Electricity Data

Year	Months	Day Units kWh	Night Units kWh	Days in Period	Average Day Units Per Day kWh	Average Night Units Per Day kWh	Base Load kWh/min	Daytime Baseload kWh/day	Night time Baseload kWh/day	No. of working Days	Total Occupancy Hours	Supplier
2007	1 Jan - 29 Jan	1778	1204	29	61	42	0.012	11.299	5.649	19	171	ESB
	30 Jan - 27 March	731	1186	57	13	21	0.012	11.299	5.649	41	369	ESB
	28 March - 29 May	2167	1795	63	34	28	0.012	10.593	6.356	42	378	ESB
	30 May - 02 Aug	2216	2086	65	34	32	0.012	10.593	6.356	46	414	ESB
	03 Aug - 27 Sept	1708	1650	56	31	29	0.012	10.593	6.356	39	351	ESB
	28 Sept to 23 Nov	2042	1744	57	36	31	0.012	11.299	5.649	40	360	ESB
2008	24 Nov - 29 Jan	2,555	2,182	67	38	33	0.012	11.299	5.649	45	405	ESB
	30 Jan - 2 Apr	1,992	810	64	31	13	0.012	11.299	5.649	43	387	ESB
	3 Apr - 29 May	1,528	621	57	27	11	0.012	10.593	6.356	40	360	ESB
	30 May - 5 Aug	2,275	714	68	33	10	0.012	10.593	6.356	46	414	ESB
	6 Aug - 1 Oct	1,539	719	57	27	13	0.012	10.593	6.356	41	369	ESB
	2 Oct - 1 Dec	1,378	1,101	61	23	18	0.012	11.299	5.649	42	378	ESB
2009	2 Dec - 4 Feb	1530	1054	65	24	16	0.012	11.299	5.649	30	270	ESB
	5 Feb- 30 March	1263	870	54	23	16	0.012	11.299	5.649	37	333	ESB
	30 Mar -13 April	264	152	14	19	11	0.012	10.593	6.356	9	81	ESB
	14 April - 04 June	1588	853	52	31	16	0.012	10.593	6.356	36	324	B. Gais
	5 June -27 July	1538	826	53	29	16	0.012	10.593	6.356	37	333	B. Gais
	28 July - 28 Sept	632	664	62	10	11	0.012	10.593	6.356	44	396	B. Gais
	29 Sept - 30 Sept	43	28	2	22	14	0.012	11.299	5.649	2	18	B. Gais
	01 Oct - 27 Nov	1239	810	58	21	14	0.012	11.299	5.649	41	369	B. Gais

Table 4 Server Room Electricity Data

Year	Months	Electricity Units kWh	Days in Period	Average Electricity Per Day kWh	Supplier
2008	January	3,507	31	113	Airtricity
	February	3,050	29	105	Airtricity
	March	1,948	31	63	Airtricity
	April	2,462	30	82	Airtricity
	May	2,489	31	80	Airtricity
	June	2,269	30	76	Airtricity
	July	4,413	28	158	Airtricity
	August	3,194	34	94	Airtricity
	Sept/ Oct /Nov	9,054	91	99	Airtricity
2009	Dec /Jan /Feb	8,527	90	95	Airtricity
	Mar /April /May	5,130	73	70	Airtricity
	Jun/July	6,750	68	99	Bord Gais
	Aug /Sept	6,350	62	102	Bord Gais
	Sept	183	2	92	Bord Gais
	Oct/Nov	5,306	58	91	Bord Gais

Table 5 Natural Gas Usage for Heating

Year	Date	Energy Consumption kWh	Degree Days	Standing Charge Days	Energy Consumption kWh/day
2007	09/01/07-31/01/07	3952		23	172
	01/02/07-23/02/07	3952		23	172
	24/02/07-11/04/07	716		47	15
	12/04/07-12/06/07	5302	232.9	61	87
	13/06/07-08/08/07	2300	117.4	57	40
	09/08/07-30/09/07	2886	117	53	54
	01/10/07-16/10/07	871	45.8	16	54
	17/10/07 - 4/12/07	6876	317.3	49	140
2008	5/12/07 - 8/02/08	8905	590.3	66	135
	9/02/08 - 14/04/08	11869	598.4	66	180
	15/04/08- 13/06/08	3697	270.5	60	62
	14/06/08 - 20/08/08	1359	139.2	68	20
	21/08/08 - 15/10/08	345	194.2	56	6
	16/10/08 - 09/12/08	10757	468.4	56	192
2009	10/12/08 - 11/02/09	14,033	693.7	63	223
	11/02/09 - 17/04/09	14,191	547.4	65	218
	18/04/09 - 30/04/09	870	89.6	13	67
	01/05/09 - 30/06/09	4,085	238.2	61	67
	30/06/09 - 24/08/09	0	105.9	55	0
	25/08/09- 30/09/09	874	107	37	24
	1/10/09 - 18/10/09	425	82.1	18	24
	19/10/09 - 16/12/09	10,258	456	59	174

Table 6 Heating Degree Day Analysis for natural Gas Usage

Date	Degree Days Base Temperature													kWh
	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	
12/04/07-12/06/07	97.7	116.8	137.5	158.6	181.2	206.3	232.9	260	288.1	316.6	345.5	374.4	404.1	5302
13/06/07-08/08/07	26.2	36	48.2	62.6	77.8	96.9	117.4	140.3	163.6	189.2	215	240.5	268.1	2300
09/08/07-30/09/07	39.1	48.4	59	71.7	85.6	101.3	117	135.4	154.9	177.2	200.1	223.1	247.1	2886
01/10/07-16/10/07	10.3	14.3	19.3	25.2	31.5	38.7	45.8	53.8	61.6	69.5	77.5	85.5	93.5	871
17/10/07 - 4/12/07	174.9	197.5	220.8	244.7	268.8	292.8	317.3	341.8	366.3	390.8	415.3	439.8	464.3	6876
5/12/07 - 8/02/08	392.9	425.9	458.8	491.3	524.3	557.3	590.3	623.3	656.3	689.3	722.3	755.3	788.3	8905
9/02/08 - 14/04/08	403	435.4	467.8	500.2	533	565.6	598.4	631.3	664.2	697.1	730.1	763.1	796.1	11869
15/04/08- 13/06/08	129.7	150.7	172.6	196.1	219.7	245.1	270.5	297.4	324.9	353.4	382	410.2	439.2	3697
14/06/08 - 20/08/08	34.6	46.7	61.5	78.1	95.5	116.9	139.2	166.1	194.3	224.2	254.3	284.3	316.4	1359
21/08/08 - 15/10/08	75	91	108.9	128.8	150.4	171	194.2	219.4	245.4	272.7	300	327.4	355.2	345
16/10/08 - 09/12/08	304.8	331.8	358.7	385.9	413.4	440.9	468.4	495.9	523.4	550.9	578.4	605.9	633.4	1412
10/12/08 - 11/02/09	501.7	533.7	565.7	597.7	629.7	661.7	693.7	725.7	757.7	789.7	821.7	853.7	885.7	14,033
11/02/09 - 17/04/09	353.6	385.7	418	450.2	482.6	515	547.4	579.7	612.2	644.7	677.2	709.7	742.2	14,191
18/04/09 - 30/04/09	51.1	57.7	64.1	70.4	76.8	83.2	89.6	95.9	102.3	108.8	115.3	121.8	128.3	870
01/05/09 - 30/06/09	108.2	126.5	145.9	167.2	190.3	213.6	238.2	264.7	292.2	320.8	349.5	378.3	408.1	4,085
30/06/09 - 24/08/09	25	33.2	43.7	55.4	69.5	87.2	105.9	125.8	146.5	170.7	195.5	220.1	247	0
25/08/09- 30/09/09	32.6	41.7	52.2	64.6	77	91.5	107	123.8	140.2	157.4	175	192.9	211.2	874
1/10/09 - 18/10/09	34.7	42	49.5	57.4	65.5	73.9	82.1	90.8	99.6	108.3	117.3	126.3	135.3	425
19/10/09 - 16/12/09	285	312.2	339.8	368.3	397.2	426.5	456	485.5	515	544.5	574	603.5	633	10,258
R2	0.7628	0.7659	0.7687	0.7709	0.7721	0.7736	0.7741	0.7735	0.7722	0.7698	0.7667	0.7630	0.7582	

Figure 2 Second Floor Day Time Electricity Consumption Trend

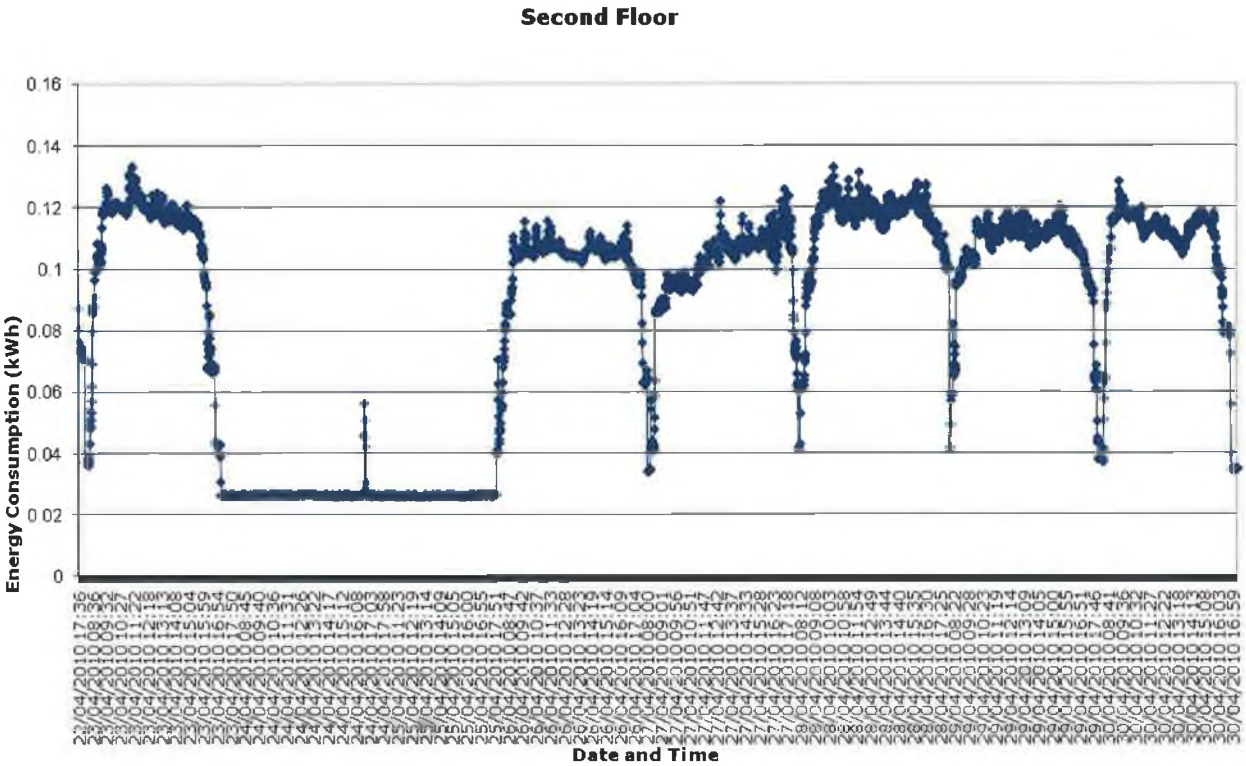


Figure 3 Second Floor Night Time Electricity Consumption Trend

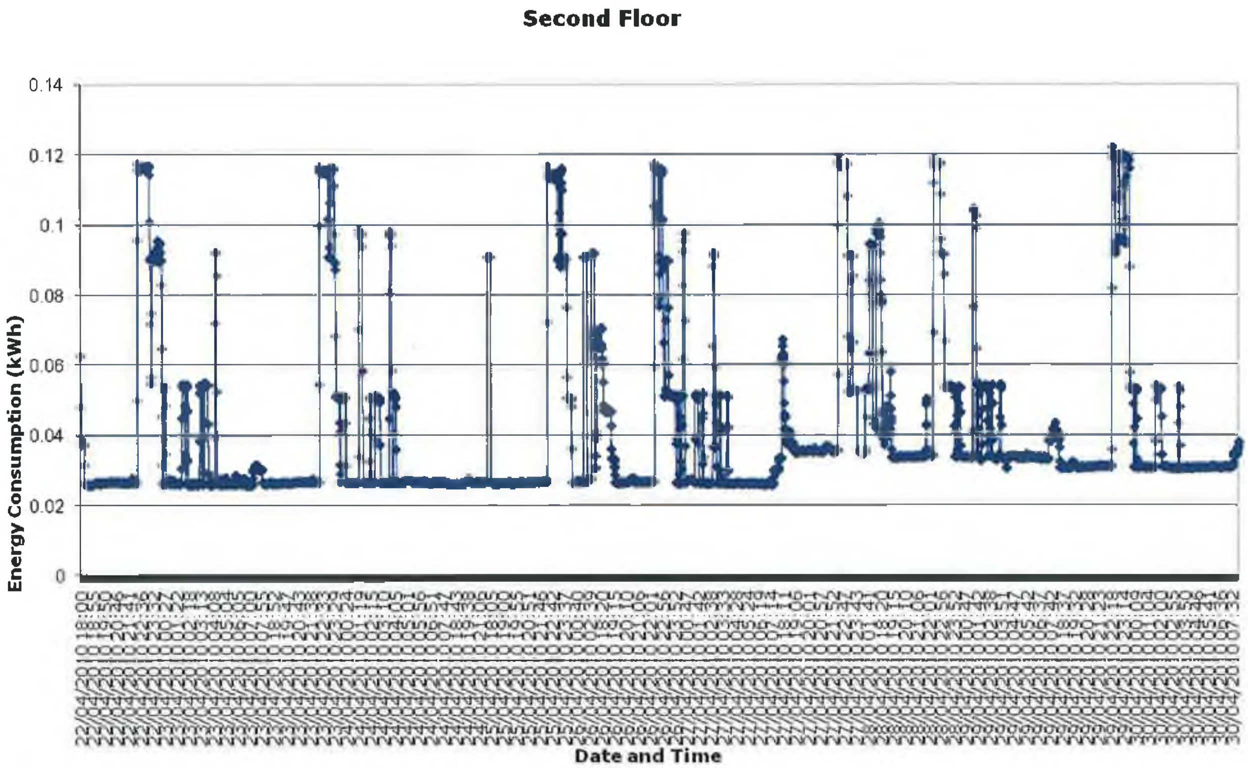


Figure 4 **Ground and First Floor Day Time Electricity Consumption Trend**

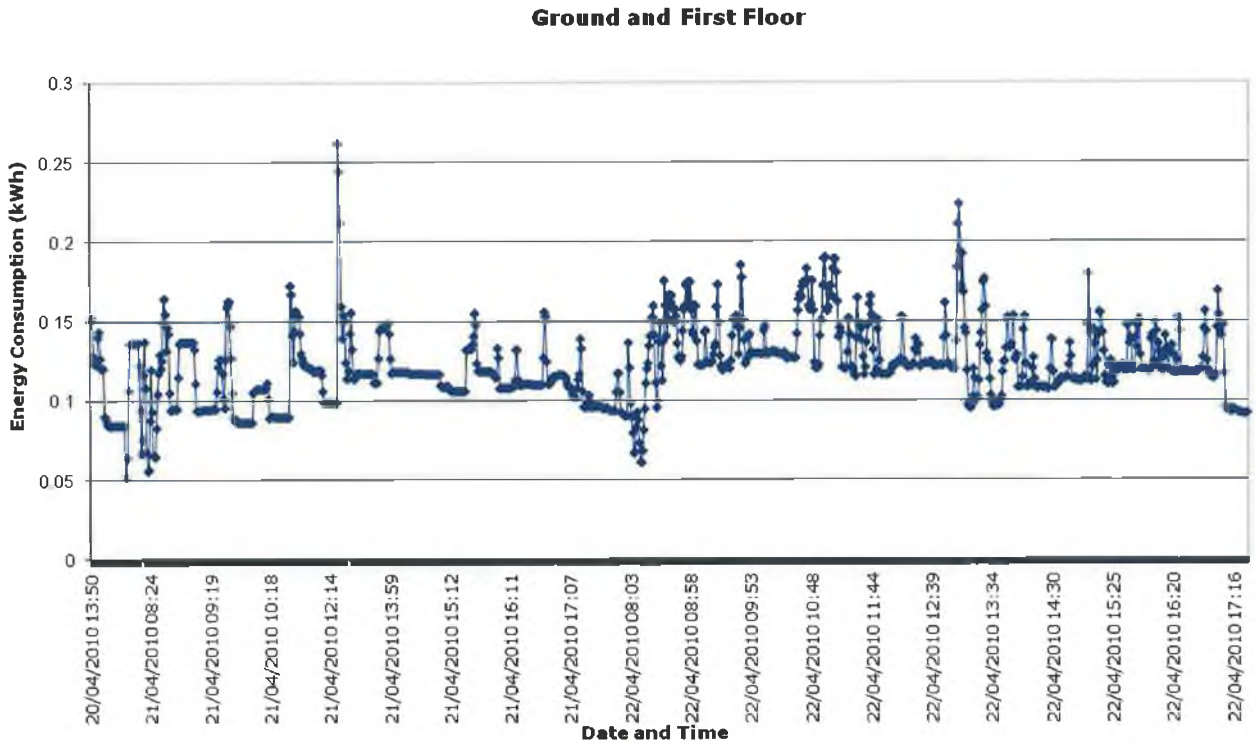


Figure 5 **Ground and First Floor Night Time Electricity Consumption Trend**

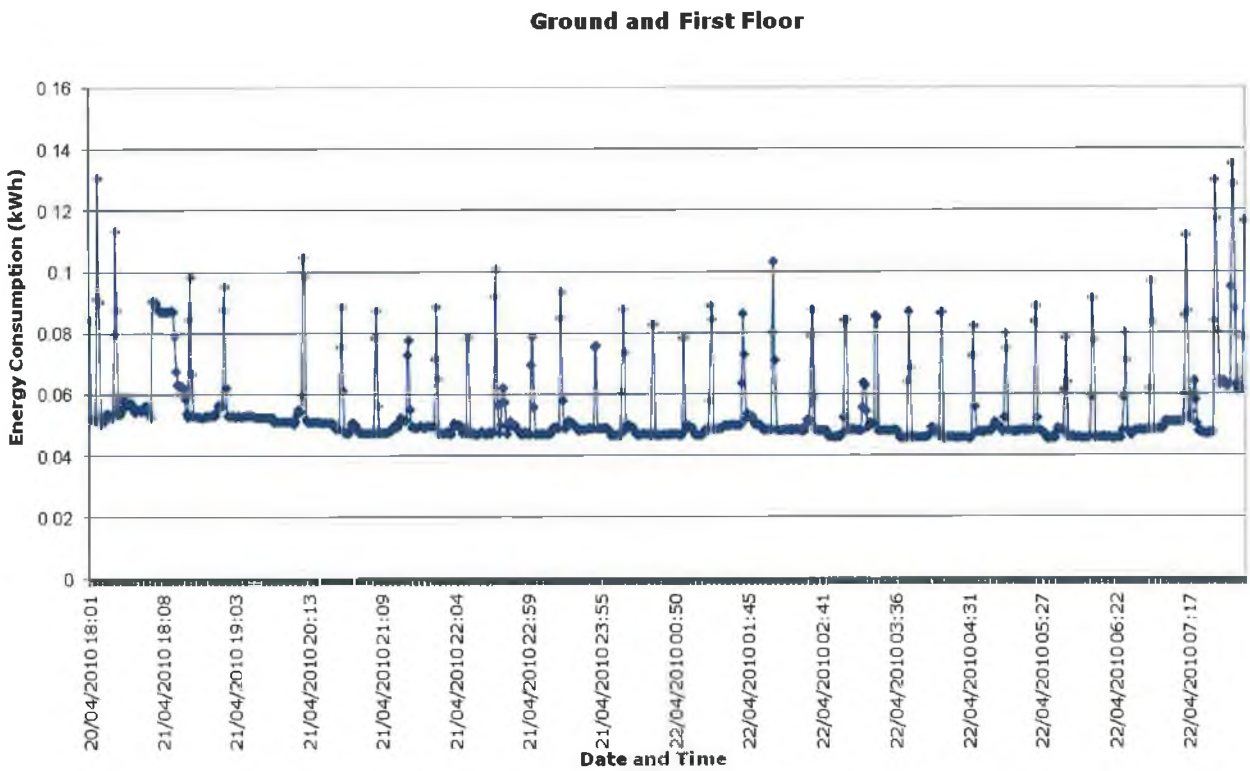


Figure 6 Landlord Day Time Electricity Consumption Trend

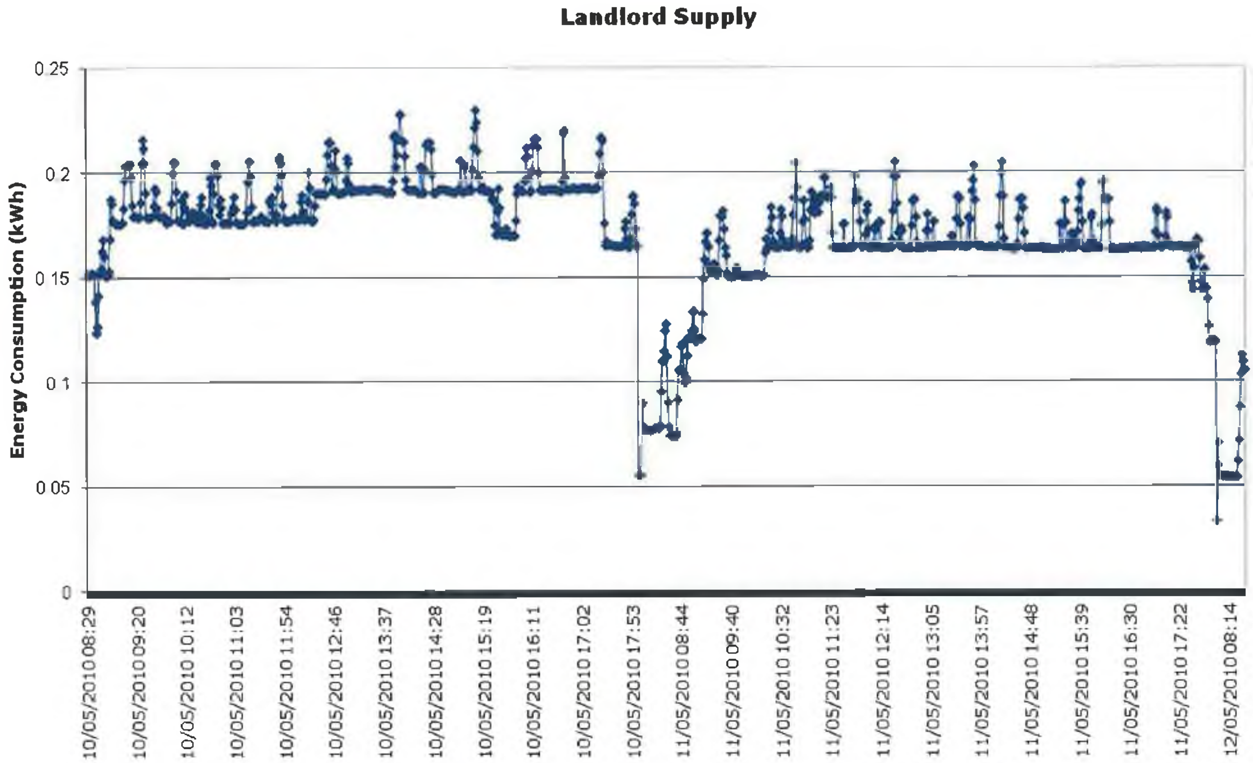
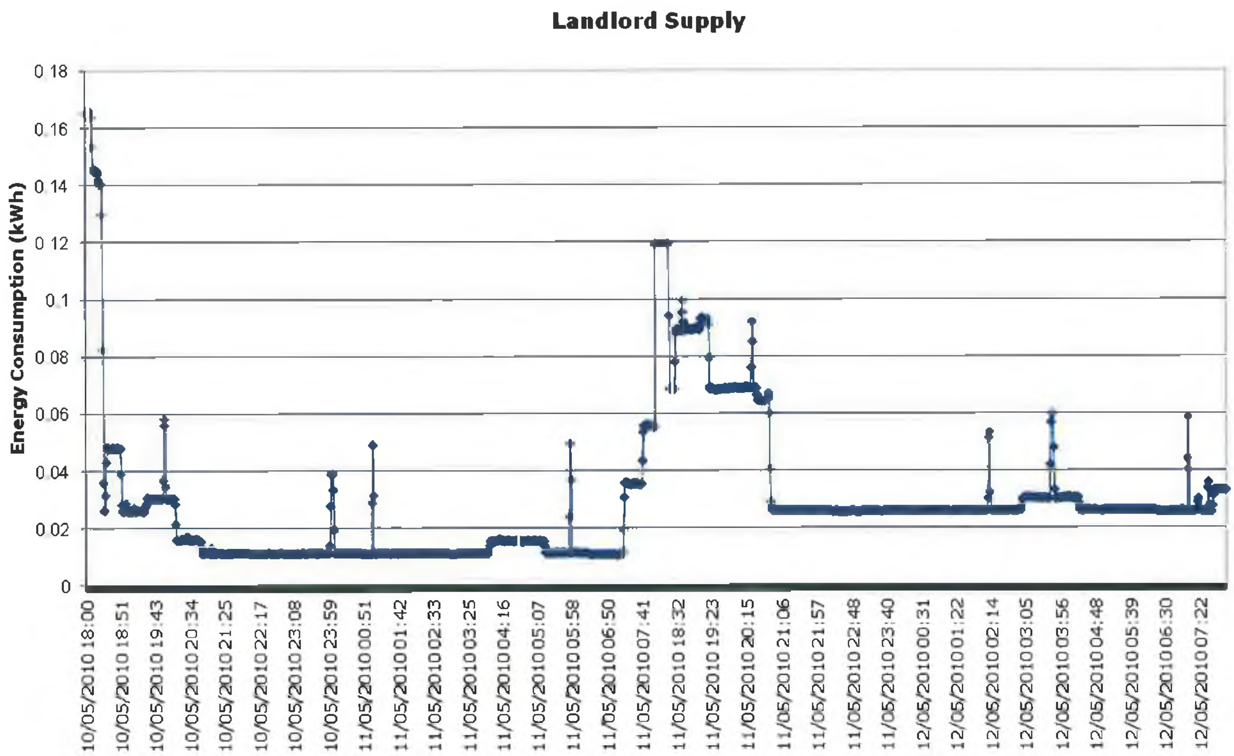


Figure 7 Landlord Night Time Electricity Consumption Trend



Date	Time	Vehicle	Site/Loc	Litres
09/06/2009	08:03	Cork Jeep	383	49.12
22/06/2009	18:49	Cork Jeep	572	61.38
05/06/2009	16:56	Van	383	42.5
03/07/2009	16:04	Cork Jeep	128	63.3
10/07/2009	17:54	Cork Jeep	383	61.72
17/07/2009	08:27	Cork Jeep	383	52.34
30/07/2009	16:36	Cork Jeep	202	56.54
21/07/2009	08:32	Van	383	38.49
09/08/2009	12:13	Cork Jeep	356	63.48
12/08/2009	17:31	Cork Jeep	383	46.16
14/08/2009	16:17	Cork Jeep	383	46.77
20/08/2009	19:59	Cork Jeep	993	57.93
10/08/2009	12:07	Van	586	43.32
26/08/2009	19:27	Van	378	36.74
07/09/2009	08:28	Cork Jeep	383	60.62
11/09/2009	17:30	Cork Jeep	383	61.74
13/09/2009	22:57	Cork Jeep	173	34.17
26/09/2009	08:58	Cork Jeep	703	51.45
08/09/2009	09:08	Van	383	41.2
22/09/2009	20:32	Van	993	44.59
28/09/2009	19:15	Van	383	41.34
30/09/2009	12:13	Van	383	19.48
02/10/2009	20:50	Cork Jeep	876	60.42
07/10/2009	09:51	Cork Jeep	600	38.48
21/10/2009	14:49	Cork Jeep	128	72
10/11/2009	18:24	Cork Jeep	993	52.94
16/11/2009	18:58	Cork Jeep	383	64.35
24/11/2009	09:31	Cork Jeep	2179	61.53
22/11/2009	17:55	Van	2169	35.25
26/11/2009	17:51	Van	765	34.9
07/12/2009	18:26	Cork Jeep	383	63.55
09/12/2009	15:56	Cork Jeep	383	36.52
11/12/2009	09:37	Cork Jeep	383	41.81
18/12/2009	08:27	Cork Jeep	383	67.92

Table 7: Significant Energy Use 'Bottom-Up' Energy Survey

Location	Division	Description	Quantity [-]	Actual Electrical Usage [W]	Annual Operating Hours [h]	Annual Electricity Consumption [kWh]	Comments / Justification for Operating Assumptions
Landlord	Lighting	Polux XL 36W/840	2	32	2187	140	On 9h -243 working days
Landlord	Lighting	Metal Halide Spot lights	31	200	2187	13,559	On 9h -243 working days
Landlord	Other Electrical	Lift Movement	1	8300	8.1	67	Average 2 twice a day for 2 minutes
Landlord	Lighting	Outside Porch Spots	4				
Landlord	Lighting	Stairs light	4	40	2187	350	On 9h for 5 days/week-243 working days
Landlord	Water Heating	Hot Water Heater	3	3700	1385.1	15,375	57 people * 3 times * 2 mins for 243 working days
Landlord	Other Electrical	Hand dryer	6	2100	145.8	1,837	6 people * 3 times * 2 mins for-243 working days (assumed 10%)
Ground & First Floor	Other Electrical	Fridge	1	35	8736	306	Continuous
Ground & First Floor	Other Electrical	Milk Fridge	1	95	8736	830	Continuous
Ground & First Floor	Other Electrical	Microwave	2	195	81	32	
Ground & First Floor	Other Electrical	Toaster	1	1500	48.6	73	Average 6 times a day
Ground & First Floor	Other Electrical	Water Cooler - Cooling	1	100	486	49	2 hours every working day
Ground & First Floor	Water Heating	Lincet water heater- boiling	1	2775	486	1,349	2 hours every working day
Ground & First Floor	Water Heating	Lincet water heater- ready	1	2	8250	17	Continuous
Ground & First	Lighting	OSRAML 18W/21-840	116	25	2187	6,342	On 9h -243 working days

Location	Division	Description	Quantity	Actual Electrica l Usage	Annual Operating Hours	Annual Electricity Consumption	Comments / Justification for Operating Assumptions
			[-]	[W]	[h]	[kWh]	
Floor							
Ground & First Floor	Lighting	Polux XL 36W/840	262	32	2187	18,336	On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Waste Printer - Start up/printing	1	400	486	194	Printing for 2 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Waste Printer - Ready	1	7	1701	12	Ready for 7 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Admin Printer - Start up/printing	1	1960	486	953	Printing for 2 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Admin Printer - Ready	1	48	1701	82	Ready for 7 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Finance Printer- Start up/printing	1	1140	486	554	Printing for 2 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Finance Printer - Ready	1	32	1701	54	Ready for 7 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Marion Printer - Start up/printing	1	400	243	97	Printing for 1 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Marion Printer - Ready	1	7	1944	14	Ready for 8 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Infra Printer- Start up/printing	1	1140	243	277	Printing for 1 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Infra Printer - Ready	1	32	1944	62	Ready for 8 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Creche Printer- Start up/printing	1	1140	486	554	Printing for 2 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Creche Printer - Ready	1	32	1701	54	Ready for 7 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	HR Printer - Start up/printing	1	400	243	97	Printing for 1 hours - On 9h for-243 working days
Ground & First	Electrical - Printers	HR Printer - Ready	1	7	1944	14	Ready for 8 hours - On 9h for-243

Location	Division	Description	Quantity [-]	Actual Electrical Usage [W]	Annual Operating Hours [h]	Annual Electricity Consumption [kWh]	Comments / Justification for Operating Assumptions
Floor							working days
Ground & First Floor	Electrical - Printers	2500 Core Printer- Start up/printing	1	1100	729	802	Printing for 3 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	2501 Core Printer- Ready	1	86	1458	125	Ready for 6 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Phaser 7760 Printer -Start up/printing	1	1373.000	729	1,001	Printing for 3 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Printers	Phaser 7760 Printer -Ready	1	50.000	1458	73	Ready for 6 hours - On 9h for-243 working days
Ground & First Floor	Electrical - Computers	Computers & Monitors	49	91	2187	9,752	On 9h -243 working days
Second Floor	Lighting	OSRAML 18W/21-840	225	25	2187	12,302	On 9h -243 working days
Second Floor	Lighting	Spot Lights	19	200	2187	8,311	On 9h -243 working days
Second Floor	Lighting	Wall light	2	40	2187	175	On 9h for 5 days/week-243 working days
Second Floor	HVAC	Mitsui Air Conditioners	4	7000	80	2,240	On 2 hours - 5 days for 2 months
Second Floor	HVAC	McQuay Air Conditioning	3	7000	80	1,680	On 2 hours - 5 days for 2 months
Second Floor	Electrical - Printers	Toshiba Printer - Start up/printing	1	1400	729	1,021	Printing for 3 hours - On 9h for-243 working days
Second Floor	Electrical - Printers	Toshiba Printer - Start up/printing	2	96	1458	280	Ready for 6 hours - On 9h for-243 working days
Second Floor	Electrical - Computers	Computers & Monitors	15	91	2187	2,985	On 9h -243 working days
Second Floor	HVAC	Dimplex Storage Heater CXL	7	3400	840	19,992	on 5 hours - for 6 months

Table 7: Summary of Significant Energy Users

Division	Annual Electricity Consumption per Area [kWh]			
	Landlord	Ground & First Floor	Second Floor	Total
Electrical- Computers		9,752	2,985	12,737
Electrical Printers		5,019	1,301	6,320
Other Electrical	1,904	1,289		3,193
HVAC			23,912	23,912
Lighting	14,049	24,678	20,787	59,514
Water Heating	15,375	1,365		16,740
Baseload	6,183	28,382	13,928	48,494
Server Room				32,246
Total	37,511	70,485	62,913	170,910

APPENDIX

B

Carbon Standard Data

Table 6 Diesel Fuel Usage for Organisation Owned Vehicles

Date	Time	Vehicle	Site/Loc	Litres
06/01/2009	16:15	Cork Jeep	383	30.13
13/01/2009	10:12	Cork Jeep	703	58.32
19/01/2009	09:06	Cork Jeep	383	65.06
27/01/2009	11:24	Cork Jeep	173	60.05
30/01/2009	11:53	Cork Jeep	383	52.69
08/01/2009	11:27	Van	383	41.71
27/01/2009	10:43	Van	876	33.03
12/02/2009	16:40	Cork Jeep	258	54.14
19/02/2009	19:52	Cork Jeep	258	54.61
24/02/2009	16:20	Cork Jeep	572	66.55
16/02/2009	21:38	Van	2006	34.85
23/02/2009	08:14	Van	572	44.94
25/02/2009	08:16	Van	383	34.56
03/03/2009	08:01	Cork Jeep	775	54.26
06/03/2009	12:30	Cork Jeep	383	53.42
10/03/2009	08:25	Cork Jeep	383	35
11/03/2009	18:25	Cork Jeep	383	33.35
13/03/2009	17:57	Cork Jeep	383	32.32
14/03/2009	17:45	Cork Jeep	527	72.42
20/03/2009	15:21	Cork Jeep	173	67.78
13/03/2009	11:07	Van	572	34.77
19/03/2009	14:57	Van	383	31.1
09/04/2009	09:45	Cork Jeep	173	43.78
16/04/2009	18:16	Cork Jeep	383	35.32
18/04/2009	14:27	Cork Jeep	201	56.5
23/04/2009	14:12	Cork Jeep	173	66.1
29/04/2009	19:45	Cork Jeep	572	67.71
09/04/2009	15:26	Van	383	37.31
30/04/2009	12:15	Van	383	45.39
07/05/2009	20:49	Cork Jeep	406	63.44
15/05/2009	12:57	Cork Jeep	383	47.1
21/05/2009	10:57	Cork Jeep	876	70.54
25/05/2009	11:20	Cork Jeep	876	65.78
28/05/2009	18:58	Cork Jeep	586	63.17
08/05/2009	09:27	Van	383	29.44
20/05/2009	14:43	Van	383	34.09
09/06/2009	08:03	Cork Jeep	383	4.47

Table 8: Detailed Calculation of GHG Inventory Data

Category of Emissions	Description	Sub-Category	Activity Data	Activity Data Units	Conversion Factor										Emission Factor						Employee Survey Ratio	Total Emission kg CO2eq
					Net Calorific Value (TJ)	Density (t /m3)	Net Calorific Value (TJ/t)	Equipment Charge Capacity (kg)	Time Used During Reporting Period (yrs)	Annual Leak Rate (%)	GWP	Uplift Factor	% Recycled	% Disposed	CO2 Emission Factor	Emission Factor Units	CH4 Emission Factor (kg CO2eq per unit)	N2O Emission Factor (kg CO2eq per unit)	Net kg CO2 eq per tonne for recycling of paper	Net kg CO2 eq emitted for disposal of paper		
Direct GHG Emissions	Natural Gas Usage for Heating		44736	kWh (Gross Calorific Value)	0.145395										57.112	tCO_2/TJ						8,304
	Diesel Usage in Organisation-owned vehicles	Jeep	2.7	m^3		0.834	0.04331								73.3	tCO_2/TJ	1.9	28.3				7,230
		Van	0.779	m^3		0.834	0.04331								73.3	tCO_2/TJ	1.9	28.3				2,086
	GHG emissions from Refrigerant/air conditioners	Fridges - R-134A (Kyoto)	2	No. of Units				0.1	1	0.003	1300											1
		Air-conditioner R-22 (non Kyoto)	4	No. of Units				1.6	1	0.085	1810											985
		Air-conditioner R-22 (non Kyoto)	2	No. of Units				1.475	1	0.085	1810											454
		Air-conditioner R-410A (Kyoto)	1	No. of Units				1.1	1	0.085	1725											161
		Air-conditione R-410A (Kyoto)	2	No. of Units				1.7	1	0.085	1725											499
Energy Indirect Emissions	Electricity Purchased and Consumed by Organisation	Airtricity	13657	kWh											0.142	kg CO2/ kWh						1,939
		ESB	81297	kWh											0.565	kg CO2/ kWh						45,933
		Bord Gais	85357	kWh											0.554	kg CO2 /kWh						47,288
Other Indirect GHG Emissions	Fuel Use in privately owned vehicles for work purposes	Conservative use of Diesel and average fuel efficiency	10.33	m^3		0.834	0.04331								73.3	tCO_2/TJ	1.9	28.3				27,662
	Fuel Use in privately owned	Petrol	8.574	m^3		0.7348	0.04472								70	tCO_2/TJ	4.7	22.6			1.93	38,487

Category of Emissions	Description	Sub-Category	Activity Data	Activity Data Units	rsion Factor										Emission Factor						Employee Survey Ratio	Total Emission kg CO2eq
					Net Calorific Value (TJ)	Density (t /m3)	Net Calorific Value (TJ/t)	Equipment Charge Capacity (kg)	me sed ring orti ng riod rs)	Annual Leak Rate (%)	GWP	Uplift Factor	% Recycled	% Disposed	CO2 Emission Factor	Emission Factor Units	CH4 Emission Factor (kg CO2eq per unit)	N2O Emission Factor (kg CO2eq per unit)	Net kg CO2 eq per tonne for recycling of paper	Net kg CO2 eq emitted for disposal of paper		
	vehicles for commuting to work	Diesel	3.949	m^3		0.834	0.04331								73.3	tCO_2/ TJ	1.9	28.3			1.93	20,394
	Fuel use in Business Travel - Flights	Short Flight	49223	pkm								1.09			0.17102	kg CO2 per pkm	0.00013	0.00168				9,273
		Medium Flight	83832	pkm								1.09			0.09826	kg CO2 per pkm	0.0001	0.00097				9,076
		Long Flight	65760	pkm								1.09			0.1122	kg CO2 per pkm	0.0001	0.0011				8,128
	Use of printing paper	Emissions from production of 100 g paper	1,715.91	€											1.2	kg CO2 per €						2,059
		Emissions from production of 80 g paper	1,144.77	€											1.2	kg CO2 per €						1,374
		100g paper	11.4	tonne									10	10					237	1500		1,987
		80g Paper	22.9	tonne									60	10					237	1500		6,690

Table 9 Use of Privately Owned Vehicles for Work Purposes

Expense	Date	Units (km)
Non Rec Mileage > 1,500 cc (< 6,347km)	06/01/2009	520
Rec Mileage > 1,500 cc (< 6,347km)	07/01/2009	200
Rec Mileage > 1,500 cc (> 6,347km)	07/01/2009	700
Rec Mileage > 1,500 cc (< 6,347km)	08/01/2009	975
Non Rec CPD Mileage	13/01/2009	23
Non Rec Mileage > 1,500 cc (< 6,347km)	14/01/2009	940
Rec Mileage > 1,500 cc (< 6,347km)	14/01/2009	540
Non Rec Mileage > 1,500 cc (< 6,347km)	15/01/2009	902
Non Rec Mileage > 1,500 cc (< 6,347km)	16/01/2009	321
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	19/01/2009	64
Non Rec Mileage > 1,500 cc (< 6,347km)	20/01/2009	420
Rec Mileage > 1,500 cc (< 6,347km)	21/01/2009	800
Non Rec Mileage > 1,500 cc (< 6,347km)	23/01/2009	420
Rec Mileage > 1,500 cc (> 6,347km)	23/01/2009	120
Rec Mileage > 1,500 cc (< 6,347km)	26/01/2009	228
Rec Mileage > 1,500 cc (< 6,347km)	28/01/2009	834
Non Rec Mileage > 1,500 cc (< 6,347km)	29/01/2009	10
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	30/01/2009	16
Rec Mileage > 1,500 cc (< 6,347km)	30/01/2009	402
Rec Mileage > 1,500 cc (< 6,347km)	02/02/2009	15
Rec Mileage > 1,500 cc (> 6,347km)	03/02/2009	194
Rec Mileage > 1,500 cc (< 6,347km)	04/02/2009	110
Non Rec Mileage > 1,500 cc (< 6,347km)	05/02/2009	390
Rec Mileage < 1,200 cc (< 6,347km)	05/02/2009	420
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	05/02/2009	122
Rec Mileage > 1,500 cc (< 6,347km)	05/02/2009	1,624.00
Rec Mileage > 1,500 cc (< 6,347km)	06/02/2009	380
Non Rec Mileage > 1,500 cc (< 6,347km)	10/02/2009	874
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	10/02/2009	119
Rec Mileage > 1,500 cc (< 6,347km)	10/02/2009	110
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	11/02/2009	78
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	12/02/2009	15
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	16/02/2009	78
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	16/02/2009	320
Rec Mileage > 1,500 cc (< 6,347km)	16/02/2009	888
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	18/02/2009	454
Non Rec Mileage > 1,500 cc (< 6,347km)	18/02/2009	547
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	18/02/2009	14
Rec Mileage > 1,500 cc (< 6,347km)	18/02/2009	160
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	19/02/2009	32
Non Rec CPD Mileage	20/02/2009	179
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	20/02/2009	78
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	20/02/2009	10
Rec Mileage > 1,500 cc (< 6,347km)	20/02/2009	1
Non Rec Mileage > 1,500 cc (< 6,347km)	23/02/2009	512
Rec Mileage > 1,500 cc (< 6,347km)	23/02/2009	228
Non Rec Mileage > 1,500 cc (< 6,347km)	24/02/2009	196
Rec Mileage > 1,500 cc (< 6,347km)	24/02/2009	57
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	25/02/2009	78

Expense	Date	Units (km)
Rec Mileage > 1,500 cc (< 6,347km)	25/02/2009	65
Non Rec CPD Mileage	26/02/2009	23
Non Rec Mileage > 1,500 cc (< 6,347km)	26/02/2009	165
Non Rec Mileage > 1,500 cc (> 6,347km)	26/02/2009	250
Rec Mileage > 1,500 cc (< 6,347km)	26/02/2009	1,217.00
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	27/02/2009	80
Rec Mileage > 1,500 cc (< 6,347km)	27/02/2009	110
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	02/03/2009	250
Non Rec Mileage > 1,500 cc (< 6,347km)	02/03/2009	1,096.00
Rec Mileage > 1,500 cc (< 6,347km)	02/03/2009	70
Non Rec CPD Mileage	03/03/2009	150
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	03/03/2009	102
Non Rec Mileage > 1,500 cc (< 6,347km)	03/03/2009	165
Rec Mileage > 1,500 cc (< 6,347km)	03/03/2009	737
Rec Mileage > 1,500 cc (< 6,347km)	04/03/2009	222
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	05/03/2009	347
Rec Mileage > 1,500 cc (< 6,347km)	05/03/2009	1,150.00
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	06/03/2009	15
Non Rec Mileage > 1,500 cc (< 6,347km)	06/03/2009	165
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	06/03/2009	141
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	09/03/2009	26
Non Rec Mileage > 1,500 cc (< 6,347km)	09/03/2009	165
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	10/03/2009	30
Non Rec Mileage > 1,500 cc (< 6,347km)	10/03/2009	24
Non Rec Mileage > 1,500 cc (> 6,347km)	10/03/2009	490
Rec Mileage > 1,500 cc (< 6,347km)	10/03/2009	374
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	11/03/2009	108
Non Rec Mileage > 1,500 cc (< 6,347km)	11/03/2009	368
Rec Mileage > 1,500 cc (< 6,347km)	11/03/2009	80
Rec Mileage > 1,500 cc (> 6,347km)	11/03/2009	360
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	12/03/2009	18
Non Rec Mileage > 1,500 cc (< 6,347km)	12/03/2009	255
Rec Mileage > 1,500 cc (< 6,347km)	12/03/2009	54
Non Rec Mileage > 1,500 cc (< 6,347km)	13/03/2009	165
Rec Mileage > 1,500 cc (< 6,347km)	13/03/2009	151
Non Rec CPD Mileage	18/03/2009	23
Non Rec Mileage > 1,500 cc (< 6,347km)	18/03/2009	645
Rec Mileage < 1,200 cc (< 6,347km)	18/03/2009	250
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	18/03/2009	82
Rec Mileage > 1,500 cc (< 6,347km)	18/03/2009	54
Rec Mileage > 1,500 cc (> 6,347km)	18/03/2009	708
Non Rec CPD Mileage	19/03/2009	353
Non Rec Mileage > 1,500 cc (< 6,347km)	19/03/2009	555
Rec Mileage > 1,500 cc (< 6,347km)	19/03/2009	374
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	20/03/2009	78
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	20/03/2009	10
Rec Mileage > 1,500 cc (< 6,347km)	20/03/2009	54
Non Rec Mileage > 1,500 cc (< 6,347km)	23/03/2009	350
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	23/03/2009	10
Rec Mileage > 1,500 cc (< 6,347km)	23/03/2009	332

Expense	Date	Units (km)
Non Rec Mileage > 1,500 cc (< 6,347km)	24/03/2009	222
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	24/03/2009	310
Rec Mileage > 1,500 cc (< 6,347km)	24/03/2009	173
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	25/03/2009	78
Non Rec Mileage > 1,500 cc (< 6,347km)	25/03/2009	540
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	25/03/2009	135
Rec Mileage > 1,500 cc (< 6,347km)	25/03/2009	276
Rec Mileage > 1,500 cc (> 6,347km)	25/03/2009	705
Non Rec Mileage > 1,500 cc (< 6,347km)	26/03/2009	255
Non Rec Mileage > 1,500 cc (> 6,347km)	26/03/2009	512
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	26/03/2009	135
Rec Mileage > 1,500 cc (< 6,347km)	26/03/2009	54
Rec Mileage < 1,200 cc (< 6,347km)	27/03/2009	250
Rec Mileage < 1,200 cc (< 6,347km)	30/03/2009	250
Rec Mileage < 1,200 cc (> 6,347km)	30/03/2009	106
Rec Mileage > 1,500 cc (< 6,347km)	30/03/2009	465
Non Rec Mileage > 1,500 cc (< 6,347km)	31/03/2009	766
Rec Mileage > 1,500 cc (< 6,347km)	31/03/2009	54
Rec Mileage > 1,500 cc (> 6,347km)	31/03/2009	300
Rec Mileage > 1,500 cc (< 6,347km)	01/04/2009	1,199.00
Non Rec Mileage > 1,500 cc (< 6,347km)	02/04/2009	18
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	02/04/2009	120
Rec Mileage > 1,500 cc (< 6,347km)	02/04/2009	275
Rec Mileage > 1,500 cc (> 6,347km)	02/04/2009	110
Non Rec Mileage > 1,500 cc (< 6,347km)	03/04/2009	285
Non Rec Mileage > 1,500 cc (< 6,347km)	06/04/2009	255
Rec Mileage > 1,500 cc (< 6,347km)	06/04/2009	551
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	07/04/2009	150
Rec Mileage > 1,500 cc (< 6,347km)	07/04/2009	586
Rec Mileage > 1,500 cc (> 6,347km)	07/04/2009	728
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	08/04/2009	510
Rec Mileage > 1,500 cc (< 6,347km)	08/04/2009	296
Rec Mileage > 1,500 cc (> 6,347km)	08/04/2009	420
Rec Mileage > 1,500 cc (< 6,347km)	09/04/2009	154
Rec Mileage > 1,500 cc (> 6,347km)	09/04/2009	92
Rec Mileage > 1,500 cc (< 6,347km)	14/04/2009	70
Rec Mileage > 1,500 cc (< 6,347km)	15/04/2009	275
Rec Mileage > 1,500 cc (> 6,347km)	15/04/2009	716
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	16/04/2009	24
Rec Mileage > 1,500 cc (< 6,347km)	16/04/2009	410
Rec Mileage > 1,500 cc (< 6,347km)	17/04/2009	54
Rec Mileage > 1,500 cc (< 6,347km)	20/04/2009	54
Non Rec CPD Mileage	21/04/2009	210
Non Rec Mileage > 1,500 cc (< 6,347km)	21/04/2009	380
Rec Mileage > 1,500 cc (< 6,347km)	21/04/2009	1,102.00
Non Rec CPD Mileage	22/04/2009	210
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	22/04/2009	253
Rec Mileage > 1,500 cc (< 6,347km)	22/04/2009	534
Non Rec Mileage > 1,500 cc (< 6,347km)	23/04/2009	70
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	23/04/2009	39

Expense	Date	Units (km)
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	23/04/2009	70
Rec Mileage > 1,500 cc (< 6,347km)	23/04/2009	338
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	24/04/2009	56
Rec Mileage > 1,500 cc (< 6,347km)	24/04/2009	219
Rec Mileage > 1,500 cc (< 6,347km)	27/04/2009	165
Rec Mileage > 1,500 cc (> 6,347km)	27/04/2009	500
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	28/04/2009	305
Non Rec Mileage > 1,500 cc (< 6,347km)	28/04/2009	16
Rec Mileage < 1,200 cc (< 6,347km)	28/04/2009	362
Rec Mileage > 1,500 cc (< 6,347km)	28/04/2009	374
Rec Mileage > 1,500 cc (> 6,347km)	28/04/2009	425
Non Rec CPD Mileage	29/04/2009	23
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	29/04/2009	305
Non Rec Mileage > 1,500 cc (< 6,347km)	29/04/2009	348
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	29/04/2009	78
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	29/04/2009	160
Rec Mileage > 1,500 cc (< 6,347km)	29/04/2009	533
Rec Mileage > 1,500 cc (> 6,347km)	29/04/2009	180
Non Rec CPD Mileage	30/04/2009	11
Rec Mileage > 1,500 cc (< 6,347km)	30/04/2009	644
Rec Mileage > 1,500 cc (> 6,347km)	30/04/2009	265
Non Rec Mileage > 1,500 cc (> 6,347km)	01/05/2009	525
Rec Mileage > 1,500 cc (< 6,347km)	01/05/2009	165
Non Rec Mileage > 1,500 cc (< 6,347km)	05/05/2009	40
Rec Mileage > 1,500 cc (< 6,347km)	05/05/2009	229
Non Rec Mileage > 1,500 cc (< 6,347km)	06/05/2009	169
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	06/05/2009	44
Rec Mileage > 1,500 cc (< 6,347km)	06/05/2009	96
Rec Mileage > 1,500 cc (> 6,347km)	06/05/2009	937
Non Rec Mileage > 1,500 cc (< 6,347km)	07/05/2009	305
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	07/05/2009	98
Rec Mileage > 1,500 cc (< 6,347km)	07/05/2009	16
Rec Mileage > 1,500 cc (> 6,347km)	07/05/2009	311
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	08/05/2009	20
Rec Mileage > 1,500 cc (< 6,347km)	08/05/2009	398
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	11/05/2009	106
Rec Mileage > 1,500 cc (< 6,347km)	11/05/2009	617
Rec Mileage > 1,500 cc (> 6,347km)	11/05/2009	37
Non Rec Mileage > 1,500 cc (> 6,347km)	12/05/2009	262
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	12/05/2009	80
Rec Mileage > 1,500 cc (< 6,347km)	12/05/2009	842
Non Rec Mileage > 1,500 cc (< 6,347km)	13/05/2009	360
Non Rec Mileage > 1,500 cc (> 6,347km)	13/05/2009	263
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	13/05/2009	608
Rec Mileage > 1,500 cc (< 6,347km)	13/05/2009	188
Rec Mileage > 1,500 cc (> 6,347km)	13/05/2009	300
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	14/05/2009	250
Non Rec Mileage > 1,500 cc (< 6,347km)	14/05/2009	160
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	14/05/2009	190
Rec Mileage > 1,500 cc (< 6,347km)	14/05/2009	800

Expense	Date	Units (km)
Non Rec Mileage > 1,500 cc (> 6,347km)	15/05/2009	365
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	15/05/2009	190
Rec Mileage > 1,500 cc (< 6,347km)	15/05/2009	295
Non Rec Mileage > 1,500 cc (> 6,347km)	16/05/2009	434
Rec Mileage > 1,500 cc (< 6,347km)	16/05/2009	27
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	18/05/2009	24
Rec Mileage > 1,500 cc (< 6,347km)	18/05/2009	900
Rec Mileage > 1,500 cc (> 6,347km)	18/05/2009	476
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	19/05/2009	490
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	19/05/2009	30
Rec Mileage > 1,500 cc (> 6,347km)	19/05/2009	557
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	20/05/2009	74
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	20/05/2009	120
Rec Mileage > 1,500 cc (< 6,347km)	20/05/2009	927
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	21/05/2009	380
Rec Mileage > 1,500 cc (< 6,347km)	21/05/2009	703
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	22/05/2009	174
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	22/05/2009	875
Rec Mileage > 1,500 cc (< 6,347km)	22/05/2009	224
Rec Mileage > 1,500 cc (> 6,347km)	22/05/2009	416
Non Rec Mileage > 1,500 cc (< 6,347km)	25/05/2009	16
Rec Mileage < 1,200 cc (< 6,347km)	25/05/2009	269
Rec Mileage > 1,500 cc (< 6,347km)	25/05/2009	648
Rec Mileage > 1,500 cc (> 6,347km)	25/05/2009	532
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	26/05/2009	139
Rec Mileage < 1,200 cc (> 6,347km)	26/05/2009	291
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	26/05/2009	20
Rec Mileage > 1,500 cc (< 6,347km)	26/05/2009	1,057.00
Rec Mileage > 1,500 cc (> 6,347km)	26/05/2009	424
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	27/05/2009	191
Non Rec Mileage > 1,500 cc (< 6,347km)	27/05/2009	975
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	27/05/2009	224
Rec Mileage > 1,500 cc (< 6,347km)	27/05/2009	1,065.00
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	28/05/2009	200
Rec Mileage > 1,500 cc (< 6,347km)	28/05/2009	698
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	29/05/2009	78
Rec Mileage > 1,500 cc (< 6,347km)	29/05/2009	100
Rec Mileage > 1,500 cc (> 6,347km)	29/05/2009	367
Rec Mileage > 1,500 cc (< 6,347km)	02/06/2009	724
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	03/06/2009	110
Rec Mileage > 1,500 cc (< 6,347km)	03/06/2009	275
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	04/06/2009	40
Rec Mileage < 1,200 cc (< 6,347km)	04/06/2009	146
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	04/06/2009	70
Rec Mileage > 1,500 cc (< 6,347km)	04/06/2009	260
Rec Mileage < 1,200 cc (< 6,347km)	05/06/2009	157
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	05/06/2009	24
Rec Mileage > 1,500 cc (< 6,347km)	05/06/2009	560
Rec Mileage < 1,200 cc (< 6,347km)	08/06/2009	192
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	08/06/2009	230

Expense	Date	Units (km)
Rec Mileage < 1,200 cc (< 6,347km)	09/06/2009	390
Rec Mileage > 1,500 cc (< 6,347km)	09/06/2009	119
Rec Mileage < 1,200 cc (< 6,347km)	10/06/2009	390
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	10/06/2009	110
Rec Mileage > 1,500 cc (> 6,347km)	10/06/2009	250
Rec Mileage > 1,500 cc (< 6,347km)	11/06/2009	510
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	12/06/2009	490
Non Rec Mileage > 1,500 cc (< 6,347km)	12/06/2009	168
Rec Mileage > 1,500 cc (< 6,347km)	16/06/2009	1,670.00
Rec Mileage > 1,500 cc (> 6,347km)	16/06/2009	40
Non Rec Mileage < 1,200 cc (< 6,437 km)	17/06/2009	580
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	17/06/2009	24
Non Rec Mileage > 1,500 cc (< 6,347km)	17/06/2009	20
Rec Mileage > 1,500 cc (< 6,347km)	17/06/2009	908
Non Rec CPD Mileage	18/06/2009	492
Rec Mileage > 1,500 cc (> 6,347km)	18/06/2009	50
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	19/06/2009	12
Rec Mileage > 1,500 cc (< 6,347km)	19/06/2009	100
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	22/06/2009	200
Rec Mileage > 1,500 cc (< 6,347km)	22/06/2009	358
Rec Mileage > 1,500 cc (> 6,347km)	22/06/2009	65
Non Rec CPD Mileage	23/06/2009	528
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	23/06/2009	410
Non Rec Mileage > 1,500 cc (< 6,347km)	23/06/2009	60
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	23/06/2009	464
Rec Mileage > 1,500 cc (< 6,347km)	23/06/2009	1,148.00
Rec Mileage > 1,500 cc (> 6,347km)	23/06/2009	290
Rec Mileage > 1,500 cc (< 6,347km)	24/06/2009	1,160.00
Rec Mileage > 1,500 cc (> 6,347km)	24/06/2009	480
Rec Mileage > 1,500 cc (< 6,347km)	25/06/2009	490
Rec Mileage > 1,500 cc (> 6,347km)	25/06/2009	400
Non Rec Mileage > 1,500 cc (> 6,347km)	29/06/2009	937
Rec Mileage > 1,500 cc (< 6,347km)	29/06/2009	416
Rec Mileage > 1,500 cc (> 6,347km)	29/06/2009	535
Non Rec Mileage > 1,500 cc (< 6,347km)	30/06/2009	16
Rec Mileage > 1,500 cc (< 6,347km)	30/06/2009	589
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	01/07/2009	60
Rec Mileage > 1,500 cc (< 6,347km)	01/07/2009	250
Rec Mileage > 1,500 cc (> 6,347km)	02/07/2009	240
Rec Mileage < 1,200 cc (< 6,347km)	03/07/2009	30
Rec Mileage > 1,500 cc (< 6,347km)	03/07/2009	16
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	06/07/2009	180
Rec Mileage > 1,500 cc (< 6,347km)	06/07/2009	1,072.00
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	07/07/2009	445
Non Rec Mileage > 1,500 cc (< 6,347km)	07/07/2009	28
Rec Mileage < 1,200 cc (> 6,347km)	07/07/2009	482
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	07/07/2009	50
Rec Mileage > 1,500 cc (< 6,347km)	07/07/2009	569
Rec Mileage > 1,500 cc (> 6,347km)	07/07/2009	165
Non Rec Mileage > 1,500 cc (< 6,347km)	08/07/2009	202

Expense	Date	Units (km)
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	08/07/2009	20
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	08/07/2009	190
Rec Mileage > 1,500 cc (< 6,347km)	08/07/2009	890
Non Rec Mileage > 1,500 cc (< 6,347km)	09/07/2009	224
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	09/07/2009	20
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	09/07/2009	270
Rec Mileage > 1,500 cc (< 6,347km)	09/07/2009	320
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	10/07/2009	70
Rec Mileage > 1,500 cc (< 6,347km)	10/07/2009	280
Rec Mileage > 1,500 cc (> 6,347km)	10/07/2009	404
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	13/07/2009	75
Rec Mileage > 1,500 cc (< 6,347km)	13/07/2009	890
Rec Mileage > 1,500 cc (> 6,347km)	13/07/2009	450
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	14/07/2009	60
Non Rec CPD Mileage	15/07/2009	30
Non Rec Mileage > 1,500 cc (< 6,347km)	15/07/2009	16
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	15/07/2009	600
Rec Mileage > 1,500 cc (< 6,347km)	15/07/2009	340
Rec Mileage > 1,500 cc (> 6,347km)	15/07/2009	712
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	16/07/2009	410
Non Rec Mileage > 1,500 cc (< 6,347km)	17/07/2009	200
Rec Mileage > 1,500 cc (> 6,347km)	17/07/2009	92
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	20/07/2009	154
Rec Mileage < 1,200 cc (< 6,347km)	20/07/2009	360
Rec Mileage > 1,500 cc (< 6,347km)	20/07/2009	70
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	21/07/2009	1,010.00
Rec Mileage > 1,500 cc (< 6,347km)	21/07/2009	180
Non Rec Mileage > 1,500 cc (< 6,347km)	22/07/2009	180
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	22/07/2009	50
Rec Mileage > 1,500 cc (< 6,347km)	22/07/2009	685
Rec Mileage > 1,500 cc (> 6,347km)	22/07/2009	520
Non Rec CPD Mileage	23/07/2009	530
Non Rec Mileage < 1,200 cc (< 6,437 km)	23/07/2009	250
Rec Mileage < 1,200 cc (< 6,347km)	23/07/2009	120
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	23/07/2009	310
Rec Mileage > 1,500 cc (< 6,347km)	23/07/2009	956
Rec Mileage > 1,500 cc (> 6,347km)	23/07/2009	750
Rec Mileage < 1,200 cc (< 6,347km)	24/07/2009	154
Rec Mileage > 1,500 cc (< 6,347km)	24/07/2009	691
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	27/07/2009	240
Non Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	27/07/2009	884
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	27/07/2009	112
Rec Mileage > 1,500 cc (< 6,347km)	27/07/2009	300
Non Rec Mileage > 1,500 cc (< 6,347km)	28/07/2009	263
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	28/07/2009	260
Rec Mileage > 1,500 cc (< 6,347km)	28/07/2009	800
Non Rec Mileage > 1,500 cc (< 6,347km)	29/07/2009	262
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	29/07/2009	65
Rec Mileage > 1,500 cc (< 6,347km)	29/07/2009	360
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	30/07/2009	210

Expense	Date	Units (km)
Rec Mileage > 1,500 cc (< 6,347km)	30/07/2009	301
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	31/07/2009	60
Rec Mileage > 1,500 cc (> 6,347km)	31/07/2009	150
Non Rec Mileage > 1,500 cc (< 6,347km)	04/08/2009	438
Rec Mileage > 1,500 cc (< 6,347km)	05/08/2009	900
Rec Mileage > 1,500 cc (> 6,347km)	05/08/2009	800
Non Rec Mileage > 1,500 cc (< 6,347km)	06/08/2009	185
Rec Mileage > 1,500 cc (< 6,347km)	06/08/2009	135
Non Rec Mileage > 1,500 cc (< 6,347km)	07/08/2009	145
Rec Mileage > 1,500 cc (< 6,347km)	07/08/2009	600
Rec Mileage > 1,500 cc (< 6,347km)	09/08/2009	511
Non Rec Mileage > 1,500 cc (< 6,347km)	11/08/2009	228
Rec Mileage > 1,500 cc (< 6,347km)	11/08/2009	420
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	12/08/2009	256
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	12/08/2009	355
Rec Mileage > 1,500 cc (> 6,347km)	12/08/2009	702
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	13/08/2009	514
Non Rec Mileage > 1,500 cc (< 6,347km)	13/08/2009	394
Rec Mileage > 1,500 cc (> 6,347km)	13/08/2009	540
Rec Mileage > 1,500 cc (< 6,347km)	14/08/2009	195
Rec Mileage > 1,500 cc (< 6,347km)	17/08/2009	280
Rec Mileage > 1,500 cc (> 6,347km)	17/08/2009	948
Rec Mileage < 1,200 cc (< 6,347km)	18/08/2009	59
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	18/08/2009	167
Rec Mileage > 1,500 cc (< 6,347km)	18/08/2009	130
Non Rec Mileage > 1,500 cc (< 6,347km)	19/08/2009	25
Rec Mileage > 1,500 cc (< 6,347km)	19/08/2009	30
Rec Mileage > 1,500 cc (> 6,347km)	19/08/2009	250
Non Rec Mileage > 1,500 cc (< 6,347km)	20/08/2009	430
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	20/08/2009	132
Rec Mileage > 1,500 cc (< 6,347km)	20/08/2009	565
Rec Mileage > 1,500 cc (> 6,347km)	20/08/2009	393
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	21/08/2009	20
Rec Mileage > 1,500 cc (< 6,347km)	24/08/2009	334
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	26/08/2009	242
Non Rec Mileage > 1,500 cc (< 6,347km)	26/08/2009	587
Rec Mileage > 1,500 cc (< 6,347km)	26/08/2009	390
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	27/08/2009	22
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	28/08/2009	230
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	31/08/2009	450
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	31/08/2009	265
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	31/08/2009	380
Rec Mileage > 1,500 cc (< 6,347km)	31/08/2009	222
Non Rec Mileage > 1,500 cc (< 6,347km)	01/09/2009	520
Rec Mileage > 1,500 cc (< 6,347km)	01/09/2009	20
Rec Mileage > 1,500 cc (< 6,347km)	02/09/2009	139
Non Rec Mileage > 1,500 cc (< 6,347km)	03/09/2009	386
Rec Mileage > 1,500 cc (< 6,347km)	03/09/2009	460
Non Rec Mileage > 1,500 cc (< 6,347km)	07/09/2009	20
Rec Mileage > 1,500 cc (< 6,347km)	08/09/2009	440

Expense	Date	Units (km)
Non Rec Mileage > 1,500 cc (< 6,347km)	09/09/2009	230
Rec Mileage > 1,500 cc (< 6,347km)	09/09/2009	180
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	10/09/2009	1
Rec Mileage < 1,200 cc (< 6,347km)	10/09/2009	306
Rec Mileage > 1,500 cc (< 6,347km)	10/09/2009	676
Rec Mileage > 1,500 cc (< 6,347km)	11/09/2009	248
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	14/09/2009	260
Non Rec Mileage > 1,500 cc (< 6,347km)	14/09/2009	520
Rec Mileage > 1,500 cc (< 6,347km)	14/09/2009	300
Non Rec CPD Mileage	15/09/2009	910
Non Rec Mileage > 1,500 cc (< 6,347km)	15/09/2009	510
Rec Mileage > 1,500 cc (< 6,347km)	15/09/2009	100
Non Rec Mileage > 1,500 cc (< 6,347km)	16/09/2009	12
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	17/09/2009	70
Rec Mileage > 1,500 cc (< 6,347km)	17/09/2009	1,173.00
Non Rec Mileage > 1,500 cc (< 6,347km)	18/09/2009	406
Rec Mileage < 1,200 cc (< 6,347km)	18/09/2009	250
Rec Mileage > 1,500 cc (< 6,347km)	18/09/2009	110
Rec Mileage > 1,500 cc (> 6,347km)	18/09/2009	196
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	21/09/2009	140
Non Rec Mileage > 1,500 cc (> 6,347km)	21/09/2009	564
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	21/09/2009	302
Rec Mileage > 1,500 cc (< 6,347km)	21/09/2009	500
Non Rec Mileage > 1,500 cc (< 6,347km)	22/09/2009	10
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	22/09/2009	500
Non Rec Mileage > 1,500 cc (< 6,347km)	23/09/2009	10
Non Rec CPD Mileage	24/09/2009	500
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	24/09/2009	35
Rec Mileage > 1,500 cc (< 6,347km)	28/09/2009	205
Rec Mileage > 1,500 cc (< 6,347km)	29/09/2009	490
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	30/09/2009	80
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	01/10/2009	430
Rec Mileage < 1,200 cc (> 6,347km)	01/10/2009	150
Rec Mileage > 1,500 cc (< 6,347km)	01/10/2009	200
Non Rec Mileage > 1,500 cc (> 6,347km)	02/10/2009	63
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	02/10/2009	65
Rec Mileage > 1,500 cc (< 6,347km)	02/10/2009	970
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	05/10/2009	95
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	05/10/2009	440
Rec Mileage > 1,500 cc (< 6,347km)	05/10/2009	190
Non Rec Mileage > 1,500 cc (< 6,347km)	06/10/2009	440
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	06/10/2009	125
Rec Mileage > 1,500 cc (< 6,347km)	06/10/2009	190
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	07/10/2009	230
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	07/10/2009	1
Rec Mileage < 1,200 cc (< 6,347km)	08/10/2009	374
Non Rec CPD Mileage	09/10/2009	100
Non Rec Mileage > 1,500 cc (< 6,347km)	09/10/2009	496
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	14/10/2009	160
Rec Mileage > 1,500 cc (< 6,347km)	14/10/2009	636

Expense	Date	Units (km)
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	15/10/2009	230
Rec Mileage > 1,500 cc (< 6,347km)	16/10/2009	55
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	19/10/2009	85
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	21/10/2009	580
Rec Mileage > 1,500 cc (< 6,347km)	21/10/2009	180
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	22/10/2009	230
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	22/10/2009	54
Rec Mileage > 1,500 cc (< 6,347km)	22/10/2009	480
Rec Mileage < 1,200 cc (< 6,347km)	23/10/2009	385
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	28/10/2009	110
Rec Mileage > 1,500 cc (< 6,347km)	28/10/2009	500
Rec Mileage > 1,500 cc (> 6,347km)	28/10/2009	378
Non Rec Mileage > 1,500 cc (< 6,347km)	29/10/2009	490
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	30/10/2009	20
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	02/11/2009	20
Non Rec Mileage > 1,500 cc (< 6,347km)	03/11/2009	250
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	03/11/2009	203
Rec Mileage > 1,500 cc (< 6,347km)	03/11/2009	600
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	04/11/2009	288
Rec Mileage > 1,500 cc (< 6,347km)	04/11/2009	619
Rec Mileage > 1,500 cc (> 6,347km)	04/11/2009	760
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	05/11/2009	250
Rec Mileage > 1,500 cc (< 6,347km)	05/11/2009	204
Rec Mileage > 1,500 cc (> 6,347km)	05/11/2009	60
Rec Mileage > 1,500 cc (< 6,347km)	09/11/2009	350
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	10/11/2009	132
Non Rec Mileage > 1,500 cc (< 6,347km)	10/11/2009	204
Rec Mileage > 1,500 cc (< 6,347km)	10/11/2009	190
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	11/11/2009	703
Rec Mileage > 1,201 < 1,500 cc (> 6,347km)	11/11/2009	35
Rec Mileage > 1,500 cc (< 6,347km)	11/11/2009	839
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	12/11/2009	70
Non Rec Mileage > 1,500 cc (< 6,347km)	12/11/2009	326
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	13/11/2009	35
Rec Mileage > 1,500 cc (< 6,347km)	13/11/2009	55
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	16/11/2009	105
Rec Mileage > 1,500 cc (< 6,347km)	16/11/2009	260
Rec Mileage > 1,500 cc (> 6,347km)	16/11/2009	390
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	17/11/2009	70
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	17/11/2009	196
Rec Mileage > 1,500 cc (< 6,347km)	17/11/2009	174
Rec Mileage > 1,500 cc (> 6,347km)	17/11/2009	758
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	18/11/2009	70
Non Rec Mileage > 1,500 cc (< 6,347km)	18/11/2009	680
Rec Mileage > 1,500 cc (< 6,347km)	18/11/2009	55
Rec Mileage > 1,500 cc (> 6,347km)	18/11/2009	60
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	19/11/2009	110
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	20/11/2009	370
Non Rec Mileage > 1,500 cc (< 6,347km)	20/11/2009	400
Rec Mileage > 1,500 cc (< 6,347km)	20/11/2009	56

Expense	Date	Units (km)
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	23/11/2009	70
Rec Mileage > 1,500 cc (< 6,347km)	23/11/2009	110
Rec Mileage > 1,500 cc (> 6,347km)	23/11/2009	776
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	24/11/2009	70
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	25/11/2009	70
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	25/11/2009	270
Rec Mileage > 1,500 cc (< 6,347km)	25/11/2009	980
Rec Mileage > 1,500 cc (> 6,347km)	25/11/2009	416
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	26/11/2009	70
Rec Mileage > 1,500 cc (< 6,347km)	26/11/2009	205
Rec Mileage > 1,500 cc (> 6,347km)	26/11/2009	565
Rec Mileage > 1,500 cc (> 6,347km)	27/11/2009	200
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	30/11/2009	150
Rec Mileage > 1,500 cc (< 6,347km)	30/11/2009	510
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	01/12/2009	70
Non Rec Mileage > 1,500 cc (< 6,347km)	01/12/2009	317
Rec Mileage > 1,500 cc (> 6,347km)	01/12/2009	380
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	02/12/2009	110
Rec Mileage > 1,500 cc (> 6,347km)	02/12/2009	1,099.00
Rec Mileage > 1,500 cc (< 6,347km)	03/12/2009	212
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	04/12/2009	70
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	07/12/2009	70
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	07/12/2009	240
Rec Mileage > 1,500 cc (< 6,347km)	07/12/2009	320
Rec Mileage > 1,500 cc (> 6,347km)	07/12/2009	438
Rec Mileage > 1,500 cc (< 6,347km)	08/12/2009	750
Rec Mileage > 1,500 cc (> 6,347km)	08/12/2009	748
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	09/12/2009	270
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	10/12/2009	70
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	11/12/2009	230
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	14/12/2009	70
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	14/12/2009	225
Rec Mileage > 1,500 cc (< 6,347km)	14/12/2009	926
Rec Mileage > 1,500 cc (> 6,347km)	14/12/2009	762
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	15/12/2009	406
Rec Mileage > 1,500 cc (< 6,347km)	15/12/2009	392
Non Rec Mileage > 1,201 < 1,500 cc (< 6,437 km)	16/12/2009	30
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	16/12/2009	305
Rec Mileage > 1,500 cc (< 6,347km)	16/12/2009	566
Rec Mileage > 1,500 cc (> 6,347km)	16/12/2009	416
Non Rec Mileage > 1,500 cc (< 6,347km)	17/12/2009	440
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	17/12/2009	300
Rec Mileage > 1,500 cc (< 6,347km)	17/12/2009	490
Rec Mileage > 1,500 cc (< 6,347km)	18/12/2009	360
Rec Mileage > 1,500 cc (> 6,347km)	21/12/2009	755
Non Rec Mileage > 1,500 cc (> 6,347km)	22/12/2009	200
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	22/12/2009	56
Rec Mileage > 1,500 cc (< 6,347km)	22/12/2009	816
Rec Mileage > 1,201 < 1,500 cc (< 6,347km)	23/12/2009	56

Table 10 Employee Commuting Activity Database

Employee	Mode of Transport - car, bus, walk, cycle etc.	Year of vehicle	Model of vehicle	Engine size	Fuel Type e.g. petrol, diesel, bio-fuel	Distance Travelled Return (km)	Average No. of days per week this distance is travelled	Distance travelled per week (km)	Distance travelled per year (km)	Average Fuel Efficiency (km/L)	No. of Occupants in vehicle	Fuel Use Per Occupant per year
1	Car	1997	Toyota Corrolla	1.4	Petrol	76	5	380	17100	12	1	1,425
2	Car	2004	Volvo S40	2	Diesel	10	5	50	2250	17	1	131
3	Car	2009	Ford Mondeo	2	Diesel	28	5	140	6300	16	1	387
4	Car	2003	Ford Focus	1.4	Petrol	13	5	65	2925	15	1	196
5	Car	2005	Toyota Avensis	1.6	Petrol	20	5	100	4500	14	1	333
6	Car	2004	BMW 320Cd	2	Diesel	50	5	250	11250	15	1	750
7	Car	2005	Peugeot 206	1.2	Petrol	25	5	125	5625	16	2	180
8	Car	2000	Renault Clio	1.2	Petrol	25	5	125	5625	17	1	332
9	Car	2006	Mazda 6	2	Diesel	10	5	50	2250	16	1	137
10	Car	2000	Toyota Corrolla	1.4	Petrol	11	5	55	2475	15	1	168
11	Walk (usually)							0	0			
12	car	1995	C250 merc	2.5l	Diesel	55	5	275	12375	17	1	728
13	car	1998	VW Passat	1.6 l	petrol	16	5	80	3600	22	1	162
14	bike							0	0			
15	Car	2004	Peugeot 407	1.6	Diesel	8	5	40	1800	20	1	88
16	Car	2004	Skoda Octavia	1.8	Diesel	5	5	25	1125	20	1	56
17	Car	2003	Ford Focus	1.6	Petrol	360	2	720	32400	21	1	1,555
18	Car	2003	Ford Focus	1.6	Petrol	0	1	0	0	21	1	0
19	Car	2003	Ford Focus	1.6	Petrol	80	2	160	7200	21	1	346

Employee	Mode of Transport - car, bus, walk, cycle etc.	Year of vehicle	Model of vehicle	Engine size	Fuel Type e.g. petrol, diesel, bio-fuel	Distance Travelled Return (km)	Average No. of days per week this distance is travelled	Distance travelled per week (km)	Distance travelled per year (km)	Average Fuel Efficiency (km/L)	No. of Occupants in vehicle	Fuel Use Per Occupant per year
20	Car	2009	Opel Astra	1.7	Diesel	23	5	115	5175	19	1	272
21	Car	2003	VW Passat	1.8	Petrol	9	5	45	2025	21	1	95
22	Car	2002	Volvo S40	1.6	Petrol	45	3	135	6075	14	1	431
23	Car	1999	Nissan Micra	1	Petrol		5	0	0	14	1	0
24	Car	1998	Toyota Avensis	1.6	Petrol	3	5	15	675	13	2	27
25	Car	1997	VW Golf	1.9	Diesel	80	5	400	18000	20	1	900
26	Car	2004	Jeep Grand Cherokee	2.7	Diesel	20	5	100	4500	9	1	500
27	Car	2004	BMW 745	4.4	Petrol	130	5	650	29250	9	1	3,250
28	Car	2002	Fiat Stilo	1.2	Petrol	5	5	25	1125	15	1	73

Table 11 Flight Details Activity Data 2009

Date	From	To	kms
	Cork	Dublin	230
	Cork	Dublin	230
	LHR	Cork	580
	Cork	STN	580
	Cork	Dublin	230
	Cork	STN	580
	Man	Cork	450
	Cork	BHX	452
	LHR	Cork	580
	Cork	Dublin	230
	LHR	Cork	580
	DXB	LHR	5500
	LHR	Cork	580
	Cork	Dublin	230
	Cork	STN	580
	Cork	NQY	288
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	LHR	560
	LHR	CRK	560
	LHR	DXB	5500
	DXB	LHR	5500
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	Dublin	230
	Dub	Cork	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	BHD	345
	Cork	LPL	406
	Cork	Dublin	230
	LHR	Cork	580
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	PLH	5140
	Cork	Dublin	230
	Cork	LHR	580
	LHR	Cork	580
	Cork	Dublin	230
	Dub	Cork	230
	Cork	Dublin	230
	Cork	Dublin	230

Date	From	To	kms
	Cork	BHD	345
	BHD	Cork	345
	Cork	Dublin	230
	Cork	Dublin	230
	Dub	Cork	230
	Cork	Dublin	230
	Cork	STN	580
	Cork	Dublin	230
	Dub	Cork	230
	Cork	Dublin	230
	Cork	Dublin	230
	Cork	LHR	580
	LHR	Cork	580
	Cork	LHR	580
	LHR	Cork	580
	Cork	LHR	580
	LHR	Cork	580
	Dub	Cork	230
	Cork	Dublin	230
	Cork Dub		230
	Cork	LHR	580
	LHR	Cork	580
	Cork	Dublin	230
	Dub	Cork	230
	Cork	Dublin	230
	Cork	LHR	580
	LHR	Cork	580
	LHR	Cork	580
	Dubln	LHR	465
	LHR	DUB	465
	LHR	DXB	5500
	DXB	LHR	5500
	Cork	LHR	580
	Cork	LHR	580
	Cork	Dublin	230
	LHR	Cork	580
	Dub	WAW	1830
	WAW	Dub	1830
	Dub	Cork	230
	Cork	Dublin	230
	LHR	BAH	5080
	BAH	LHR	5080
	Cork	LHT	6400
	LHT	Cork	6400
	Dub	Sou	428
	Sou	Dub	428
	Cork	Dublin	230
	Cork	Dublin	230
	Dub	Cork	230
	Cork	Dublin	230
	Cork	Dub	230

Date	From	To	kms
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Dub	Cork	230
	Dub	Cork	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Dub	Cork	230
	Cork	Dub	230
	LGW	Dub	465
	Cork	Dub	230
	Cork	Dub	230
	BCN	Dublin	1475
	STN	Dub	465
	Cork	STN	580
	Dub	Cork	230
	Dub	Sou	428
	Sou	Dub	428
	Cork	Dub	230
	SOU	Dub	428
	Dub	Cork	230
	Cork	Dub	230
	Cork	LHR	580
	LHR	Cork	580
	Cork	LHR	580
	LHR	Cork	580
	Cork	LHR	580
	LHR	Cork	580
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	KRK	Dub	1830
	Dub	KRK	1830
	Cork	Dub	230
	Dub	Cork	230
	Cork	KTW	1209
	POZ	Cork	1072
	POZ	Cork	1072
	SNN	WRO	1055
	SOU	Cork	310
	Cork	KTW	1209
	POZ	Cork	1072
	Dub	CWL	183

Date	From	To	kms
	CWL	Dub	183
	Cork	Dub	230
	Dub	CWL	183
	CWL	Dub	183
	Cork	Dub	230
	Cork	Dubq	230
	Dub	SOU	428
	SOU	Dub	428
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	BHD	345
	BHD	Cork	345
	Cork	Dub	230
	Cork	Dub	230
	Cork	LHR	580
	LHR	Cork	580
	Dub	SOU	428
	SOU	Dub	428
	Dub	LIS	1021
	LIS	DUB	1021
	LHR	Dub	465
	Cork	Dub	230
	Cork	Dub	230
	Dub	Man	170
	Dub	CWL	183
	CWL	Dub	183
	Dub	Cork	230
	Cork	Dub	230
	SOU	Dub	428
	Dub	BOH	260
	Dub	Cork	230
	Dub	Cork	230
	Dub	LHR	465
	LHR	DUB	465
	Dub	Cork	230
	WRO	Dub	946
	LHR	BAH	5080
	BAH	DUB	5080
	Dub	LHR	465
	LHR	Dub	465
	Dub	Cork	230
	Dub	Cork	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230
	Cork	Dub	230

Date	From	To	kms
	Cork	BHD	345
	BHD	Cork	345
	Dub	BHX	190
	BHX	Dub	190
	Cork	BHX	452
	BHX	Cork	452
	Dub	BRS	200
	Cork	LHR	580
	LHR	Cork	580
	Dub	BRS	200
	Cork	LHR	580
	LHR	Cork	580
	Cork	LHR	580
	LHR	Cork	580
	Dub	BHX	190
	Dub	BHX	190
	LHR	Cork	580
	LHR	Cork	580
24/04/2009	Dub	Cork	230
14/10/2009	Cork	STN	600
	STN	Cork	600
14/10/2009	Bahrain (BAH)	Abu Dhabi (AUH)	450
14/10/2009	Abu Dhabi (AUH)	Bahrain (BAH)	450
19/10/2009	Cork	Liverpool	420
	Liverpool	Cork	420
25/10/2009	Dublin	Copenhagen	1240
	Copenhagen	Dublin	1240
27/10/2009	RIYADH SA	DAMMAM SA	350
05/11/2009	Cork	Belfast	350
	Belfast	Cork	350
11/11/2009	Cork	Belfast	350
	Belfast	Cork	350
11/11/2009	Cork	Dub	230
	Dub	Cork	230
13/11/2009	Dub	Cork	230
15/11/2009	Bahrain (BAH)	Abu Dhabi (AUH)	450
17/11/2009	Dublin	LHR	450
	LHR	Dublin	450
17/11/2009	Cork	LHR	560
	LHR	Cork	560
18/11/2009	Cork	Dub	230
18/11/2009	Cork	London	560
19/11/2009	Cork	Dub	230
	Dub	Cork	230
19/11/2009	Cork	Dub	230
	Dub	Cork	230
19/11/2009	Dub	Cork	230
19/11/2009	Birmingham	Cork	465
20/11/2009	Cork	London	560
	London	Cork	560
23/11/2009	Shannon	Glasgow	425

Date	From	To	kms
	Glasgow	Shannon	425
30/11/2009	Cork	London	560
	London	Cork	560
02/12/2009	Cork	Dub	230
	Dub	Cork	230
03/12/2009	Dublin	Krakow	1830
	Krakow	Dublin	1830
07/12/2009	Dublin	Southhampton	425
	Southhampton	Dublin	425
07/12/2009	Cork	Dub	230
08/12/2009	Dublin	Malta	2500
	Malta	Dublin	2500
08/12/2009	Dublin	Malta	2500
	Malta	Dublin	2500
10/12/2009	Cork	Belfast	350
	Belfast	Cork	350
13/12/2009	Malta	Dusseldorf	1800
13/12/2009	Dusseldorf	Sofia	1560
13/12/2009	London	Sofia	2000
13/12/2009	Sofia	London	2000
13/12/2009	Dublin	London	450
13/12/2009	London	Sofia	2000
13/12/2009	Sofia	London	2000
13/12/2009	Cork	London	560
	London	Cork	560
14/12/2009	Cork	Belfast	350
	Belfast	Cork	350
14/12/2009	RUH	DMM	350
14/12/2009	Cork	Dub	230
14/12/2009	Cork	Dub	230
15/12/2009	Belfast	Cork	350
16/12/2009	London	Cork	560
16/12/2009	London	Dublin	450
18/12/2009	Cork	Birmingham	465
	Birmingham	Cork	465
21/12/2009	Cork	Belfast	350

Table 12: Paper Usage Activity Data

Printer	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
	Total Pages											
7750GX-233	7,532	3,117	3.894	1,725	975	5,126	5,852	1,411	238	1,504	728	
Admin-4250tn-236	5,147	6,598	4,844	5,239	5,054	5,731	3,597	3,276	3,835	3,981	3,176	2,356
ADMIN-HP2840-222	46	128	9	61	93	8	2	17	17	8	3	4
B and W in Small Room			31									
CAD4200-225	3,702	1,705	826	1,042	1,314	781	1,058	705	1,135	1,942	969	786
Creche-HP4200-220	18	1,003	753	891	1,494	1,926	2,345	1,047	1,746	1,764	1,779	1,783
DJ750C-250	15		2	1		33	147	2	6		1	
DJ800-226	306	160	144	227	17	35	31	233	42	34	61	65
Envsci-HP-P2015dn-228	2,656	2,397	673									
Envsci-HP2015			1,725	2,001	2,407	3,447	3,679	2,901	3,139	3,502	2,838	2,053
\EnvSci_HP4050tn_243	3,053	2,597	4,207	3,600	1,311		596		242	567	692	1,198
\Finance-HP4200-230					25	381	405					
\EnvScience-HP4050-235	1	1						665				
\GOS-HP4250-240	2,743	5,470	3,819	3,976	1,257	41	3	15	1	3	1	
\IT-HP2200-224	145	112	204	300	46							
\Renewables					788	2,472	362					
\Phaser 7760DX PS	6,102	7,860	3,708	6,011	10,513	15,069	12,663	6,642	13,551	11,218	13,922	7,135
\Roads-HP4200-223	2,104	955	1,110	909	748	870	1,114	1,161	1,919	1,019	1,926	486
\Roads-HP5100-234	110	35	48	57	69	82	83	56	68	4	3	15
\STR-HP5100-232	100	229	237	231	10							
\TOSHIBA e-Studio3510C_ Colour	847	1,494	658	463	958	1,645	6.841	2,904	1,227	970	903	1,077
\TOSHIBA e-STUDIO3510c_Black	918	3,292	2,278	2,240	4.063	4,832	8,419	3,316	4,707	4,260	4,486	3,249
\WMS-Colour-HP2840-221	41	101	14	244	5		2	1				
\WMS-HP4200-230	1,530	1,894	1,179	964	482							
\WMS-HP5100-229	257	556	313	699	120							
\TOSHIBA e-STUDIO3511									3			

Printer	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
	Total Pages											
\TOSHIBA e-STUDIO3511 -244									6			
\TOSHIBA-3511-244									181	492	265	5
\TOSHIBA-3511-244-Colour									84	689	96	8
TOTAL PAGES	**37,373**	**39,704**	**30,676**	**30,881**	**31,749**	**42,479**	**47,199**	**24,352**	**32,147**	**31,957**	**31,849**	**20,220**
Total 100 g Quality	6,102	7,860	3,708	6,011	10,513	15,069	12,663	6,642	13,551	11,218	13,922	7,135
Total 80g Quality	31,271	31,844	26,968	24,870	21,236	27,410	34.536	17.710	18,596	20.739	17,927	13,085

Table 13: Calculation of Activity Data Uncertainty Interval

Category of Emissions	Description	Sub-Category	Activity Data	Activity Data Units	Confidence Level	t-factor	No of measur-ments	Sample Average	Sample Standard Deviation	Step 4	Step 5
						t	n	X	s	Eqn	Interval
Direct GHG Emissions	Natural Gas Usage for Heating		44736	kWh (Gross Calorific Value)	95%	2.37	8	5592	6,230.81	5,220.93	93%
	Diesel Usage in Organisation-owned vehicles	Jeep	2.7	m^3	95%	2.01	50	54	13.60	3.87	7%
		Van	0.779	m^3	95%	2.09	21	37	6.20	2.83	8%
	GHG emissions from Refrigerant/air conditioners	Fridges - R-134A (Kyoto)	2	No. of Units	95%	12.71	1	Cannot be Calculated - as only one measurement			
		Air- conditioners R-22 (non Kyoto)	4	No. of Units	95%	12.71	1				
		Air- conditioners R-22 (non Kyoto)	2	No. of Units	95%	12.71	1				
		Air- conditioners R-410A (Kyoto)	1	No. of Units	95%	12.71	1				
		Air- conditioners R-410A (Kyoto)	2	No. of Units	95%	12.71	1				
Energy Indirect Emissions	Electricity Purchased and Consumed by Organisation	Airtricity	13657	kWh	95%	4.3	3	4552	3,632.00	9,016.83	198%
		ESB	81297	kWh	95%	2.13	16	3919	3,503.00	1,865.35	48%
		Bord Gais	85357	kWh	95%	2.03	34	2511	2,644.00	920.49	37%
Other Indirect GHG Emissions	Fuel Use in privately owned vehicles for work purposes	Conservative use of Diesel and average fuel efficiency	10.33	m^3	95%	1.96	548	0.019	0.02	0.0014	7%

Category of Emissions	Description	Sub-Category	Activity Data	Activity Data Units	Confidence Level	t-factor	No of measur-ments	Sample Average	Sample Standard Deviation	Step 4	Step 5
						t	n	X	s	Eqn	Interval
	Fuel Use in privately owned vehicles for commuting to work	Petrol	8.574	m^3	95%	2.13	16	0.536	0.86	0.46	85%
		Diesel	3.949	m^3	95%	2.26	10	0.395	0.31	0.22	56%
	Fuel use in Business Travel - Flights	Short Flight < 463 km	49223	pkm	95%	1.96	181	272	80.00	11.65	4%
		Medium Flight >436<3700	83832	pkm	95%	1.98	96	873	566.00	114.38	13%
		Long Flight >3700	65760	pkm	95%	2.2	12	5480	472.00	299.76	5%
	Use of printing paper	100g paper	11.4	tonne	95%	2.2	12	9533	3,750.00	2,381.57	25%
		80g Paper	22.9	tonne	95%	2.2	12	23849	6,670.00	4,236.02	18%

Table 14: WRI GHG Protocol Uncertainty Calculation Tool

	Step 1+2						Step 3					
	A	B	C	D	E	F	G	H	I	J	K	L
	Activity Data (e.g. Quantity of fuel used)	Unit used to measure Activity Data	Uncertainty of activity data (a) (Confidence interval expressed in ± percent)	GHG emission factor	Unit of GHG emission factor (for kg CO2!)	Uncertainty of activity data (Confidence interval expressed in ± percent)	CO2 emissions in kg	CO_2 emissions in metric tonnes	Uncertainty of calculated emissions	Certainty Ranking	Auxiliary Variable 1	Auxiliary Variable 2
							A * D	G/1000	$I = \sqrt{C^2 + F^2}$		(H*I)	K^2
Example: Source 1	1000.00	GJ	+/- 5.0%	56.10	kg CO2 / GJ	+/- 10.0%	56,100.00	56.10	+/- 11.2%	Good	6.27	39.34
Source description												
							0.00	0.00	+/- 0.0%	High	0.00	0.00
Natural Gas	0.14539	TJ	+/- 93.4%	8,281.24	kg CO2 / TJ	+/- 2.5%	1,204.06	1.20	+/- 93.4%	Poor	1.12	1.26
Diesel - Jeep	2.7	m^3	+/- 7.2%	2,647.64	kg CO2 / TJ	+/- 2.5%	7,148.62	7.15	+/- 7.6%	Good	0.54	0.29
Diesel - Van	0.779	m^3	+/- 7.6%	2,647.64	kg CO2 / TJ	+/- 2.5%	2,062.51	2.06	+/- 8.0%	Good	0.17	0.03
Refrigerant/air conditioning emissions							0.00	0.00	+/- 0.0%	High	0.00	0.00
Electricity- Airtricity	13657	kWh	+/- 198.1%	0.14	kg CO2 / kWh	+/- 2.5%	1,939.29	1.94	+/- 198.1%	Poor	3.84	14.76
Electricity- ESB	81297	kWh	+/- 47.6%	0.57	kg CO2 / kWh	+/- 2.5%	45,932.81	45.93	+/- 47.7%	Poor	21.89	479.30
Electricity- Bord Gais	85357	kWh	+/- 36.7%	0.55	kg CO2 / kWh	+/- 2.5%	47,287.78	47.29	+/- 36.7%	Poor	17.38	301.89
Fuel Use in privately owned vehicles for work	10.33	m^3	+/- 7.3%	2,647.64	kg CO2 / TJ	+/- 2.5%	27,350.08	27.35	+/- 7.7%	Good	2.11	4.47
Commuting Diesel	8.574	m^3	+/- 85.3%	2,647.64	kg CO2 / TJ	+/- 2.5%	22,700.83	22.70	+/- 85.4%	Poor	19.38	375.62
Commuting Petrol	3.949	m^3	+/- 55.9%	2,300.00	kg CO2 / TJ	+/- 2.5%	9,082.70	9.08	+/- 56.0%	Poor	5.08	25.84
Short Flight	49223	pkm	+/- 4.3%	0.19	kg CO2 / pkm	+/- 2.5%	9,175.75	9.18	+/- 5.0%	High	0.46	0.21
Medium Flight	83832	pkm	+/- 13.1%	0.11	kg CO2 / pkm	+/- 2.5%	8,978.69	8.98	+/- 13.3%	Good	1.20	1.43
Long Flight	65760	pkm	+/- 5.5%	0.12	kg CO2 / pkm	+/- 2.5%	8,042.32	8.04	+/- 6.0%	Good	0.48	0.23
Paper -100g	1,715.91	€	+/- 25.0%	1.20	kg CO2 / €	+/- 2.5%	2,059.09	2.06	+/- 25.1%	Fair	0.52	0.27
Paper -80g	1,144.77	€	+/- 17.8%	1.20	kg CO2 / €	+/- 2.5%	1,373.72	1.37	+/- 17.9%	Fair	0.25	0.06

Note: For individual uncertainties greater than 60%, the results of the tool are not valid

Sum CO_2 emissions (M):	194,338.23	194.34

Step 4: Cumulated Uncertainty:

$$\pm u = \pm \frac{\sqrt{\sum_{i=1}^{n} (H_i * I_i)^2}}{M}$$

	Aggregated Certainty Ranking
+/- 17.9%	**Fair**