

**Implementation of Energy Efficiency in  
Small and Medium Sized Organisations  
Using Team-Based Methodologies Delivered  
via the World Wide Web and  
Collaborative Virtual Environments**

In One Volume

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# Declaration

I hereby declare that the work presented in this thesis is my own and that it has not been used to obtain a degree in this Institute of Technology or elsewhere.

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Gabriel J. Costello

Date: \_\_\_\_\_

*To Mary,  
Mark, Colm and Maria*

# Abstract

## **Implementation of Energy Efficiency in Small and Medium Sized Organisations Using Team-Based Methodologies Delivered via the World Wide Web and Collaborative Virtual Environments**

Gabriel J. Costello

The promotion and implementation of energy policy is a major EU and Irish priority driven by three primary objectives: security of supply, environmental protection and cost competitiveness. The target given to Ireland under the Kyoto protocol is to limit greenhouse gas emissions to 13% above the 1990 levels. This objective was breached in 1997 and projections are that emissions will rise to almost 40% above the 1990 level if the country continues on its present path, which could cost the exchequer up to €240 million per annum in penalties. Furthermore, Ireland's energy import dependency at 86% is the highest in the EU outside of Luxemburg. The estimated cost saving potential of successfully implementing energy efficiency is approximately 30% of final energy demand with the introduction of "no cost" and "low cost" measures resulting in savings of up to 15%. Based on 2002 energy consumption figures, there is a potential saving of €1 billion to the Irish economy if the latter measures could be successfully implemented. The Large Industry Energy Network (LIEN) is a voluntary network operated by Sustainable Energy Ireland (SEI) for eighty of the largest energy consumers, accounting for approximately 10% of the country's total primary energy requirement (TPER). Meanwhile, small and medium sized enterprises (SME) are also being urged to become more involved in reducing the national energy bill and resulting greenhouse gas emissions but without the same level of support. The task of implementing energy efficiency in this latter sector poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity.

This thesis proposes that energy efficiency must be addressed through organisational learning and cultural change. A process called STEMS (Structured Team-based Energy Management System) has been developed to help implement energy efficiency in organisations. The process is delivered by means of a web-based collaborative virtual environment and focuses on "no-cost" and "low cost" measures. STEMS integrates technology and people, promoting collaboration between policy makers, energy users, educators and professional energy managers to facilitate organisations to become energy efficient. A case study is presented of a Rational Use of Energy (RUE) project undertaken by a multi-disciplinary team in the Galway-Mayo Institute of Technology that involved the participation of four geographically dispersed campuses. This energy project contributed to a net 8.5% reduction in electricity use and the study showed the effectiveness of the application of STEMS to introducing energy efficiency practices in the Institute. It also demonstrated the use of a web-based collaborative virtual environment (CVE) to facilitate both the management of the project and the multi-site implementation. In a second case study, a prototype energy management service was developed with an energy management consultant to evaluate the practicability of using web-based technologies to support STEMS users and develop new business.

## Published work associated with this Thesis

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Costello, G. J., and Lohan, J. "Supporting Intelligent Energy-Europe (EIE) using web-based collaborative environments." *The Eighth Institutes of Technology Science & Computing Research Colloquium, 2004*, Waterford Institute of Technology, Waterford.

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# List of Acronyms

<b>AEPI</b>	Association of Energy Professionals in Ireland
<b>BAT</b>	Best Available Technology
<b>BEM</b>	Building & Energy Management (Consultancy)
<b>BEMS</b>	Building Energy Management Systems
<b>BIC</b>	Best in Class
<b>CCL</b>	Climate Change Levy
<b>CCI</b>	Chambers of Commerce of Ireland
<b>CDM</b>	Clean Development Mechanism
<b>CER</b>	Commission for Electricity Regulation
<b>CGPP</b>	Cleaner Greener Production Programme
<b>CODEMA</b>	The City of Dublin Energy Management Agency
<b>COFORD</b>	Irish National Council for Forestry Research and Development
<b>COP</b>	Conference of the Parties to the Framework Convention on Climate Change
<b>CPD</b>	Continuing Professional Development
<b>CSR</b>	Corporate Social Responsibility
<b>CVE</b>	Collaborative Virtual Environment
<b>DEA</b>	Danish Energy Agency
<b>DEFRA</b>	Department of Environment, Food and Rural Affairs (UK)
<b>DFE</b>	Design for Environment
<b>DSM</b>	Demand Side Management
<b>DTI</b>	Distance-to-Target
<b>E<sup>3</sup>ST</b>	Energy Efficient and Environmentally Sound Technologies
<b>EC</b>	European Commission
<b>EEBPP</b>	Energy Efficiency Best Practice Program (UK)
<b>EI</b>	Enterprise Ireland
<b>EMAS</b>	Eco-Management and Audit Scheme (EU)
<b>EMP</b>	Energy Management Process
<b>ENSR</b>	European Network for SME Research
<b>EPA</b>	Environmental Protection Agency
<b>EPIC</b>	European Political-economy Infrastructure Consortium
<b>ERUs</b>	Emission Reduction Units
<b>ESP</b>	Environmentally Superior Product
<b>ESRI</b>	Economic and Social Research Institute
<b>EU</b>	European Union
<b>GEAL</b>	Galway Energy Agency Limited
<b>GDP</b>	Gross Domestic Product
<b>GHG</b>	Greenhouse Gas
<b>GIC</b>	Gross Inland Consumption (aka TPER)
<b>GMIT</b>	Galway Mayo Institute of Technology
<b>GPCS</b>	Good Practice Case Study (Action Energy Program)
<b>GPG</b>	Good Practice Guide (Action Energy Program)

<b>HETAC</b>	Higher Education and Training Awards Council
<b>IBEC</b>	Irish Business and Employers Confederation
<b>ICT</b>	Information and Communications Technology
<b>IEA</b>	International Energy Agency
<b>IEC</b>	Irish Energy Centre (now SEI)
<b>IEETN</b>	International Energy Efficiency Training Network
<b>IEEN</b>	Industrial Energy Efficiency Network (Norway)
<b>IGP</b>	Irish Green Paper
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>IPPC</b>	Integrated Pollution Prevention and Control
<b>ISO</b>	International Standardisation Organisation
<b>JI</b>	Joint Implementation: Allows for the acquisition and transfer of ERUs arising from climate change mitigation projects.
<b>LIEN</b>	Large Industry Energy Network
<b>LULUCF</b>	Land Use, Land Use Change and Forestry
<b>M&amp;T</b>	Monitoring and Targeting
<b>MACC</b>	Making a Corporate Commitment
<b>Mt</b>	Mega (Million) Tonnes
<b>Mtoe</b>	Million tonnes of oil equivalent, unit for measuring energy
<b>NCCS</b>	National Climate Change Strategy
<b>NCPP</b>	National Centre for Partnership and Performance
<b>NPD</b>	New Product Development
<b>NPI</b>	New Product Introduction
<b>NVQ</b>	National Vocational Qualifications (UK –except Scotland)
<b>OPET</b>	Organisations for the Promotion of Energy Technologies
<b>PBL</b>	Problem Based Learning
<b>PDMA</b>	Product Development and Management Association
<b>PRINCE</b>	PRojects IN a Controlled Environment
<b>RES</b>	Renewable Energy Sources
<b>RUE</b>	Rational Use of Energy
<b>SEAV</b>	Sustainable Energy Authority, Victoria
<b>SEI</b>	Sustainable Energy Ireland
<b>SME</b>	Small and Medium sized Enterprises
<b>SQV</b>	Scottish Vocational Qualifications
<b>STEMS</b>	Structured Team-based Energy Management System
<b>TFC</b>	Total Final Consumption
<b>TEPM</b>	Total Productive Energy Management
<b>TPER</b>	Total Primary Energy Requirement
<b>TPM</b>	Total Productive Maintenance
<b>TQM</b>	Total Quality Management
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>WBCSD</b>	World Business Council for Sustainable Development
<b>WEEE</b>	Waste from Electrical and Electronic Equipment Directive
<b>WDRI</b>	Winter Demand Reduction Initiative (ESB)
<b>WMO</b>	World Meteorological Organisation
<b>WWW</b>	World Wide Web

# Chapter One: Introduction

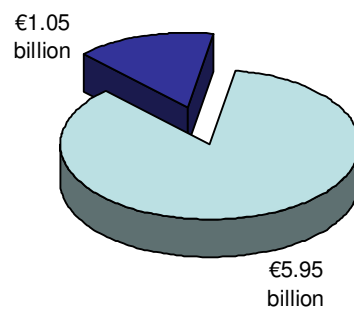
- 1.1 Introduction
- 1.2 Thesis Motivation
- 1.3 Thesis Objectives
- 1.4 Research Methodology
- 1.5 Thesis Structure

## 1.1 Introduction

Implementation of energy policy in Ireland and the European Union (EU) is now a major priority driven by three primary objectives: environmental protection, security of supply and cost competitiveness (DPE 1999; NCCS 2000). Under the Kyoto Protocol, the EU has committed to reduce annual greenhouse gas (GHG) emissions to 8% below 1990 levels. The agreed target given to Ireland under a burden sharing agreement is to limit emissions to 13% above the 1990 levels (Howley *et al.* 2003). However this target was breached in 1997 and projections are that emissions will rise to almost 40% above the 1990 level if Ireland continues on its present path (NCCS 2000). The potential recurring cost to the Irish exchequer could amount up to €240 million per annum depending on the market price placed on carbon dioxide (CO<sub>2</sub>) (EPSSU 2003). While all the consequences of this scenario is still unclear, a recent European study forecasts that a “business as usual” approach will result in severe energy and climate problems in thirty years time (WETO 2003). At 86%, Ireland’s import dependency is the highest in the EU outside of Luxemburg (EU\_Energy 2002) leaving the country vulnerable to increased energy prices and/or disruption of supply.

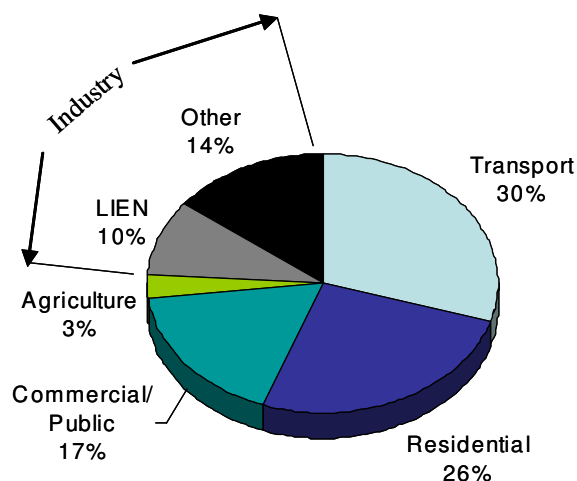
Action Energy, the UK government funded programme established to assist businesses and the public sector to reduce energy consumption, maintain that thousands of businesses have reduced energy consumption by up to 20% by availing of their services (Action Energy 2003). The estimated cost saving potential of implementing

energy efficiency is approximately 30% of final energy demand (PIU 2002), with the introduction of “no cost” and “low cost” energy efficiency measures resulting in savings of up to 15% (Action Energy 2003; Nifes 2003). In 2002, over €7 billion was spent by Ireland on energy (SEI 2002). Therefore, the savings to the Irish economy from a ubiquitous implementation of energy efficiency could result in a saving of €1 billion and approximately 6.3 Mt of energy related CO<sub>2</sub> emissions (Howley *et al.* 2003). Figure 1 presents this opportunity based on the 2002 expenditure.



**Fig.1:** Potential saving to the Irish economy of implementing energy efficiency in all sectors

The total primary energy requirements (TPER)<sup>1</sup> of the Irish economy, by sector for the year 2001, are shown in figure 2. This figure allocates Ireland’s energy supply to each sector of the economy according to their energy demand, and can be divided into four major categories: Transport, Residential, Commercial/Public and Industry.



**Fig.2:** TPER by sector (Howley *et al.* 2003)

<sup>1</sup> The term Total Primary Energy Requirement (also known as Gross Inland Consumption – GIC) is defined as the total energy consumed in a country in a given year and includes all energy consumed including the energy overhead used to transform primary sources such as oil into electricity.

Sustainable Energy Ireland (SEI), who over the last year has been running high visibility public awareness campaigns on television and radio, has led Irish energy efficiency initiatives. SEI also runs a comparable program to Action Energy that targets large industry known as the Large Industry Energy Network (LIEN), which is a voluntary network of eighty of the largest energy consumers in Ireland. As shown in figure 2, these companies account for 40% of the total Irish industrial demand (LIEN 2002), or 10% of the country's total primary energy requirement (TPER). Energy projects implemented by the LIEN since its inception in 1994 have resulted in savings of 285 GWh which equates to 120,000 tonnes of CO<sub>2</sub> (Murray 2003). However, according to SEI, there is still considerable potential for emissions and cost reductions in the remaining 4,400 firms of the industrial sector by implementing improved energy efficiency (Parish 2003). Small and medium sized enterprises (SME) are now being urged to become more involved in reducing the national energy bill and resulting greenhouse gas emissions. The estimated 150,000 SMEs in the business sector have the potential to make a very significant contribution to reducing energy consumption (Taylor 2000). However, the task of implementing energy efficiency across this sector poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity and it was this challenge that became the focus of this project. This thesis is targeted at establishing a process of implementing energy efficiency outside the LIEN and within the SME, Commercial and Public sectors. Based on previous energy studies, the total potential for "no cost/low cost" energy efficiency in these sectors is estimated in table 1 (EPSSU 2003; Howley *et al.* 2003).

**Table 1:** Potential Savings for Energy Efficiency in Target Sectors (EPSSU 2003)

<b>Sector</b>	<b>% TPER</b>	<b>TPER (M€)</b>	<b>Mt CO<sub>2</sub></b>
Industry (excluding LIEN)	14%	980	6.12
Commercial / Public	17%	1190	7.53
Total		2170	13.65
<b>POTENTIAL SAVINGS</b>		<b>248</b>	<b>1.56</b>

This table shows a potential saving of €248 million and 1.56 Mt of CO<sub>2</sub> by implementing energy efficiency in the three sectors targeted by this study. The forecast in table 1 is based on figures supplied by the Energy Policy Statistical Support Unit of Sustainable Energy Ireland (EPSSU 2003; Howley et al. 2003). A figure of 15% cost reduction is applied to the industrial sector while a figure of 8.5% is applied to the Commercial and Public sectors. This latter percentage is based on the results obtained from the public service case study undertaken during the course of this research. The residential, agricultural and transport sectors are excluded from the estimate as a different approach is considered more appropriate for these sectors. However it could be argued that there are a number of organisations within the transport and agricultural sector that could also be included.

The EU action plan aimed at the promotion of energy efficiency gives priority to removing the institutional barrier resulting from the continued practice of selling energy in the form of kilowatt-hour (kWh) instead of efficient heating and cooling, lighting and motive power which are the services actually required the consumer (EC 2000a). This approach will give incentives to the energy provider to maximize the efficiency of the service in order to optimize profits. The plan highlights the emerging market for bundling SME energy services based on this new approach and identifies the use of information technology as a means of providing these services. The report highlights an important driver for this study when it concluded that the “use of information technology in providing energy and energy-related services will be a priority area” for current research direction.

## 1.2 Thesis Motivation

Clearly from table 1, the economic and environmental benefits of energy efficiency is very significant and a challenge exists to determine the most effective way of successful implementation in the Irish context. Many publications in this area concentrate on energy management at the level of skills development and operations procedures (HEFCE 1996; Næss 2000). The operations level deals with topics such as load management, audits and installation of building energy management systems (BEMS) using digital control technologies. This level is well catered for in publications such as the IEEE standard 739-1995 and other text books and journal publications (Capehart *et al.* 2000; Nicholson *et al.* 2000). In the Irish educational sector, the Higher Education and Training Awards Council (HETAC) issued guidelines for curriculum development to support Irish and EU policies in the area of energy and environmental performance. The HETAC document identifies the role of the higher education sector as being crucial to the success of these policies (HETAC 2000). In the UK, an energy management study in the Higher Education Sector (HEFCE 1996) dealt with the state of energy management practice in higher education organisations. However, the methodology presented concentrated on implementation of projects at the training and operations level. It did not propose a model that would also assist organisational change.

Dulleck and Kaufmann (2004) demonstrated the effectiveness of a demand side management (DSM) program that reduced the overall electricity requirement by roughly 7% among Irish consumers. This report recommended the setting up of an independent institution to distribute DSM information but did not address any process to put energy efficiency into practice. Europe-wide research on the successful implementation of energy efficiency in industrial, commercial and service sectors concluded that company culture is a more significant factor governing the implementation of energy efficiency than pure economic decision making (InterSEE 1998). The concept of total productive energy management (TPEM) introduced by AL-Homoud (2000) extends the combined approach of total productive maintenance (TPM) and total quality management (TQM) to the area of energy management. TPEM proposes that this will be successful where unified objectives and teamwork exist and employees become responsible for managing energy systems under their control.

### 1.3 Thesis Objectives

The aim of this thesis is to provide a structured process that can be employed in any small and medium sized organisation to reduce energy costs and greenhouse gas (GHG) emissions by improving energy efficiency.

The primary objectives can be summarised as follows:

1. Develop a process methodology to support the implementation of energy efficiency in small and medium sized organisations; to include both small and medium sized enterprises (SMEs) and the Commercial and Public Services sectors.
2. Facilitate energy efficiency implementation by energy teams who most probably have little or no experience in the area of energy management.
3. Research the use of web technologies to:
  - Assist collaboration between and learning within energy teams.
  - Enable Irish energy professionals to provide electronic energy services to support objectives 1 and 2 above and to develop new national and international business.

The secondary objectives can be summarised as follows:

1. Analyse the viability of transferring tem-based methodologies proven in other disciplines, such as new product development and reengineering, to the energy sector.
2. Promote a culture of energy conservation and awareness by all energy users and investigate the role of the educational sector to meet this objective.
3. Examine the suitability of Action Research to the process of applied research in the area of energy efficiency.



## **1.4 Research Methodology**

This section outlines the approach to the work and the research methodologies applied during the course of the study.

### **1.4.1 Approach to Work**

The approach to this work was as follows:

- Perform a literature review to establish the drivers behind energy policy: environmental considerations, security of supply, competitiveness and business ethics.
- Review approaches to organisational change and process implementation in other disciplines such as product development and business process reengineering.
- Develop a Prototype Model of energy management based on interviews with energy policy makers and energy professionals, discussion with SME managers, the literature review and the author's own experience.
- Conduct trial implementation in Case Study I: Rational Use of Energy (RUE) within GMIT
- Conduct trial implementation in Case Study II: Building Energy Management (BEM) Consultancy.
- Development of the Structured Team-based Energy Management System (STEMS) delivered via the World Wide Web using a Collaborative Virtual Environment.

## 1.4.2 Methodologies

### 1.4.2.1 Action Research

Action Research began in the USA in the 1940's as a research method used in the social sciences (McNiff 1997). Since then, action research is most commonly used in the area of educational research (Cohen and Mannion 1994) but is increasingly being used in the public sector. Industrial use of this methodology is not very widespread but the approach has been used in such areas as Quality Change Management (Ó Béarra 1998) and Environmental Management (Allen 2001). The action research approach involves the practitioner and sits within the philosophical approach of Interpretivism rather than the external and objective methodology of Positivism (Haugh 1999).

McNiff outlines the process of action research as follows:

*Identify the issue -> imagine ways of tackling it -> implement a possible solution  
-> evaluate the solution -> change practice in the light of the evaluation.*

The problem of implementing energy efficiency using team-based approaches and web-based technologies required the involvement of the author so it was considered that the action research methodology would be suitable. As the application of this methodology to energy research was somewhat novel, the proposal was discussed with Jean McNiff in May 2003 who concluded that the methodology was valid in this research context (McNiff 2003). As a result, two case studies are presented in which this approach was taken to test and refine the energy process.

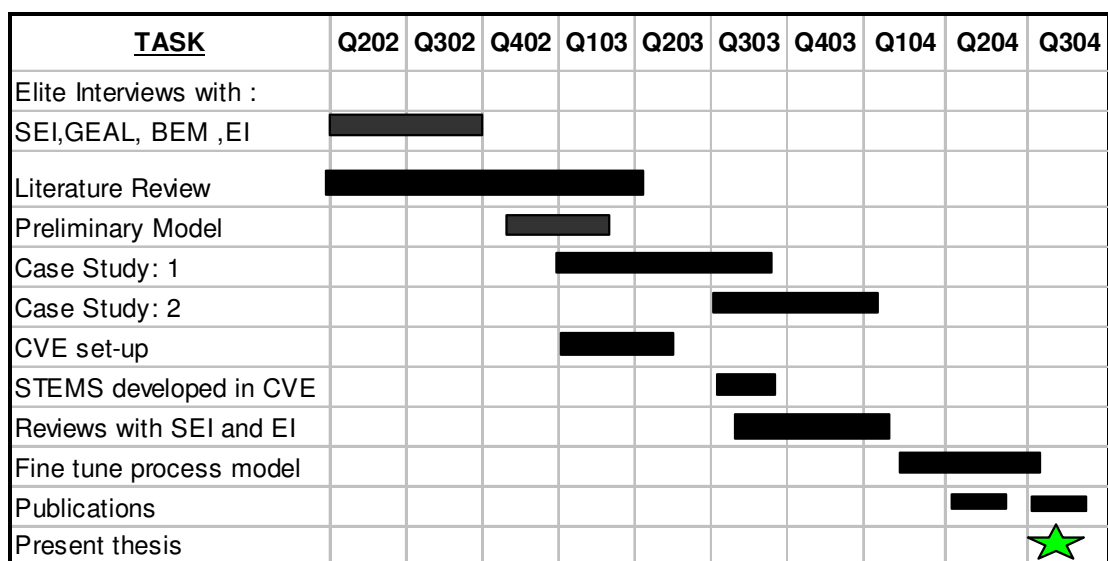
### 1.4.2.2 Case Studies, Interviews and Questionnaires

Two case studies are presented in this thesis. The case study, being a qualitative research method, had initial difficulty in gaining acceptance as a valid research methodology from champions of the scientific method. However, it is now an established research technique especially in the field of sociology.

Six sources of evidence are commonly identified when taking this approach: Interviews, Direct observation, Participant-observation, Archival records, Documents and Physical artefacts (Tellis 1997). Case studies can provide a holistic view of a process and are suitable for studying organisation culture (Haugh 1999) , but have been criticised as being incapable of providing a generalising conclusion.

Interviews can be open-ended, focused or structured and one particular version of the open-ended approach is the “elite interview” of experts in the field (Gillham 2000b). The interviewing of elites and subsequent analysis is regarded as crucial to the understanding the character of sectors of society (EPIC 2002). This research included interviews and meetings with Policy Makers and Professionals in the energy sector. Another method of gathering information is the use of a questionnaire (Gillham 2000a) and an electronic version was used during the course of a behavioural survey .

Figure 3 shows a high-level project timeline of how the research methodologies above were utilised in the development of the STEMS process.



**Fig.3:** Thesis project timeline from May 2002 to July 2004

**Key to figure 3:**

Q202 = Quarter 2 year 2002, SEI= Sustainable Energy Ireland, EI = Enterprise Ireland  
 GEAL = Galway Energy Agency Limited, BEM = Buildings & Energy Management

## **1.5 Thesis Structure**

The remaining chapters of the thesis are structured as follows:

**Chapter 2** provides an overview the major drivers behind Irish energy policy. The context of global environmental issues, international agreements, European energy policy and the principle of sustainability is presented. Next, the factors that are driving Irish energy policy: security of supply, environmental protection and competitiveness are discussed. Barriers to the implementation of policy are then examined. The important roles of the Industrial and Educational sectors in meeting Ireland's stringent obligations under various international agreements are considered. Finally, the task of implementing energy efficiency in small and medium sized organisations is addressed.

**Chapter 3** reviews the effectiveness of team-based and process methodologies to address the requirement for company learning and organisational change to support the implementation energy efficiency. Methods of information delivery to the large number of geographically dispersed organisations via the World Wide Web and Collaborative Virtual Environments are presented.

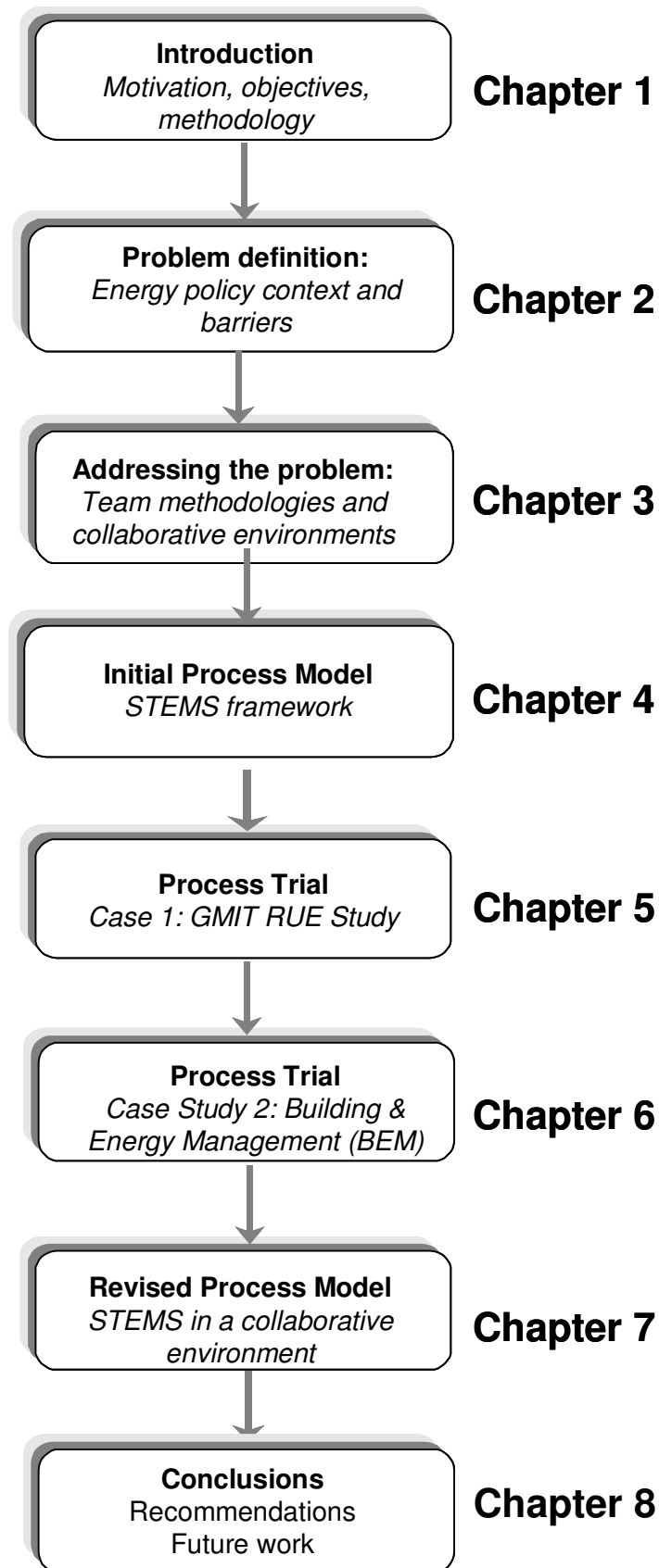
**Chapter 4** introduces a prototype model of a structured team-based energy management system (STEMS) developed to support the implementation of energy management in small and medium sized organisations. An initial trial, as part of a problem-based learning (PBL) exercise at undergraduate student level is discussed. Reviews and presentations of the proposal with experts and professional practitioners in the area of energy policy and management are then considered.

**Chapter 5:** Case Study one presents a detailed review of the first management implementation of the STEMS process during the Rational Use of Energy (RUE) project undertaken by a multi-disciplinary team in the Galway-Mayo Institute of Technology between January and May 2003. This project was conducted as part of the “Partnership IT” program. It involved participation from four geographically dispersed campuses and the team included six staff and the Students Union Vice-President.

**Chapter 6:** Case Study two presents the preliminary development of a web based energy service via a collaborative virtual environment (CVE) to clients of an energy management services company, Building & Energy Management (BEM). The company, as an executive member of the Association of Energy Professionals of Ireland (AEPI), explored the possibility of using web technologies to improve present services, increase business efficiency and develop new business nationally and internationally. Another important research objective was to investigate the possibility of AEPI members providing a support role to energy teams during the sustaining phase of the STEMS process.

**Chapter 7** presents the updated Structured Team-based Energy Management (STEMS) process delivered via a web-based collaborative virtual environment to meet the challenge of implementing energy efficiency in small and medium sized organisations. The process incorporates a toolset called the STEMS wizard to train and provide resources for energy teams that have little or no experience in the area of energy management. The steps, deliverables and templates of the STEMS model, developed based on the initial prototype model presented in chapter four and the case studies described in chapters five and six are detailed.

**Chapter 8** concludes the thesis with a summary of the work done, the conclusions drawn and lists recommendations for future work.

**Fig.4:** Thesis Structure

## **Chapter Two: Literature Review**

- 2.1 Introduction
- 2.2 Energy Policy Drivers
- 2.3 Policy Barriers
- 2.4 Educational sector
- 2.5 Industrial Sector
- 2.6 Ethical Issues
- 2.7 Conclusions

### **2.1 Introduction**

Energy policy is a set of measures decided and implemented by a political body concerning the production, transportation or consumption of energy (SNEA 2001). This section outlines the major drivers of energy policy in terms of the global environmental context, international agreements, the principle of sustainability and business ethics. It reviews the barriers to policy implementation that have been outlined in a number of major research studies. The important role of the Educational sector in meeting Ireland's stringent energy obligations under various international agreements is discussed. The task of implementing energy efficiency in small and medium sized organisations is addressed, as this poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity.

## 2.2 Energy Policy Drivers

### 2.2.1 Climate Change

There is real concern among the scientific community (IPCC 2001) that the basic conditions that have allowed life to thrive on earth will significantly change by the middle, or end of the twenty first century. The 1992 United Nations Framework Convention on Climate Change is one of a number of responses to meet this perceived challenge. Related issues being addressed internationally include:

- pollution of the oceans
- expanding deserts
- damage to the ozone layer
- rapid extinction of plant and animal species.

The Climate Change Convention focuses on the way energy from the sun interacts with and escapes from our planet's atmosphere. It is feared that upsetting this balance will result in alterations to the global climate. Among the expected consequences are:

- An increase in the average temperature of the earth's surface
- Shifts in worldwide weather patterns.

The principal change to date is in the balance of gases that form the earth's atmosphere. The key "greenhouse gases" are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O). Greenhouse gasses make up less than one tenth of one per cent of the total atmosphere, which consists mostly of oxygen (21%) and nitrogen (78%). Without this natural blanket of greenhouse gasses, the surface of the earth would be some 30 °C colder than it is today (UN 2002). The burning of coal, oil, and natural gas generates carbon dioxide. Carbon is also stored in trees. It escapes to the atmosphere when forests are destroyed. The atmospheric concentrations of key GHG reached their highest recorded levels in the 1990s, primarily due to the combustion of fossil fuels, agriculture, and land-use changes (IPCC 2001). It has been by the UN (2002) that if emissions continue to grow at current rates then atmospheric levels of carbon dioxide will double during the 21st century from pre-industrial levels. If no steps are taken to slow greenhouse gas emissions, levels could triple by the year 2100. The thrust of the United Nations argument is that there must be a change in human behaviour to meet the challenges of climate change.



In Ireland, studies of bird migration patterns by Sweeney (2003) shows that the recent arrival of bird species such as the Pied Flycatcher and Mediterranean gull provides supportive evidence of climate change (MacConnell 2003). It is also significant that a substantial part of Ireland's GHG emissions is in the form of Methane and N<sub>2</sub>O from agriculture, which is different from most other EU states.

While the majority of the scientific community believe that there is enough evidence of climate change, there are some dissenting voices. One of these is the Harvard Astrophysicist, Willie Soon who contends that there is much confusion in the discussion the reports between "climate" and "weather" (Soon and Baliunas 2003). Soon argues that the evidence that the 1990s was the warmest period in the 140 years since records began is not enough to support the thesis that the 20th century was unusual. Even the Intergovernmental Panel on Climate Change (IPCC 2001) admit that the climate system is so vast and complex that much uncertainty remains. However, the issue of climate change still remains one of the major drivers behind European and Irish energy policy to which this research project responds.

### 2.2.2 Carbon Cycle

Despite its bad press recently linking carbon dioxide (CO<sub>2</sub>) to global warming and climate change, it must be remembered that carbon dioxide is a key component in sustaining life. The fundamental food generation process of plants by means of photosynthesis depends on the availability of carbon dioxide as shown in figure 5 below.



Fig.5: Photosynthesis equation

Trees remove CO<sub>2</sub> from the atmosphere by sequestering (absorbing) the carbon during photosynthesis. The rate at which trees sequester carbon depends on the species and this has been modelled by Dewar and Cannell (Gardiner *et al.* 2000). The carbon removed from the atmosphere is stored in the wood, bark, foliage and roots of the tree. As a result, carbon also passes to the forest floor via litter of dead foliage and twigs. The decomposition of this litter passes carbon to the soil and as a result forest soil is an important reservoir of carbon.

### 2.2.3 Fossil Fuel Reserves

The amount of energy that is available from the earth's fossil fuel reserves is finite. Estimation of how long these will last is difficult, but studies such as Pickering and Owen (1997) indicate that coal reserves are sufficient for 150-200 years while that of oil is about 50 years. Figure 6 gives a historical perspective on the consumption of fossil fuel (Shepherd and Shepherd 1998). The World Oil Supply Report by Douglas-Westwood (2004) concludes that present and yet-to-find reserves may not even satisfy present demand beyond and forecast a future of oil price increases, similar to that currently being experienced.

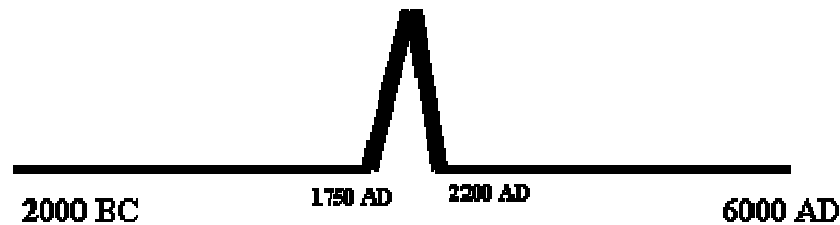


Fig.6: Fossil Fuel Consumption profile (from Shepherd and Shepherd 1998)

Before oil runs out, cheap oil will run out (Appenzeller 2004) due to the increasing difficulty of accessing reserves. Since Ireland imports 86% of its energy demand, of which almost 60% is oil, these predictions place the country in a vulnerable position regarding energy cost.

### 2.2.4 From Stockholm to Johannesburg

The world's governments have met at irregular intervals to address the issues of environment and development at a forum that is commonly known as the Earth Summit. The first such meeting was in Stockholm in 1972 as the United Nations Conference on Human Development, the second in Rio de Janeiro in 1992 and the third in Johannesburg in 2002 (Pearce 2002). The political landscape has changed significantly from the Cold War outlook in 1972 when many of the environmental problems such as the hole in the ozone layer had not emerged. More than a hundred

world leaders, led by Brazilian President Collor de Mello, and approximately thirty thousand other interested parties, attended the Earth Summit at Rio. The Rio summit was a landmark with 152 countries signing the Biodiversity Convention and 150 countries signing the UN Framework Convention on Climate Change. The Framework was a general treaty with just a few specific requirements (UNEP 1994): with the main points being:

- It recognised that there is a problem.
- It set an "ultimate objective" of stabilising "greenhouse gas concentrations.
- It directed that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner".
- It established a framework and a process for agreeing to specific actions.
- It placed the main responsibility for tackling climate change on the rich countries.

The treaty took effect in March 1994 and the countries ratifying the convention are called "Parties to the Convention". The Conference of Parties (COP) was put in place to implement the agreement, review the obligations of the parties and facilitate data gathering and information exchange (Pickering and Owen 1997). Table 2 shows a list of COP meetings extracted from the UNFCCC website (UNFCCC 2004) . The COP met for the first time in March 1995 and on a yearly basis thereafter. Two subsidiary bodies, one for scientific and technological advice and the other for implementation assist the Conference of Parties. Also at Rio de Janeiro, plans were developed for a declaration of principles on sustainable development known as Agenda 21 (Agenda for the twenty first century). The Rio Declaration states that the human being must be at the heart of the concern for sustainable development and that any global policy should consider this as a basic principle.

**Table 2:** List of Conference of Parties (UNFCCC)

	<b>LOCATION</b>	<b>YEAR</b>
COP-1	Berlin	1995
COP-2	Jakarta	1996
COP-3	Kyoto	1997
COP-4	Buenos Aires	1998
COP-5	Bonn	1999
COP-6	The Hague	2000
COP-6 part 2	Bonn	2001
COP-7	Marrakesh	2001
COP-8	New Delhi	2002
COP-9	Milan	2003
COP-10	Buenos Aires	2004

### **2.2.5 Intergovernmental Panel on Climate Change**

Recognizing the problem of potential global climate change, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The panel provides scientific, technical and socio-economic advice open to all interested parties but in particular to almost two hundred parties to the United Nations Framework Convention on Climate Change (UNFCCC) (IPCC 2004). It is open to all members of the UN and WMO. The panel does not engage in research per se but bases its assessment on peer reviewed and published scientific/technical literature on climate change.

The IPCC has produced three major assessment reports in 1990, 1995 and 2001 which are comprehensive up-to date assessment of the scientific, technical and socio-economic research on climate. The First-Assessment Report resulted in the adoption of the UN Framework Convention on Climate Change, which was opened for signature at the Earth Summit in Rio de Janeiro in June 1992. The Second-Assessment Report (SAR) was provided to the Second Session of the Conference of the Parties (Geneva, 1996) and made a significant contribution to negotiations for the Kyoto Protocol.

The Third-Assessment Report provided the new research findings since 1995 and included a much greater input from non-English literature. The IPCC also publishes special reports on specific topics in response to requests from members of the UNFCCC or as it see fit itself. Examples include the report on Emissions Scenarios and the report on Land Use, Land Use Change and Forestry (LULUCF) made available in 2000.

### 2.2.6 Kyoto Protocol

Participants at the United Nations conference in Kyoto in 1997 (UN 2002), agreed to reduce the emission of greenhouse gases in the period 2008 to 2012 by 5% compared to 1990 levels. The target for the European Union is 8% reduction. Following Kyoto, the European Commission has been taking action with a number of energy directives and programmes. Member states have been assigned individual emission targets. The agreed target for Ireland is an increase of 13% over 1990 figures. Ireland ratified the Kyoto Protocol on May 31<sup>st</sup> 2002. The GHG abatement targets for EU member states under the “burden sharing” agreement are shown in the table 3 (Energy Ireland 2000).

**Table 3:** EU CO<sub>2</sub> Emissions Targets under the Kyoto Protocol

<u>Member State</u>	<u>% Change in GHG emissions</u>
Portugal	+27.0
Greece	+25.0
Spain	+15.0
<b>Ireland</b>	<b>+13.0</b>
Sweden	+4.0
Finland, France	0
Netherlands	-6.0
Italy	-6.5
Belgium	-7.5
U.K.	-12.5
Austria	-13.0
Denmark, Germany	-21.0
Luxemburg	-28.0

For this protocol to come into force, it must be ratified by more than 55 countries including those responsible for 55 percent of the emissions of developed countries. Presently approximately one hundred countries have ratified the protocol. The Kyoto Protocol provides that Parties' targets are to be achieved over the five year period 2008 – 2012 known as the "first commitment period". Targets for future commitment periods (post 2012) are yet to be negotiated but indications are that targets will even be more stringent (O'Rourke 2003b). Significantly, the USA, which accounts for 36 percent of emissions, has declined to ratify the protocol (De Leyva and Lekander 2003). According to the UK Action Energy Agency, the single most effective way of achieving the Kyoto targets is through energy efficiency (GPG311 2001). Figure 7 graphically shows the status of the Kyoto Protocol as of July 8<sup>th</sup> 2004.

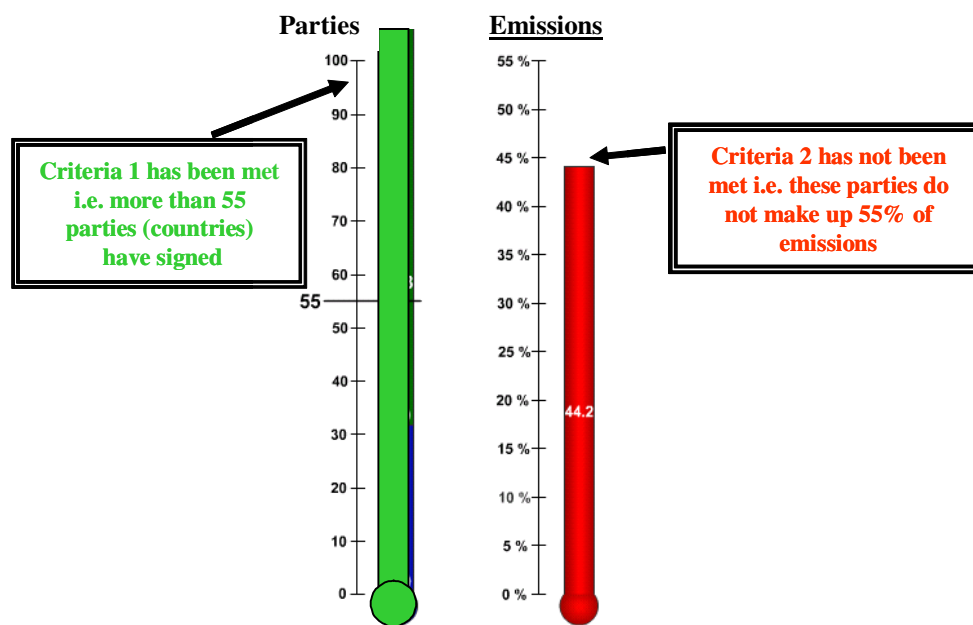


Fig.7: Kyoto Protocol Thermometer (UNFCC 2004)

More than the required number of countries have ratified but the combined figure for these countries still does not meet the 55% of emissions criteria.

### 2.2.6.1 Carbon Sinks

A carbon sink is a reservoir where sequestered carbon dioxide is stored (see section 2.2.2). An example of a carbon sink is a forest. Under the Kyoto Protocol, parties may meet part of their targets through flexible mechanisms such as international emissions trading, Joint Implementation (JI), and the Clean Development Mechanism (CDM).

Joint Implementation (JI) is a project-based instrument that allows Parties with defined targets to share reduction credits where one Party invests in a project in the territory of another with the aim of reducing emissions or enhancing sinks. The Clean Development Mechanism (CDM) is a project-based mechanism similar to the JI that allows Parties, who are developed countries, to gain carbon credits from investing in projects in the developing world. The CDM in addition must meet criteria that support sustainable development in the host country. The Irish government recognises the value of Irish firms investing in both of these mechanisms (NCCS 2000). The Danish Energy Authority provides a manual for Joint Implementation (JI) projects that provides a guide to Danish project developers on implementing JI projects (DEA 2002b). Article 3.3 of the Kyoto Protocol defines the activities from which removals and emissions will be accounted for:

- Afforestation
- Reforestation
- Deforestation

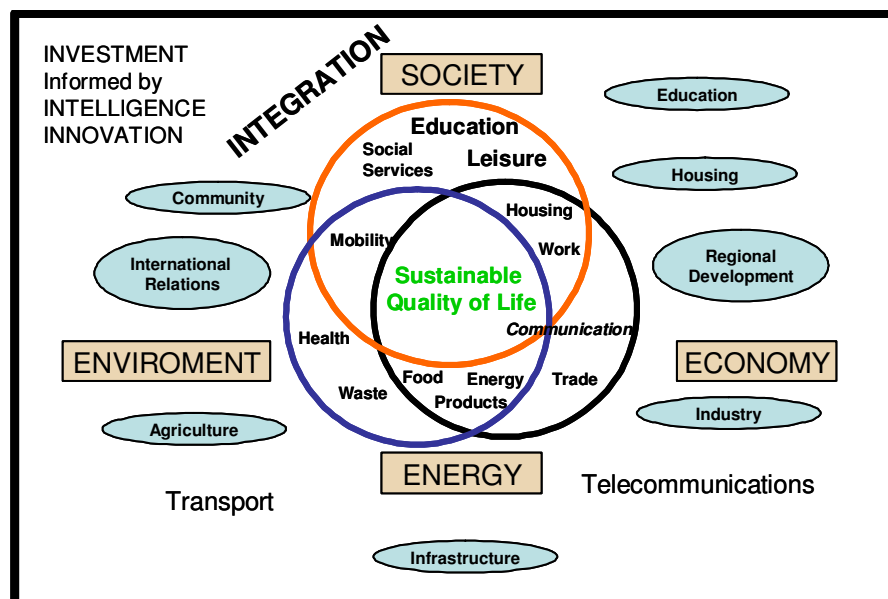
However the details on rules and modalities for the inclusion of forestry projects in the Clean Development Mechanism (CDM) are one of the last non-resolved implementation issues of Kyoto (Jung 2003). The Marrakesh Accords allow four more eligible activities that parties can choose from to meet emissions targets as outlined in articles 3.4.

- Forest management
- Cropland management
- Grazing land management
- Revegetation

Also the Marrakesh Accords now allows CDM forestry projects in under-developed countries to be used to generate credits. This will help developed countries to meet their emission limitation and reduction targets (limited to 1% of base year emissions) (COFORD 2002). The Land use, land use change and forestry (LULUCF) sector provide relatively low cost opportunities to combat climate change. It does this by increasing the removal of carbon and through carbon sequestration. The introduction of a market for carbon credits from CO<sub>2</sub> sinks will potentially make investment in forestry more attractive (Sikkema and Kenzie 2000).

### 2.2.7 Sustainability

The World Commission on Environment and Development was established in 1984 as a result of a UN General Assembly resolution. The report published three years later became known as the Brundtland Report after the name of its chairman, former Norwegian Prime minister, Gro Harlem Brundtland. It defined sustainable development as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’. The issue of sustainability and the goal of providing a sustainable quality of life is complex. Bell and Morse (1999) contend that ‘though most would agree that sustainability implies ‘not cheating on your kids’, they consider that a clearer definition has proved to be elusive. Figure 8 shows a more comprehensive view of sustainability as being the integration of society, environment and the economy. The World Business Council for Sustainable Development’s definition is perhaps more specific and descriptive citing a triple point bottom line (O’Rourke 2003b).



**Fig.8:** Sustainability – Contributing elements & Policies (adapted from O’Rourke 2003)

Kevin O’Rourke of SEI believes that sustainable development will require radical changes in the way that society is organised, equipped and conducted. It will necessitate “a quiet, relentless revolution in awareness and action” (O’Rourke 2003c). In Ireland, Comhar is the body responsible for National Sustainable development Partnership (Comhar 2004). Comhar’s terms of reference are to advance the national agenda for sustainable development, to evaluate progress in this regard, to assist in



devising suitable mechanisms and advising on their implementation, and to contribute to the formation of a national consensus. In the EU, Article 6 of the Amsterdam Treaty states that environmental protection requirements must be integrated into the definition and implementation of community policies and activities, in particular with a view to promoting sustainable development (Baker *et al.* 1999). Energy will play a key role in this process (DGTREN 2003) and clearly the issue of sustainability and sustainable development is one of the key drivers of this study.

### **2.2.8 IEA – International Energy Agency**

The European Union is represented in a wide range of international forums and organisations such as the International Energy Agency (IEA). The IEA was created by the Organisation for Economic Co-operation and Development (OECD) in 1974 in response to the major oil crisis of that year (OECD 1974). Its immediate objectives were to establish adequate oil stocks, reduce consumption and share supplies if required. In the long term the IEA would strive to increase energy efficiency, conserve resources, diversify from dependence on oil and develop cleaner and more efficient technologies. Energy security is a main goal of the IEA and part of its mandate is to improve relations between oil producing and consuming countries. Among the major challenges now facing the organisation is to reconcile energy production with environmental protection. There is still a fundamental link between economic growth and energy production (Mandil 2004). Ireland is one of the members of the IEA. In June of 1993 the IEA Minister adopted nine shared goals to meet its aim of creating conditions where energy sectors could contribute fully to sustainable development and the well-being of people and the environment (IEA 2004).

1. Diversity, flexibility within the energy sector
2. Ability of energy systems to respond quickly and flexibly to emergencies
3. Environmentally sustainable provision and use of energy
4. More environmentally acceptable energy sources
5. Improved energy efficiency (as a cost-effective solution)
6. Research, development and deployment of new and improved technologies
7. Undistorted energy prices
8. Free and open trade
9. Co-operation among all energy market participants

The approach to changing energy performance advocated by the IEA (O'Rourke 2003a) is as follows:

- Changes in Demand – e.g. consumption of goods or services
- Changes in Structure – e.g. move to public transport or tele-working
- Changes in Efficiency – e.g. management practices or consumer behaviour

### **2.2.9 European Policy**

Christos Papoutsis, former EU Energy Commissioner, summed up the situation confronting the European Union as follows: “The Challenge requires new policy responses –business as usual will not be sufficient” (Energy Ireland 2000). The Directorate-General for Energy and Transport reports to the Vice-President of the European Commission. It has a staff of approximately one thousand officials and was created by merging the Directorate-General for Transport and the Directorate-General for Energy in January 2001 (DGTREN 2003). This Directorate-General is responsible for developing and implementing European policies in the energy and transport field. Its mission is to ensure that energy and transport policies are designed for the benefit of all sectors of the society, businesses, cities, rural areas and above all of citizens. The energy and transport sectors are pivotal to the European way of life and to the functioning of the economy and their operation have to be responsible in economic, environmental, safety and social terms. The Directorate-General for Energy and Transport carries out these tasks using legislative proposals and programme management, including the financing of projects. The European Commission indicated energy to be a key factor for Europe's competitiveness and economic development in its strategic objectives for 2000-2005 (EC 2000c).

The prime aim of the European Community's energy policy, as set out in the November 2000 Green Paper (EC 2000b) on the security of energy supply, is to ensure a supply of energy to all consumers at affordable prices while respecting the environment and promoting healthy competition on the European energy market. The Union's external energy dependence is continuing to grow (it currently meets 50% of its energy requirements through imports). As the Green Paper states, if nothing is done,

this rate of dependence will grow to 70% by 2030, which would further weaken the Union's position on the international energy market. For the first time, the Green Paper on security of energy supply stresses the fundamental importance of influencing demand rather than concentrating solely on energy supply. In order to limit energy dependence, the growth in demand has to be limited by legislative means, among others. This is significant in the context of this thesis which has the goal to influence the demand side. A series of measures are presented to this end in the Green Paper. In the context of the Kyoto Protocol, improved energy efficiency has become an even more important element of Community strategy. In April 2000, the Commission adopted an action plan to improve energy efficiency in the European Community. The SAVE programme encourages energy efficiency measures, and will be the main instrument for coordination of the plan.

The legislative framework of the EU is graded according to regulations, directives, decisions and finally opinions or recommendations (Baker 1997). For example the European Parliament Decision No. 647/2000/EC and Decision No. 646/2000/EC (EC 2002) are concerned with rational use of energy (RUE) on the demand side and increased use of renewable energy on the supply side (RES) through the following programmes:

- Integrated actions that address issues relevant to RUE and RES
- Replication of good practice within the field of energy efficiency and renewable energy resources.
- Specific actions on energy efficiency aiming to achieve the goals identified in the EU Action Plan on energy efficiency and the EU White Paper on RES.
- Local and regional level action on energy efficiency and renewable energy sources aimed at local end-users including industries, consumers and planners.

The Green Paper (EC 2000b) on security of energy proposes a series of measures, including legislative to limit energy dependence and the growth in demand. It addresses the concepts of security of supply and environmental protection in the context of economic growth and market liberalisation.

Important points raised in the Green Paper include:

- The European Union must take better charge of its energy destiny.
- The Union must rebalance its supply policy by clear action in favour of a demand policy.
- A real change in consumer behaviour is called for.
- The EU has a technical potential of 40% for improved energy efficiency.
- The EU has very limited scope to influence the energy supply side.
- Demand for electricity has grown much more rapidly than for any other type of energy.
- North Sea oil and gas deposits will be exhausted within 25 years.
- Enlargement will do nothing to increase internal supply.
- EU is largest energy importer and second largest energy user in the world.
- EU imports 50% of energy compared with 24% for US and 80% for Japan.
- World energy demand is forecast to increase by 65% over the next 20 years (developing nations will account for 90% of this increase)
- The Union suffers from having no competence and no community cohesion in energy matters.
- The lack of a real energy policy reduces the EU's bargaining power.
- Between 1985 and 1998 the increase in energy production from renewable energy was significant in relative terms (+ 30 %), but still fairly insignificant in absolute terms. It has stagnated at around 6 % of global consumption.
- Between 1975 and 1985, the improvement in energy efficiency was 24 %, whereas it was 10 % between 1985 and 1999. This underlines the importance of acting on the demand side.
- Energy savings are the most efficient and cheapest way to reduce dependence on imported energy.
- 94% of man made CO<sub>2</sub> emissions are due to the energy sector.

The EU action plan to promote energy efficiency (EC 2000a) states that there is a pressing need to renew commitment both at Community and Member State level to promote energy efficiency more actively. The report estimates that there is an economic potential to save more than 18% of present energy usage by the efficient use of energy and dissemination of energy efficient technology. This potential is

equivalent to over 160 Mtoe, or 1900 TWh, which is almost the total combined energy demand of Austria, Belgium, Denmark, Finland, Greece and the Netherlands. A major current barrier to energy efficiency is the practice of selling energy per kilowatt hour (kWh) instead of efficient energy services such as efficient heating and cooling, lighting and motive power, the services the consumer actually wants. The report also stated that the “use of information technology in providing energy and energy-related services will be a priority area”. The case study in chapter six addresses the issue of developing web-based energy services with an energy management consultancy. The EU stated that its goal is to become “the most competitive and dynamic knowledge based economy in the world” at the year 2000 Lisbon Summit. Energy prices, having direct and indirect effects on economic performance will have a significant impact on the attainment of this objective (EC 2000d). The main challenge to EU supply policy is the growing dependence of Europe on imported fossil fuel (EC 2000d). This situation has implications for the economy, environment and international relations. Currently Intelligent Energy - Europe (EIE) is the Community’s support programme for non-technological actions in the field of energy (EIE 2004). The main objective of the program is to promote energy efficiency in industry in order to strengthen competitiveness, particularly in the SME sector. Target areas include energy management and energy services for SME and this challenge falls within the remit of this thesis.

The EU has delivered on its commitment to stabilise emissions of carbon dioxide at their 1990 level by 2000. This is despite an emissions upturn in the final year of the period. It can be seen that energy policy has major implications for the future prosperity and stability of society in the European Union. Action is required immediately to curb the growing dependence on imported energy and the environmental results of emissions due to the use of energy. The quickest and most cost effective way to address this is through energy efficiency, which is the theme of this study.

### **2.2.10 International Policy Perspective-Japan**

Writing on the challenges facing Japanese energy policy, Uchiyama (2002) states that energy issues must be considered from three key factors; accessibility, availability and acceptability:

- Accessibility is the provision of affordable modern energy services with low energy tariffs.
- Availability covers both high quality and reliability of delivered energy.
- Acceptability is to achieve environmental and safety goals to address public acceptance.

Uchiyama believes that stable energy supply is absolutely essential for leading a high quality of life. A well-balanced utilization of energy resources must be achieved through economic growth, a stable energy supply and environmental preservation. “The key task of energy policy in Japan consists of promoting energy conservation and assuring a stable energy supply”. However, Uchiyama argues that under the present trend of low energy prices and poor economic climate, it would be difficult to meet the government’s targets. It is argued, that such targets could only be achieved by lifestyle changes to reduce their energy consumption and by the industrial sector agreeing to voluntary plans for energy saving which is in line with the argument for organisational culture change outlined in this research.

### **2.2.11 UK Energy Policy and Programmes**

This section reviews the mechanisms that are being used in the United Kingdom to meet its Kyoto Protocol targets. Unlike Ireland, the UK is on target to meet its burden sharing agreement of an emissions reduction of 12.5% from 1990 levels.

#### **2.2.11.1 Carbon Trust and Action Energy**

The UK Government set up an organisation called the Carbon Trust in April 2001 to spearhead the drive to reduce carbon emissions. The Trust is provided with funding of about STG£50 million per annum by the Department of Environment, Food and Rural Affairs (DEFRA), the Scottish Executive, the National Assembly for Wales and the

Northern Ireland Assembly. The main objective of the Trust is to promote the adoption of energy efficient practices and low-carbon technologies.

The main programme operated by the Carbon Trust to assist businesses and the public sector to reduce energy consumption, costs and GHG emissions is called “Action Energy”. This scheme was formerly known as the Energy Efficiency Best Practice Program (EEBPP) that was originally set up in 1989.

The free of charge services and products provided by Action Energy include:

- Tips for getting started: This service stresses that energy savings can be achieved immediately by implementing “no-cost” measures that do not require specific energy training or expertise
- Telephone Help line
- On-line Advice
- On-site energy surveys
- Publications available for downloading or ordering online: The Action Energy website contains an extensive database of guides, case studies and references. Organisations outside of the UK can register on-line and download the publications.
- Local and national energy events

Other Services provided by Action Energy include:

- Interest-free energy loans of between STG£5,000 and STG £50,000 to help businesses to invest in energy-saving equipment.
- Enhanced Capital Allowance (ECA) scheme enabling businesses to claim allowances against taxable profits on investments in energy-saving technologies and products. The qualifying equipment for an ECA is maintained on the Energy Technology List. An ECA will allow businesses to write off 100% of the cost of energy saving equipment against their taxable profits within the first year of investment. Also, businesses claim the allowance on their income tax or corporation tax returns (Action Energy 2003).
- Low Carbon Innovation programme that supports development of low-carbon technologies.

Action Energy maintains that thousands of UK businesses have reduced energy consumption by up to 20% by availing of these services. The Agency believes that the single most effective way of achieving the Kyoto targets is through energy efficiency (GPG311 2001). The success of Action Energy in bring about a reduction in energy consumption in a large number of private and public organisations with the resulting contribution to meeting the UK Kyoto target is a valuable benchmark for any similar undertaking in Ireland.

### ***2.2.11.2 Energy Management Vocational Qualifications***

The United Kingdom has a well-structured support system and framework for achieving vocational qualifications in energy management. The Standards for Managing Energy (GPG251 2001) is the UK national benchmark for energy management. These standards were developed in 1995 and are organised to describe the role and function of an energy manager. The Standards are structured specifically to provide a framework for Vocational Qualifications in Energy Management. The UK National Vocational Qualifications (NVQs) and Scottish Vocational Qualifications (SVQs) are based on achieving on-the-job competence levels (GPG235 2001) rather than academic qualifications. The University of Oxford Delegacy for Local Examinations is the awarding body for the NVQs in Energy Management in England Wales and Northern Ireland and the “The Institute of Energy” is responsible for delivery. In Scotland, the awarding body is the Scottish Qualifications Authority. The qualifications are also designed to facilitate meeting of Continuing Professional Development (CPD) requirements. The Standards for Managing Energy are also integrated into the overall UK suite of occupational management.

The UK Government re-launched its “Making a Corporate Commitment program (MACC)” in 2000 as MACC 2 where chief executives of organisations are invited to sign-up to reducing one of the following by a specified quantity:

- Greenhouse gas emissions (GHG)
- Waste production
- Water consumption



Organisations that have signed up to MACC have performed significantly better in developing energy management structures and processes (HEFCE 1996). The Energy Efficiency Accreditation Scheme (EEAS) is administered by the National Energy Foundation and the accrediting body is the Institute of Energy (IoE) (IoE 2003). To obtain the accreditation, an organisation must undergo an independent assessment of the organisation's performance in the areas of:

- Energy management policy and reporting procedures
- Actual and planned investment in energy efficiency procedures
- Improvements in energy efficiency achieved over the previous three years.

The organisation must be re-assessed every three years to maintain the accreditation. However, the number of organisations accredited is presently less than 200.

The UK energy policy and programmes have been very well organised and funded over a long number of years. They have demonstrated significant positive results in the area of energy efficiency. Many UK organisations have high energy intensity and include energy management expertise within their staff. One criticism of the Action Energy service is that it is complicated for people without energy training. Replication in an Irish context would be prohibitive in terms of cost and resource requirements. In contrast, the approach taken in this research is to address the problem of energy efficiency from the viewpoint of personnel that have little knowledge of the area. However, this methodology also cites suitable reference material available from Action Energy whenever appropriate.

### **2.2.12 Danish Energy Authority**

The Danish Energy Authority (DEA) has launched several campaigns to introduce energy management practices to industry. By the end of 2001, more than 400 companies that account for 60% of energy consumption in trade and industry had implemented energy management. The DEA have used a number of methods to encourage companies including voluntary agreements, subsidies and information campaigns. Energy intensive companies can get a tax rebate on Denmark's green taxes by implementing energy management systems. A number of local dialogue networks, among companies involved with energy management, have been formed around the

country to provide support and learn from sharing experiences. Presently, it is mainly energy-intensive companies that implement energy management. The objective is to gradually involve more companies in the schemes (DEA 2002a). Denmark opted for legislation to promote energy efficiency when in May 2000 an Act was passed on the promotion of savings in energy consumption (Folketing 2000). The objective was to “promote energy savings by consumers in accordance with environmental and economic considerations with a view to contributing to the fulfilment of Denmark's international environmental commitments”. Standards are also a main part of the DEA program. For example Dansk Standard DS/INF 136E on Energy Management was prepared by the Danish standards committee S 365 at the request of the Danish Energy Agency (DS136 2001). The success of developing cross-sectoral networks in Denmark influenced the approach taken in this work.

### **2.2.13 Irish Energy Policy**

Over the past two decades Ireland's energy policy as a member of the EU and International Energy Agency (IEA) has been driven by three primary objectives:

- Security of supply
- Environmental protection
- Cost competitiveness

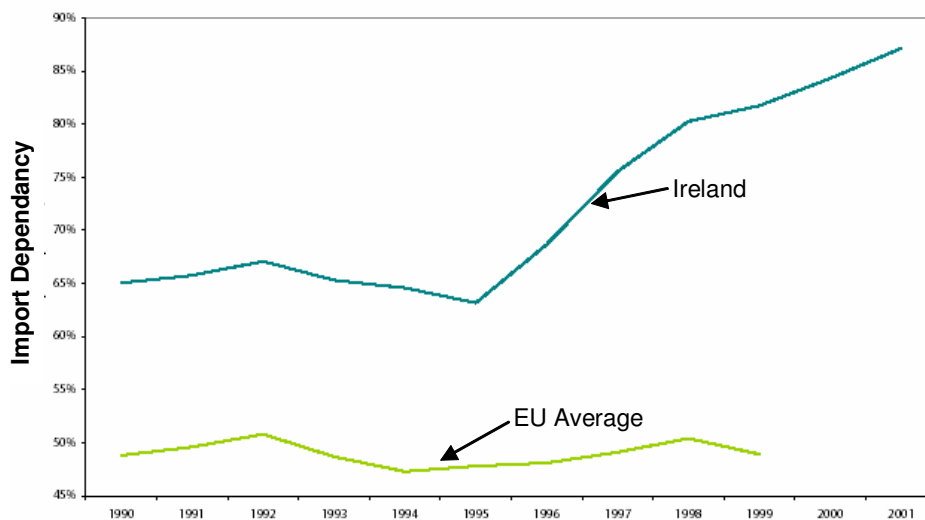
The Irish Green Paper on sustainable energy (DPE 1999) outlined policies that Ireland must implement to meet its energy requirements in an environmentally and economically sustainable way. These policies were designed to meet forecasted economic growth and security of supply objectives. The Green Paper proposed focused measures targeted at various consumer sectors. These actions were designed to enhance energy awareness, expertise and practice. Priority was given to energy management practices in industry, the services sector and the public sector.

Milestones in the development of Irish Energy policy include:

- Kyoto targets (1997)
- Irish Green Paper (1999)
- National Climate Change Strategy (2000)
- Irish Energy Centre (IEC) becomes Sustainable Energy Ireland (SEI) in May 2002

### 2.2.13.1 Irish Energy Requirements

From 1990 to 2001, consumption of energy in Ireland grew by 57%, driven by an average annual economic growth (GDP) of 7.3%. By 2001 energy production and consumption accounted for 66% of GHG emissions – up from 57% in 1990. This was in a period when the energy intensity of the economy (amount of energy used per unit of activity) fell by 26.4% due to structural changes. For example, manufacturing industry became less energy consuming due to the growth in the ICT (information and communications technology) sector. Figure 9 shows the scale of the Irish import dependency which grew from 65% to 87% in the same period in contrast to the EU average which has remained around 50% (Howley *et al.* 2003).



**Fig.9:** Import dependency – Ireland v EU average (Howley *et al.* 2003)

Forecasts are that final energy consumption will continue to grow by 32% in the period 2000 to 2010. The largest percentage growth is predicted to be in the transport sector at 41% which will account for 38% of total energy consumption at that time. Commercial sector energy requirements are forecasted to grow by 37%, Residential by 30% and Industry by 16%. Figures for the Agricultural sector indicate a 38% growth but this sector will only account for 3.3% of total consumption. Total Final Consumption (TFC) is the energy used by the final consuming sectors above and excludes energy used to transform primary sources such as oil into electricity. This loss is known as “energy overhead”. In 1990 Irish oil consumption was approximately 3.5 million

tonnes growing to 9 million tonnes in 2004 with a forecasted requirement of approximately 13 million tonnes by 2010. Oil consumption has grown by 1.8% for every 1% growth in gross domestic product (GDP), which is three times the EU average (O'Neill 2004).

Based on UK research, the estimated cost saving potential of implementing energy efficiency is approximately 30% of final energy demand (PIU 2002), with the introduction of “no cost” and “low cost” energy efficiency measures resulting in energy savings of up to 15% (Action Energy 2003; Nifes 2003). In 2002, over €7 billion was spent by Ireland on energy (SEI 2002). As indicated in figure 1, the savings to the Irish economy from a ubiquitous implementation of energy efficiency would result in a very significant saving of €1.05 billion. Again this is one of the key drivers behind this projects and one of the reasons the research has been followed with interest by Enterprise Ireland (EI) and financially supported by SEI.

### ***2.2.13.2 Irish Green Paper on Sustainable Energy (1999)***

This Green Paper on Sustainable Energy addresses the issues of how Ireland will progress towards meeting its energy requirements in an environmentally and economically sustainable way in the context of forecast economic growth and security of supply objectives (DPE 1999). The success of the Irish economy in the 1990s resulted in an increase in energy demand and to the rise in associated greenhouse gas emissions (Howley *et al.* 2003). The Green Paper states that environmental policy and the Kyoto Protocol commitments demand early action to place Ireland's energy requirements on a more sustainable track. A study by the London School of Economics suggested that that this country could achieve substantial reductions in energy use for a modest cost in proportion of the total output of the economy provided that energy efficiency measures are implemented cost-effectively (LSE 1999). The Paper goes on to assume that most of the energy related CO<sub>2</sub> reductions will result from consumption reductions by the various energy consumers including small consumers, industrial and large consumers, the transport sector and the power sector.

### 2.2.13.3 Ireland's CO<sub>2</sub> emissions

Figure 10 has been extracted from the National Climate Change Strategy (NCCS 2000) and presents the Kyoto challenge for Ireland. It shows that the Kyoto target for Ireland translates into a reduction in CO<sub>2</sub> emissions of approximately 15 Mega-tonnes (MT). Two thirds of this target is to be met by measures affecting energy production, supply or use. The concept of tonnes of carbon dioxide is not within the experience of most people and is explained by the author in Appendix J. Ireland reached the EU agreed limit in the year 1997 – less than the halfway point between 1990 and the Kyoto commitment period (Howley *et al.* 2003).

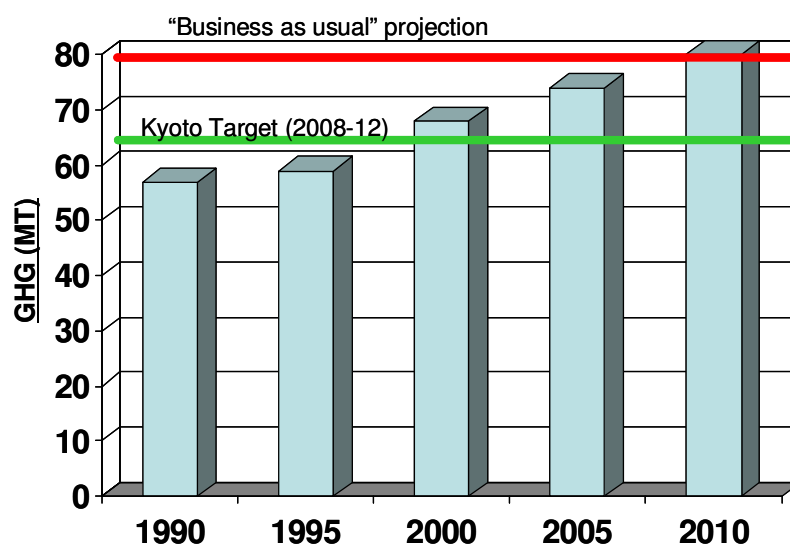


Fig.10: Ireland's GHG Profile (NCCS 2000)

Understandably, this is a major concern for policy makers. In his foreword to the National Climate Change Strategy, Minister Noel Dempsey stated, “business as usual is no longer an option for Ireland”. He emphasised that there is a need to make changes right across the economy and society: “to the way we work and in attitudes and awareness” (NCCS 2000). The present situation (EPA 2003; Howley *et al.* 2003) regarding CO<sub>2</sub> emissions in Ireland can be summarised as follows:

- The target for the period 2008 –2012 was breached in 1997.
- By 2001, annual GHG emissions were 20% above 1990 levels.
- Projections are that emissions levels will rise to 37% if the country continues on a ‘business as usual’ path.

- Emissions per capita are 18 tonnes per annum. The EU average is 10 tonnes while the average in the developing world is 2 tonnes per capita.
- Ireland's per capita emissions is fifth largest in the world after Australia, US, Canada and New Zealand.
- As indicated in figure 11, Ireland's distance to target (DTI) was the second worst in the EU in 2000. Only Spain was further from the target.
- Ireland will be liable for fines or penalties if the Kyoto targets are not achieved (McDonald 2003). The potential recurring cost to the exchequer could amount up to €240 million per annum, over the period 2008-2012, depending on the market price of CO<sub>2</sub> (EPSSU 2003).
- The most significant area of growth is in energy related emissions in particular since 1995.
- It is also anticipated that stronger targets will be agreed for the post Kyoto period.

The Environmental Protection Agency report (EPA 2002) reiterates that a high priority needs to be given to energy conservation and to the further development of renewable resources. On a positive note the report states that the increases in energy consumption and greenhouse gas emissions from the industrial sector have been at much lower rates than the increases in production levels. This is attributable to structural shifts in the industrial sector due to the relatively low energy consumption of the Software and ICT sectors. The targets for cutting CO<sub>2</sub> emissions are outlined in the National Climate Change Strategy. Industry, Commercial and Services Sector have been set a target of 2.175 Mt (Howley *et al.* 2003) from a total target of 15.4 Mt.

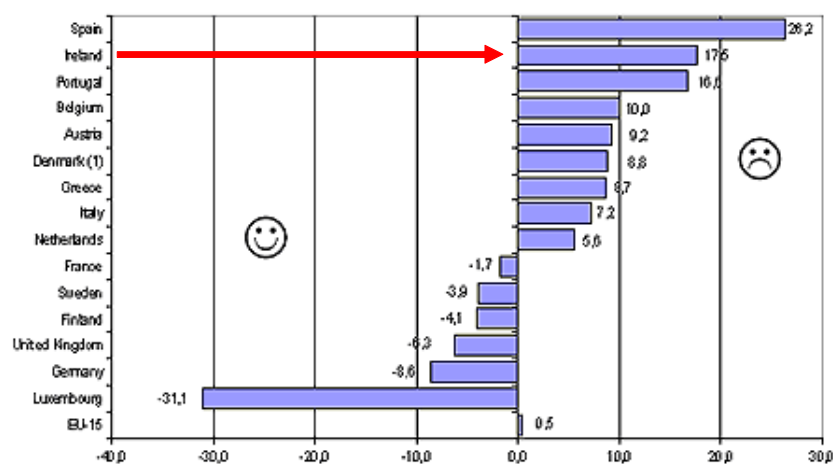


Fig.11: Distance-to-target (DTI) for EU Member States (Murray 2003)

### 2.2.13.4 CO<sub>2</sub> emissions in Galway Region

The local situation in Galway is shown in figure 12 presented by the Galway Energy Agency Limited (GEAL) climate change strategy (GEAL 2001). It shows that the growth in emissions significantly exceed even the national figures.

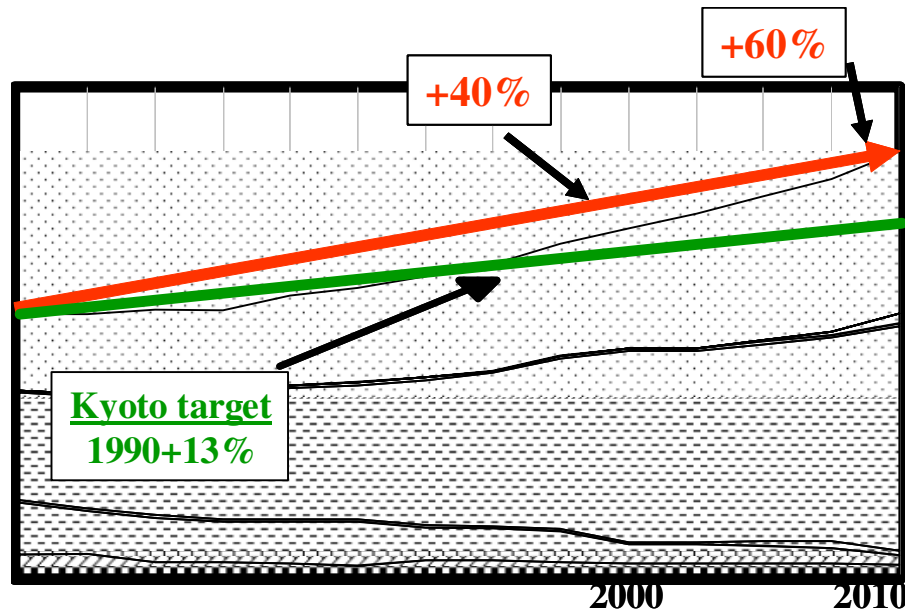


Fig.12: Galway CO<sub>2</sub> emissions (GEAL 2001)

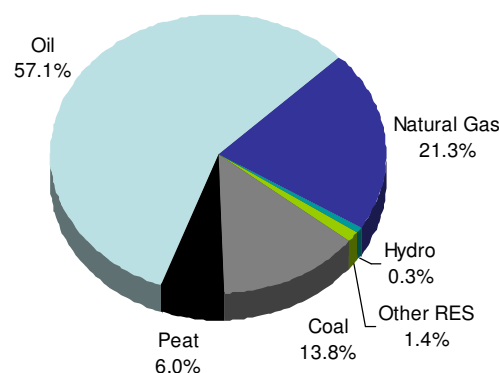
The report estimates that a reduction of 3.42 tonnes of CO<sub>2</sub> per person is required in the Galway area to help meet the national Kyoto targets. This approximately translates into a 35% reduction from 2001 levels. The report states that energy consumption in Galway is growing at an “alarming rate”. Transport energy consumption grew by 89% in the period 1990-1999, while the figures for Industry (+36%) and Commercial (+23%) can be attributed to strong economic growth in the area. Residential energy consumption actually decreased in this period (-5.3%) attributed to a switch from inefficient solid fuel and to public awareness campaigns managed locally by GEAL and via national television by SEI.

### 2.2.13.5 Electricity Deregulation

Electricity deregulation is driven by the EU directive 96/92/EU. The Department of Public Enterprise has responsibility for implementation of the directive. The Electricity Regulation Bill, 1998 set up the Commission for Electricity Regulation (CER) to open the electricity market to competition (CER 2004). As a result the provision of new generating capacity is not the sole function of the Electricity Supply Board (ESB). Major new projects coming on line include the power station developed by the Northern Ireland Viridan group and the new peat powered station contracted to the Finish IVO group.

### 2.2.13.6 Renewable Energy Sources (RES)

The current state of development of the Renewable Energy Sources in Ireland makes it difficult to compete with traditional electricity generation methods. The Alternative Energy Requirement (AER) programme was set up with the objective of increasing the amount of electricity generated from renewable sources to 10% of total capacity. Ireland has one of the best wind energy resources in Europe. Hydro production as a percentage of TPER (total primary energy requirement) decreased in the period from 1990 to 2001 from 0.62% to 0.32%. Other RES such as wind, biomass, and biogas have increased in absolute terms by 89.4% since 1990 but this only translates into an increase from 1.16% to 1.41% of TPER in the same period. Most of this increase was biomass used for domestic heating. Figure 13 shows the contribution of each energy source to energy supply in 2001.



**Fig.13:** Contribution of different fuel sources to Irish energy supply (Howley *et al.* 2003)



### **2.2.13.7 Economic Instruments**

Economic instruments comprise a variety of measures, which use market processes to achieve objectives. These include measures to change prices of goods or services, and the development of markets (in carbon or greenhouse gas emissions) where they do not currently exist (NCCS 2000). Proposed measures to Control Emissions in the period 2003 to 2008 include:

- Energy taxes
- Negotiated agreements
- Emissions Trading
- Tax exemptions for using Renewable Energy Sources (RES)

In the 2003 Budget, the Minister for Finance announced the Government's intention to introduce a carbon tax from the end of 2004 (McDonald 2003). The Irish Green Paper (DPE 1999) on sustainable energy recognises that implementation of economic instruments must be carried out within the framework of the National Partnership Framework (NCCP 2004). It also warns that the real challenge is to position the economy for any post-Kyoto agreement, which is forecasted to be more stringent. FitzGerald (2000) of the Economic and Social Research Institute (ESRI) argues that fiscal instruments must be used to change behaviour. He advocates that the best mechanism for reducing emissions is by means of a carbon tax with a free trade in quotas on a world level being the next best arrangement. The ESRI report on "Barrier to Energy Efficiency" (O'Malley *et al.* 2003) concludes that economic instruments can address access to capital and hidden cost issues and also overcome the barriers associated with values and organisational culture.

### **2.2.13.8 Carbon Taxes**

Minister for Finance, Mr Charlie McCreevey, committed in Budget 2003 to introducing a general carbon tax from the end of 2004. It is likely that the tax will be based on the carbon content of each fuel rather than a flat energy tax (Cullen 2003). The Irish Business and Employers Confederation (IBEC 2002) stated in their Pre-Budget Submission that they were "fundamentally opposed to energy taxation (i.e. climate change carbon taxes)". It is also concerned about the effects of the EU emissions Trading Directive (IBEC 2002). A study commissioned by IBEC concluded

that all the energy tax options that were analysed would have competitiveness implications for a strategically important group of sectors. Also emissions would only be marginally affected both relative to the total national level of emissions and relative to the costs expended (IBEC 2000). Enterprise Ireland (EI) believes that a carbon tax will place significant pressure on the competitiveness of the SME sector while achieving minimal reduction emissions. EI considers that a policy mix of market and project-based mechanisms would prove to be more effective (O'Malley 2003). The tax strategy group set up by the Department of Finance to examine the implications for tax policy of any specific tax proposals concluded that it is clear that there are a number of quite divergent points of view on the idea of introducing a carbon tax (Dept\_Finance 2002).

### **2.2.13.9 Emissions Trading**

“Emissions trading” is a scheme whereby companies are allocated allowances for their emissions of greenhouse gases as specified by their government. These allowances can then be traded with each other. These emission allowances are also known as “quotas”, “permits” or “caps”. Under the scheme, companies can exceed their allowance provided that they can find another company or companies that are in a position to trade unused allowances. Advantages are that both companies accrue lower compliance costs and result in competition to reduce emissions cost-effectively and to use environmentally friendly technologies. In this scenario, it is important that energy taxes and emissions trading should be designed in such a way that they act as a complementary way to cover the totality of emissions.

Expected European market price of CO<sub>2</sub> emissions rights is forecasted to be in the range of €15 to €30 per tonne and settling a about €25 per tonne by 2008 in one study (De Leyva and Lekander 2003). According to Pat Swords, the EC Emission Trading Directive has finally given teeth to the Kyoto Protocol (Swords 2003) and forecasts that a tonne of carbon dioxide will trade at €7 to €10 after 2005. Parish (2003) assumed a cost of €17.50 per tonne of CO<sub>2</sub> as the full level of tax payable by firms not participating in negotiated agreements (Parish 2003) while the Department of Finance is proposing an initial tax of €7.50 /tCO<sub>2</sub> rising in time to €20 /tCO<sub>2</sub> . The European Commission directive on emissions trading excludes SME to avoid the costs of monitoring and reporting on enterprises that do not have a significant level of

emissions (Commission 2003). The directive established a Community scheme for greenhouse gas allowance trading in order to promote reduction in GHG in a economically efficient way. Emissions trading (De Leyva and Lekander 2003) has been tested in a number of schemes for managing scarce environmental resources e.g. :

- reducing sulphur dioxide (SO<sub>2</sub>) emissions from US coal plants
- managing blue-fin tuna stocks in the South Pacific,
- reducing CO<sub>2</sub> emissions in Danish power plants
- promoting renewable energy technologies in the United Kingdom and Italy,
- reducing CO<sub>2</sub> emissions in the plants of BP and Royal Dutch/Shell, companies in which business units trade their emissions rights

#### ***2.2.13.9.1 Negotiated Agreements***

SEI began a pilot programme involving twenty six companies to develop and test a framework of negotiated agreements suitable for Ireland (Parish 2003). The National Climate Change Strategy (NCCS) envisaged negotiated agreement to be one of a number of economic instruments that included carbon taxes and emissions trading. The notional framework of the negotiated agreement, assumes a method of compliance (carbon tax on fossil fuel energy sources) with firms committing to a set of:

- Specific energy investment actions
- Energy Management improvement measures
- Overall efficiency benchmarks.

The overall goal is to reduce CO<sub>2</sub> emissions due to energy use in the firm as there is considerable potential for emissions and cost reductions in the industrial sector through improved energy efficiency. It adopted an 80% rebate to firms complying with the agreement. A carbon tax level of €17.50 per tonne of CO<sub>2</sub> was assumed as the full level of tax payable by firms not participating in the negotiated agreement.

Analysis of the Swedish experience of introducing voluntary agreements concluded that the communication, planning and implementation sequences and steps had been neglected to the detriment of the program (Lindén and Carlsson-Kanyama 2002).

### 2.2.14 SEI - Sustainable Energy Ireland

Among the major proposals of the Irish Green Paper was the proposal to strengthen the Irish Energy Centre by providing €37 million of funding. It also recommended that the IEC be established as a separate statutory body which came about in May 2002 when the IEC became Sustainable Energy Ireland (SEI). The mission given to SEI is to promote and assist the development of sustainable energy. The mandate covers the environmentally and economically sustainable production, supply and use of energy, in support of Government policy, across all sectors of the economy. The Organisation is tasked with implementation of many major recommendations of the Irish Green Paper (DPE 1999) and the National Climate Change Strategy (NCCS 2000). Programmes developed by SEI to meet these objectives include:

- Deployment of advanced energy technologies
- Awareness, information, advice and publicity on best practice
- Stimulating research, development and demonstration (RD&D)
- Preparation of necessary standards and codes
- Publishing statistics through its Energy Policy Statistical Support Unit
- Advising government on policy development and implementation

The profile of Irish energy users is shown in figure 14. This thesis concerns itself with the SME++ sector which currently has little support except for a number of booklets aimed at this area (SEI 2004).

- The Large Industry Energy Network (LIEN) is a voluntary network operated by Sustainable energy Ireland (SEI) for the largest industrial energy users in Ireland. The objective of the LIEN is to develop role model companies in the area of energy management for their own competitiveness, for Ireland's economy and for the environment. These organisations typically have full-time Energy Management professionals as a member of staff. Cost of energy is significant part of operational financial management. This programme has approximately eighty major Irish companies who participate in energy reduction initiatives.

- SME++ is a term coined by the author to cover industrial firms outside the LIEN and small and medium sized organisations that typically do not have staff members with energy management expertise or training. This sector includes Small and Medium sized Enterprises (SME), tertiary services organisations and public sector organisations. In most of these organisations, energy costs are not a significant part of operational costs but the combined consumption of these organisations is 31% of TPER for Ireland (figure 14). There are approximately 150,000 SME in Ireland. Because of the large number of these organisations, the cumulative affect of their energy usage will have a considerable influence on the success of Irish Energy policy. SEI accepts that the motivation and support for this sector provides a considerable challenge.
- The third section is made up of Transport, Agriculture and Residential consumers. Residential consumers account for approximately one quarter of energy use in Ireland and are addressed by SEI through media campaigns and events such as the annual Energy Awareness Week. The campaign of Energy Awareness Week in 1999 achieved a reduction in CO<sub>2</sub> emissions of 17,000 tonnes per annum (Taylor 2000).

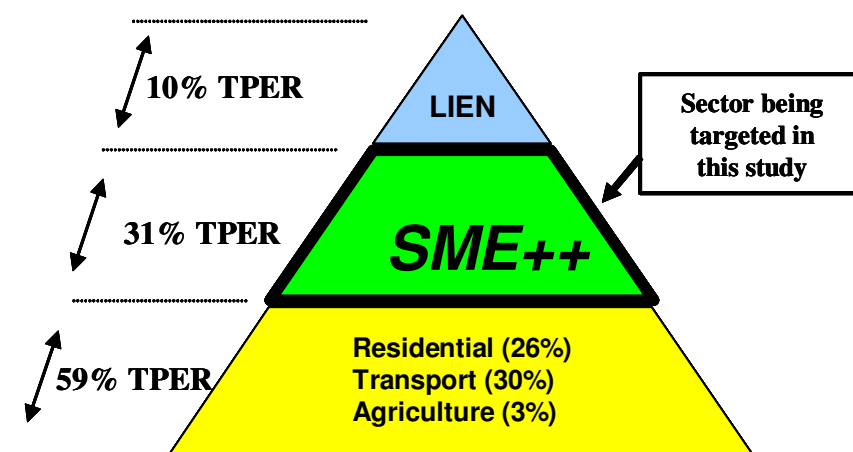


Fig.14: Profile of Energy users

## **2.3 Policy Barriers**

At a national level there is concern that Kyoto has not got the attention it deserves because of the long timescale and a general uncertainty of the consequences of not meeting the agreed targets (FitzGerald 2000). This section reviews the literature related to the barriers that oppose the implementation of energy policy, particularly in small and medium sized organisations.

### **2.3.1 Energy Costs**

Europe's plan to control greenhouse gases is forecasted (De Leyva and Lekander 2003) to result in higher energy prices for both consumers and businesses and up to 40% increase in wholesale electricity prices. The result will greatly accelerate the shift from coal to gas as the primary fuel used in power plants since gas contains a lower level of carbon. In addition, modern gas plants are more efficient. In general, rising energy costs however are reawakening interest in energy management (Norland 2001).

### **2.3.2 Research on Energy Policy Barriers**

A major research project on implementation of energy efficiency in industrial, commercial and service sector organisations was funded by the European Commission in 1998 (InterSEE 1998). The study was undertaken within the socio-economic research area of the JOULE programme. The methodology consisted of case studies of successful SME implementation of energy efficiency as well as supporting policy programmes. The result was a number of recommendations aimed to improve energy efficiency of SME within the target sectors. The report stresses the importance of activities to promote and increase energy efficiency if Europe is to meet its Kyoto Protocol targets. Significant reductions in energy consumption and associated GHG emissions are achievable because:

- a wide range of energy efficiency technologies is readily available but not exploited.
- a large potential of cost-effective measures is still untapped due to a variety of barriers.
- increases in energy efficiency result in higher competitiveness.

Most “mainstream” energy programs presently concentrate on barrier identification and removal while InterSEE approaches the problem from a socio-economic point of view by focusing on empirical investigation of SME success stories. The project looked at the problem from an economic, psychological, behavioural and technical perspective with the following aims:

- to provide insight into the underlying internal and social change process of efficiency measures (a better understanding);
- to formulate policy implications related to crucial determinants, interdependencies and patterns of implementation processes (a new philosophy);
- to derive recommendations for the design of policy instruments and appropriate mixes including socio-economic marketing and market transformation strategies (a new strategy).

Energy services are defined as “integrated and comprehensive solutions, combining advanced energy technologies and necessary services (e.g. energy audits, management schemes, financing) in order to serve the customer's need for warm/cold buildings, process heat, power, communication, illumination, etc”. The InterSEE study took the following assertions as a normative starting point:

- successful realisation of energy efficiency is the result of consecutive operational decisions and actions forming an ongoing process in time rather than the result of an isolated and instantaneous event
- enterprises are seen as a social system rather than an individual agent.

The research analysed positive example of success of implementation programs in SME and concluded that the conditions for development of an “energy efficiency culture” starts with simple measures.

In the Irish Context, a policy research project by the Economic and Social Research Institute (ESRI) examined a range of barriers to energy efficiency by using case studies from the Mechanical Engineering, Brewing and Higher Education Sectors (O'Malley *et al.* 2003). The report concluded that there are many “cost-effective” energy efficiency opportunities in the organisations that were studied. Barriers to implementation included financial and organisational. The limited access to capital was strongly felt in all sectors as well as the hidden cost associated with time

constraint on staff that has many additional and higher priority responsibilities than energy. The report suggests that in the area of policy intervention there is ample scope for government to “help individuals and organisations to help themselves”. Measures such as industry specific or technology specific information programmes in a user friendly format are among suggested policy measures. Barriers and misconceptions to the introduction of energy efficiency in organisation outlined by Action Energy Management (GPG200 2001) is shown in table 4.

**Table 4:** Common barriers and misconceptions to the implementation of energy efficiency (GPG 200)

The effort of the individual will make no difference
There is no clear responsibility or accountability
The return does not justify the effort
Middle management is overloaded and fails to act on senior level commitment
Management has more important issues to address
The subject is technical and peripheral to the business
Energy efficiency is discretionary
The organisation lacks the necessary technical skills
Energy and environmental investments are high risk
The organisation has no money to invest
Nobody thinks it's an issue
There is no opportunity for staff involvement
We don't have the time and resources
There is no workable policy
Issues are not reported effectively
There is no competitive edge to be gained
Staff are apathetic towards energy and environmental issues
Targets for saving are unrealistic or unrelated to business needs
There is no value for the individual
There is a lack of appreciation of contribution to bottom line among financial management
Senior management only pay lip service



## 2.4 Educational sector

Education is one of the most effective ways to change human behaviour to a “rational use of energy”. The education process is the instrument to reach the entire population and enlighten them on the necessity for energy conservation (Dias *et al.* 2004). There is large potential for saving in energy efficiency in the Higher Education Sector. However barriers to improvement include lack of organisational motivation, lack of framework for borrowing, high VAT (value added tax) rate on purchase of energy efficiency services and poor energy performance of buildings (O'Malley *et al.* 2003). The public sector when considered as a single entity is the biggest user of energy in the country with an annual expenditure of approximately €180 million (Edwards 2004). The Irish Energy Centre calculated the energy bill of Irish Higher Education Institutions in 1998 at approximately €8 million (O'Malley *et al.* 2003). Some of the barriers facing this sector are being addressed by Sustainable Energy Ireland (SEI) by the establishment of a University Energy Management Bureau, "e3", bringing together four of Ireland's largest third level institutions, in an effort to reduce their annual energy consumption (BizWorld 2004). With regard to teaching and dissemination of information, the Higher Education and Training Awards Council (HETAC) issued guidelines for the higher education sector to support Irish and EU policies in the area of energy and environmental performance (HETAC 2000). These guidelines are a response to the Irish Green Paper proposal that the “non-commercial public sector will adopt energy efficiency targets, practices and procurement policies which will give leadership to the rest of the community by setting an example of best practice”. The HETAC document identifies the role of the higher education sector as being crucial to the success of these policies:

- At the level of curriculum and course development.
- In terms of institutions improving their own environmental performance.

The Rational Use of Energy (RUE) project undertaken in the Galway-Mayo Institute of Technology, described by the case study in chapter five, directly addressed the second point. The outcomes can now be disseminated to future generations of students by integrating the results into the curriculum to meet the first objective.

### 2.4.1 Educational Sector Obligations

The following are a number of extracts from the Irish Green Paper that outline obligations and implications for educational organisations:

- Non-commercial public sector will adopt energy efficiency targets, practices and procurement policies which will give leadership to the rest of the community by setting an example of best practice
- A strong emphasis to be placed on accountability of public bodies which in practice will require explicit targets and measurement of performance
- The application of the public service obligation provisions of the Electricity Regulation Act, 1999 for the purchase of electricity generated from renewable sources linked to AER or similar competitions
- A revitalised approach to the promotion of research into the development of renewable sources of energy
- An obligation to include energy efficiency and CO<sub>2</sub> in Annual Reports

Again the case study in chapter five responds addresses many of these issues.

### 2.4.2 Educational Energy Initiatives

The Energy Management study in the Higher Education Sector: National Report 1996 for the higher Education Funding Councils for England, Scotland and Wales and Department of Education Northern Ireland deals with energy management in higher education organisations. The report concentrates on implementation of projects at a training and operations level. It does not propose a model that would also assist organisational change. The Chairman of the Steering group, Professor Tom Husband, stated that the “*principal message of the study is that energy is a management concern and not just a technical issue: a structured and co-ordinated approach to energy management can give rise to real cost savings, year on year*”.

In 2000/2001, the TEACH Project (Training pupils for Energy Analysis in School buildings) was undertaken to promote an energy analysis methodology shared by pupils of European school buildings. Dr Gerry Wardell of CODEMA (The City of Dublin Energy Management Agency) was the Irish co-ordinator of the project.

European Partners for this project included representatives from Austria, Ireland and three locations in Italy. The project produced a multi-language training CD designed for analysis of school buildings.

Ciarán Lynch, Director of Rural Development, Tipperary Institute proposed that “greening” of Higher Level colleges must be approached as a Business management task using for instance a methodology of Goals/Objectives/Actions (Lynch 2001).

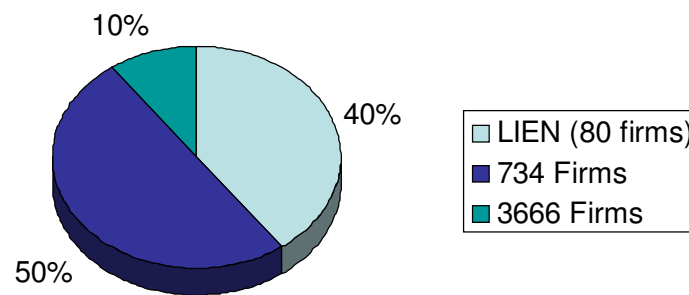
## **2.5 Industrial Sector**

### **2.5.1 Introduction**

The Industrial sector in Ireland spends over €600 million on energy per annum (Taylor 2000), and accounts for almost 60% of GHG emissions. There is considerable potential for emissions and cost reductions in the industrial sector through improved energy efficiency (Parish 2003). Environmental and energy policies have resulted in a number of pressures on businesses in terms of legislation, standards and market pressures. These environmental pressures together with those of quality and safety are now significant issues that companies must face from customers and legislators (Goggin 1998). Examples of such legislation are WEEE (waste electrical and electronic equipment) and ELV (end-of life vehicle) directives. Donnellan proposes an integrated model, based on management practices, to meet the requirements of total Quality, Safety and Environment (QSE) in order to meet a problem facing today’s businesses due to pressures from customers and legislators. This model also responds to businesses desire to reduce duplication of resources (Donnellan 2001).

### 2.5.2 Large Industry

The distribution of energy use in the industrial sector is very uneven as is shown in figure 15. Of the approximately 4,500 firms in this area, 814 (or 18%) account for 90% of total industrial energy consumption which is 24,732,302 MWh (Parish 2003). Breaking this down further, 734 firms account for 50% of industrial energy consumption. This significant section of the large industrial users is not supported at the moment and is one of the main sectors addressed by this thesis. Sustainable Energy Ireland (SEI) through the Large Industry Energy Network (LIEN) supports the remaining eighty largest industrial energy users. These companies account for 40% of the total Irish industrial demand.

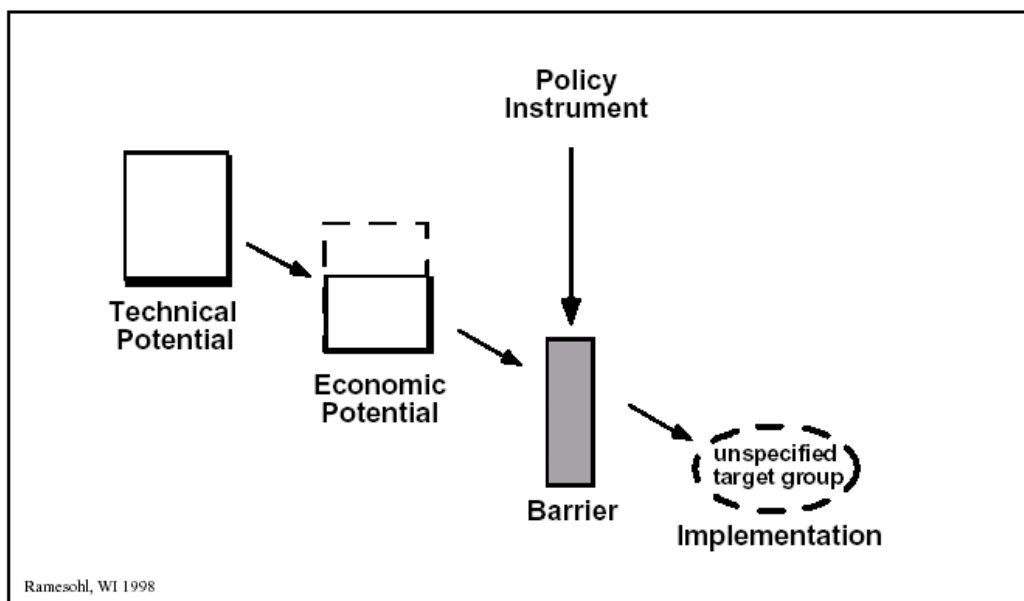


**Fig.15:** Distribution of Industrial energy use (EPSSU 2003)

The Industrial sector accounts for 24.1% of the total primary energy requirement in Ireland and 25% of energy related CO<sub>2</sub> emissions which amounted to 10.2 Mt CO<sub>2</sub> in 2001 (EPSSU 2003). In this sector alone, this research addresses 60% of industrial energy use, which translates into 14% of Ireland's total primary energy requirement (TPER).

### 2.5.3 Small and Medium-sized Enterprises (SME)

There is large scope for energy efficiency in SME (PIU 2002). However, the task of implementing energy efficiency across this sector poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity. A “less energy intensive” sector is defined where, on average, energy costs represent approximately 1-3% of turnover (InterSEE 1998). However, it must be remembered that these costs can be a much larger percentage of profits. As a result “motivation campaigns based on economic arguments and improved economic incentives (e.g. by an ecological tax reform) are helpful, but insufficient to trigger energy saving measures”. Figure 16 shows the traditional view of energy efficiency as the result of a strictly economic decision making process. This model is a far too linear and static view of this sector as company culture is a more significant factor governing the implementation of energy efficiency than pure economic decision making (InterSEE 1998).



**Fig.16:** Traditional understanding of barrier related energy policy (InterSEE 1998)

In Ireland, small and medium sized enterprises (SME) are now being urged to become more involved in reducing the national energy bill and resulting greenhouse gas emissions. The estimated 150,000 SMEs in the business sector have the potential to make a very significant impact (Taylor 2000). The UK Performance and Innovation Unit

(PIU 2002) proposes the provision of “advice centres” for SME for resource productivity strategy for small business that includes energy efficiency. The EU action plan aimed at the promotion of energy efficiency (EC 2000a) prioritises removing the institutional barrier resulting from the continued practice of selling energy in the form of kWh instead of efficient heating and cooling, lighting and motive power which are the services actually required the consumer. The plan highlights the emerging market for bundling SME energy services based on actual end-user requirements. The report states that the “use of information technology in providing energy and energy-related services will be a priority area”. Networks and associations are suggested as a way to disseminate energy efficient and environmentally sound technologies (E<sup>3</sup>ST) in small and medium scale industries (Thiruchelvam *et al.* 2004). This research takes up this theme by building a prototype web-based collaborative energy network and by exploring the use of the internet to provide energy services with an energy management consultant.

#### **2.5.4 Enterprise Ireland – [envirocentre.ie](http://envirocentre.ie)**

Enterprise Ireland has established an environmental e-business initiative to support industry in the area of environmental obligations (Costello and Lohan 2004). The website (EI 2004) is designed to provide an on-line guide to sustainable environmental practices against a backdrop where legislation and marketplace demand is bringing environmental issues to the fore in business management. The resource is primarily intended for the small and medium sized industry sector. The incentive for SME to become eco-efficient and implementing environmental best practice is outlined as follows:

- Competitive advantage of environmentally superior products
- Reduction in costs and increase productivity from becoming eco-efficient
- International compliance will enhance trade opportunities

The Management of [envirocentre.ie](http://envirocentre.ie) see energy as an integral part of sustainable energy practices and require a web resource to support the implementation of energy efficient methods in SME. This was discussed with the author at a number of meetings and the collaborative energy network developed in the course of this study was designed to meet this specification.

### 2.5.5 Rational Use of Energy (RUE)

European energy policy has been traditionally separated into two areas: rational use of energy (RUE) on the demand side and increased use of renewable energy on the supply side (RES) (EC 2002). The immediate benefits to business of the rational use of energy include:

- lower energy costs
- immediate savings to the bottom line
- improved competitiveness.

However organisations are increasingly recognising (Action Energy 2003) that greater energy efficiency goes beyond the short term financial gain to incorporate important strategic factors such as:

- business reputation
- carbon emissions management
- environmental responsibility
- risk management

Many organisations see energy as a fixed operating cost and, with the exception of businesses in energy intensive sectors, a relatively low cost, especially when the price of energy has been declining. A company's energy bill is however largely dependent on how a company behaves – it is a variable cost that can be controlled by cutting down on wasteful energy consumption.

In the UK, the Carbon Trust emphasise that energy efficiency is good for business (Carbon Trust 2003) and provides a number of company case studies to support this claim. One example, J. Sainsbury, introduced a carbon management program that resulted in energy consumption rising only 1% at a time of significant business expansion including a 5% increase in total floor area. It is estimated that the energy saving program resulted in a 3% improvement in overall operational efficiency. The research of the London based Performance and Innovation Unit have estimated that cost effective potential for energy efficiency is approximately 30% of final energy demand (PIU 2002). In Sweden, the biggest share of government energy RD&D (research, development and demonstration) programmes was allocated to the area of energy efficiency at about 47% (SNEA 2001). This contrasted to the RD&D share in other countries e.g. US (17%), Denmark (15%), Germany (7%) and Norway (4%). In

Ireland, Dulleck and Kaufmann (2004) demonstrated the effectiveness of a demand side management (DSM) program that reduced the overall electricity requirement by approximately 7% among Irish consumers. This report recommended the setting up of an independent institution to distribute DSM information but did not address any process to put energy efficiency into practice. The significance for this research is that the study confirmed the potential for energy efficiency in the Irish context and the need for a mechanism to dispense relevant information and training. The estimated savings of successfully implementing energy efficiency throughout the economy has been provided in chapter one.

### **2.5.6 Business Sustainability**

The World Business Council for Sustainable Development (WBCSD) is an organisation made up of almost 200 international companies. They are committed to sustainable development with three objectives: economic growth, ecological balance and social progress (WBCSD 2004) which are also stated as Eco-Efficiency, Innovation and Corporate Social Responsibility (CSR). Members are drawn from more than 35 countries and 20 major industrial sectors and are requested to publicly report on their environmental performance. The growing interest by companies and investors in the area of sustainability is indicated by the establishment of Dow Jones Sustainability Indexes (Dow\_Jones 2004), which aims to create long-term shareholder value by harnessing the market for sustainable products and services. An associated developing business is that of the “carbon market” with related research and consultancy services being provided by companies (Point\_Carbon 2004). An example of the growing “marketability” of energy efficiency can be seen in the large-scale media campaigns been undertaken by ESSO to demonstrate its corporate responsibility by a commitment to energy conservation and emissions reductions (ESSO 2004).



## 2.6 Ethical Issues

A number of writers contend that the extent of environmental challenges facing humankind clearly transcend the capacities of science and technology to provide technical solutions. Sustainable development is a meta-problem that requires expertise and input from politics and other fields, including culture, philosophy and religion to be solved (Carley and Chrilsie 1998). Wall contends that the present use of resources in society is non-sustainable and is a moral question (Wall 2002). The Brundtland report (Brundtland 1987) states that the response of industry to sustainable development should not only be driven by regulatory compliance but should be part of the social responsibility of an organisation. Burret and McCreight (1999) point out that there is a range of instruments available to influence the attitudes and behaviour of industry towards environmental and ecological issues. At one end of the spectrum there are no ethical judgments required as in the case of “command-and-control” instruments such as taxation or legislation. At the other end, ethics come into decisions such as whether to undertake voluntary agreements and to comply with the norms of self-regulation. In an EU survey of small and medium sized enterprises, “ethical reasons” was given as the main motive for involvement in external community activities (SME 2002). Section two of the Code of Ethics of the Institution of Engineers of Ireland deals with environmental and social obligations of members, and imposes a responsibility on its members to promote the principle and practices of sustainable development. Also, members “shall strive to accomplish objectives of work including maximum reduction in energy usage, waste and pollution”.

As energy is the driving force behind the modern way of life, the European Commission guaranteeing the supply of energy is required to safeguard the future of society (EC 2000b).

In June of 2002, Pope John Paul II and Orthodox Patriarch Bartholomew I of Constantinople signed a historic joint document on the environment (Zenit 2002). The Religion, Science and Environment Commission, created by Bartholomew I, who holds the place of honour among the Orthodox Churches, organized the symposium. The Orthodox patriarch of Constantinople concentrated on the dimension of sacrifice, obscured today by a culture that often harms the protection of the environment. There is an philosophical disagreement between a publication of UNESCO’ s Division of

Philosophy and Ethics (Kim 1999) and the Holy See over some underlying values presented by Yersu Kim. Both support concern for the environment, sustainable development, human rights, respect for minorities, democracy, social justice, health and education for all. However, Kim's New Paradigm proposes to be "a new spirituality that supplants all religions, because the latter have been unable to preserve the ecosystem". This spirituality is embodied in the term Gaia (Greek word for Earth Goddess). The Gaia Hypothesis was developed in the late sixties by James Lovelock (Pickering and Owen 1997). This hypothesis proposes that the Earth is an organism which can self-regulate the conditions to sustain and support life. However, Archbishop Lozano Barragán states that this philosophy becomes a new secular religion where the earth takes the place of God (Barragán 2002). The Holy See proposes the idea of "human ecology" which it bases on the first principle of the Rio declaration that "*Human beings are at the centre of sustainable development concern*" (Holy\_SEE 2002). An individual in the developed world consumes almost 7 tons of oil, while someone in developing countries consumes 10 times less. The U.N. Food and Agriculture Organization [FAO] has stated Western lifestyle should not be exported to developing countries, because they would cause enormous damage to the environment. Many influential and responsible businesses and professional and religious bodies recognise the moral obligations on energy consumers not to be wasteful. This adds support to this study, which aims to provide, am mechanism for organisations to optimise the efficient use of energy.

## 2.7 Conclusions

The literature review undertaken has shown that there is considerable potential for improved energy efficiency and emissions reductions by addressing energy use in small and medium sized organisations. However, this sector is not catered for in the present structures that are in place to implement Irish Energy Policy. Implementation of energy policy in this sector poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity. In order to meet the significant challenge of implementing energy policy, energy efficiency must be addressed through company learning and organisational change. Ethical reasons for efficient use of energy can also be added to the present main policy objectives: security of supply, environmental protection and cost competitiveness.

A summary of the main energy policy drivers outlined in this chapter is as follows:

- The majority of scientific opinion is that manmade greenhouse gas emissions, mainly attributable to energy use, are causing climate change that will cause significant problems for the planet (IPCC 2001).
- Energy Policy implementation is now a significant challenge driven by Kyoto Protocol targets, business competitiveness and security of supply issues (NCCS 2000).
- Ireland has committed to keeping CO<sub>2</sub> emissions at 13% over the 1990 levels under the Kyoto protocol. The country has now a serious challenge given that emissions are currently about 30% over the 1990 levels (Howley *et al.* 2003).
- The country is facing the imposition of carbon taxation and other economic instruments which is a major concern for the business sector (IBEC 2000).
- Ireland has the highest import dependency in Europe which has major long term implications given the predictions that oil reserves will run out by 2050 (Shepherd and Shepherd 1998).
- About 80 companies are working together as part of the Large Industry Energy Network (LIEN) to control energy use and CO<sub>2</sub> emissions. Sustainable energy Ireland (SEI) is convinced that there is considerable potential for improved energy efficiency by targeting the next highest group of industrial energy users which number 734 firms and account for 50% of industrial energy use (EPSSU 2003)

- The SME sector and other public and private organisations that account for approximately 30% of TPER must become more involved to reduce the national energy bill and greenhouse gas emissions. Simple efficiency actions by these sectors can have a very considerable impact but a significant culture change is required in these organisations (Taylor 2000).
- Education and Training is a central to culture change in society (Dias *et al.* 2004).
- In the short term, focusing on the Rational Use of Energy will provide the main impact on reducing energy consumption and CO<sub>2</sub> emissions (Action Energy 2003).
- Energy policy plays a key role in the move to Sustainable Development (IEI 2003).
- Businesses which move towards corporate sustainability will derive significant competitive advantage particularly in an economic downturn especially firms most at risk (the SMEs) (SEI 2004).
- The EU Green Paper on security of energy supply stresses the fundamental importance of influencing demand rather than concentrating solely on energy supply. It states that the growth in demand has to be limited by legislative means, among others (EC 2000b).
- Enterprise Ireland considers that energy is integral to environmental sustainability and wish to include a resource to support SME on the [envirocentre.ie](http://envirocentre.ie). Website (EI 2004).
- Business ethics maintain that environmental concern and the proper use of energy should be part of the social responsibility of an organisation (Brundtland 1987).
- There are ethical considerations for the use and distribution of energy supported by Professional bodies, world religions and some atheistic philosophies (Carley and Chrilsie 1998).

The next chapter investigates a number of different ways to address the problem of implementing energy efficiency in geographically dispersed small and medium sized organisations.

## **Chapter Three: Team-Based Methodologies and Collaborative Virtual Environments**

- 3.1 Introduction
- 3.2 Culture Change
- 3.3 Team Methodologies
- 3.4 Structured Approach to Energy Management
- 3.5 Collaborative Virtual Environments
- 3.6 Energy Training
- 3.7 Conclusions

### **3.1 Introduction**

This chapter addresses the problem of implementing energy efficiency in the target sector: small and medium sized organisations. It reviews the effectiveness of team-based and process methodologies to facilitate the company learning and organisational change required to meet energy policy objectives. Methods of delivery to the large number of geographically dispersed organisations in this sector via World Wide Web environments are also investigated. The objective is to translate ideas from one field of research to another (Sharp 1996). In doing so the author draws on over twenty years of Industrial experience in roles that included developing new processes for new product introduction (NPI), leading process reengineering teams and utilising the World Wide Web in the area of global project teams and e-Business.

## 3.2 Culture Change

The classic definition of culture was proposed by Edward Burnett Tylor in the first paragraph of his *Primitive Culture* (1871): *Culture . . . is that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society* (Britannica 2001). Chapter five of the Action Energy good practice guide “Managing People, managing energy” deals with developing a culture for energy efficiency (GPG235 2001). Best progress is achieved in organisations that encourage and support an energy efficiency culture. The Irish Energy Centre, now SEI, stated that the implementation of Irish energy policy ‘requires significant culture change within an organisation’ (IEC 2001) . At the Irish Energy Show 2002, Paul Reading in a presentation on Auditing Management and Use of Benchmarking advocated that a systems approach to energy management requires an organisation to “encourage culture change” using a change management methodology and a structured approach (Reading 2002). Culture change can be brought about by a range of methods, for instance, education is an important instrument in effecting corporate culture change (Tribus 1998). One of the main findings of the UK Energy Management Study in the Higher Educational Sector (HEFCE 1996) was that raising awareness of the importance of energy efficiency promotes energy conservation. Meanwhile, Donnellan (2001) proposes the following methods to change people’s beliefs, attitudes and behaviours when addressing culture change in an organisation:

- Communication
- Counselling
- Education and Awareness
- Training and Development
- Participation/ Involvement
- Role Models
- Learning Organisation

However the scale of the culture change required moving to a low emissions economy has prompted some researchers to argue that the challenge is to look for ways of bringing about fundamental changes in society. Rotman *et al.* (2001) proposes that transitions and transitions management is a way to approach this. A transition is

defined as a “transformation process in which society changes in a fundamental way over a generation or more”. As far back as 1980, Verhage argued that government must consider energy conservation as a social marketing problem that requires the application of marketing principles (Verhage 1980). Similarly, new approaches are needed where the demand for energy is treated as a social demand that is supported by a network of social institutions (Wilhite *et al.* 2000).

### 3.3 Team Methodologies

Katzenbach and Smith (1993) define teams as “a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable”. Peter Senge, Director of the Center of Organisational Learning at MIT’s Sloan School of Management, describes teams as the fundamental learning units in the modern organisation (Pedler *et al.* 1991). This section will review team methodologies that are being used successfully in the areas of product development, process centred organisations, project management and energy teams.

#### 3.3.1 Product Development Processes

The new product development process developed by Robert G. Cooper has been implemented by more than half the US firms involved in product development (Cooper 2001). The Stage-Gate process (Cooper and Kleinschmidt 1993) was first introduced solely in the area of product portfolio management, but the approach is now being extended to other types of projects and has been introduced into companies in Europe and Japan. Cross-functional teams carry out the most successful implementations.

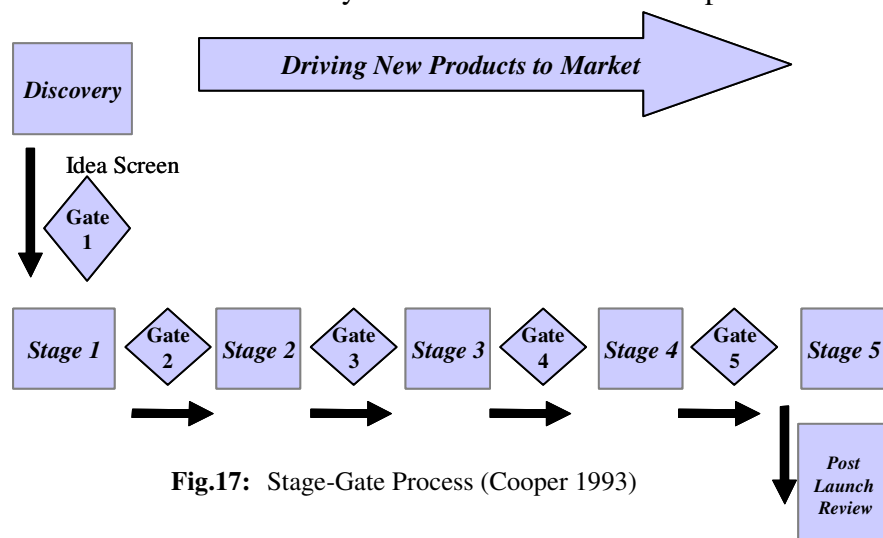


Fig.17: Stage-Gate Process (Cooper 1993)

The field of project management is often regarded as something akin to a stab in the dark, particularly in the area of software development. However there have been a number of structured and systematic approaches applied to running projects (O'Connell 1996) and Watts focuses on the team-based nature of successful software development (Watts 1999).

### **3.3.2 Process Centred Organisations**

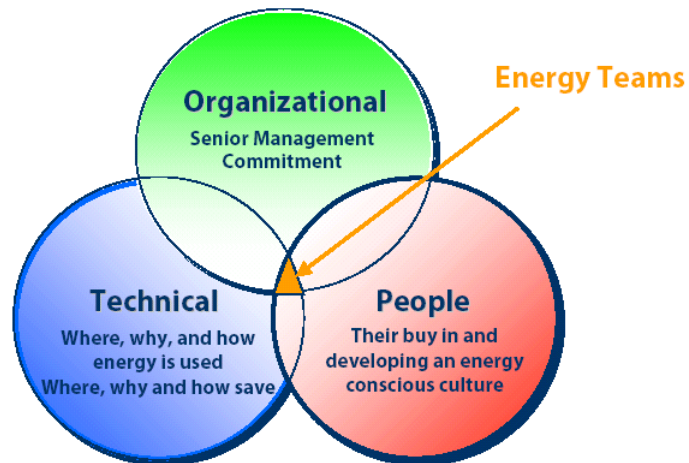
The two best-known business improvement techniques adopted by American companies in the 1990s to meet increasing international competition were TQM (total quality management) and Reengineering. Both of these focused on process. Michael Hammer defines Reengineering as “the radical redesign of business processes for dramatic improvement”. His initial view (Hammer and Champney 1994) was that “radical” was the most important word in the definition but later said that this was wrong and the most important word was “process” (Hammer 1996). Hammer described the most significant change in organisations since the Industrial Revolution was from the “task” based organisation to the process centred organisation. Process reengineering requires improved leverage of people and technology operating within the appropriate structure where the importance of people cannot be overemphasised (Fitzgerald and Murphy 1996). Product development is an example of a process carried out in Industrial and increasingly in Service organisations. Typically, such processes involve teams where the members are drawn from different functional areas. In Norway, the Industrial Energy Efficiency Network (IEEN) successfully applies the methodology of “Business Excellence” to energy management in SME using a “Competence of Action Model” (Helgerud and Mydske 1999).

### **3.3.3 Energy Teams**

The Irish Energy Self-Audit Scheme (now the LIEN) addressed the implementation of energy teams in a Seminar (IEC 2002) which included successful case histories in companies such as Hewlett-Packard (Manufacturing), Masonite, Pfizer Pharmaceuticals and Bristol Myers Squibb. At the Energy Show 2004, the pivotal role of energy teams in bringing together the organisational, technical and people aspects of energy management was highlighted as shown in figure 18 (Ryan 2004).



Utilisation of work groups was found to be one of the best practices used by best-in-class (BIC) companies having a fully integrated energy management process (EMP) (Kaman 2002) and a teamwork approach contributed to significant energy performance improvement in Indian Paper Mills (Newell and Gandhi 2000). The key to the success of an energy program in a plant of the Rom and Haas Chemical Company that resulted in a reduction of 17% in energy consumption and savings of \$15 million per annum was the willingness to work as a team (Fendt 2002) .



**Fig.18:** Role of Energy Teams (Ryan 2004)

### 3.4 Structured Approach to Energy Management

Action Energy Good Practice Guides (GPG119 2001; GPG200 2001) outline a five step structured approach to organising an energy management program. The intent of these guides is to provide guidelines to develop an energy management infrastructure. The Danish Standard (DS136 2001) provides a similar approach to energy management consisting of five stages with each stage including a number of steps. The Sustainable Energy Authority, Victoria module on developing an energy management system uses a comparable methodology (SEAV 2002). The concept of total productive energy management (TPEM) (AL-Homoud 2000) extends the combined approach of total productive maintenance (TPM) and total quality management (TQM) to the area of energy management. TPEM proposes that this will be successful where unified objectives and teamwork exist and employees become responsible for managing energy systems under their control. In this approach, energy management is

approached in a systematic and planned way where the basic principles are presented as good management techniques. Henze models the problem of energy management in the framework of a classical feedback control loop as shown in the figure 19 (Henze 2001).

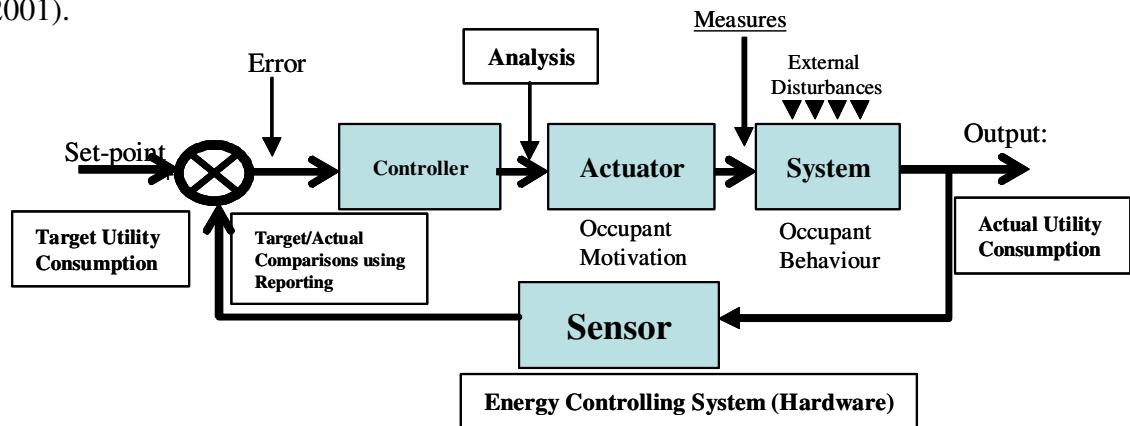


Fig.19: Feedback Control Loop for Reducing Consumption (Henze 2001)

The importance of feedback was incorporated in the process developed during the course of this research. Using the analogy in figure 19, the energy team Sponsor is the comparator that checks if the project results (output) are meeting the actual project objectives (set-point).

### 3.4.1 Partnership Programs

The National Centre for Partnership and Performance (NCPP) was established by the Irish Government to support and drive change in the Irish workplace (NCCP 2004). The mandate of the NCPP is to “enable organisations in the private and public sectors, through partnership, to respond to change, to build capability and to improve performance”. The organisation is tasked with supporting the country’s change to a high value knowledge-based economy. Businesses, public services and workplaces in general are facing into a period of very significant change (Cassells 2002). To bring about the required changes will require a complete remodelling of social partnership in Ireland. To meet the NCCP objectives will need the development of an on-going culture of co-operation and change by means of managers, employers and unions working together. This situation will require a role change from the traditional situation where an employee waited for plans to be “handed down from management” to a situation where the employee now feels empowered to “synthesise views and

suggest changes to management” (O'Connell 2002). Within the NCPP framework, “Partnership IT” under the auspices of the National Partnership Forum, oversees the implementation of the Partnership process in the Institutes of Technology (GMIT 2003).

### 3.5 Collaborative Virtual Environments

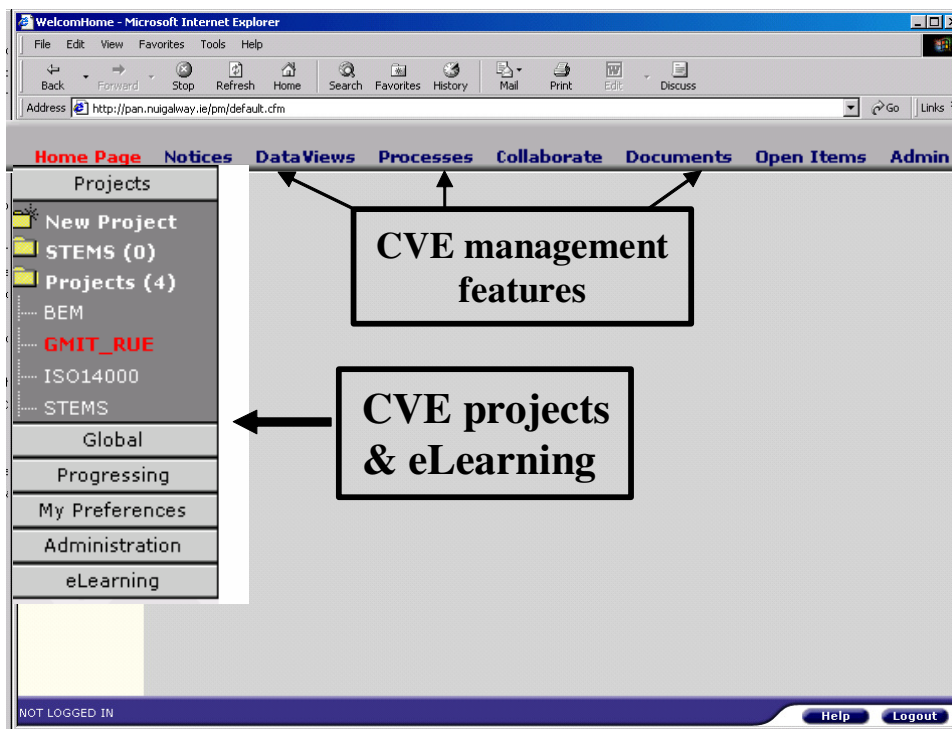
Web-based collaborative virtual environments (CVE) enable the cooperation process among distributed individuals (Chira 2002). This distribution can be:

- Geographical (the users are dispersed in different geographic locations).
- Temporal (the users participate within a distributed environment at different zones of time).
- Functional (the users are structured in clusters defined by specific perceptual, effectual and intellectual capabilities).
- Semantic (the users are structured in clusters defined by specific languages and conceptual realities)

Collaborative virtual environments are now being used by distributed design teams (Borkowski *et al.* 2001) and in concurrent engineering (CE) virtual teams (Pena-Mora *et al.* 2000). The construction industry has a long tradition of collaborative working between the members of a construction project team. Project extranets are currently a “hot topic” within the construction Industry (Kenny 2003). A screen shot of one collaborative software product is shown in the figure 20. The CVE software provides a framework to deal with the scope, quality, risk, communications, and integration of a project. Typical CVE software has features such as:

- Project homepage.
- Linking to project schedule programs such as Open Plan or Microsoft Project to manage schedules and costs.
- Set-up of Process templates and documentation storage and history.
- Collaboration among team members by email, chat, whiteboards.
- E-Learning and web conferencing facilities.

The Project Management Institute defines a project as a “group of tasks or activities to be performed in a definable period to meet a specific set of objectives”. The Advantages of collaborative virtual environments over Web pages is that the software is structured in such as way as a project team can quickly create a secure space and use process and workflow templates without the need for bespoke development.

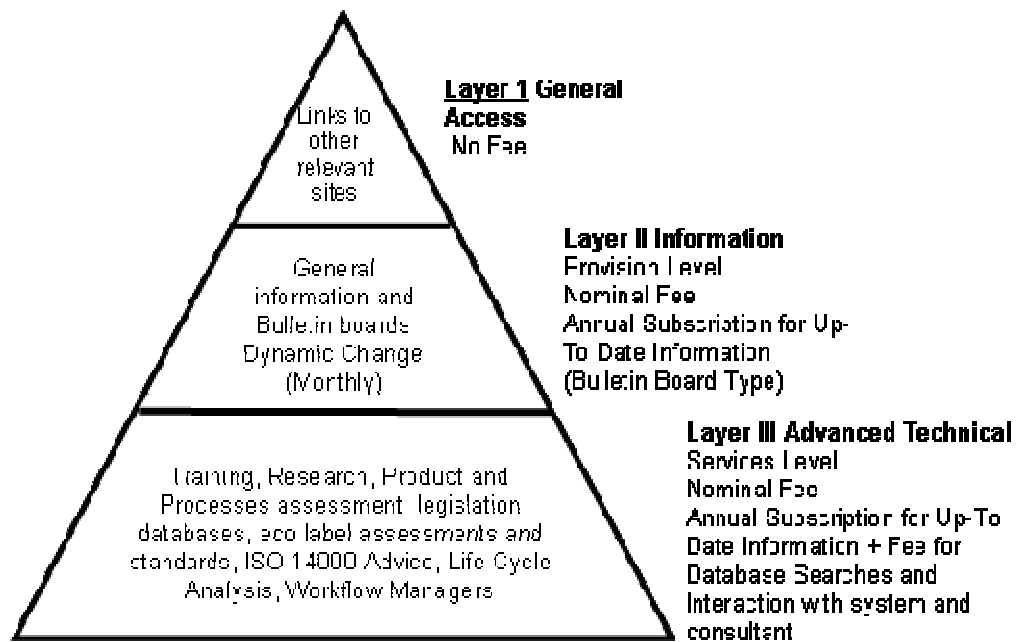


**Fig.20:** Screenshot from a Collaborative Virtual Environment (CVE)

This research uses the basic features of the CVE. However, the more advance features such as web-conferencing could be utilised by a collaborative network of energy users proposed in the study.

### 3.5.1 EE-Services

A proposed use of CVE is to provide environmental services via the World Wide Web to SME. Roche (2000) provides a model for the commercial application of such electronic environmental Services (EE-Services) shown graphically in figure 21.



**Fig.21:** Proposed Layers in EE-Services Web-site (Roche 2000)

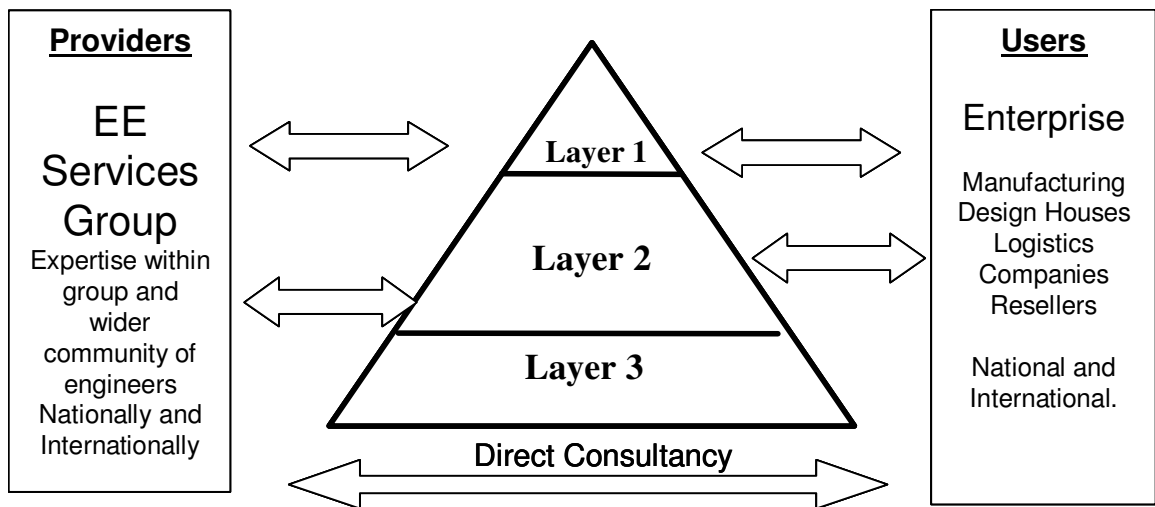
The layers shown in figure 21 are described as follows:

- Layer 1      Access is on a no fee basis and is the point of contact for the users.  
 ⇒ Targeted at international audience requiring general information
- Layer 2      Access is on membership fee basis and would provide general information in the form of newsletters, papers and articles.  
 ⇒ Targeted for a general audience of engineers and academics.
- Layer 3      Access is on a membership fee to provide technical services.  
 ⇒ Targeted at environmental managers within an enterprises.

The services proposed in layer three include:

- Training, E-Workshop, E-Seminars using advanced technologies, such as computer based training (CBT) and Video Conferencing.
- Workflow Managers, This includes tools to help users through steps to achieve either an environmentally superior product or implementation of ISO 14000.
- Legislation search engine – this tool allows users to search for legislation relating to their product or process under a set of search criteria.
- Life Cycle analysis tools –This tool would be used to carry out a life cycle impact of a product or process for reporting process.
- Eco-label Assessment.

Figure 22 shows the proposed architecture of the operation of the EE Services group who would provide services nationally and internationally.



**Fig.22:** Operation of EE Services Ireland Limited (Roche 2000)

This structure was considered to be a suitable model for energy professionals to provide technical backup to energy teams using the STEMS process, if required.

### 3.5.2 SME Readiness for CVEs

Surveys by the Chamber of Commerce of Ireland indicate a significant level of utilisation of information technology in Irish SME (Butler 2002; CCI 2001)

- 97% use Internet for email
- 91% use Internet to source information
- 64% have their own website
- 47% receive orders on-line and 35% make payments on-line
- 95% expect their use of Internet and e-Business to increase over the next 5 years
- 67% believe that e-Business will offer new opportunity to their business
- 69% believe that competitive forces are pushing them to get involved in e-Business
- 50% state lack of technical skills is a problem

With over 90% access to the Internet, The Irish SME sector is well prepared to avail of web-based services. This influenced the direction of this study.

### 3.6 Energy Training

A major barrier to energy efficiency is the shortage of skilled people and the lack of a focus on energy management as an area of professional practice that is key to the development of an “energy efficiency culture” (Tripp 2000). The International Energy Efficiency Training Network (IEETN) was established in 1997 by academics and professional organisations having a common interest in energy efficiency and renewable energy. Members participated from Ireland, the United Kingdom, Europe, Canada, North and South America, and Africa. The organisation considered that available “off-the-shelf” training packages did not meet the requirements of today’s complex energy and environmental challenges. The group saw a need for various levels of energy efficiency and renewable energy training. Such training needs to address awareness, knowledge, skills and actions required by governments and the private sector for implementing energy efficiency projects. The IEETN consortium objective was to address the gaps in human resource training needs by providing fully comprehensive internationally recognised energy efficiency and renewable energy training services within the context of national climate change strategies and economic development specifically:

- To support national and regional capacity building energy strategies through training partnerships.
- To design and deliver job-oriented energy efficiency and renewable energy training.
- To provide internationally recognised accreditation and equivalencies certification.
- To use the full range of training media, including web based training, as needs and costs require.

The IEETN faced similar problem that are address in this study: providing energy efficiency training to geographically dispersed with different levels of awareness. The groups being in different countries and having different cultural backgrounds further complicated this. As a result the IEETN relied on face-to-face contacts that limited the penetration to a few successful projects. However, due to the overall lack of progress, the group was disbanded in 2001.

A training programme for operating and maintenance personnel in commercial buildings was introduced by the Norwegian Minister for Petroleum in 1984 and since then over 10,000 people have attended the courses (Næss 2000). A great stress is placed on the educational environment and the communication skills of the teachers. The people who work on the daily operation and maintenance of buildings are regarded as key to the process. As buildings systems become more complex, it is forecasted that the demand for skilled Facilities personnel will grow in the future. An innovative energy training centre was established in the Ukraine under a EU Tacis<sup>2</sup> Technical Dissemination Project (TDP) (Kiev 1997). However these seem to be isolated training initiatives and it is noticeable that of the five hundred energy efficiency policies and measures introduced by EU Member states, only ten were in the area of training (EC 2000a). As a result, there is still a need to establish a new, more accessible energy training format and this research represents one such to address the needs in an Irish context.

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<sup>2</sup> The Tacis Programme is a European Union initiative to support development in the New Independent States and Mongolia



### 3.7 Conclusions

This chapter addressed methodologies suitable for supporting the implementation of energy efficiency in small and medium sized organisations. Change management methodology and a structured approach will assist an organisation to “encourage culture change” to energy efficiency. The modern knowledge-based organisation is likely to be process-centred and familiar with procedures such as structured project management and development processes. Teams are the fundamental learning units in the modern organisation and energy teams have been successful in this area albeit without any formal training or support structures. Web-based collaborative virtual environments (CVE) enable cooperation among geographically distributed groups and are suited to functional clustering. The framework of the CVE is well structured for the establishment of Electronic Services targeted to enterprises that require environmental and energy expertise and assistance. The Irish SME sector, with almost 100% Internet access, is well placed to avail of such services. Focused training, when backed by Government policy, has made a significant impact in Norway. The task of implementing energy efficiency, in small and medium sized organisations, poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity. The evidence suggests that the development of a structured team-based approach using a World Wide Web environment is a viable way of providing training and resources for energy teams in this sector.

## Chapter Four: Prototype Process Model

- 4.1 Introduction
- 4.2 Overview of Concept
- 4.3 Concept Test
- 4.4 Conclusions

### 4.1 Introduction

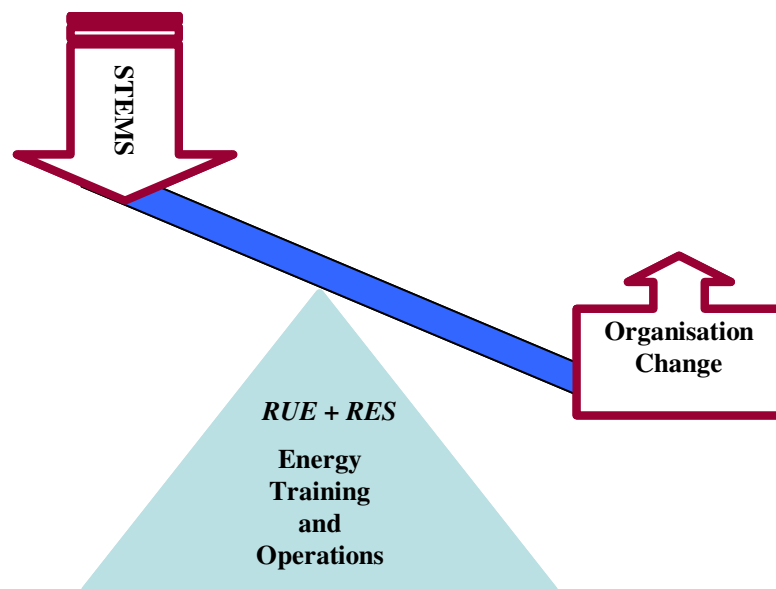
The first prototype model of a structured team-based methodology to support the implementation of energy efficiency in small and medium sized organisations is presented in this chapter and is based on:

- Literature review of the drivers of energy policy.
- Literature review of structured processes in the areas of product development, new product introduction, organisational change and team methodologies.
- Literature review of web-based environments that facilitate distributed teams.
- Presentation of the idea to the Industrial and Public Sector department of Sustainable Energy Ireland.
- Discussions with Mr. Patrick Stephens, the Chairman of the Association of Energy Professionals in Ireland (AEPI).
- Discussions with SME managers regarding implications of energy and environmental policies on their business and supervising a Final Year degree project on energy management in an SME, based in Galway.
- Over twenty years experience in industry in the areas of manufacturing engineering, process development, logistics, new product introduction (NPI) management and product development management. Many of these roles involved introducing change in the supply chain driven by rapid technological and organisational developments.

- Teaching a final year degree course in Applied Energy Management. This provided an opportunity to use project based learning (PBL) methods to test the concept within the context of a class project.

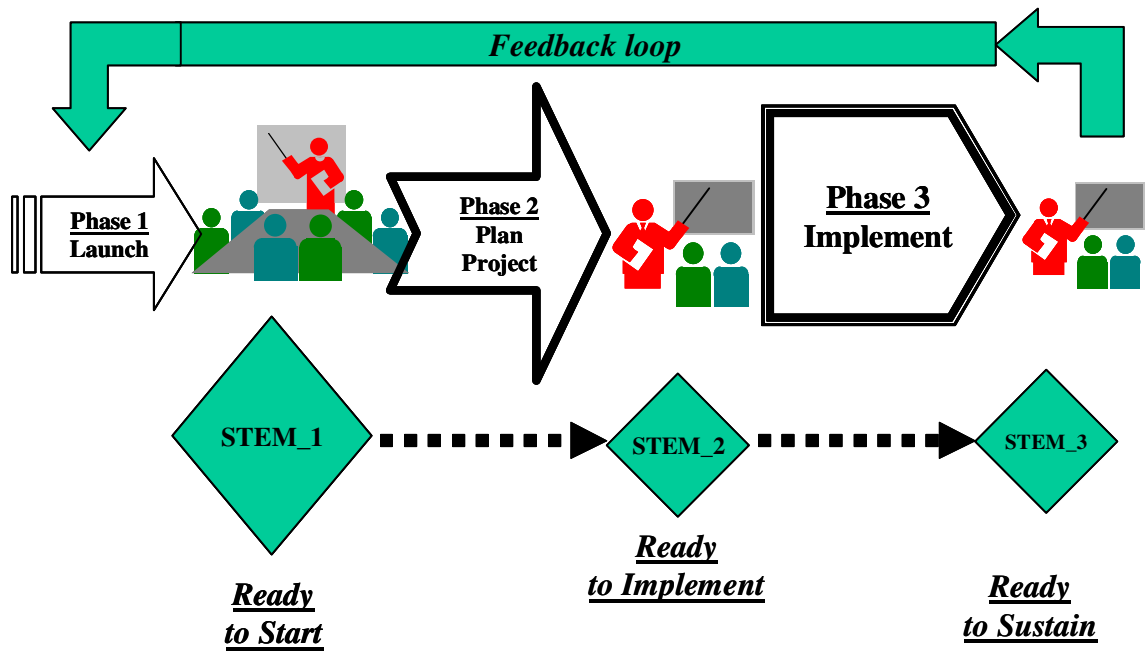
## 4.2 Overview of Concept

A methodology called STEMS (Structured Team-based Energy Management System) was developed to provide a conceptual and process model, which goes beyond conventional energy training and good practice guidelines. Such models and theories are essential tools of research in stimulating the advancement of knowledge (Bell 1999; Cohen and Mannion 1994)]. The framework for change has the flexibility to be applied to small and medium sized enterprises (SME), tertiary/commercial organisations and the public sector. A graphical representation of the research concept is presented in the figure 23, which shows the STEMS process enabling organisational change.



**Fig.23:** Graphical presentation of initial STEMS model

A pictorial overview of the proposed STEMS structure and implementation model is shown in figure 24.



**Fig.24:** Schematic of the Structured Team-based Energy Management System (STEMS)

The structured approach (O'Connell 1996) has three main management reviews (DS136 2001) with a set of deliverables (Cooper and Kleinschmidt 1993) associated with each review milestone. This is in contrast to the U.K.'s Action Energy management process that does not include reviews.

## 4.3 Concept Test

### 4.3.1 Problem Based Learning (PBL) trial

This prototype was initially tested while teaching a final year Degree class in Manufacturing Technology; subject "Applied Energy Management" in the academic year 2001-2002. The exercise provided an opportunity to use problem based learning (PBL) methods to test the concept within the context of a class project. The problem given to the students was to re-engineer GMIT to meet the Irish Green Paper objectives using project teams following the STEMS process. The students completed phase 1 and phase 2 of setting goals and formulating plans. Phase 3 (implementation)

was not possible given the timeframe and resources. The deliverables completed during the process trial included surveys of students and staff, data collection, measurement and historical analysis. It also involves awareness initiatives, communications, logo and web site development. It provided students with the methodology required to be implement energy utilisation through organisational change and to “learn by doing”. Much emphasis in the area of energy policy and management is on energy experts and champions. Here the emphasis was on mobilising the “significant many” to implement change in an energy inefficient organisation.

### **4.3.2 Review with Sustainable Energy Ireland (SEI)**

Research on the implementation of energy efficiency necessitated meeting the body responsible for energy policy formulation and implementation. A number of meetings were held with Sustainable Energy Ireland, the most significant being in Dublin on 7<sup>th</sup> November 2002. The attendees included the Head of Industry & Public Sector (SEI), the Project Manager of the Large Industry Energy Network (LIEN), the Energy Technology Promotions Leader, the Chief Policy Advisor to SEI and the SEI Project Manager for Negotiated Agreements. The main points from this meeting were:

- The feedback on the initial STEMS proposal was very positive. SEI regards the SME (Small Medium Enterprise) sector to be important to the success of the implementation of Ireland’s policy on energy sustainability. However because of the large number of businesses in this sector, they had not the resources to prioritise supporting this area.
- SEI provided the following specific recommendations on the research:
  - Research should be very focused:
    - On the SME sector in particular
    - In Galway-Mayo region
    - Process proposal should be easily implemented and not overly complex to maximise acceptance by SMEs.

- SEI were very interested in exploring the use of the World Wide Web in the task of implementing energy efficiency and provided financial support to aid the development and dissemination of the STEMS concept.

### 4.3.3 Comparison with Established Approaches

This section describes how the STEMS concept differs from established approaches provided by Action Energy in Good Practice Guide GPG 119 and the Danish Energy Authority Standard (DS136 2001).

- GPG119 is a top down and assumes a corporate structure and professional input.
- STEMS is bottom up, 'lighter' and designed for teams with no energy background and an organisation that does not have an 'energy manager'.
- STEMS is designed for organisations that want to implement something fast and then evaluate a long term energy policy.
- STEMS has regular planned reviews with the Senior Management Sponsor as in most project management and development processes.
- GPG119 and DS/INF 136E can be a useful resource to the STEMS energy team.
- However, all the approaches stress the importance of teams.

## 4.4 Conclusions

A prototype model of a structured team-based methodology to support the implementation of energy efficiency in small and medium sized organisations was developed. It was initially trailed as part of a problem based learning (PBL) exercise to a final year Manufacturing Technology degree subject. The model was presented to the members of the Industry & Public Sector Department of Sustainable Energy Ireland (SEI) with their main policy consultant. Feedback was very positive as SEI regarded the SME (Small Medium Enterprise) sector to be important to the success of the implementation of Ireland's policy on sustainable energy. SEI was also very interested in exploring the use of the World Wide Web in the task of implementing energy efficiency.

## Chapter Five: Case Study I - Rational Use of Energy (RUE) in GMIT

- 5.1 Introduction
- 5.2 Phase 1: Setting Project Objectives
- 5.3 Phase 2: Project Planning and Data Gathering
- 5.4 Phase 3: Project Implementation
- 5.5 Conclusions from GMIT RUE project
- 5.6 Chapter Conclusions

### 5.1 Introduction

A Rational Use of Energy (RUE) project was undertaken by a multi-disciplinary team in the Galway-Mayo Institute of Technology from January to May of 2003. This project was conducted as part of the “Partnership IT” program (NCCP 2004). It involved participation from four geographically dispersed campuses, Galway, Letterfrack, Castlebar and Cluain Mhuire (figure 25) and the team included six staff and one student (ref Appendix A). This chapter is adapted from the final report of the project team (Costello *et al.* 2003). The RUE team focused on electricity usage and completed the following tasks as part of the project:

- Comprehensive profile of electricity usage in all campuses.
- Expression of electricity usage in terms of CO<sub>2</sub> emissions, which is the “currency” of the Kyoto Protocol.
- A population survey of energy awareness, attitudes and behaviours.
- Survey of unoccupied lecture rooms to determine if lights were left on during the day.
- A detailed monitoring of three selected computer rooms over a four-week period to investigate the effectiveness of an energy awareness programme.
- Development of an Energy Awareness Logo.

- Staging an Energy Awareness Day on April 30<sup>th</sup> 2003.
- Development of Power Saving Guidelines for personal computers (PCs) and Lights.

The report provided a number of recommendations that made a significant contribution to the reduction in electricity use at a time when the campus real estate was growing. The project was implemented using a structured process methodology (ref. Appendices B and C).

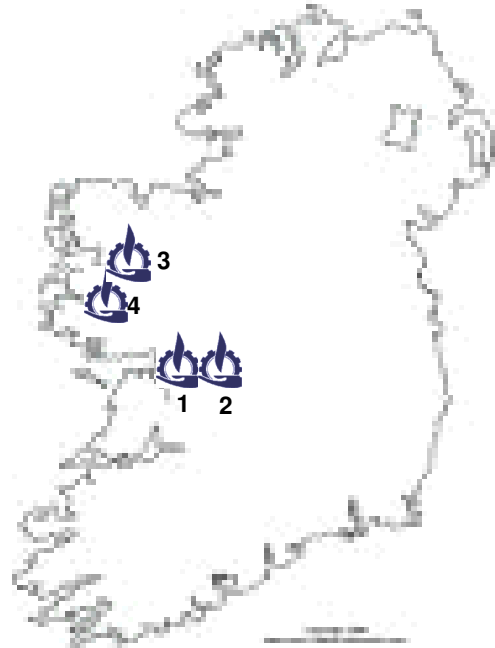
*Campuses of the Galway-Mayo Institute of Technology that took part in the RUE proje*

*Campus 1: Dublin Road, Galway*

*Campus 2: Cluain Mhuire, Galway*

*Campus 3: Castlebar, Co- Mayo*

*Campus 4: Letterfrack, Connemara*



**Fig.25:** GMIT RUE multi-campus map

## **5.2 Phase 1: Setting Project Objectives**

### **5.2.1 Partnership in the Institutes of Technology**

The RUE project was carried out as part of the ‘Partnership IT’ program under the auspices of the National Partnership Forum for Institutes of Technology. Under the program, GMIT has a fulltime facilitator. The GMIT Partnership program was formally launched on April 2<sup>nd</sup> 2003 by Ms. Lucy Fallon-Byrne, Director of the National Centre for Partnership and Performance (NCP) (GMIT 2003).



### 5.2.2 RUE Project

As part of the GMIT Partnership training, a project kick-off meeting was held in January 2003 during which the RUE team developed project objectives in conjunction with the project sponsor. The projected outcomes and benefits of undertaking this project were also outlined at this stage. The timescale of the project was set at sixteen weeks (Ref. Appendix A): Objectives of the project were as follows:

- GMIT to adopt energy efficiency targets, practices and procurement policies that will give leadership to the rest of the community by setting an example of best practice.
- Brand GMIT as an energy responsible location.
- Culture change by raising awareness of the GMIT community on the need for energy conservation and CO<sub>2</sub> abatement.
- Motivate all members of the GMIT community to be part of the solution being promoted at a national level by Sustainable Energy Ireland (SEI).

### 5.2.3 Project Description

- The project team developed a project plan to meet the above objectives by defining measurable and achievable actions.
- Because of the timescale, the project team concentrated on the Rational Use of Energy (RUE) within GMIT. The scope covered the soft side of energy management such as awareness, housekeeping and motivation.
- The project team was to explore developing some quantitative and qualitative measures of success.
- Quantitative measures were considered to require some monitoring equipment. Qualitative measurements could be in the form of a population survey.

### 5.2.4 Projected Outcomes and Benefits

- Increased awareness at management, staff and student level of the implementation of best energy practices in GMIT.

- Projection of GMIT into a prominent position within the higher education sector in relation to the implementation of Irish Green Paper policy and HETAC guidelines.
- Related benefits to local community, future generation of students and the national interest.
- Cost reduction potential estimated at 10- 15% by implementation of “no-cost low-cost” measures

### **5.2.5 Project Methodology**

The initial project proposal outlined the terms of reference that the RUE team would use to meet the objectives. The methodology included sub-dividing the team to focus on each of the main objectives. The team agreed to use a web-based collaborative virtual environment (CVE) to facilitate storage and access of all project documentation across the different campuses and information networks.

#### **5.2.5.1 Terms of reference**

The project team developed the following terms of reference based on the project objectives.

- Because of the sixteen-week timescale, the project team decided to concentrate on electricity usage. The scope would cover the soft side of energy management such as awareness, housekeeping and motivation.
- The project team was divided into sub-teams in line with the project objectives.
- Each project teams was tasked with the development of a project plan to define measurable and achievable actions.
- Each project sub-teams were to develop some quantitative and qualitative measures of success.
  - It was estimated that quantitative measures would require some monitoring equipment
  - A population survey was suggested as a means of providing qualitative measurements of knowledge, behaviour and attitudes.

### **5.2.5.2 Project Sub-Teams**

The project team was sub-divided into two main areas:

1. Energy Usage

The responsibilities of this team included providing base-line data and analysis of electricity usage in GMIT campuses. Efforts were also made to present data in terms of CO<sub>2</sub> emissions, which is the ‘currency’ of the Kyoto protocol.

2. Energy Awareness

The responsibilities of this team included surveying present levels of energy awareness and behaviours among all sectors of the GMIT population. Methods of increasing awareness to be reviewed included marketing campaigns, development of a logo and hosting an Energy Awareness Day event.

### **5.2.5.3 Project Meetings**

Project meetings were held weekly in the Galway campus and attended by the Partnership facilitator. Minutes of meetings and the updated action register were posted on the collaborative server by the Tuesday following the team meeting. The meeting agenda was circulated by email. Consultations on items requiring team input were also carried out electronically.

### **5.2.5.4 Collaborative Virtual Environment (CVE)**

Collaborative virtual environments (CVE) enable the cooperation process among distributed individuals. Outside of this project, they are being used in research and implementation projects across a number of organisations including the ICT and Construction industries. The CVE is designed to facilitate project teams that are distributed geographically. The aim is to enhance personal and team knowledge and creativity, and to improve chances of success. The environment requires the implementation of Web based tools and technologies. Figure 26 shows the collaborative virtual environment used by the RUE project team to manage all project documentation. Refer to Appendix L for details on how to access the CVE.

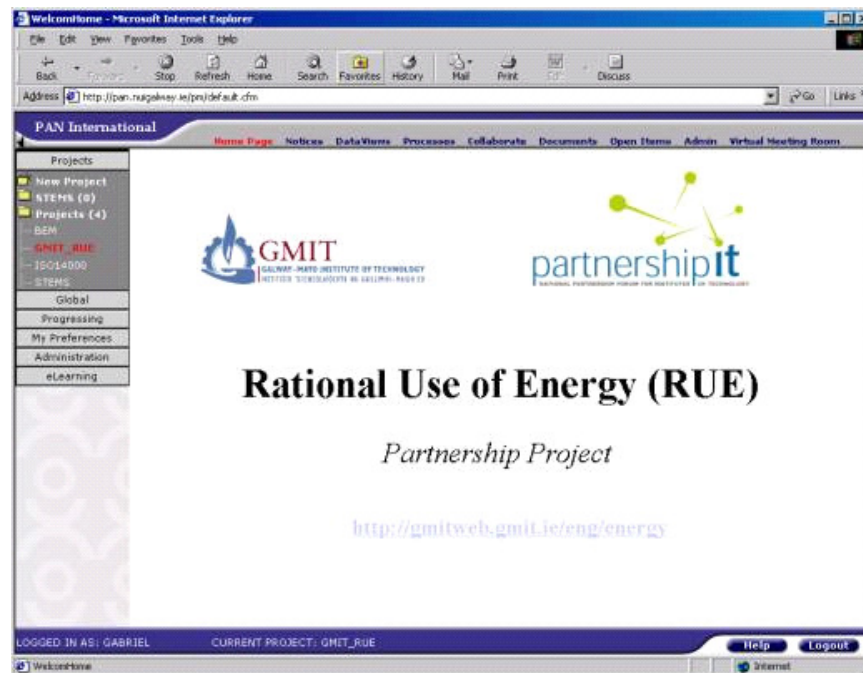


Fig.26: RUE team Collaborative Home Page (<http://gmitweb.gmit.ie/eng/rue>)

### 5.2.5.5 *Project updates for Sponsor*

The team provided three main presentations to the sponsor:

- Project objectives at the kick-off meeting.
- Mid project review after eight weeks.
- Final presentation after sixteen weeks/

The Sponsor was copied on all project correspondence, including weekly minutes, and was consulted as required during the course of the project. Furthermore, the Sponsor was please with the regular updates and being involved in the process.

## 5.3 Phase 2: Project Planning and Data Gathering

### 5.3.1 Introduction and Overview

This section provides an overview of the buildings estate for each campus that took part in the RUE project. The aim of this initial phase of the projects were:

- Develop a comprehensive profile of electricity usage in all campuses
- Express the electricity usage in terms of CO<sub>2</sub> emissions, which is the “currency” of the Kyoto Protocol.

### 5.3.1.1 Dublin Road – Galway

The largest campus and central administration section is housed at the Dublin Road campus, Galway. From this location five schools operate. The real estate is outlined in table 5.

**Table 5:** GMIT Dublin Road Campus buildings

<b>Building Type</b>	<b>Date of Construction</b>
Original Buildings	1971 / 1972
Major extension	1976
Sports hall	1979
Hotel & Catering extension	1993 / 94
Miscellany Prefabricated Buildings	1999 / 2003
New Learning Centre	2003
Sport field changing rooms	2003

The campus at the time of the project had approximately 35,000 m<sup>2</sup> of built space. The original buildings were constructed at a time when minimal legislation existed with regard to energy efficiency or usage. The construction methods incorporated various types of concrete based materials with limited insulation value. All windows were single glazed, the concrete panels contained 12mm of insulation and the roof areas were un-insulated. Subsequent buildings from 1996 onwards were constructed to more stringent energy efficiency requirements driven mainly by legislation. The energy sources used in this campus are given in table 6.

**Table 6:** Energy sources in Dublin Road campus

<b><u>Heating</u></b>	<b><u>Teaching</u></b>	<b><u>Lighting</u></b>
Electricity	Electricity	Electricity
Propane Gas	Propane Gas	n/a
Oil	n/a	n/a
Electric Storage Heaters	n/a	n/a
Electric Space Heaters	n/a	n/a

### 5.3.1.2 *Cluain Mhuire Campus – Galway*

The Cluain Mhuire Campus is mainly housed in a converted monastery that was constructed around 1940. GMIT acquired the site in 1995 from the Galway County Council. The existing buildings are constructed of mass masonry that was a common form of construction for the period and relies on its density to retain heat. Little design emphasis was given at the time of construction to energy saving due to lack of regulations at the time. The campus now houses the Arts Department and Film & TV sections of the Institute in refurbished sections of the existing buildings. Large extensions have been added at the rear of the buildings to provide workshop facilities. Future works are planned to provide more space for Arts, Film & TV and a new facility for a School of Music for Galway when funding is made available. This campus had approximately 7500 m<sup>2</sup> of developed buildings at the time of the project and energy sources are shown in table 7.

**Table 7:** Energy sources in Cluain Mhuire campus

<u>Heating</u>	<u>Teaching</u>	<u>Lighting</u>
Oil	Electricity	Electricity
Electric Storage Heaters	Propane Gas	n/a
Radiant Electric Heaters	n/a	n/a

### 5.3.1.3 *Castlebar Campus – Co. Mayo*

The Castlebar Campus is situated in Mayo and offers a wide range of courses including Business, Computing, Construction and Nursing. The campus is situated on the site of the St Mary's Hospital. The Hospital remains open, but over recent years GMIT has acquired surplus space for conversion into a teaching facility. The first courses offered by GMIT commenced in 1995 in a small section of the hospital. The GMIT portion of the site has now grown to around 8000 m<sup>2</sup>. An additional area under construction will provide a health science facility of approx 3000 m<sup>2</sup> during 2004 / 05. The existing construction dates from the 19<sup>th</sup> century and is generally of mass masonry construction with minimum energy efficiency that is typical of this time. Substantial upgrades have been carried out to several parts of the building and these have greatly

improved heat retention and fuel efficiency. The energy sources used in this campus are given in table 8.

**Table 8:** Energy sources in Castlebar campus

<u>Heating</u>	<u>Teaching</u>	<u>Lighting</u>
Oil	Electricity	Electricity
	Propane Gas	

Energy saving initiatives that had been undertaken at GMIT Castlebar to reduce electricity usage before the RUE project gave very encouraging results.

#### **5.3.1.4 Letterfrack Campus- Connemara**

Located in Connemara, this campus houses the GMIT furniture making and restoration department. The campus was formally an industrial boy's school and is now owned and run by a local development company, Connemara West. In 2002 GMIT leased the facility from Connemara West and are currently considering upgrades to the existing buildings. The site is split into two distinct sections:

- The former Industrial School buildings that date from the 19<sup>th</sup> Century and are currently in need of modernisation.
- A new addition was built on site in 1998/99 that provides modern accommodation.

Generally the new building is built to modern energy efficient standards. The existing buildings are mainly of mass masonry construction and offer little in the way of energy efficiency or insulation.

Since 2002, the Furniture College has been participating in a programme called the Cleaner Greener Production Programme (CGPP). This is an EPA sponsored programme funded under the National Development Plan 2000-2006. The objective of the CGPP is to encourage companies to adopt a high standard of environmental performance by adapting production processes and services in order to minimise negative impact on the environment. This is achieved through the application of increased resource productivity, waste reduction, reuse of materials, up-cycling (adding value to a recycled product), energy management and an environmentally

friendly based purchasing policy. By enacting such policies visibly within the Furniture College, it is hoped that the CGPP will have a positive influence not just on staff but also on students and that they may in turn promote this awareness in their future employment. The energy sources used in this campus are given in table 9.

**Table 9:** Energy sources in Letterfrack campus

<u>Heating</u>	<u>Teaching</u>	<u>Lighting</u>
Oil fired burners	Electricity	Electricity
n/a	Oil	n/a

Note: In the above examples use of fuel for teaching generally indicates electricity use. Some other types of fuel are also used for teaching i.e. Gas is used in the Hotel & Catering, Engineering, Science and Art & Design sections for practical classes.

### 5.3.2 GMIT Electricity Usage – by Campus

The project team decided that the project would focus on electricity use. The rationale behind this choice is that the end users i.e. staff, students and visitors have direct control and can dramatically affect electricity usage (ref. Appendix H). Other fuel usages such as teaching and heating are generally controlled on a central basis and end users have limited control over these energy sources.

An analysis of the electricity use in the Dublin road campus is shown in table 10.

**Table 10:** Dublin road campus electricity charges (2001/2)

	<u>2001(€)</u>	<u>2002(€)</u>
Standing charge	450	2700
Capacity Charge	11,102	17,430
Excess Demand	Nil	483
Demand Charge	28,827	21,851
Day Units ( kWh )	114,200	145,008
Night Units ( kWh )	17,250	26,937
<b>Sub Total</b>	<b>171,829</b>	<b>214,409</b>
<b>Inc VAT</b>	<b>193,307</b>	<b>241,210</b>



The increase year on year is around 24% due to the following reasons:

- Adjustments in the way ESB apply service charge that was carried out in preparation for industry deregulation.
- Increases in ESB tariff costs.
- A new learning centre and pre fabricated buildings added around 40% to the built campus area in 2002.
- Weather patterns in 2002 were worse than 2001 thus heating etc was used for longer periods.
- Significant new equipment was purchased such as computers, science and engineering equipment as education budgets were high.

An analysis of the electricity use in the Cluain Mhuire campus is shown in table 11.

**Table 11:** Cluain Mhuire campus electricity charges (2001/2)

	<u>2001(€)</u>	<u>2002(€)</u>
Standing charge	140	840
Capacity Charge	5305	10,500
Demand Charge	7,104	4,998
Day Units ( kWh )	23,788	27,862
Night Units ( kWh )	3,808	4,214
<b>Sub Total</b>	<b>40,145</b>	<b>48,414</b>
<b>Inc VAT</b>	<b>45,163</b>	<b>54,465</b>

The above figures indicate an increase of around 20% due to:

- The methods the ESB use to apply standing charges has changed
- A number of previously vacant areas were refurbished and are now in use.
- Increases in the ESB tariff costs.
- Several additional workshops have been built for ceramics and sculpture.
- Cluain Mhuire had a significant increase in student numbers during the period indicated.
- Educational budgets were high and significant extra equipment was purchased for the campus. This equipment increased the demand for electricity.

Breakdown figures for Castlebar were not available. The actual total costs for electricity are shown in table 12.

**Table 12:** Castlebar total electricity cost and consumption ( 2000-2002)

<b>Year</b>	<b>Cost (€ incl. VAT)</b>	<b>Total Consumption (kWh)</b>
2000	42,013.13	456,000
2001	55,328.00	615,000
2002	69,682.50	693,000

Electricity usage at Castlebar rose in line with the other campuses. This was due to the growth in campus floor area, growth in student numbers, increase in quantity of equipment and increase in ESB tariffs and costs.

Connemara West, owner of the Letterfrack buildings, pays the energy bills for the entire complex. They then allocate the bills between GMIT users and other occupants of the complex on the basis of a metered charge per area occupied. Detailed information was not available from the ESB on electricity usage in Letterfrack complex due to the billing/monitoring system in place with Connemara West. However, the costs allocated to GMIT are shown in table 13.

**Table 13:** Letterfrack total electricity costs (2000-2002)

<b>Year</b>	<b>Electricity Cost (€ incl. VAT)</b>
2001	25,221
2002	33,405

### 5.3.3 Computers in GMIT

As computers are a major source of electricity use, data was obtained from the Computer Service Survey of personal computers (PC) during September 2002 and is shown in table 14.

**Table 14:** PC population in GMIT (Sept 2002)

New Learning Centre and IT Suite	412
Dublin Road existing campus	1023
Castlebar campus	300
Cluain Mhuire Campus	53
Letterfrack campus - not surveyed	
<b>TOTAL</b>	<b>1788</b>

The machines indicated were generally of Pentium grade although the Institute had a significant number of older 386 & 486 type PC's that were generally in non-computer rooms. Almost the entire stock of computers used in student computer rooms was Pentium or better grade. New models were expected to be more energy efficient. Refer to Appendix D for computer energy efficiency guidelines.

### 5.3.4 GMIT CO<sub>2</sub> Emissions (electricity)

Table 15 shows a consolidated view of the amount of Carbon Dioxide (CO<sub>2</sub>) released into the atmosphere due to the electricity consumption in the GMIT campuses. Refer to Appendix I for data on which calculations were based.

**Table 15:** GMIT consolidated costs and emissions 2002

<b>Campus</b>	<b>Electricity cost (€)</b>	<b>Electricity usage (kWh)</b>	<b>Emissions Tonnes CO<sub>2</sub></b>
Dublin Road	241,210	2,398,900	1859
Cluain Mhuire	54,465	542,450	420
Castlebar	69,682	693,000	537
Letterfrack	33,405	334,050	259
<b>TOTAL</b>	<b>398,762</b>	<b>3,968,400</b>	<b>3074</b>

### 5.3.5 GMIT Total Energy Costs Summary

The RUE project focused on electricity consumption. However it is important to place this in context of all energy use in the Institute shown in the table 16. Energy costs account for approximately 15% of GMIT non-pay budget.

**Table 16:** GMIT total energy costs summary

<b>Energy Source</b>	<b>Cost (k€)</b>
Electricity	398
Oil	65
Gas	40
<b>TOTAL</b>	<b>503</b>

## 5.4 Phase 3: Project Implementation

Based on the data gathered in Phase one of the project, the team carried out a number of sub-projects as part of the implementation phase. These included:

- A detailed monitoring of three selected computer rooms, in the Dublin Road campus, over a four-week period to investigate the effectiveness of an energy awareness programme.
- Development of an Energy Awareness Logo.
- A population survey of energy awareness, attitudes and behaviours.
- Survey of unoccupied lecture rooms to determine if lights were left on.
- Hosting an Energy Awareness Day.
- Development of Power Saving Guidelines for PCs and Lights.

### 5.4.1 Monitoring of Computer Laboratories

An electricity consumption monitor was purchased ECM Systems, Ballina, Co.Mayo, to measure use in three computer rooms in the Dublin Road campus: Rooms 482, 483 and 484 (Appendix E). The unit was installed on the electricity supply feeding into the rooms. The computer laboratories belonged to the Computing Department of the School of Science. The monitor had the facility to check and record usage of power within the rooms i.e. PCs, Printers, Scanners and any items plugged into the general outlets. Lighting was excluded since this is run via central electrical boards. The rooms were tested for a two-week period, with the end users unaware of the project or of the fact that the monitor was installed. After this period, the computer technician working in the area gave talks and informed the end users of the project and the need to conserve energy. A subsequent monitoring period of a further two weeks then took place.

### 5.4.1.1 Meter analysis

The Meter Analysis Chart in figure 27 showed that the power consumption for week 3 and 4 was considerably lower than that of week 1 and 2 even though the number of users had increased in the second period.

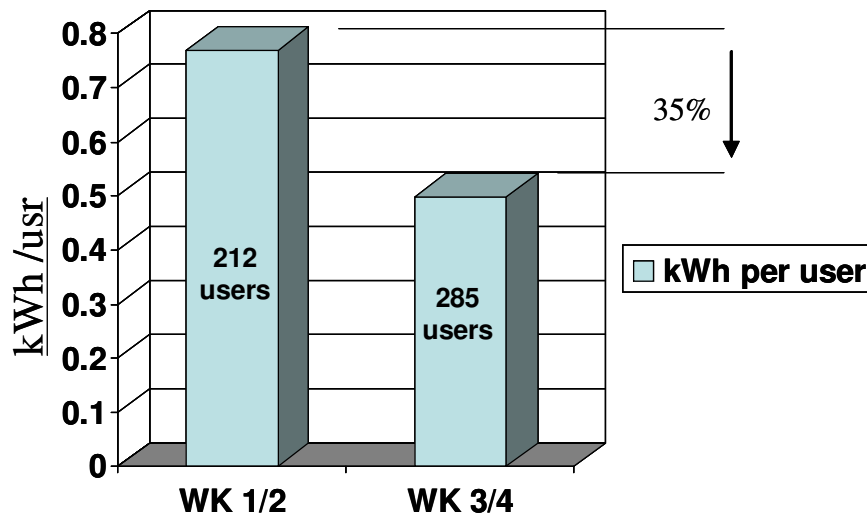


Fig.27: User Data for Weeks 1/2 of and Week 3/4 of lab monitoring

- The power consumption was 163 kWh when 212 students used the computers over the two-week period Week 1/2 which gives an energy use per user of 0.769 kWh.
- The power consumption was 142 kWh when 285 students used the computers over the two-week period Week 3/4 which gives an energy use per user of 0.498 kWh.
- This gave a reduction of 35% in energy use per user as a result of the awareness project.

### 5.4.1.2 Light Usage during observation period

Although there was no facility to monitor electricity consumption of the lights, it was decided to observe behaviour of students regarding turning off lights when leaving the room. Again there was a considerable improvement after the awareness campaign as shown in the figure 28.

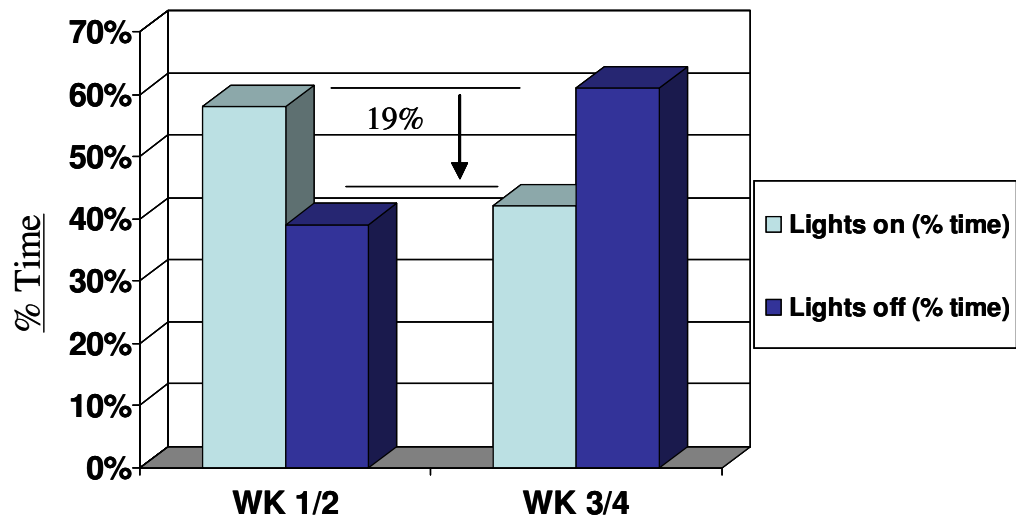


Fig.28: Data on Lights for Week 1/2 and Week 3/4 of lab monitoring

- Figure 28 shows that in Weeks 1/2, before the Energy Saving Program was introduced, students left the lights on 58% of the time.
- Following the implementation of the program the lights were left on only 39% of the time, which showed a 19% reduction in use of electricity.

### 5.4.1.3 Conclusions: Computer Lab Monitoring

The data showed that after the implementation of the Program:

- Total Power Consumption was reduced by approximately 13%.
- Power consumption per user was reduced by 35%.
- There was a 19% reduction in the time that lights were left on.

## **5.4.2 Energy Awareness**

### **5.4.2.1 Introduction**

This sub-team on energy awareness carried out the following:

- Energy Logo development and opinion poll.
- e-Survey of behaviour and awareness.
- Staff education.

### **5.4.2.2 Energy Awareness Logo**

A poll of GMIT staff and students was carried to determine the preferred logo from the two choices provided by the project team.

### **5.4.2.3 Methodology**

A poster was produced depicting the two energy logos shown in figures 29 and 30. These were put on display at the partnership launch and during the Energy Awareness Day. A form was made available for people to indicate their preference. In addition a question was included on the e-survey that allowed people to register their choice. Education consisted of a poster campaign, talks with lecturers who used the particular computer labs and with the students. In addition e-mail mailing lists were used to disseminate information to relevant individuals.

## **5.4.3 Logo Development**

At the outset, it was decided by the team that one objective of the project was to raise awareness within the GMIT community of the need for energy conservation. To help achieve this goal the team considered that it was important to brand this initiative with a logo that would be instantly recognisable as an energy conservation symbol for GMIT.



### 5.4.3.1 *Design Process*

As part of the undergraduate PBL project described in chapter four, the students had designed an Energy logo (Logo Y in figure 29) and displayed it on the energy web page that was developed. The RUE team decided to take this logo as a starting point for the development of the RUE logo. A member of the team from the Department of Art and Design in the Cluain Mhuire campus was asked to develop a number of possible alternatives taking into account the GMIT logo and that of the partnership programme. This exercise produced Logo X shown in figure 30.



**Fig.29:** Logo Y developed by Final Year BSc in Manufacturing Technology Students (2002)



**Fig.30:** Logo X developed as part of the RUE project (2003)

### 5.4.3.2 *Logo Selection*

It was decided to let the GMIT community vote on the two logos. A question was incorporated into the electronic survey to allow respondents to highlight their preferred option. Logo X was chosen by a sizable majority to be the GMIT energy symbol.

### 5.4.4 Energy Behaviour Survey

This section provides the analysis of the energy behaviour survey undertaken by the energy awareness sub-team. The Rational Use of Energy or RUE approach is based on the idea of ‘soft’ energy management. Whereas ‘hard’ energy management is concerned with using technology and equipment to minimise energy use, soft energy management is concerned with the way in which the user community uses and manages their energy needs. One of the major tasks undertaken during the RUE project was a “user community survey”, to establish the existing *knowledge*, *attitudes* and *behaviour* of the user community in relation to energy use.

#### 5.4.4.1 Methodology and Scope

The user survey was carried out by placing a questionnaire (Survey 2003) on a website using third-party web-based questionnaire software (Appendix F). In addition, paper versions of the survey were provided for those without computer access. There were 177 responses in total, including academic, administrative and technical staff, and students and the analysis of the Responses are presented below.

#### 5.4.4.2 Results

Members of the energy user community can be characterised in terms of three global variables: their *attitudes*, *knowledge*, and *behaviour* in relation to energy use. A simple user model can be characterised in the figure 31 below.

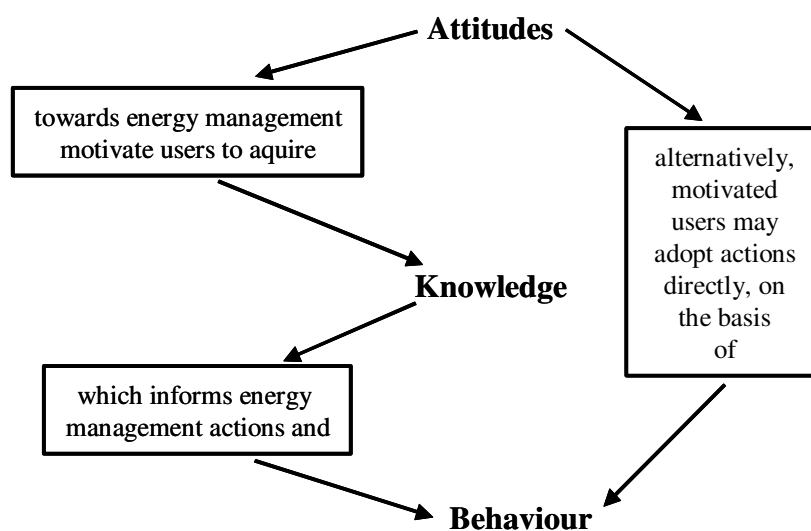


Fig.31: GMIT survey energy user model (Murnion in Costello *et al.* 2003)

The questionnaire provided answers in relation to each of these variables and how they interact.

#### **5.4.4.3 Attitudes**

User attitudes to energy conservation were very positive. Almost nine out of every ten respondents totally agreed that energy conservation was important. More specifically, when asked whether conservation was good because it saved money or because it helped the environment, only 4% favoured the financial argument. Opinion in the user community is overwhelmingly consistent about the goal of energy management in favour of the environment. The next question is whether the positive impact has been translated into useful knowledge.

#### **5.4.4.4 Knowledge**

User knowledge consists of general knowledge of energy conservation (the context), technical knowledge (how to 'do' energy conservation), and knowledge about the specifics of energy conservation in GMIT.

##### General Knowledge

Energy conservation in GMIT does not occur in isolation. There are targets and strategies at an international, national and sector level. The general knowledge of energy conservation can be described as 'middling'. About one in four had never heard of the Kyoto protocol. However, of those that had, almost two thirds were able to state correctly Ireland's status in relation to the protocol in terms of targets and current position. In contrast, only one quarter were informed on Sustainable Energy Ireland (SEI).

##### Technical Knowledge

Energy conservation and management at this level involves the use of heating, lighting and other power-using appliances. Basic technical knowledge of these appliances is important in any energy conservation strategy.

Technical knowledge was quite poor. Almost half were uninformed in relation to energy-using devices such as fluorescent lights and computers, while two-fifths didn't know if their office PC was set to save energy.

### GMIT Energy Knowledge

Knowledge about the energy conservation in GMIT can be divided into two types. The first is basic knowledge about the physical energy use situation at GMIT. The second is knowledge about the current approach at GMIT to energy conservation. Since one in six respondents mentioned turf as an energy source at GMIT, although it has not been used in two years, it is reasonable to infer that there is a need for further information on the basic energy situation. The situation in relation to energy management approaches was however, worse. Only a quarter of respondents were aware of GMIT energy initiatives, rising to nearly one third among students, while a third did not know which office (Development) is responsible for energy management at GMIT.

#### **5.4.4.5 Behaviour**

Although user attitudes and knowledge are important drivers of energy conservation, ultimately 'soft' energy management works only when users take actions such as modifying their behaviour. The questionnaire examined two types of actions: those in a general energy context and those specifically related to GMIT. Respondents were very active in relation to energy management in their home context. On average respondents already apply an average of 3.8 energy-saving measures at home. The picture in relation to actions in GMIT was more mixed. Respondents were active in switching off lights when leaving rooms, but less inclined to control heat by closing windows or adjusting radiators. PC (personal computer) energy management was definitely in place in only about one half of offices and labs. Interestingly, users were more active where they had more control, in their offices as opposed to labs and classrooms.

#### **5.4.4.6 Behaviour Survey Conclusions**

Referring to the original model of the user the situation can be summarised as follows. Users are very positive about energy conservation on an environmental basis. However knowledge of the energy management is poor on both the larger scale and on specifics. Notwithstanding the lack of knowledge users are already taking actions to conserve energy, particularly where they see results and understand the particular

problem. In any programme dependent on a user community there has to be a balance of top-down guidance and bottom-up activity. Clearly a greater supply of information both general and specific is required. In relation to user actions, clear guidelines are required, specifying specific actions in specific contexts and clarifying responsibilities whether those of the user or those of the institution.

The following actions were recommended:

1. The provision of 'context' information such as energy consumption updates to all members of the user community.
2. The provision of guidelines on what actions users should take and what actions will be the responsibility of Institutional systems.
3. Specific instructions to energy users regarding precise actions which can be taken.

## **5.4.5 Student RUE Initiatives**

### **5.4.5.1 Introduction**

The Student Environmental Society and the Student Marketing Society undertook a room Electricity Survey and organisation of an Energy Awareness Day. For a period of the project, these societies became a sub-team of the main RUE team. Including the student population in the RUE project was regarded as very important. It was particularly encouraging to have the enthusiastic participation of these student societies under the umbrella of the GMIT branch of the Union of Students in Ireland (USI). The initiatives were proposed and carried out by the students themselves.

### **5.4.5.2 Scope and Methodology**

The societies saw the challenges as:

- Promoting the use and understanding of an energy logo.
- Organisations of an Energy day to further strengthen the communication campaign.

### 5.4.5.3 Results

In order to develop an appropriate communication strategy for the Energy Efficiency logo the following positioning statement was developed by the student team:

*“The Galway Mayo Institute of technology recognises the need to employ a responsible approach to the Rational Use of Energy in all its Institutions, and strives to incorporate a spirit of energy consciousness in its operations both internally and within the community. As a focal point of the educational environment in the community, GMIT also accepts the responsibility of being a leader in the conveyance of information regarding the conscious and responsible use of Energy”*

A slogan was also developed with the recommendation that it be placed in classrooms and labs alongside the new logo (figure 32). It was recommended that a sticker campaign on lights and electrical equipment should be used to remind people to turn them off once finished. The use of the colour green would be used to emphasise the “greening” of the college.

**“GMIT-Teaching Energy-Learning Energy”**

**Fig.32:** Student Energy slogan

An education and promotion campaign to publicise the logo and slogan was proposed by the sub-team to include:

- Poster campaign, using Art students based at the Cluain Mhuire campus.
- “What’s happening sheet” monthly article.
- Screen savers illustrating the RUE logo.
- An article about energy efficiency to be discussed at Class representatives council meeting.
- Continuous reminders/ promotion every 3 weeks.
- Memos to staff.
- Posters on office doors.

In addition to the promotion and education campaign it was decided to hold an Energy Day on Campus. This entailed information from the Galway Energy Agency, Sustainable Energy Ireland and information about procedures adopted on campus.

The sub-team also proposed that the Institute should be looked on as a number of diverse groups and needed to be targeted differently i.e. Staff , Student, Night course attendees, and Caretakers.

#### **5.4.5.4 Room electricity Survey**

The Marketing Sub-tem and other members of the Marketing Society took a random selection of six rooms and surveyed them over a period of one week. The results were published in conjunction with the Energy Day to highlight to the target audience the extent of ineffective energy usage on campus. Over the course of a one-week period, commencing on the 24<sup>th</sup> March 2003, six classrooms were surveyed at various time periods. Each room was viewed at 10 minutes past the hour and relevant data recorded. The number of free hours per week was calculated.

##### Analysis of room survey

After analysing the data (reference Appendix G) the following results were obtained:

- 34% of the rooms surveyed had lights left on even though there was no class occupying the room at the time.
- 66% of the rooms surveyed had no lights on, indicating that the rooms had either not yet been used that day or that the previous occupiers had switched off the lights on leaving the room.

#### **5.4.5.5 Energy Awareness Day 2003**

In conjunction with the environmental society, the sub-tam organised an Energy Awareness Day on Wednesday the 30<sup>th</sup> April 2003, to highlight the findings of the group and to distribute any other relevant information to both students and staff. Information leaflets and pamphlets were obtained from Sustainable Energy Ireland, Galway Energy Agency Limited and relevant web-sites. The stand contained information on:

- The importance of Rational Use of Energy.
- Computer Myths and facts.
- ESB Ballpark costs – what you can get for your money.
- Domestic energy efficiency.

- Energy conservation.
- Important facts about energy consumption.
- What can be done about Climate change?
- Wind and Solar energy.
- Understanding Domestic Energy.
- Waste Energy and Wood energy.
- What is Renewable Energy?
- Energy use, the environment and you.
- Heating systems.

The exhibit was visited by a large number of staff and students. A number of photographs were taken over the course of the day including the one below (figure 33) showing the members of the student sub-team with Ms Marion Coy, Director of GMIT and Mr. Bernard O’Hara, Registrar of GMIT.

The Student Environmental society was delighted to get the opportunity to be part of the Energy Day and undertook the task enthusiastically. The information stand was organized with colourful posters and arranged with the large amount of information that had been collected. There was an encouraging response with many members of the Institute having a genuine interest in energy conservation. It also demonstrated the importance of involving the student population in any Educational energy initiatives.



**Fig.33:** Energy Day 2003 Photo: Mr. Bernard O’Hara, Ms Marion Coy with student team



## **5.4.6 Energy Saving Guidelines**

### **5.4.6.1 Introduction**

A number of people during the course of the project expressed a willingness to save energy, but were unsure of what to do. To address this issue, a set of power consumption guidelines were drawn up and are contained in Appendix D. The guidelines concern electricity usage and specifically address personal computers (PCs) and lights. Tufts University is an educational role model in this area and has a very proactive energy programme (Tufts 2003). The site contains much useful information and references. The GMIT guidelines are based on the Tufts Climate Initiative Computer Brochure that has been adapted for local use in GMIT.

## **5.5 Conclusions from GMIT RUE project**

The following are the conclusions of the GMIT RUE team:

- The role of the Educational sector is very important in meeting Ireland's stringent obligations under various international agreements. Issues facing GMIT and the higher education sector include:
  - Requirements to adopt energy efficiency targets, practices and procurement policies which will give leadership to the rest of the community by setting an example of best practice.
  - Requirement to reduce costs due to increasing budget pressures.
  - Accountability of public bodies which in practice will require explicit targets and measurement of performance.
  - Electricity Regulation Act, 1999 requirement to purchase electricity generated from renewable sources linked to AER or similar competitions.
  - An obligation to include energy efficiency and CO<sub>2</sub> in Annual Reports.
- The implementation of Irish energy efficiency 'requires significant culture change within an organisation' according to SEI. The use of a specific 'energy logo' is seen as a very effective instrument to enable such a culture change.

- There has been little movement to implement the HETAC guidelines for the higher education sector to support Irish and EU policies in the area of energy and environmental performance.
- GMIT can be a model of best practice in the Higher Education and Public Sector if “energy” and CO<sub>2</sub> containment is given a high priority in the Institute’s policies.
- RUE culture change requires many interrelated tasks that suit a team based implementation approach.
- The use of a Collaborative Virtual Environment (CVE) was found to be very effective support to running the RUE project. It was particularly suited to the team distributed across multiple campuses.
- GMIT electricity charges increased by approximately 24% from 2001 to 2002.
- Almost all of the electricity usage of a computer can be saved if it is put into sleep mode when not in use.
  - An initiative in Castlebar resulted in 70% of computers being switched to power saving with one month.
- The project showed that the implementation of an energy program in three computer rooms resulted in:
  - Power consumption per user being reduced by as much as 35%.
- A room survey showed that 34% of the rooms had lights left on even though there was no class occupying the room at the time. This situation can be targeted for future improvement.
- Reducing the GMIT electricity usage by 20% would result in (per annum):
  - a cost saving of €80,000
  - a reduction of CO<sub>2</sub> emissions of 625 tonnes (which could be liable to a carbon tax in the future)
- The GMIT energy attitude and behaviour survey concluded that:
  - The population is very positive about energy conservation on an environmental basis.
  - Knowledge of energy management is poor in relation to the global context (Kyoto Protocol, etc.). Technical knowledge, about devices and power consumption, was also lacking. Finally, there was uncertainty about what specific actions to take in the Institute.

- There is little awareness about the existence of Sustainable Energy Ireland (SEI), which is the government agency responsible for meeting the national Kyoto targets.
  - Users are already taking actions to conserve energy, particularly where they see results and understand the particular problem.
  - Users are particularly active in relation to energy management in their home context.
  - Clear guidelines are required, specifying explicit actions in particular contexts and clarifying responsibilities whether those of the user or those of the Institute.
- GMIT should include an energy management positioning statement in the Institute's future strategy roadmap.
  - The Student Environmental Society was delighted to get the opportunity to organise the GMIT Energy Day. Involvement of students was a very important part of the RUE project. There was an excellent response to the Energy Day from staff and students. Students are enthusiastic about this topic and want to be involved in making GMIT an example of best practice.
  - The project resulted to an even bigger recognition when GMIT was selected by SEI as one of the five regional centres to host a one-day Workshop and Information Event on September 23<sup>rd</sup>, 2003 as part of National Energy Awareness Week.

### **5.5.1 Recommendations**

The team recommendations were distributed over three areas, policy, activities and technology.

#### **5.5.1.1 Policy:**

- Adoption of RUE logo as part of the GMIT corporate brand.
- GMIT to give leadership to the Higher Education Sector and to the rest of the community by a policy commitment to best practice in energy usage.
- GMIT to adopt the positioning statement on energy management proposed by the GMIT student Marketing Society.

- Investigate obligation to purchase ‘green electricity’ under terms of Electricity Regulation Act, 1999.
- Promotion of collaborative virtual environments to manage cross campus teams and projects.

#### **5.5.1.2 Activities:**

- Logo stickers to be placed on classroom and office light switch.
- Annual GMIT Energy Awareness Day to be organised by the Students Union.
- Provision of guidelines on what actions users should take and what actions that are the responsibility of the Institute.
- Include Energy Awareness in Induction Days for Staff and Students.
- Energy awareness to be placed on the agenda for the Class Representatives Council.
- Provide the GMIT user community with information on the basic energy situation in GMIT and the functional responsibilities.
- GMIT to be proactive and provide a CO<sub>2</sub> balancing statement in the Annual Report.

#### **5.5.1.3 Technical**

- Logo to be placed on PC desktops and incorporated in a screen saver.
- Investigate feasibility of cloning PCs to shut down at specified times.
- Dedicated RUE website to be commissioned.

### **5.5.2 Sustain Phase**

Many of the recommendations of the project team have now been put in place including:

- GMIT has now got a dedicated RUE website (RUE 2004).
- This site includes specific PC energy saving instructions.
- ICT training in the Institute includes information on energy saving guidelines and the URL of the RUE website.
- Energy Policy for the Institute has been provided (Appendix K).
- RUE is included in the GMIT five-year strategy document.

Data made available in May 2004, one year after the conclusion of the project showed that the implementation of the RUE recommendations has made a significant contribution to a net decrease of 6% in electricity usage in GMIT during 2003-2004. This was in a period where the real estate grew of the Institute increased by 40%. The focus on monitoring and targeting has identified that 25-30% of electricity is used at night, when the college is closed, and a program is now being put in place to address this situation.

## 5.6 Chapter Conclusions

The structured methodology proposed in chapter four was tested during the RUE (Rational Use of Energy) project undertaken by a multi-disciplinary team in the Galway-Mayo Institute of Technology from January to May of 2003. The project was conducted as part of the “Partnership IT” program. It involved participation from four geographically dispersed campuses, Galway, Letterfrack, Castlebar and Cluain Mhuire, and the team included six staff and one student. The RUE team focused on electricity usage and completed a number of tasks in the course of the project that included, the profile of electricity usage in all campuses, population survey, a room survey, monitoring of computer labs, development of an energy logo and an Institute Energy Awareness Day. Results reported one year after the finish of the project showed that the implementation of the report findings made a significant contribution to a net decrease of 6% in electricity usage during 2003-2004. The benefit to the Institute was a net decrease of approximately €20,000 in electricity costs and an associated reduction in emissions of 250 tonnes of CO<sub>2</sub>. This had occurred during a period where the campus real estate grew by 40%. The focus on monitoring and targeting has identified that 25-30% of electricity is used at night, when the college is closed, and a program is now being put in place to address this situation. This case study demonstrated that introducing an energy efficiency culture in an organisation requires many interrelated tasks suited to a team-based approach. It also confirmed that the management of the project in a web-based collaborative virtual environment facilitated the multi-site implementation and execution of the project.

## **Chapter Six: Case Study II – BEM Energy Consultancy**

- 6.1 Introduction
- 6.2 Association of Energy Professional in Ireland (AEPI)
- 6.3 Overview of BEM Energy Consultancy
- 6.4 Set up of BEM E-Services in the CVE
- 6.5 Case II: Conclusion

### **6.1 Introduction**

Chapter four outlined a prototype model for a team-based energy management process and chapter five described a case study of a trial of the process in an organisation. The STEMS process was designed for energy teams that have little expertise or training in the area of energy management. However, it was considered that there was a potential need to provide technical support to these teams, especially in the sustaining phase. As a result, the main driver for this second Case Study was to investigate if the Association of Energy Professionals of Ireland (AEPI) could provide web-based technical support to users of the STEMS process. A second motive was based on the literature review undertaken in chapter two that highlighted the emerging market for energy services and the priority of using information technology to provide these services. This chapter presents the preliminary development of a web-based energy service in a Collaborative Virtual Environment for a member of the AEPI, Building & Energy Management (BEM) based in Kilcolgan, Co. Galway. The pro-active director of the company also wished to explore the viability of developing his business through utilising the web and also to cut travel time to customers for routine requests and reports that could be handled and distributed electronically. Many of the company's clients are distributed around the country and security was a major concern as some

reports were site specific and contained sensitive cost information. However, a good number of reports were of a general nature and could be shared across sites especially in the same organisation. The specification for the web environment included ease of use, ability to control content and no requirement for software development skills. Conveniently, the director of BEM was also the Chairman of the Association of Energy Professional of Ireland (AEPI). The AEPI were also eager to investigate the use of web technologies to expand the energy services market nationally and in the European Union. This is in the context of forecasted growth in demand for services driven by policy, legislation and market demand. The following sections provide an overview of the development process involved in setting up a BEM client with a number of geographically distributed sites using a Collaborative Virtual Environment (CVE). Issues encountered and the lessons learnt are highlighted and general guidelines for organisations planning to embark on a similar development are presented.

## **6.2 Association of Energy Professional in Ireland (AEPI)**

The Association of Energy Professionals of Ireland (AEPI) was formed in 2002 with the objective is to represent the interests of all persons working in the generation or demand side management of energy in Ireland (ManagEnergy 2004). With over eighty members, the stated role of the AEPI (figure 34) is to assist the government bodies at local and national level, in delivering the many energy related policies and programs. Members are drawn from engineering, technical and managerial backgrounds. Areas of expertise include:

- All Engineering Disciplines
- Energy Market Specialists
- Carbon Abatement / Levy Specialists
- Buildings Specialist

The AEPI members seek to work in partnership with the Energy sector, Industry, Commerce, Health, National Government Agencies and Local Government Agencies to implement energy policies and programs.



Fig.34: AEPI logo

### 6.3 Overview of BEM Energy Consultancy

Building & Energy Management (BEM), based in Kilcolgan, Co. Galway, offer a range of consulting and project management services associated with energy and environmental management (figure 35).



Fig.35: BEM Company Logo

The company markets energy management services as being essential today for all organisations seeking to operate in a world of diminishing resources, and environmental concerns. Services provided by BEM are listed in the table 17.



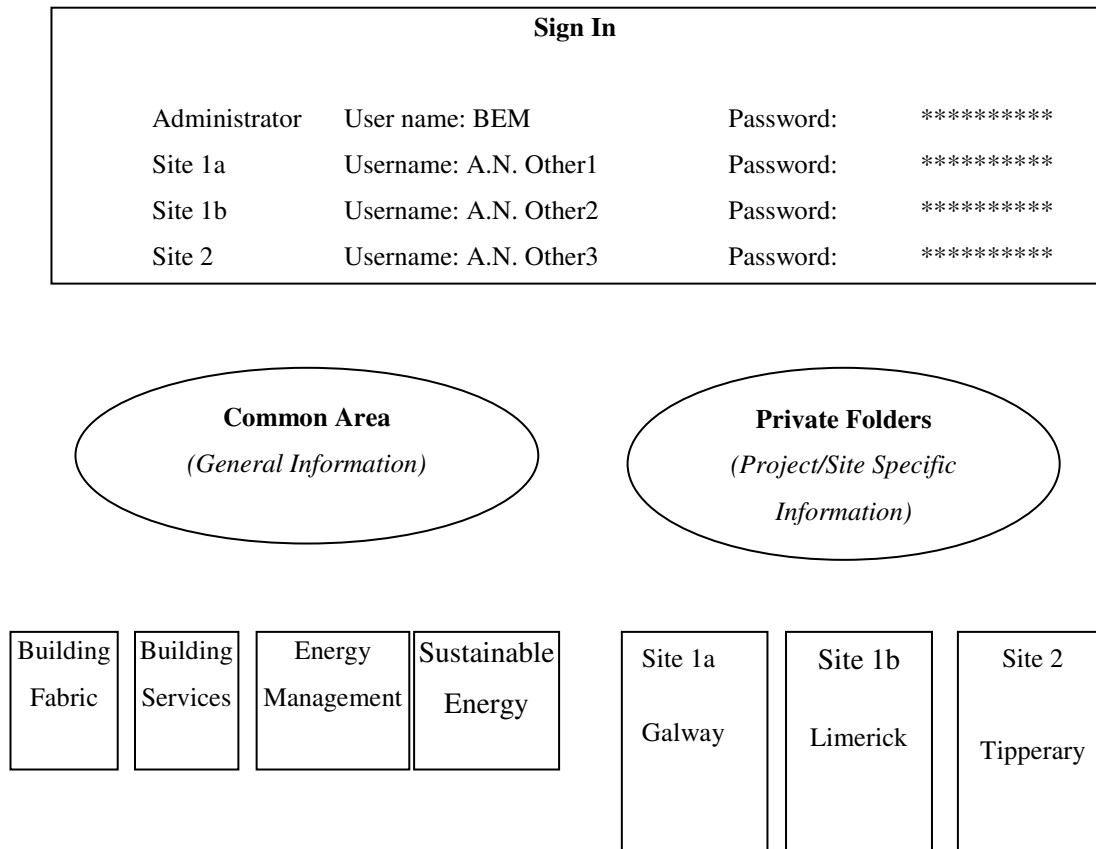
**Table 17:** BEM energy services

<ul style="list-style-type: none"> <li>• Rapid results energy surveys</li> </ul>	<ul style="list-style-type: none"> <li>• Detailed energy surveys and audits.</li> </ul>
<ul style="list-style-type: none"> <li>• Bureau Energy Management.</li> </ul>	<ul style="list-style-type: none"> <li>• Utility purchasing reviews and fuel supply tariff analysis.</li> </ul>
<ul style="list-style-type: none"> <li>• Management reports on energy use, cost and conservation.</li> </ul>	<ul style="list-style-type: none"> <li>• On-going utility monitoring and target setting.</li> </ul>
<ul style="list-style-type: none"> <li>• The administration of good housekeeping programmes.</li> </ul>	<ul style="list-style-type: none"> <li>• Energy awareness campaigns.</li> </ul>
<ul style="list-style-type: none"> <li>• Staff energy training and education programmes.</li> </ul>	<ul style="list-style-type: none"> <li>• Energy efficient design.</li> </ul>
<ul style="list-style-type: none"> <li>• On-going management of maintenance contracts.</li> </ul>	<ul style="list-style-type: none"> <li>• Alternative energy schemes.</li> <li>• Environmental studies and audits.</li> </ul>
<ul style="list-style-type: none"> <li>• Combined heat and power studies.</li> </ul>	<ul style="list-style-type: none"> <li>• Investment appraisals.</li> </ul>

The company had also developed software to store and analyse energy consumption and costs, and compare the data against industry benchmarks. The results are then used to advise clients of their energy efficiency and environmental impact. BEM took part in this research to explore the use of the World Wide Web as a means of disseminating general and project specific data to clients and to develop new business.

## 6.4 Set up of BEM E-Services in the CVE

For the purpose of this study, BEM chose two sites from one client (to be referred to as Site 1a and Site 1b) and one site from another client (to be referred to a Site 2). The architecture of the client services in the CVE is shown in the figure 36. BEM were given control the administrator function, which allowed uploading of documents and access to folders, by users. The login front-end of the CVE is shown in figure 37.



**Fig.36:** BEM client structure within the CVE

The CVE was set-up to allow all clients to view the common area folders containing generic information on Building Fabric, Building Services, Energy Management and Sustainable Energy. Each site then had a private folder, which, by setting the password protected administration privileges, could only be viewed by that particular client. The procedure to set up the CVE web environment was quick and simple. Initially, BEM the following information to the CVE administrator:

- The homepage layout.
- Structure required for clients (figure 36 above).
- Files for common and private folders.
- Usernames and passwords

The files were in standard word processing and presentation software packages. The CVE software was configured in a matter of a few hours and then BEM was immediately live on the World Wide Web. BEM was given administration privileges to allow uploading of files and the ability to add and remove clients. The administration could be carried out with a basic level of computer literacy. Figure 37 shows the Home Page of the BEM E-Services in the CVE.

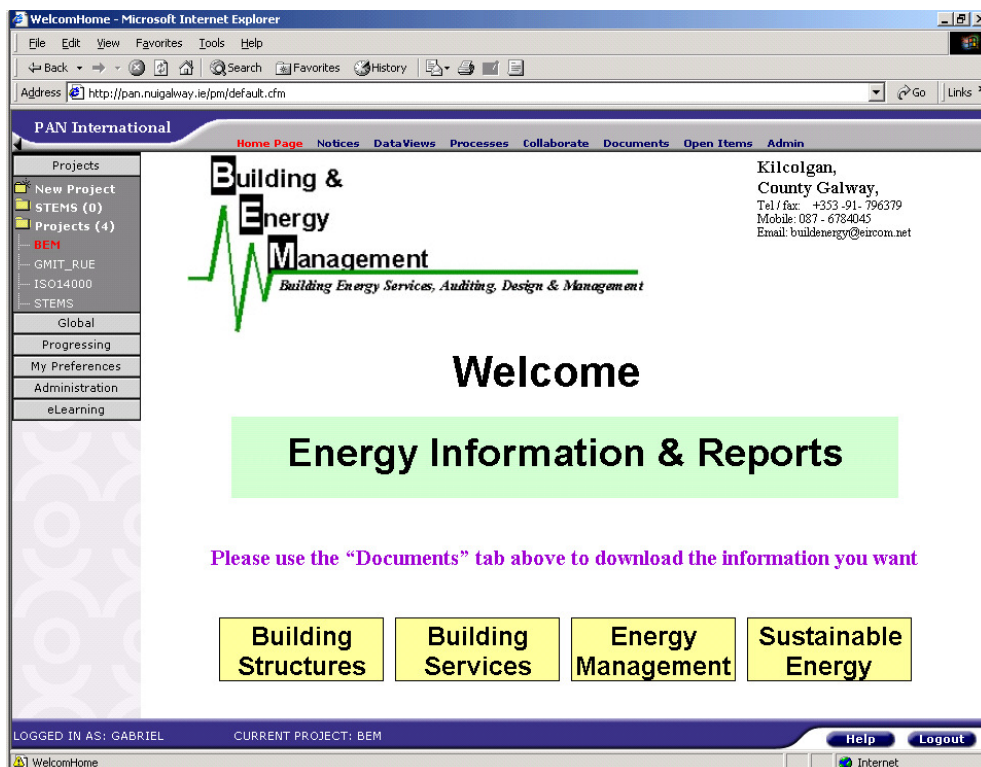


Fig.37: User front-end for BEM services in the CVE

## 6.5 Case II: Conclusion

In line with the EU recommendations to provide electronic energy services to SME, this study explored the possibility of establishing e-Services in conjunction with the AEPI. The main conclusions of this case study of the trial with BEM consultancy are outlined below.

### (a) Positive Feedback Aspects

- Energy professionals have recently formed an association (AEPI) to support the implementation of energy policy and develop energy services
- Energy consultants are eager to utilise web-based technologies to improve their present services and to increase business efficiency by removing duplication of work and unnecessary travel.
- Energy professionals see the World Wide Web as a means increasing business opportunities in the EU in the context of forecasted growth in demand for energy services driven by Policy, Legislation and Market demands.
- The Collaborative Virtual Environment provided a very easy mechanism for BEM to have a web presence.
- The architecture of the CVE is conducive to managing a number of customers that can share common information while at the same time protecting sensitive information.
- The networking features of the CVE can facilitate information sharing and communication between Consultant and client and between clients.

### (b) Negative Feedback Aspects

- There was a concern from BEM that the security of any information placed on the CVE server and protection from unauthorised access.
- There is hesitancy among clients to use web-technologies as clients still prefer the familiarity of face-to-face meetings and personal contact.
- The trial was limited in its scope given the time and resources available.

## Chapter Seven: Collaborative Process Model

- 7.1 Introduction
- 7.2 Process Rationale and Overview
- 7.3 Process Framework
- 7.4 General Information and Resources
- 7.5 Process Flow
- 7.6 Feedback on STEMS
- 7.7 Gap Analysis
- 7.8 Conclusions

### 7.1 Introduction

This section contains a detailed description of the steps, deliverables and templates contained in the process model that was developed based on the prototype presented in chapter four and the case studies described in chapters five and six. This process called STEMS (Structured Team-based Energy Management System) has been developed to implement energy programs in small and medium sized organisations. It incorporates a toolset called the STEMS wizard to train and provide resources for energy teams that have little or no experience in the area of energy management. The process is delivered through a web-based collaborative virtual environment. The intended audience is the large number of SMEs and public and private organisation that need to become energy efficient if the country is going to meet the challenges of the Kyoto Protocol and any other follow-on international agreements that have yet to be negotiated.

A basic level of computer literacy is required to navigate the environment and download templates. The process has three main phases, each of which concludes with a project review with the Energy Team Sponsor. STEMS is similar to methodologies used in product development and project management processes that

were discussed in chapter three. References to more detailed information and guidelines that the team can consult are also provided. At the end of each phase, the team is required to give a presentation to the executive sponsor using the format suggested in the review template. The process focuses on “no-cost” and “low cost” measures that can be implemented quickly.

## **7.2 Process Rationale and Overview**

This thesis proposes that in order to meet the significant challenge of implementing energy efficiency in small and medium sized organisations, energy efficiency must be addressed through company learning and organisational change. The approach is unique but compliments and utilises developments and research at the skills and operational levels of energy management. The Structured Team Based Energy Management system (STEMS) developed in the course of the research provides a conceptual and process model, which goes beyond conventional energy training and good practice guidelines. Such models and theories are essential tools of research in stimulating the advancement of knowledge (Bell 1999; Cohen and Mannion 1994). The framework for change has the flexibility to be structured and applied to the needs of small and medium sized organisations in the industrial, commercial and public sectors

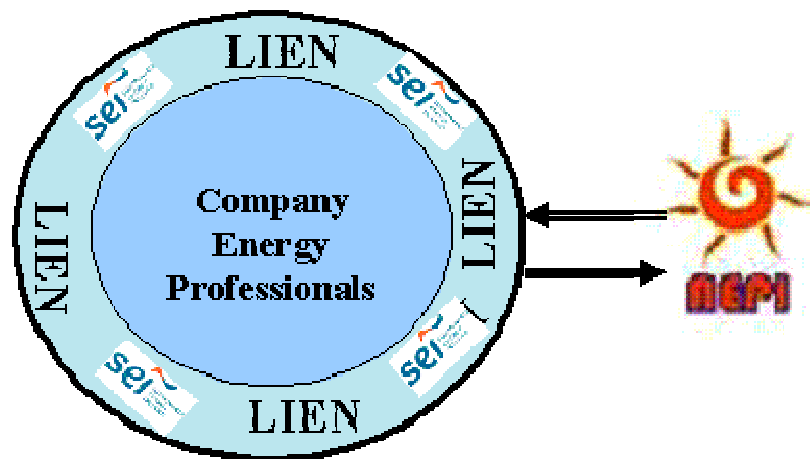
STEMS extends the structure used in the Large Industry Energy Network (LIEN) to the realm of the small and medium sized organisation using web-technology networking combined with self-learning process methodologies. A successful implementation of STEMS can provide organisations with the experience and impetus to progress to programs such as EMAS (EMAS 2004) and ISO14001. Presently, energy management is not integrated into environmental management systems (EMS) and there is a need to integrate and emphasise energy management within EMS (e.g. EMAS, ISO14001) (Amundsen 2000).

STEMS integrates collaborative technology and people such as policy makers, energy users, educators and professional energy managers to facilitate organisations to become energy conscious and efficient. The process is intended as a bottom-up approach

that will allow interested and committed members to make an impact in a relatively short period of time. The focus is on awareness and behaviour among the general population of the organisation combined with influencing people in key positions. This methodology contrasts with that provided by Action Energy or outlined in the UK Higher Education Funding Councils report that take top-down approaches, which require formal energy training and education. The evidence presented in chapter five suggests that the bottom up approach suits the modern “learning organisation” and can be implemented quickly and successfully while linking with a senior management sponsor to gain top management support.

The following figures attempt to capture the development of a structure to support small and medium sized organisations (SME++) to complement the Large Industry Energy Network and improve on the present situation where there is weak support for this sector.

1. Figure 38 depicts the close interaction that currently exists between the LIEN and SEI. There is also a good link to energy professionals when back-up expertise is required.



**Fig.38:** LIEN Interaction between policymakers (SEI) and energy professionals (AEPI).

2. Figure 39 shows the very weak connection between the policy makers, SEI, and the energy professionals, AEPI, with small and medium sized organisations.

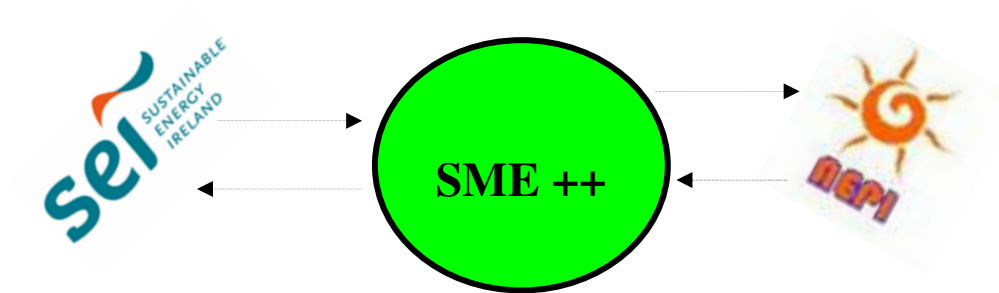
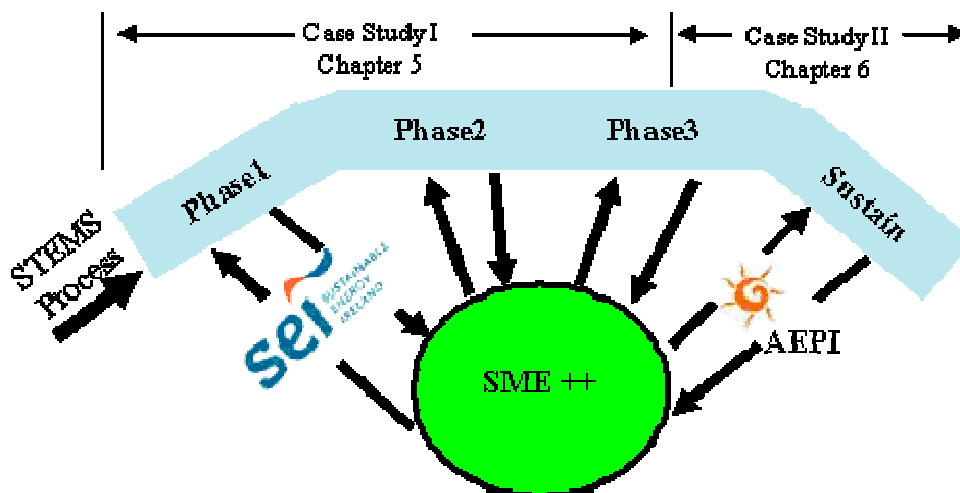


Fig.39: Interaction between policymakers (SEI) energy professionals (AEPI) and SME++ sector

3. Figure 40 shows how the stems process can provide a link between SEI and small and medium sized organisations particularly at the beginning of the process as tested in Case Study I. It also shows how the AEPI can link into this sector particularly in the sustain phase when an organisation has developed some energy efficiency experience as explored in Case Study II.

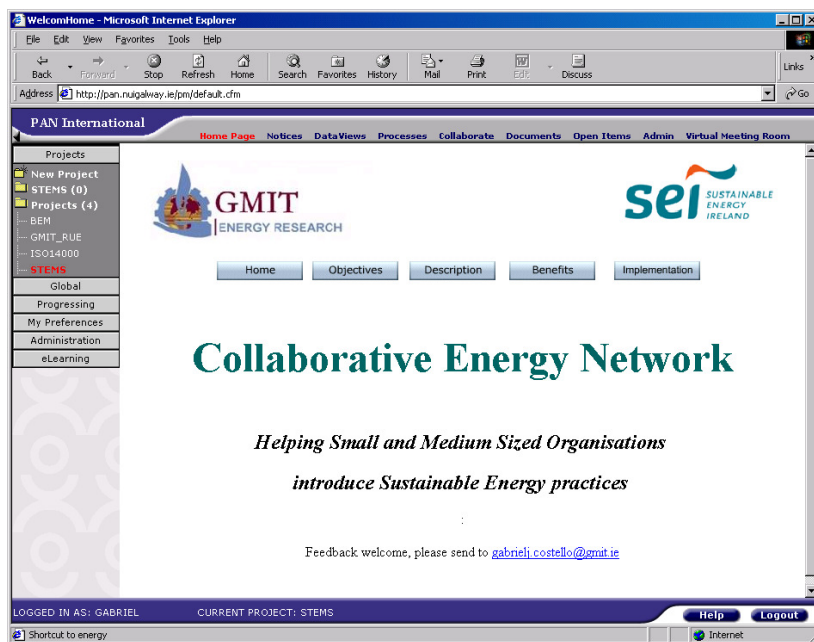




**Fig.40:** Architecture of STEMS process integrating SEI and AEPI

## 7.2.1 Requirements for Using the Process

The process incorporates a toolset called the STEMS wizard to train and provide resources for energy teams that have little or no experience in the area of energy management. A basic level of computer literacy is required to navigate the environment and download templates. The STEMS Home Page is shown in figure 41, which is similar to that presented in figure 26 for Case Study I, and in figure 37 for Case Study II. Instructions on how to access this CVE can be found in the Quick Reference Guide in Appendix L.

**Fig.41:** STEMS CVE Homepage

### 7.3 Process Framework

The process has three main phases, each of which concludes with a project review with the Energy Team Sponsor and/or Senior Management. Phase One involves forming the Energy Team within the organisation. A number of process steps offer guidance and templates that the team can adapt to their particular circumstance. References to more detailed information and guidelines that the team can consult are provided. At the end of Phase One, the team gives a presentation to the Sponsor using the format suggested in the STEM\_1 Review template. The goal here is to ensure that there is support in the organisation for the initiative. The management reviews are integral to the successful implementation of the process as they provide progress milestones for the team, formal interaction with the Sponsor and provide the go-ahead to the next phase.

Phase Two involves project planning and data gathering on the energy use in the organisation. The energy data should be translated into CO<sub>2</sub> output figures for the organisation. This has a twofold objective: raising the awareness of the environmental impact of energy use and preparing the organisation for carbon taxes and other emissions based economic instruments or legislation. The steps in Phase Two provide guidance and simple templates that the team can adapt as required. A concise energy policy template is provided that is geared to a low energy use organisation. Phase 2 is completed with the STEM\_2 Review with the Sponsor. The goal is to gain support to proceed with implementation of the plans.

Phase Three involves implementation of the plans presented at the STEMS\_2 review. It consists of an awareness and education program, an energy survey and a review of the purchasing of energy. The deregulation of the energy market has resulted in enhanced customer focus and information systems by suppliers. However it is important that an organisation is proactive in pursuing the best deal. The STEM\_3 review concludes this phase and is also the final major project milestone. The review provides a presentation to the Sponsor and Management on the achievements of the project, barriers in the organisation to the rational use of energy, conclusions and recommendations. The project team should complete the feedback loop by providing suggestions for future work by similar energy project teams. Finally the “sustain” section of the project is included as an epilogue to the three main phases. The objective

is to ensure that the project successes are maintained by building them into the existing processes of the organisation.

Figure 42 shows the process topology with the main phases of the system and the steps to be carried out in each phase. The positions of the main project reviews are also indicated.

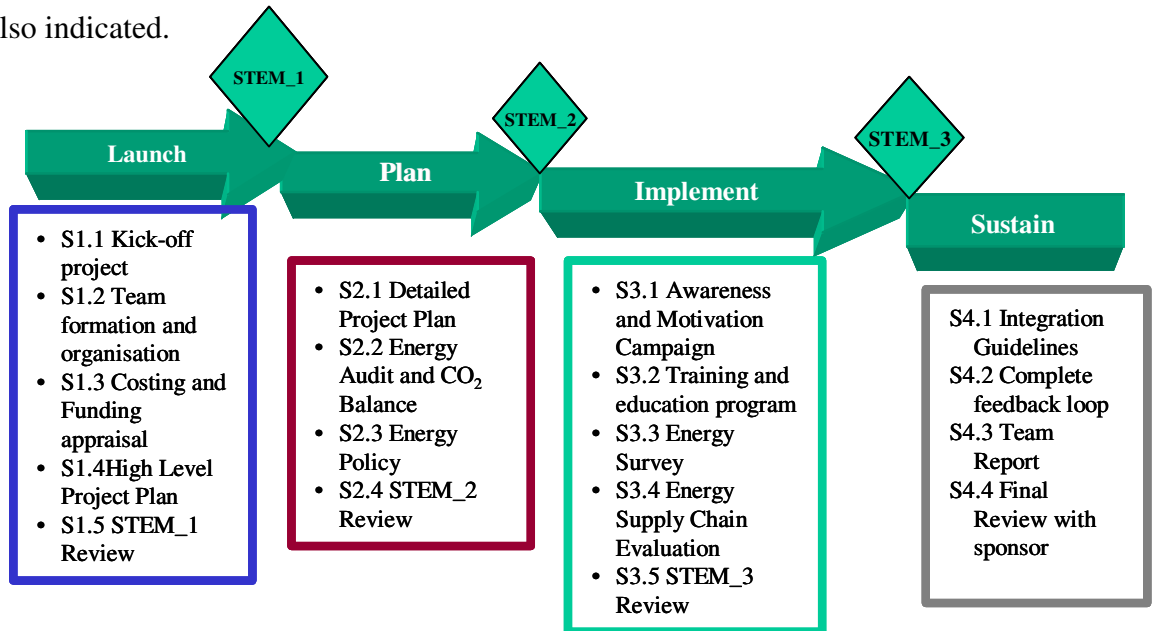


Fig.42: STEMS workbench and workflow showing Steps, Deliverables and Templates

### 7.3.1 Reading Key

The STEMS wizard makes use of Name, Guidance, Links and References to explain the process step and guide the user. These are presented in boxes as they appear in the Collaborative Virtual Environment (CVE). Table 18 illustrates the keys used in the Process and their functions

Table 18: Reading Key to the STEMS Process

Key	Function
<i>Name</i>	STEMS provides a step-by-step process for the project team to follow. This cell contains the name of the process step.
<i>Aim</i>	This cell describes the aim or goal of this process step.
<i>Guidance</i>	The Guidance cell provides direction to the project team on how to carry out this particular step.
<i>Link</i>	The link provides the URL of the resource or template(s) recommended for this step.
<i>References</i>	This cell contains references to more detailed information and publications associated with this step.

### 7.3.2 Summary of Phases and Table References

Table 19 contains a summary of the resources and reference tables in the STEMS process for each phase. Detailed information on each step is provided in each of the individual tables. The information in each table is structured in a similar way to the way it appears in the CVE.

**Table 19:** Summary table of STEMS resources

Phase	Name of Process Step	Table number
<b>Information Resources</b>	STEMS Process Overview	20
	Sustainable Energy Ireland (SEI)	21
	UK Action Energy	22
	Irish Green Paper on Sustainable Energy	23
	European Commission: Directorate-General for Energy /Transport	24
	Danish Energy Agency	25
<b>Phase 1: Launch</b>	S1.1 Kick-off project	26
	S1.2 Team formation and organisation	27
	S1.3 Costing and Funding appraisal	28
	S1.4 High Level Project Plan	39
	S1.5 STEM_1 Review	30
<b>Phase 2: Plan Project</b>	S2.1 Detailed Project Plan	31
	S2.2 Energy Audit and CO2 Balance	32
	S2.3 Energy Policy	33
	S2.4 STEM_2 Review	34
<b>Phase 3: Project Implementation</b>	S3.1 Awareness and Motivation Campaign	35
	S3.2 Training and education program	36
	S3.3 Energy Survey	37
	S3.4 Energy Supply Chain Evaluation	38
	S3.5 STEM_3 Review	39
<b>Sustain</b>	S4.1 Integration Guidelines	40
	S4.2 Complete feedback loop	41
	S4.3 Team Report	42
	S4.4 Final Review with sponsor	43

## 7.4 General Information and Resources

This section provides general information on the format and utilisation of the STEMS process. It also recommends a number of useful resources for the project team on energy efficiency and rational use of energy.

**Table 20:** Process Overview

<b>NAME</b>	<b>STEMS Process Overview</b>
<b>Aim</b>	The aim of this step is to provide an overview of the STEM process
<b>Guidance</b>	The Structured Team-based Energy Management Systems provides a process, called the STEMS wizard, to enable project teams to implement an Energy Management programme. The process consists of three main phases – “Launch”, “Plan” and “Implement” with a concluding part called “Sustain”. Each phase has of a number of steps. Each step contains guidance on how to carry it out and templates that can be used in conjunction with the step. There is a link to the location where the template is stored. References are also provided that the team can consult to get more in depth information on associated topics. A Phase is completed when all the steps are executed and a Management review is held. Management Sponsor approval is required at the review to move on to the next phase.
<b>Links</b>	<a href="http://gmitweb.gmit.ie/eng/stems/">http://gmitweb.gmit.ie/eng/stems/</a>

**Table 21:** Important Resource: SEI

<b>NAME</b>	<b>Sustainable Energy Ireland (SEI)</b>
<b>Aim</b>	To provide an overview of SEI and how to access energy information
<b>Guidance</b>	<p>Sustainable Energy Ireland (SEI) is Ireland’s national energy agency. SEI has a mission to promote and assist the development of sustainable energy. This encompasses environmentally and economically sustainable production, supply and use of energy, in support of Government policy, across all sectors of the economy. Its remit relates :</p> <ul style="list-style-type: none"> <li>• to improving energy efficiency</li> <li>• deployment of renewable energy sources and combined heat and power</li> <li>• reducing the environmental impact of energy production and use, particularly in respect of greenhouse gas emissions.</li> </ul> <p>SEI manages programmes aimed at:</p> <ul style="list-style-type: none"> <li>• assisting deployment of superior energy technologies in each sector as required</li> <li>• raising awareness and providing information, advice and publicity on best practice;</li> <li>• stimulating research, development and demonstration (RD&amp;D)</li> <li>• stimulating preparation of necessary standards and codes</li> </ul> <p>Bookmark the SEI website as it is will be a key resource during implementation of the project.</p>
<b>Links</b>	<p>For general energy information <a href="http://www.sei.ie">www.sei.ie</a></p> <p>For renewable energy information <a href="http://www.sei/reio">www.sei/reio</a></p>

**Table 22:** Important Resource: Action Energy

<b>NAME</b>	<b>UK Action Energy</b>
<b>Aim</b>	To provide instructions on registration with Action Energy
<b>Guidance</b>	<p>The UK Government has set up an organisation called the Carbon Trust to spearhead the drive to reduce carbon emissions. The main programme operated by the Carbon Trust to assist businesses and the public sector is called Action Energy.</p> <p>The Action Energy website contains an extensive database of guides, case studies and references. Organisations outside of the UK can register on-line and download the publications.</p> <p>It is recommended that you visit this site and register. The registration process involves providing your email address and choosing a password. Action Energy provides many of the references suggested in the STEMS steps. Once you have registered, you can locate the guide using the “search” facility. These publications can be downloaded in PDF format. Many of the publications are large files and will take a long time to download on a modem connection.</p>
<b>Link</b>	<a href="http://www.actionenergy.org.uk">www.actionenergy.org.uk</a>

**Table 23:** Summary of Irish Green Paper

<b>NAME</b>	<b>Summary of Irish Green Paper on Sustainable Energy</b>
<b>Aim</b>	To provide instructions on how to access Irish Green Paper
<b>Guidance</b>	<p>This Irish Green Paper on Sustainable Energy indicates how Ireland will progress towards meeting its energy requirements in an environmentally and economically sustainable way having regard to forecast economic growth and security of supply objectives.</p> <p>A link is provided to an executive summary of the Green Paper. Further background information is contained in the National Climate Change Strategy that is available from the Environmental Protection Agency.</p>
<b>Link</b>	<a href="http://www.irlgov.ie/tec/energy/greenpaper/execsum.html">http://www.irlgov.ie/tec/energy/greenpaper/execsum.html</a>

**Table 24:** EU Energy Website

<b>NAME</b>	<b>European Commission : Directorate-General for Energy and Transport</b>
<b>Aim</b>	To provide direction on how to access EU energy information
<b>Guidance</b>	The Directorate-General for Energy and Transport is responsible for developing and implementing European policies in the energy and transport field. Its mission is to ensure that energy and transport policies are designed for the benefit of all sectors of the society, businesses, cities, rural areas and above all of citizens. The energy and transport sectors are pivotal to the European way of life and to the functioning of the EU economy and as such their operation have to be responsible in economic, environmental, safety and social terms. Connect to this site and choose “Energy” for information on European policy and programmes.
<b>Link</b>	<a href="http://europa.eu.int/comm/dgs/energy_transport/index_en.html">http://europa.eu.int/comm/dgs/energy_transport/index_en.html</a>

**Table 25:** Danish Energy Agency

<b>NAME</b>	<b>Danish Energy Agency</b>
<b>Aim</b>	To provide direction on how to access the Danish Energy Authority
<b>Guidance</b>	The Danish Energy Agency has comprehensive information in English on energy management. Denmark has a well-established set of energy standards. Further information can be obtained from the website below.
<b>Link</b>	<a href="http://www.ens.dk">http://www.ens.dk</a>



## 7.5 Process Flow

The process flow outlines the steps that should be followed for the project. Each phase has a series of steps to be completed. Guidance, links and templates are provided as well as recommended reference material. In order to view the templates, it is necessary to login to STEMS in the CVE per the instructions in Appendix L.

### 7.5.1 Phase 1: Launch Project

The guidelines and templates for Phase one of the project are provided in this section.

**Table 26:** Step S1.1: Kick-off Energy Project

<b>NAME</b>	<b>S1.1 Kick-off the Rational Use of Energy project</b>
<b>Aim</b>	To identify suitably motivated people and form an energy team.
<b>Guidance</b>	<p>Before starting please ensure that you are familiar with the folder called “STEMS Process Overview”.</p> <p>The first step is to convince your organisation that energy issues are important. You will need to identify and involve a number of people who will become members of the energy team. Also, you need to obtain a senior management sponsor for the project. The purpose of the Sustainable Energy Overview template attached below is to assist you in getting support and embarking on an energy project. Eventually everybody in the organisation needs to be won over to the rational use of energy mentality. The presentation template delivers the message by highlighting:</p> <ul style="list-style-type: none"> <li>• the environmental impact of energy use</li> <li>• cost of energy use</li> <li>• taxation measures and legislation</li> </ul> <p>Adapt the template as required and included your organisations logo in the slide master.</p>
<b>Templates</b>	<a href="#">Sustainable Energy Overview.ppt</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem1">http://gmitweb.gmit.ie/eng/stems/stem1</a>
<b>References</b>	For more details on Sustainable Energy consult: <a href="http://www.sei.ie">www.sei.ie</a>

**Table 27:** Step S1.2: Team formation and organisation

<b>NAME</b>	<b>S1.2 Team formation and organisation</b>
<b>Aim</b>	To provide guidelines for the formation of an effective energy team
<b>Guidance</b>	<p>The STEMS process is designed to facilitate the formation of a team of interested people who are motivated to assist bringing an energy management culture to their organisation. Experience in the area of energy management is not a requirement. The emphasis is on assembling a number of people who can work together as a team and have credibility in the organisation. The role of team leader is important in order to motivate and direct the team through the project steps. Ideally, team members should be from a wide variety of departments if possible. The STEMS process can be introduced as part of other organisational programmes, for instance, Teambuilding initiatives, Management Development programmes, Partnership programmes to maximise senior management support and publicity. Some team building training is recommended at this stage. Information sharing and access is very important and preferably all team members will have access to the collaborative virtual environment. However some key members may not have access due to equipment or skills issues. In such cases, a designated team member with the required skills should act as a mentor and point of contact for information. It is also imperative at this stage to decide on the scope of the project. Electricity is the most used energy source for the majority of organisation and its use can be impacted directly by all members of the organisation.</p>
<b>Templates</b>	<p><a href="#">Team formation template</a>      <a href="#">Team agenda and minutes template</a>  <a href="#">Action Register template</a>      <a href="#">Team contact details matrix</a>  <a href="#">Project Proposal template</a></p>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem1">http://gmitweb.gmit.ie/eng/stems/stem1</a>
<b>References</b>	<p>More detailed information on organisation of energy management :</p> <p><a href="#">Action Energy GPG119 Energy Management :a corporate approach</a>  <a href="#">Action Energy GPG 235 Managing people, managing energy</a>  <a href="#">Danish Energy Authority DS/INF 136 E : Energy Management</a></p>


**Table 28:** Step S1.3:Energy Business Case : investment appraisal

<b>NAME</b>	<b>S1.3 Energy Business Case: investment appraisal</b>
<b>Aim</b>	To ensure the team reviews the financial aspects of the project and build in some incentive or reward into the project.
<b>Guidance</b>	<p>The objective of energy management is to minimise energy costs to an organisation by:</p> <ul style="list-style-type: none"> <li>• Reducing the consumption of energy and exposure to carbon taxation</li> <li>• Paying less for energy</li> </ul> <p>From a financial perspective, energy management initiatives are usually divided into:</p> <ul style="list-style-type: none"> <li>• No cost measures</li> <li>• Low cost measures</li> <li>• High cost measures</li> </ul> <p>The emphasis in the STEMS process is initially on “no cost” measures. Savings of 10-20% is common without the need for capital investment. However, the team should aim to obtain even a modest budget from the Sponsor at the STEM_1 review to cover items such as posters and training literature. The business case template is structured to ensure that the team considers the financial aspects of the project from the start. Having a representative from the finance department on the team or as an auxiliary member to provide advice is a worthwhile consideration. If the team decides that it requires significant funding, then access to financial expertise will be required.</p>
<b>Templates</b>	<a href="#">STEMS Business Case template</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem1">http://gmitweb.gmit.ie/eng/stems/stem1</a>
<b>References</b>	For more details on financial appraisal consult: <a href="#">Action Energy GPG312: Invest to save</a>

**Table 29:** Step S1.4: High Level Project Plan

<b>NAME</b>	<b>S1.4 High Level Project Plan</b>
<b>Aim</b>	To ensure the energy project follows project management practices
<b>Guidance</b>	The high level plan sets out the main tasks and milestones in the project timeframe. STEMS is designed to be completed in a three to four month cycle. Each Phase is concluded with a project review with the Sponsor and Senior Management team. The steps outlined in the template can be adapted to the needs and requirements of the organisation. The structured approach is similar to that used to introduce new projects, products or processes. Having team members that are familiar with this type of methodology is an advantage. Like any project, success will depend on translating the overall objective into specific tasks that has an owner. The High Level Plan will be expanded into a more detailed project plan in Phase 2, the Planning phase.
<b>Templates</b>	<a href="#">High level Project plan template</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem1">http://gmitweb.gmit.ie/eng/stems/stem1</a>

**Table 30:** Step S1.5: STEM\_1 Launch Review

<b>NAME</b>	<b>S1.5 STEM_1 Launch Review</b>
<b>Aim</b>	To obtain management support and deliver a professional presentation
<b>Guidance</b>	This is the first and most important milestone of the project. Here the project must get the required level of organisational support to ensure success. The presentation template specifically requests this support from the Senior Management of the organisation. The terms and scope of the project as well as the membership of the team should be agreed with the Sponsor before the STEM_1 meeting. The presentation template will include many of the items that have been completed using the templates in Steps 1.1 to 1.4 of Phase 1.
<b>READY TO PLAN</b> 	
<b>Templates</b>	<a href="#">Presentation template for STEM_1 review</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem1">http://gmitweb.gmit.ie/eng/stems/stem1</a>

## 7.5.2 Phase 2: Plan Project

The guidelines and templates for the second phase of the project are provided in this section.

**Table 31:** Step S2.1 Detailed Project Plan

<b>NAME</b>	<b>S2.1 Detailed Project Plan</b>
<b>Aim</b>	To develop a detailed project plan for the energy project
<b>Guidance</b>	<p>The detailed project plan builds on the High Level Project Plan and the Project Proposal produced during Phase 1. Here the main project tasks and activities are set out and scheduled within the project timeframe.</p> <ul style="list-style-type: none"> <li>• Ensure that a team member is responsible for each project step.</li> <li>• Each task must be specific and measurable</li> <li>• Each task must have a realistic timeframe</li> <li>• Only include tasks that the team intends doing</li> <li>• Include any assumptions, support, resources or facilities required.</li> <li>• Review at each team meeting and keep it up to date - as with any project things can change frequently</li> </ul> <p>The template is a suggested format – modify to suit scope of project and your preferred format. This can be an advanced project management software product or manual spreadsheet.</p>
<b>Templates</b>	<a href="#">Project plan template</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem2">http://gmitweb.gmit.ie/eng/stems/stem2</a>

**Table 32:** Step S2.2: Energy Audit and CO<sub>2</sub> balance

<b>NAME</b>	<b>S2.2 Energy Audit and CO<sub>2</sub> balance</b>
<b>Aim</b>	To obtain figures on all energy used and associated CO <sub>2</sub> emissions
<b>Guidance</b>	<p>The energy audit consists of the analysis of the energy usage in your organisation over a certain period, one year for example. The STEMS process template deals with a basic type of audit. This involves obtaining the figures for the quantity and cost of each type of energy used by your organisation. It can mainly be done from your desk by analysing energy invoices.</p> <p>The aim of the audit is to determine the quantity and cost of each type of energy that you use in one or all of the following areas:</p> <ul style="list-style-type: none"> <li>• Main site or all sites used by the organisation</li> <li>• One particular building</li> <li>• A sub-set of a site or building e.g. computer room, manufacturing unit, kitchen, workshop</li> <li>• A particular piece of equipment</li> </ul> <p>The result of the Energy Audit should help you decide where to concentrate in order to reduce consumption and CO<sub>2</sub> emissions. The energy audit is an important reference for the Energy Survey that will be undertaken in Phase 3.</p> <p>Note: The Customer Service department of your energy supplier can provide a lot of useful information and reports on your energy usage.</p>
<b>Templates</b>	<a href="#">Energy Audit and CO<sub>2</sub> emissions template</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem2">http://gmitweb.gmit.ie/eng/stems/stem2</a>
<b>References</b>	<p>For more details on formulation of energy audits consult:</p> <p><a href="#">Action Energy GPG311: Detecting energy waste</a></p>

**Table 33:** Step S2.3: Energy Policy

<b>NAME</b>	<b>S2.3 Energy Policy</b>
<b>Aim</b>	To develop an approved energy policy for the organisation
<b>Guidance</b>	An energy policy demonstrates and promotes the commitment of an organisation to the rational use of energy. Energy policies will vary because organisations are different. To be most effective the energy policy should harness and influence the culture of the organisation. The sample template outlines the main areas that are normally covered in an energy policy. It is an important part of the STEMS process as it is a mechanism to put energy management on the organisational agenda.
<b>Templates</b>	<a href="#">Energy Policy template</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem2">http://gmitweb.gmit.ie/eng/stems/stem2</a>
<b>References</b>	For more details on formulation of energy policy consult: <a href="#">Action Energy GPG186 Developing an effective energy policy</a>

**Table 34:** Step S2.4 : STEM\_2 Planning Review

<b>NAME</b>	<b>S2.4 STEM_2 Planning Review</b>
<b>Aim</b>	To provide an update to Sponsor and obtain approval for next stage
<b>Guidance</b>	This is the second milestone of the project and concludes the planning phase and information-gathering phase. This interim review should provide an update to the Sponsor and Senior Management on : <ul style="list-style-type: none"> <li>• Project plan and tasks for the implementation phase</li> <li>• Results of the preliminary audit</li> <li>• Proposal for the energy policy</li> </ul> <p>The objective of the review is to obtain support to move on to the implementation phase of the project. The presentation template will summarise the items that have been completed in step 2.1 to step 2.3.</p>
<b>Templates</b>	<a href="#">Presentation template for STEM_2 review</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem2">http://gmitweb.gmit.ie/eng/stems/stem2</a>

### 7.5.3 Phase 3: Implementation

The guidelines and templates for the third phase of the project are provided in this section.

**Table 35:** Step S3.1: Awareness and Motivation Campaign

<b>NAME</b>	<b>S3.1 Awareness and Motivation Campaign</b>
<b>Aim</b>	To motivate people in the organisation to reduce energy consumption
<b>Guidance</b>	<p>An awareness and motivation campaign is key to the successful implementation of the energy project. This is particularly important where the project is concentrating on “no-cost” and “low-cost” measures. Promotion of rational use of energy will involve communications and marketing techniques. Two templates are provided to assist this step.</p> <p>The awareness survey will help to establish the existing state of knowledge, attitudes and behaviour in relation to energy use. The template provides a set of questions that can be adapted to your organisation. The administration and running of the questionnaire will also help to raise awareness and stimulate interest in the topic. Consider putting the questionnaire on-line, if appropriate for your organisation.</p> <p>The awareness and motivation checklist provides a listing of simple but effective methods to promote the rational use of energy. Information and Communications Technology (ICT) provides many opportunities to get the message across if it is widely used in your organisation.</p> <p>The slogans and sound-bites can be used to broadcast regular energy messages.</p>
<b>Templates</b>	1) Energy awareness questionnaire 2) Awareness and Motivation checklist 3) Slogans and sound-bites template
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem3">http://gmitweb.gmit.ie/eng/stems/stem3</a>
<b>References</b>	<p>For DIY posters: Action energy website: <a href="#">Search for Clip-art</a></p> <p>Free survey website: <a href="http://www.chumpsoft.com/products/phpq/">http://www.chumpsoft.com/products/phpq/</a></p> <p>For more details on promotion and motivation: <a href="#">Action Energy GPG 84: Managing and motivating staff and GP G 235 on managing people.</a></p>



**Table 36:** Step S3.2 :Training and Education Program

<b>NAME</b>	<b>S3.2 Training and Education Program</b>
<b>Aim</b>	Educate and train all people in the organisation on energy efficiency
<b>Guidance</b>	<p>The project should identify the high level training and education needs of the organisation. This step is closely connected to step 3.1. A suggested way to implement this is to adapt the Sustainable Energy Overview Template used in Phase 1. A number of basic templates are included to provide instructions on saving energy by controlling lights, PCs and heating. Remember that many people are unsure of “what to do” and “what they can and are allowed to do”. There are also many myths concerning energy saving practices. The thrust of the STEMS project is to introduce a culture of rational use of energy in an organisation. Integrating the project with training and education initiatives is an important part of this. Some suggestion on how to this:</p> <ul style="list-style-type: none"> <li>• Integrate the rational use of energy into the existing training infrastructure in the organisation.</li> <li>• Train the “Trainers” within your organisation.</li> <li>• Prioritise training of personnel who perform tasks or provide support and services that significantly impact on energy consumption.</li> <li>• Include Energy Related topics in approved CPD (Continuing Professional Development) programmes.</li> <li>• Use on-line facilities if the organisation provides e-Learning.</li> <li>• Other methods based on your knowledge of your organisation.</li> </ul>
<b>Templates</b>	<p><a href="#">Sustainable Energy Overview ( reference step S1.1)</a>  <a href="#">What is a tonne of CO<sub>2</sub>?</a>  <a href="#">PC Power save guidelines template</a>  <a href="#">Lights save guidelines template</a>  <a href="#">Heat Save _template</a>  <a href="#">Unsure what to do template</a></p>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem3">http://gmitweb.gmit.ie/eng/stems/stem3</a>


**Table 37:** Step: S3.3 Energy Survey

<b>NAME</b>	<b>S3.3 Energy Survey</b>
<b>Aim</b>	Carried out a detailed energy survey in the organisation
<b>Guidance</b>	The energy survey is a follow on from the audit that was carried out in Phase 2. It involves examining your location to see if there is energy saving opportunities. The checklist suggests what to review during the examination of a particular area. It is designed to be easy to use and not to require specialist knowledge or training. The focus is on “no-cost” and “low-cost” measures. Also water is included as this is a cost item for most organisations.
<b>Templates</b>	<a href="#">Energy Survey Checklist</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem3">http://gmitweb.gmit.ie/eng/stems/stem3</a>
<b>References</b>	<a href="#">Action Energy GPG 316: Undertaking an industrial energy survey</a> <a href="#">Action Energy GPG 311: Detecting energy waste</a>

**Table 38:** Step S3.4: Energy Supply Chain evaluation

<b>NAME</b>	<b>S3.4 Energy Supply Chain evaluation</b>
<b>Aim</b>	Involve suppliers and customers in energy efficiency
<b>Guidance</b>	There are two methods of reducing energy expenditure: i) Use less energy and ii) Pay less for energy.  The checklist template prompts you to consider many aspects of the purchase and consumption of energy and raw materials and also to influence the energy policy of your Supply Chain Partners.  De-regulation of the electricity market allows an organisation to shop around for suppliers. In Ireland, the Commission for Electricity Regulation is responsible for overseeing this process. Information on suppliers can be found on their website.
<b>Templates</b>	<a href="#">Energy supply chain template</a> <a href="#">Purchasing policy template</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem3">http://gmitweb.gmit.ie/eng/stems/stem3</a>
<b>References</b>	Commission for Electricity Regulation <a href="http://www.cer.ie">www.cer.ie</a> SEI Renewable Energy Web: <a href="http://www.sei.ie/reio.htm">http://www.sei.ie/reio.htm</a>

**Table 39:** Step S3.5: STEM\_3 Implementation Review

NAME	<b>S3.5 STEM_3 Implementation Review</b>
<b>Aim</b>	Update Sponsor on project status and obtain support for next phase
<p data-bbox="304 421 454 454"><b>Guidance</b></p> <p data-bbox="304 562 454 703"><b>READY TO SUSTAIN</b></p> 	<p data-bbox="486 421 1417 510">This is the final major milestone of the project and concludes the implementation phase.</p> <p data-bbox="486 544 1417 633">The objective of this review with the Sponsor and Senior Management is to:</p> <ul data-bbox="486 674 1002 853" style="list-style-type: none"> <li data-bbox="486 674 948 707">• Outline achievements of project</li> <li data-bbox="486 748 948 781">• Recommend sustaining strategy</li> <li data-bbox="486 822 1002 855">• Recommend future work or projects</li> </ul> <p data-bbox="486 965 1417 1099">The process flow indicates that the final project report (if team decides to provide one) is completed shortly after this review and presented to the team Sponsor.</p> <p data-bbox="486 1144 1417 1279">This will allow for incorporation of feedback from the review meeting. However complete the report for the final review if this is more suitable for your project.</p>
<b>Templates</b>	<a href="#">Presentation template for STEM_3 meeting</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem3">http://gmitweb.gmit.ie/eng/stems/stem3</a>

### 7.5.4 Sustain Phase

The objective of the STEMS process is to bring about a culture of rational use of energy in an organisation. The structured system is designed to provide a framework for an energy team to begin this process. The goal is that everyone in the organisation should be “won over” and practising rational use of energy. This objective of this section is to ensure that the achievements of the project are integrated into everyday operations and to provide an impetus for further projects or initiatives. This section is presented as an epilogue rather than a Phase of the project.

**Table 40:** Step S4.1 Integration guidelines

NAME	S4.1 Integration guidelines
<b>Aim</b>	To incorporate energy efficiency into everyday operations
<b>Guidance</b>	<p>The achievements of the project will only be sustained if they are integrated into the Operations of the organisation. Use the lessons learned, the contacts made and wider influence of the energy team and sponsor to build rational use of energy into the running of the organisation. Be confident in the knowledge of the team in its own organisation; develop your own list. Consider including rational use of energy in the following processes :</p> <ul style="list-style-type: none"> <li>• Employee induction</li> <li>• Training and CPD (continuing professional development)</li> <li>• Quality Procedures</li> <li>• Environmental Procedures</li> <li>• Management objectives</li> <li>• Health and Safety Procedures</li> <li>• Suggestion scheme</li> <li>• Job descriptions and objectives</li> <li>• Organisational Newsletter, Intranet, Internet and Extranet</li> <li>• Clubs and Societies</li> </ul>
<b>References</b>	<a href="#">Action Energy GPG 251: Maintaining the Momentum –Sustaining Energy Management.</a>

**Table 41:** Step S4.2: Complete the project feedback loop

<b>NAME</b>	<b>S4.2 Complete the project feedback loop</b>
<b>Aim</b>	Publicise the results of the energy project
<b>Guidance</b>	<p>Before concluding your project it is important to communicate the results. The ideal situation is that the team leader or some other team member has good communication skills and experience. If not, then look around your organisation for someone who meets the criteria, for instance the marketing or training functions. Perhaps there is a communications or PR role in your organisation that could assist. The objective at this stage is to build on the work of the team and continue the momentum. Identify further energy related projects, programmes and ideas and find people who will take the lead. This will close the project loop and help develop an impetus within the organisation to keep rational use of energy on the agenda.</p> <ul style="list-style-type: none"> <li>• Tell people what you have done</li> <li>• Tell them what still needs to be done</li> <li>• Tell them there is a process that will help them succeed</li> <li>• Encourage them to be part of the solution</li> <li>• Gain as much influence in the organisation as possible</li> </ul>
<b>References</b>	<a href="#">Action Energy GPG 235: Managing People, managing energy</a>

**Table 42:** Step S4.3: Team report – draft structure

<b>NAME</b>	<b>S4.3 Team report – draft structure</b>
<b>Aim</b>	To provide guidelines and a template to complete a project report
<b>Guidance</b>	<p>The team should decide early in the project if they will produce a project report. Plan the layout of the report and make team members responsible for sub sections. Also ensure that there is one person that is in charge of pulling the report together. Plan enough time for the preparation of the report as this is often underestimated resulting in much stress to meet a deadline. This decision will depend on considerations such as:</p> <ul style="list-style-type: none"> <li>• There may be a requirement to produce a report if the energy project is undertaken as part of some other programme e.g. management training.</li> <li>• Project communication – a report may be a very beneficial way of doing this in your organisation.</li> <li>• Case study publication.</li> <li>• Reference point for future work and future teams.</li> <li>• Organisation is distributed over many locations.</li> </ul>
<b>Templates</b>	<a href="#">STEMS final report template</a>
<b>Link</b>	<a href="http://gmitweb.gmit.ie/eng/stems/stem3/">http://gmitweb.gmit.ie/eng/stems/stem3/</a>

**Table 43:** Step S4.4 :Final review with Sponsor

<b>NAME</b>	<b>S4.4 Final review with Sponsor</b>
<b>Aim</b>	To obtain feedback on project from the Sponsor
<b>Guidance</b>	The team is recommended to have a final review of the project with the project Sponsor. The objective here is to review how the project team worked together and the lessons that have been learned. Recognise the achievements and participation of the team members in some way.
<b>Templates</b>	The team is encouraged to develop its own questionnaire

## 7.6 Feedback on STEMS

The author had regular meetings with Sustainable Energy Ireland (SEI) and Enterprise Ireland's Envirocentre to present interim and the final versions of the STEMS process and receive expert feedback. SEI considered that the research "will be of considerable value to smaller firms who are making energy efficiency part of their business" and believe that "the use of the internet is a valuable resource for engaging the SME sector". SEI was also pleased with the emphasis on culture change as they remain convinced "this is key to any move towards sustainability or even in implementing the most basic energy programme in a firm". At a final review, SEI was supportive of the "how-to" approach of the STEMS process, in contrast to other energy management methods. The main concerns expressed were how to attract "otherwise disinterested" firms to use this process and the capacity of an SME to dedicate a team to an energy project. Enterprise Ireland considered that the STEMS process could provide entry-level 'easy to use' process for the SME sector. They were willing to incorporate STEMS as a link within the existing Envirocentre site as an energy support for this sector if the process was hosted on a commercial Internet service provider (ISP) and externally maintained. There is a very small uptake by SME for the ISO14001 grant provided by Enterprise Ireland and it was hoped that a focus on energy efficiency could improve provide a more comprehensive service pack and improve the uptake.

Another minor test of STEMS was carried out in a Final year, BSc. In Manufacturing Technology, project carried out in the academic year 2003/2004. The student undertook a review of energy management within the Irish Defence Forces with a view to developing an energy policy for the organisation and an organisational structure to implement it. The results were encouraging as the student was able to login remotely to the CVE and follow the process steps using the guidance and templates provided without any supervision (Weld 2004).

## 7.7 Gap Analysis

The first major gap to be addressed is the lack of energy management practices in the majority of small and medium sized organisations in Ireland. It is recommended that such organisations use the STEMS process to begin the process of implementation of energy efficiency. A Pareto analysis shows that the seven hundred odd companies that account for 50% of industrial energy consumption need support in the area of energy efficiency to strengthen competitiveness and meet the challenges of economic instruments such as carbon taxation (EPSSU 2003). The effectiveness of such networks focused on energy efficiency across the SME sector has been demonstrated in Norway (Helgerud and Mydske 1999). This support is also required by the remaining SME and commercial and public sector organisations if the country is to meet its international commitments.

The second gap that needs to be addressed is the emerging market for energy services in the SME sector and ICT is seen as a way to bridge this gap (EC 2000a). Energy professionals need to develop electronic services to meet the requirement of this new market and to develop business opportunities at home and abroad.

The third gap that needs to be addressed is the development of an integrated educational and training structure for energy systems (Weidlich *et al.* 2003). This “Energy Education” formation is essential to effect the cultural and behavioral changes required in the general population (Dias *et al.* 2004) by targeting the next generation of decision makers.

The fourth gap is in relation to accreditation. Energy efficiency must have a stronger presence in EMAS and ISO14001 (Amundsen 2000) and there is a case to establish an Irish energy accreditation body that could provide carbon tax rebates as is the case in Denmark (DS2403 2001).

The fifth gap relates to the need to provide incentives to people in small and medium sized organisations to begin using the process as a bottom-up approach. However the rising cost of energy (Norland 2001) and national energy and environmental campaigns will help to increase the interest in energy efficiency.



## **7.8 Conclusions**

The task of implementing energy efficiency in small and medium sized organisations poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity. This thesis proposes that in order to meet the important challenge of implementing energy policies in this sector, energy efficiency must be addressed through company learning and organisational change. A process called the Structured Team-Based Energy Management System (STEMS) has been developed to implement energy programs in organisations and is detailed in this chapter. It incorporates a toolset called the STEMS wizard to train and provide resources for energy teams that have little or no experience in the area of energy management. The process is delivered via a web-based collaborative virtual environment which is now being used extensively by distributed project teams in the ICT and Construction industries. The Structured Team-based Energy Management System provides a “how-to” approach that can be implemented by non-expert energy teams in industrial, commercial and public service organisations. Guidance and templates arranged in the self-learning format of the collaborative software are geared to teams that are new to the area of energy efficiency. Use of the web-based collaborative virtual environment makes the process accessible to a large number of organisations. Harnessing the Internet provides a mechanism where these organisations can avail of more complex energy advice that could in future be supplied electronically by energy professionals such as the AEPI.

## Chapter Eight: Conclusions

- 8.1 Thesis Overview
- 8.2 Conclusions
- 8.3 Recommendations for future work

### 8.1 Thesis Overview

The work presented in this thesis is concerned with the development of a process methodology to support the implementation of energy efficiency in small and medium sized organisations that account for 31% of total primary energy consumption in Ireland. It is now becoming crucial to address this issue to ensure a competitive economy given Ireland's almost complete dependence on imported energy and the financial penalties that will result from unacceptable levels of greenhouse gas emissions. Presently, there is inadequate energy efficiency support for industrial firms outside of the Large Industry Energy Network (LIEN), and for commercial and public service organisations. Energy efficiency implementation in these sectors poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity. Furthermore, such organisations have little or no experience in the area of energy management and it has been estimated in this study that the successful implementation of energy efficiency could result in savings of €248 million and 1.56 Mt of CO<sub>2</sub>.

The Structure Team-Based Energy Management System (STEMS) developed during the course of this research addresses this problem by providing a "how-to" methodology for energy teams. It is designed for implementation by non-experts and is delivered via a web-based collaborative virtual environment (CVE) enabling co-operation among dispersed individuals and organisations. STEMS was developed based on interviews with energy policy makers and energy professionals, SME energy users, a literature review, a prototype trial and two case studies. The methodology was tested in a

case study carried out in the Public sector with an energy team distributed over four campuses of an educational institute. A second case study explored supporting STEMS by an association of energy specialists and the development of electronic energy services. The STEMS toolsets contains detailed guidance, templates and links arranged in a self-learning format. Use of the World Wide Web with a collaborative virtual environment makes the process accessible to a large number of organisations and facilitates the formation of Collaborative Energy Networks among generic groups.

## 8.2 Conclusions

The principal conclusions of the work described in this thesis are:

- Implementation of Irish energy policy is now a major national priority driven by security of supply, environmental protection, cost competitiveness and ethical considerations and has a potential to provide very significant savings to the Irish economy amounting to €1 billion based on 2002 energy usage.
- Implementation of energy management in small and medium sized organisations poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity. There is considerable potential for improved energy efficiency and emissions reductions in this area amounting to €248 million and 1.56 Mt of CO<sub>2</sub>. However, this sector is not catered for in the present structures that are in place to implement Irish Energy Policy and there is tension between the policy requirements and organisational/business priorities.
- Energy efficiency must be addressed through company learning and organisational change, as economic models alone are not sufficient to address this issue.
- The outcome of the Rational Use of Energy (RUE) case study conducted within GMIT concluded that introducing an energy efficiency culture in an organisation requires many interrelated tasks suited to a team-based approach. This energy team project contributed to a net 8.5% reduction in electricity consumption taking into account growth in real estate. This translates into an

annual saving of approximately €20,000 and a reduction of 260 tonnes in CO<sub>2</sub> emissions. The focus on monitoring and targeting has identified that 25-30% of electricity is used at night, when the Institute is closed, and a program is now being put in place to target further savings. The project demonstrated the suitability of a web-based collaborative virtual environment management to facilitate both the project management and the multi-site implementation in a timely and efficient manner. However more work is required to bring the Institute's energy savings up to an industry benchmark level of 15%.

- The case study of the Energy Management consultancy concluded that Collaborative Virtual Environment (CVE) provide a framework for energy professionals to provide services to existing clients and develop new business both nationally and internationally. This study was limited in its scope and there was some reticence about implementing the technology among clients who preferred traditional face-to-face meetings. However, great scope exists for energy professionals such as the AEPI to support the STEMS process using CVEs.
- The Structured Team Based Energy Management System (STEMS) developed in the course of the research provides a conceptual and process model, which goes beyond conventional energy training and good practice guidelines. Such models and theories are essential tools of research in stimulating the advancement of knowledge. The framework for change has the flexibility to be structured and applied to the needs of small and medium sized organisations in the industrial, commercial and public sectors and only requires a basic level of computer literacy.
- The Structured Team-based Energy Management System provides a “how-to” approach that can be implemented by energy teams in industrial, commercial and public service organisations. Guidance and templates arranged in the self-learning format provided by the collaborative software are geared to teams that are new to the area of energy efficiency. Use of the web-based collaborative virtual environment makes the process accessible to a large number of organisations in a user-friendly format.

### 8.3 Recommendations for Future Work

Addressing the gaps identified in section 7.7, the following recommendations for future work are made.

#### Recommendations based on the STEMS process:

- The study demonstrates that the scope for implementing greater energy efficiency in the Irish economy is very significant. One detailed case study was carried out for a public sector organisation. Further trial case studies could be carried out in the industrial, commercial and public service sectors or subsets within these sectors to refine and extend the process.
- The STEMS process was developed based on the research carried in this study. Live implementation in sectors would validate the process and provide data to extend, improve and generalise the system. Such studies could provide information for performance measurement and benchmarking.
- This research suggests that the development of a virtual collaborative energy network for the industrial organisations outside of the LIEN would be very beneficial for co-ordinating projects and could also provide a link to professional support from the Association of Energy Professionals of Ireland (AEPI).
- This research could be extended to develop a web-based adaptive e-Learning toolset for energy and environmental compliance. Such a development could provide a conduit for the dissemination of existing e-Tools with sustainable energy and environmental research, possibly through [envirocentre.ie](http://envirocentre.ie) or other commercial organisations.
- There is a need to benchmark energy reductions in public service and educational organisations. The savings of 8.5% in the RUE Case Study could provide a basis for such a study.

- There is interest within the body of energy professionals in Ireland in the development of web based energy services as outlined in Case Study II. Further research could develop this theme in conjunction with the Association of Energy Professionals of Ireland (AEPI) to support the sustaining phase of STEMS.
- Motivating SME and public sector bodies to implement energy efficiency is still a challenge. There is need to research the barriers that have been identified in related studies. The role of performance related bonuses based on energy savings to provide an incentive to energy team members could also be explored. There is also an associated requirement to study the use and structure of teams within SME and the Commercial and Public service. The STEMS process could be used in conjunction with such research.
- Sustainable energy practices are fundamental to the concept of “Sustainability” in organisations. The STEMS model could be further developed to encompass the problem of supporting “Organisational Sustainability”.

#### Recommendations based on the Literature Review and Observations:

- The issues of sustainability will become more and more important in organisations in a future of dwindling resources, Kyoto II, increasing costs and market demands. There is a need to study these implications for Irish industry and the West of Ireland in particular.
- There is no structure for energy training and qualifications in Ireland. Experiences in other countries have shown impressive results from such programs. Further research into the development, structure and qualifications associated with such educational and training programs is required. In addition to traditional taught courses, Web-based learning would also seem to be very suitable medium for this task.

- Education is a key to culture change and the Educational Sector needs to be more involved in tackling the challenge of sustainable energy and “sustainability” through best practice programs, course development, incorporation into existing curricula and through research.
- There is little research funding in Ireland in the area of energy efficiency with the main focus at present on Renewable Energy Systems (RES). The Sustainable Energy Ireland Renewable Energy Information Office (REIO) has been very successful and has received the European Commission's high profile Campaign for Take Off award for the 'Best National Renewable Energy Partnership' in 2003. It is using the web very effectively to disseminate its services and provide on-line resources. However RUE (rational use energy) has an even greater potential for savings in a much shorter timeframe with very little investment. Research could look at the development of a sister EEIO (energy efficiency information office) to address this area.
- Recent development of standards and research in the areas of Safety, Health, Environment and Quality, have not given energy a high priority. Research is required to prominently position energy within these areas given its growing importance. A program is required to integrate and emphasise energy management within Environmental Management Systems (EMS) (e.g. EMAS, ISO14001).
- Dedicated accreditation for energy efficiency does not exist in Ireland at present but is indirectly promoted through Integrated Pollution Prevention and Control (IPCC) licensing and Negotiated Energy Agreements. Research could review the possibility of basic energy efficiency accreditation using the STEMS process. It could also look at a path from STEMS to environmental management schemes, such as EMAS (Eco-Management and Audit Scheme), and to ISO14001. Such research could investigate if this accreditation could be offset against carbon taxation and thereby provide an incentive to organisations as is employed in the Danish Standards (DS2403 2001). There is also a pressing need for organisations to be aware of the GHG emissions associated

with energy use. Providing standard methods of calculating and publishing emissions data could be associated with this study.

- Action Energy has an extensive database of energy management resources based on a long period of experience in the area. It would be unrealistic to expect Sustainable Energy Ireland (SEI) to build a comparative resource due to financial and capability requirements. Research into the creating a formal link between the two organisations should be carried to in order to share resources within the All-Ireland framework established under the Good Friday agreement.



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## Appendix A: “Partnership IT” Proposal Form and Team Members

### Name of Proposer(s)

Gabriel J. Costello

### Project Objectives

- GMIT to adopt energy efficiency targets, practices and procurement policies that will give leadership to the rest of the community by setting an example of best practice.
- Brand GMIT as an energy responsible location.
- Culture change by raising awareness of the GMIT community on the need for energy conservation and CO<sub>2</sub> abatement.
- Motivate all members of the GMIT community to be part of the solution being promoted at a national level by Sustainable Energy Ireland (SEI).

### Project Description

- Project teams will develop a project plan to meet the above objectives by defining measurable and achievable actions.
- Because of the timescale, the project team will concentrate on RUE (Rational use of Energy). The scope will cover the soft side of energy management such as awareness, housekeeping and motivation.
- The project team will explore developing some quantitative and qualitative measures of success.
- *Quantitative measures may require some monitoring equipment (Eg ECM Systems, Ballina).*
- *Qualitative measurements could be in the form of a population survey. Such a survey will be a challenge given the intangible nature of the attributes but will be explored nonetheless.*
- Total funding estimate: TBD

### Outcomes/Benefits of Project

- Increase awareness and implementation of best practices in GMIT.
- Leadership position for GMIT in the higher education sector in the implementation of Irish Green Paper policy and HETAC guidelines.
- Related benefits to local community and the national interest.
- Cost reduction potential estimated at 10- 15% by implementation of housekeeping measures (source: UK Government Energy Efficiency Best Practice Program).

### Timescale

16 weeks

### Project Team Members

Gabriel J. Costello	Lecturer, Dept. Mech. /Ind. Engineering, Galway – <b>Team Leader</b>
Sean Treacy	Lecturer, Letterfrack Campus.
Rose O’ Dea	Vice-President, Students Union, Galway.
Phelim Murnion	Lecturer, Business Studies, Galway.
Pat Folan	Technician, Dept of Computing, Galway.
Martin Taggart	Deputy Buildings & Estates Manager, Galway.
Pearse McDonnell	Lecturer, Electronic Engineering, Castlebar.
David Lee	Buildings & Estates Manager – <b>Sponsor</b>
Íde Ní Fhaoláin	Local Partnership Facilitator

## Appendix B: Sample Action Register

### Open actions:

Opened	Prime	Action	Est. closure
7/2/03	ALL	Send excel plan to GC for consolidation	21/2
14/2	PF	Evaluate <b>alternative</b> Questionnaire web software	14/3
14/2	GC	Post project template for final report on server	14/3
7/3	INF	Arrange caretaker to attend meeting (2 weeks)	14/3
7/3	INF	Arrange presentation to all campuses at end of project	2/5
7/3	PM	Agree plan for room survey with Rose	14/3
7/3	ST	Contact Connemara West to give go-ahead for ESB to release Letterfrack data to	14/3
7/3	ST/ROD	Recommend preferred logo option	14/3
7/3	GC	Student to provide ST with CO2 calculator	14/3
7/3	GC	Provide Ide with presentation for Partnership launch	14/3

### Closed actions:

Opened	Prime	Action	Status
31/1/03	PM	Create PowerPoint objective for DL presentation	Closed
31/1/03	GC	Create project plan template and circulate to team by 5/2/02	closed
31/1/03	PM	Email PowerPoint objectives to GC for storage and Amend to prioritise electricity	CLOSED
7/2/03	GC	Add links to website	14/2
31/1/03	PM	Scan info from DL for storage and analysis and email PowerPoint objective to GC.	14/2
14/2	MT	Draft plan to monitor labs	21/2
7/2/03	PM	Report if sampling of energy usage is feasible and if so provide plan	21/2
7/2/03	PF	Evaluate feasibility of monitoring computer lab usage for project	21/2
7/2/03	MT	Obtain PC energy costs from Martin Gibbons	28/2
	INF	Arrange a meeting between Sean Treacy, Rose O Dea and Austin Ivers to discuss logo development	Scheduled for 7/3
28/2	MT	Contact ESB customer care to get information for all GMIT campuses	7/3
14/2	GC	Obtain Monitoring equipment from ECM	28/2



## Appendix C: SAMPLE Project Meeting Minutes

**Venue:** Prefab 18

**Date:** Friday 14<sup>th</sup> March

**Time:** 9.00

### **In attendance**

Ide Ni Fhaolain, Phelim Murnion , Pat Folan, Martin Taggart, Gabriel J.Costello, Sean Treacy, Pearse McDonnell, Rose O' Dea, David Lee

### ***Castlebar (Non attending member)***

Pearse McDonnell

### **Minutes**

#### **1. Matters Arising**

- Íde unable to track down reference GMIT logo – will continue to pursue.

#### **2.Action Register**

- Updated as agreed

#### **3.Logo development**

- Agreement to revert to the existing energy logo with two versions: (1) main logo and (2) main logo plus GMIT and Partnership info. PF to assist in modifying present version.

*Existing logo to be slightly modified and to be available for marketing and environmental society next week...ST/ROD*

#### **4.Sub-team Updates**

- Marketing society will survey rooms on week of March 24<sup>th</sup>.
- User group survey will be via web. Brian Crean will assist Pat in development.
- Environmental society will organise energy day before Easter holidays.

- ECM equipment has arrived. Monitoring of computer lab will begin next week.
- Meeting held with ESB customer care. Good data received on electricity usage.

**5. April 2<sup>nd</sup> Partnership launch**

- Íde will circulate agenda in near future. RUE project team to be in attendance at the Project stands.
- General format of RUE presentation agreed. GC to send additional RUE one chart for main presentation.

**6. Sponsor update**

- David attended meeting and was updated on team activities. He concluded that good progress has been made at the project halfway stage.

## Appendix D: Electricity Usage Guidelines

**Be a turn-off**

### **Make a difference... turn off the computer!**

Turn off your computer at night and when you are not using it for several hours.

Enable the Power Management feature for your monitor (see below).

Turn off your monitor when you are not using your computer for 15 minutes or longer.

If you buy a new computer, consider a laptop. Laptops use only 1/4 the energy.

If you buy a new monitor, consider a flat screen. They use only 1/3 the energy.

### **COMPUTER MYTHS AND FACTS**

#### **Myth #1: Turning off is bad for a computer – Wrong!**

Fact

The Lawrence Berkeley National Laboratory states that modern hard disks are not affected by frequent shut-downs and that equipment may actually last longer because mechanical wear and heat stress are reduced.

Action

Turn off your computer during the night!

Security Benefit

When you turn your computer off you decrease the risk of someone accessing your files or e-mail.

**Myth #2: Computers don't need a lot of power if they are on but not used –**

**Wrong!**

Fact

During heavy usage (e.g., when you open a new application) your computer draws only slightly more power. The average computer uses about 120 Watts (75 Watts for the screen and 45 Watts for the CPU) whether you're using it or not.

When in sleep mode PCs that are a few years old tend to draw 2 – 5 watts.

Most modern PCs have sleep consumption down to 1 watt.

Action

Turn off your computer if you are not using it for 1 hour or more!

**Myth #3: Screen savers save energy –Wrong!**

Fact

Despite the name, screen savers don't save anything, especially not power!

Action

Turn off your monitor if you are not using your computer for more than 15 minutes!

**Enable the Power Management Feature on Your Computer**

The instructions differ slightly from system to system.

**On PCs (running Windows):**

1. Right-click on your desktop. A dialog box appears.
2. Select Properties.
3. Select Screen Saver tab.
4. Select Energy Saving Features.
5. Select Settings.
6. Select the number of minutes after which you want your screen (and your CPU) to power down. We recommend something between 5-15 minutes. Not all computers let you install Power Management features (e.g. Windows NT).
7. If you have trouble on older machines, disable this feature.

### **Plug-in Energy Savers**

An alternative to the Power Management feature is plug-in devices with motion sensors that will turn off your monitor (and desk lamp), when you are not at your desk.

One computer left on 24 hours a day will cost GMIT €90 in electricity costs a year and dump 680 kg of CO<sub>2</sub> into the atmosphere.

A tree absorbs between 1.4- 6.8 kg of CO<sub>2</sub> each year. That means that 100-500 trees would be needed to offset the yearly emissions of one computer left on all the time!

GMIT has about 2000 PCs.

## **Make a difference... turn off the lights!**

Myth – “Switching fluorescent lights on and off uses a lot of electricity – it is cheaper to leave them on”.

Truth – a fluorescent tube uses over 500 times more energy if left on for 15 minutes than the energy needed to restart it.

Note: Remember that Health and Safety are always the primary concerns.

Ensure that turning off lights or any other equipment does not result in a hazard.

Contact the Building Services if you have any queries.

## **Appendix E: Computer Lab Monitoring**

Contacts	Martin Taggart	Buildings office	Ext 2035
	Pat Folan	Technician Computing	Ext 2256

### **Specific monitoring of Science Department Computer Labs 484, 483 & 482**

1. Keep daily record of power consumption for the three labs, readings to be taken at the same time each day.
2. Keep daily record of numbers of people using each lab and the numbers of lights on and given times. Suggest to get a usable sample this needs to be done 3 / 4 times per day at the same time each day. Set up a form to record the data
3. Initially do not make staff or students aware that you are part of an energy awareness project. The first week W/C 24<sup>th</sup> March should be a benchmark and staff and students should be allowed to carry on with normal usage patterns.
4. Once sufficient benchmark data is gathered Pat Folan will speak to the staff and students and tell them they are guinea pigs for a usage trial. The RUE group will assist in urging staff and students to save energy in the labs.
5. You should carry on recording data during this period to see what difference awareness of the users can make to electricity consumption.
6. The monitoring will run until Easter.

General monitoring of four computer labs by marketing sub group of RUE

Please contact Rose O'Dea, vice president of the student union for information on this matter.

## Appendix F: Energy Questionnaire

1. State your position

- Central Administration
- School administration
- Academic staff
- Technical staff (define?)
- Student
- Other (specify) \_\_\_\_\_

2. Have you heard of the Kyoto Protocol?

- Never heard of it
- Heard of it
- Know a little bit about it
- Understand the Protocol in general

If you checked 'Never heard of it' skip the next two questions

3. Ireland's current annual output of CO<sub>2</sub> is

- Over 100 million tonnes
- Over 50 million tonnes
- Over 5 million tonnes

4. Under the protocol Ireland has a target based on the 1990 CO<sub>2</sub> output. The target is to:

- Keep to the 1990 figure
- Reduce by 13% from the 1990 figure
- Increase by no more than 13% from the 1990 figure.

5. What do you know about Sustainable Energy Ireland (SEI)

- Never heard of it
- Heard of it
- Know a little bit about it
- Know all about SEI.

6. Fluorescent lights are better left on because they use a lot of energy when they power up

- True
- False

7. If you have a computer at home or at work do you know how to control it's use of energy?

- Yes
- No

8. Check the energy efficiency measures you use at home (check as many as applicable)

- Insulation of the house, loft, cavity walls, floors
- Draught proofing windows/doors
- Use of low voltage lamps
- Insulating the hot water tank
- Regularly switch off lights in empty rooms

Other (specify one) \_\_\_\_\_



9. What heating systems are used in GMIT? (check any you are aware of)

Turf

Oil

Gas

Electricity

10. Have you been informed of or involved in any existing GMIT energy saving initiatives?

Yes

No

11. Which office is responsible for energy management at GMIT?

Development

Accounts

Registrars

Don't know

12. If you are a student, what do you know about Student Union policy on energy saving?

Not aware of any policy

Have heard something

Am involved in energy saving

Do you agree with the following statement?

13. Energy conservation is extremely important.

Totally disagree

Slightly disagree

No opinion

Slightly agree

Totally agree

14. Energy conservation saves money and is good for the environment. The most important is:

- Saving money is most important
- Saving money is slightly more important
- They are of equal importance
- The environment is slightly more important
- The environment is most important

What actions do you take in relation to energy use in GMIT at the minute?

15. Turning off lights when you leave a room

- Never
- Rarely
- Sometimes
- Always

16. Close open windows purely to save energy (not because there is a draught)

- Never
- Rarely
- Sometimes
- Always

Do you change the heating settings on the radiator?

17. In your office

- Never
- Rarely
- Sometimes
- Often

**18. In classrooms**

- Never
- Rarely
- Sometimes
- Often

Are the energy saving settings on in PCs that you use?

- 19. Your office PC**
  
- Don't have an office PC
- Don't know
- No
- Yes

**20. In computer labs that you us**

- Don't use computer labs
- Don't know
- No
- Yes

21. Have you heard of the Rational Use of Energy (RUE) project here at GMIT?

- Never heard of it
- Heard of it
- Know a little bit about it
- Understand the project in general

Part of the RUE project is selecting an energy saving logo to go on documents and wall signs. State which of the logos that you prefer.

Logo X



Logo Y



Suggestions

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## Appendix G: Room Survey Data

Below is the record of all 6 rooms surveyed with days and times.

<b>Day</b>	<b>Time</b>	<b>Rm 301</b>	<b>Rm 378</b>	<b>Rm 367</b>	<b>Rm 836</b>	<b>Pf 17</b>	<b>Rm 158</b>
<b>Mon 24<sup>th</sup></b>	09:10	all on					
	11:10				all off		
	13:10				all off	all off	all on
	14:10			all off			
	17:10		all off	all off	all off	all off	all off
<b>Tues</b>	10:10					all on	
	11:10				all off		
	13:10			all off			
	14:10				all on		
	17:10		all off			all off	all off
<b>Weds</b>	10:10				all on		
	12:10	all off				all off	
	13:10			all on	all on		
	15:10			all off			all off
	16:10						all off
	17:10					all off	
<b>Thurs</b>	09:10	all off					
	11:10	all off					
	13:10	all off	all on	all on		all off	
	15:10						all on
	16:10	all on		all on			
	17:10		all off				all off
<b>Friday</b>	10:10	all off	all off				
	12:10		all on				
	13:10	all off					
	14:10					all on	all on
	15:10		all on				
	16:10			all off			all off

## **Appendix H: Understanding Electricity Costs**

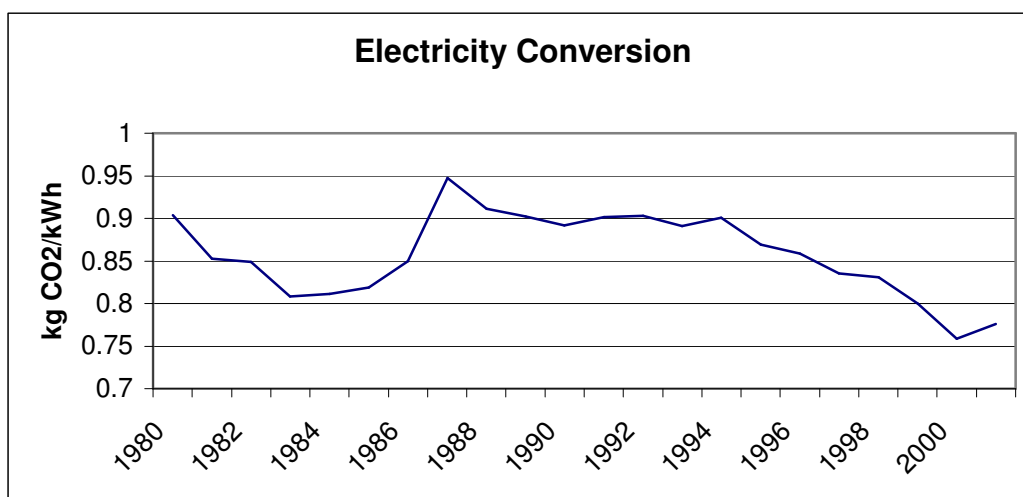
- In January 2003 the cost of one unit of electricity in Ireland was 12.20 cent including VAT. The list below shows typical values obtained from one unit (kilowatt-hour - kWh) of electricity when running household appliances

Normal 100 Watt Light bulb	10 Hours
20 Watt CFL low energy bulb	50 Hours
Electric Cooker	Meals for a day for one person
750 Watt Microwave Oven	Just over one hours use
Electric Kettle	Heat 9 litres for 30 minutes
Immersion Heater	Heat 15 Litres of Water
2 KW heater with Thermostat	30 / 40 Minutes heat
Television	About 8 hours viewing
Refrigerator	Run for one day (€ 44.53 / year)
Washing Machine	1 Boil wash
Electric Iron	2 Hours use
Electric blanket	2 / 3 nights use
2 KW Tumble dryer	30 minutes
Vacuum Cleaner	One and half hours
Electric toaster	About 40 slices of Toast
Desktop Computer	About 8 hours

## Appendix I: CO<sub>2</sub> Emissions Calculations

Carbon intensity is the amount of carbon dioxide released per kWh of energy of a given fuel. In the case of electricity it will depend on the fuel mix to generate the electricity and the efficiency of the generating technology (Howley *et al* 2003)

	TJ/ktoe	Carbon Factor				
		t C/TJ	t CO <sub>2</sub> /TJ	kg CO <sub>2</sub> /TJ	g CO <sub>2</sub> /MJ	g CO <sub>2</sub> /kWh
<b>Coal</b>	41.87	24.6	90.2	90200	90.2	324.72
<b>Peat</b>	41.87	29.57	108.4233	108423.33	108.42333	390.324
<b>Briquettes</b>	41.87	29.57	108.4233	108423.33	108.42333	390.324
<b>Gasoline</b>	41.87	18.9	69.3	69300	69.3	249.48
<b>Kerosene</b>	41.87	19.47	71.39	71390	71.39	257.004
<b>Fueloil</b>	41.87	20.73	76.01	76010	76.01	273.636
<b>LPG</b>	41.87	17.37	63.69	63690	63.69	229.284
<b>Gasoil</b>	41.87	19.99	73.29667	73296.667	73.296667	263.868
<b>Gas</b>	41.87	14.98	54.92667	54926.667	54.926667	197.736
<b>Hydro</b>	41.87					
<b>Other RE</b>	41.87					
<b>Electricity</b>	41.87					775.770
<b>Town Gas</b>	41.87	15	55	55000	55	198



## **Appendix J: A Tonne of CO<sub>2</sub> Explained**

The currency of the Kyoto Protocol is CO<sub>2</sub> emissions as CO<sub>2</sub> is the most important greenhouse gas (GHG). Most literature and information provide targets and statistics in terms of Mt (Million Tonnes) of CO<sub>2</sub>.

This appendix provides an explanation of what this means using some familiar examples.

- Energy is the fundamental capacity to do work
- Power is the rate at which energy is used and is measured in watts (W)
- Energy consumption is expressed in kilowatt-hours (kWh)
- When the power company charges for a unit of electricity, they are actually charging for a kilowatt-hour (kWh)
- A household uses one unit of electricity when it uses 1000 watts of electricity for one hour. For example, if ten 100W light bulbs were left on for one hour then one unit of electricity (1000W) would be consumed
- 13 light bulbs (100W) left on for one hour will result in the emission of 1 kg of CO<sub>2</sub>
- If 13,000 light bulbs (rated at 100W) were left on in a city for 1 hour, the result would be an emission of one tonne of CO<sub>2</sub>
- Two kilograms of CO<sub>2</sub> will approximately fill the average household 1000 litre oil tank.
- One tonne of CO<sub>2</sub> requires about of 0.1 hectares of growing forest as compensation (the term usually used is ‘carbon sequestration’)
- Ireland’s limit under Kyoto is just over 60 Mt of CO<sub>2</sub> equivalent. To achieve this, the NCCS has set a target reduction of 15Mt.

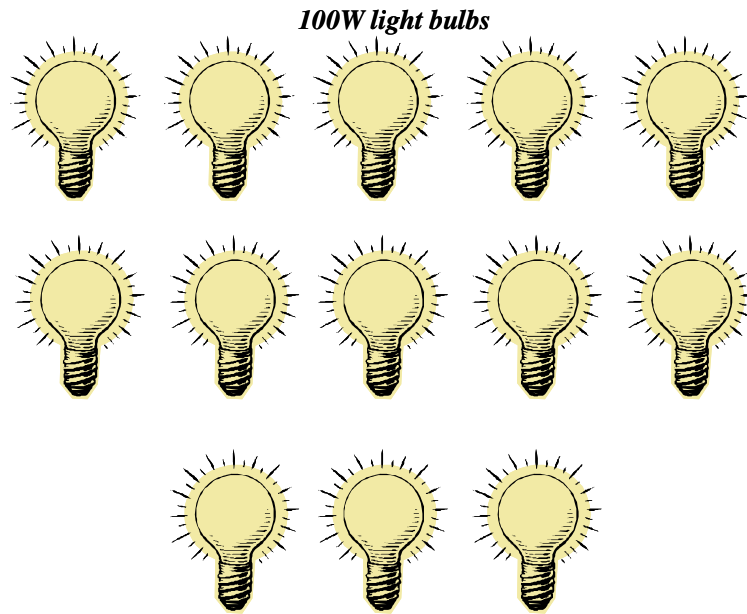


**Calculations:**

- Electricity generated in Ireland\* results in emissions of 776 grams of carbon dioxide (CO<sub>2</sub>) per kilowatt hour (kWh) i.e. unit of electricity
- 13 bulbs rated at 100W use 1.3 units in one hour
  - $1.3 \times 776\text{g} \approx 1 \text{ kg}$  of CO<sub>2</sub> emissions
- 1 mole of CO<sub>2</sub> occupies a volume of 22.4 litres at Standard Temperature and Pressure (s.t.p.)
- *Mass of one mole of CO<sub>2</sub> = 12 + (16x2) = 44 grams (relative molecular mass)*
- 44 g of CO<sub>2</sub>  $\equiv$  22.4 litres at S.T.P.
  - 1 kg of CO<sub>2</sub> occupies approx 500 litres at s.t.p.

\*Note: This is the figure as of 2001. The carbon factor depends on the primary fuel mix that is utilised to generate the electricity. The carbon factor varies from year-to-year and from country-to-country. e.g. The 2001 carbon factor for the UK was 430 g CO<sub>2</sub>/kWh . The difference can be accounted for by factors such as nuclear power generation in the UK.

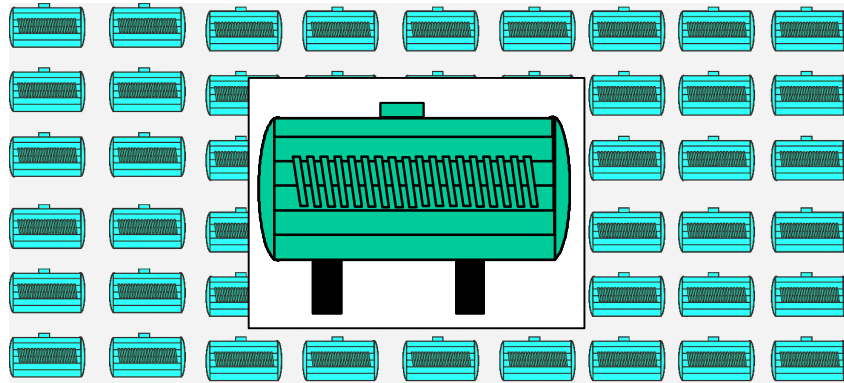
**Illustrations**



**13 bulbs will emit 1 kg of CO<sub>2</sub> in one hour**

***=> 13,000 bulbs will emit a tonne of CO<sub>2</sub> in one hour***

Fig.43: CO<sub>2</sub> emissions per kWh of electricity



**2 kg of CO<sub>2</sub> will fill a domestic oil tank (1000L)**

***=> 1 tonne will fill 500 oil tanks***

Fig.44: Volume occupied by a tonne of CO<sub>2</sub>

## Appendix K: Energy Policy Statement: GMIT

### Issue Control:

Version	Date	Name:	Reason for Update
1.0	Jul 14th 03	G.J. Costello	First draft for review
2.0	Sept 5th 03	G.J. Costello	Second draft for review

### Declaration and policy statement

Energy derived from fossil fuels is an important and finite resource. The use of energy has economic, environmental and ethical dimensions.

GMIT is committed to the responsible use of energy in order to:

- Minimise energy use and costs.
- Contribute positively to the national targets for greenhouse gas emissions under the terms of the Kyoto Protocol.
- Educate its staff on energy usage.
- Contribute to a more sustainable society.

Key points to consider in relation to this policy:

- Each member of GMIT has a role to play in conserving energy.
- Rational Use of Energy will not involve undue sacrifice or deterioration in the working environment within the Institute.
- Energy conservation will result in the reduction in waste, will have significant environmental benefits and allow financial resources to be invested in other important areas.

### Objectives

#### Short Term Objectives:

- The Institute will adopt the Rational Use of Energy (RUE) logo shown in Appendix K1 below as the official energy symbol.
- The Institute will adopt the Rational Use of Energy (RUE) positioning statement outlined in Appendix K2.

- Maintain records and monitor energy usage that will include data on CO<sub>2</sub> emissions. This information will be communicated at intervals determined by the Energy Management Team.
- Include Energy Awareness in Induction Training for Staff and Students.
- Reduce energy use, expenditure and CO<sub>2</sub> emissions by a target determined by the Energy Management Team.
- Provide guidelines on what actions users should take and what actions are the responsibilities of Functional departments.
- Provide a Rational Use of Energy (RUE) website for staff and student communications.

### **Longer Term Objectives:**

- Provide a CO<sub>2</sub> balancing statement in the GMIT Annual Report.
- Consider utilising ‘green electricity’ where practicable.
- Include cost and CO<sub>2</sub> emissions in all energy purchasing decisions.
- To include energy related criteria in supplier evaluation procedures.
- Energy efficiency will be an assessment criteria for all equipment purchased.
- Energy efficiency considerations will be included in purchasing, construction or renovation of buildings.

### **Implementation**

Energy initiatives can be divided into two complimentary areas.

- Efficient and cost effective Rational Use of Energy (RUE)
- Use of Renewable Energy Sources (RES).
- 

### **Responsibilities**

- All members of the organisation are responsible to efficiently use energy that is under their direct control.
- The Energy Management Team will be made up of the following people and will meet on a quarterly basis.

- Name 1
  - Name 2
  - Name 3
  - Name 4
  - Name 5
  - Name 6
- 
- The Energy team will report annually to the GMIT Management Team on the following topics: (*e.g.*)
    - Energy consumption
    - CO<sub>2</sub> emissions
    - Energy initiatives
    - Business issues
    - Legislation or policy changes
    - Purchasing of energy
    - Awareness and training
    - Review and update of energy policy

Appendix K1: GMIT RUE Energy Logo



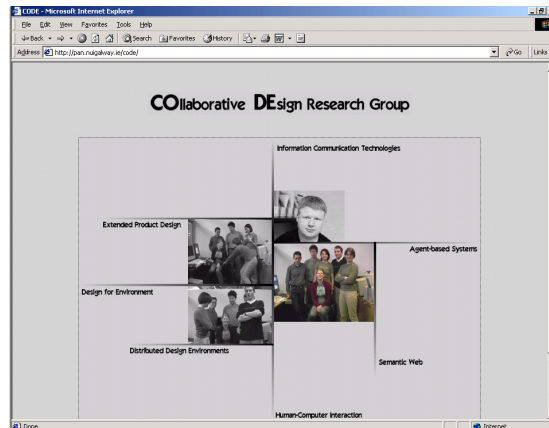
Appendix K2: GMIT Positioning Statement

*“The Galway Mayo Institute of technology recognises the need to employ a responsible approach to the Rational Use of Energy in all its institutions, and strives to incorporate a spirit of energy consciousness in its operations both internally and within the community.*”

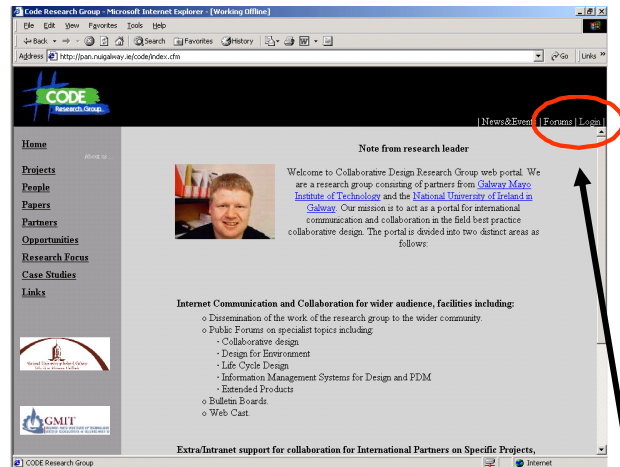
# Appendix L: Quick Reference Guide

## 1. Instruction to access STEMS Collaborative Virtual Environment (CVE):

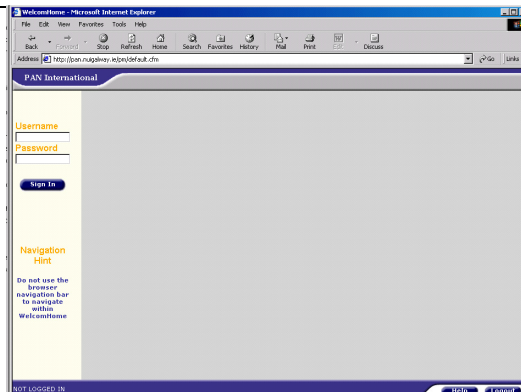
1. URL <http://pan.nuigalway.ie/> to get to :



2. Click anywhere on the Web-Page to get to:

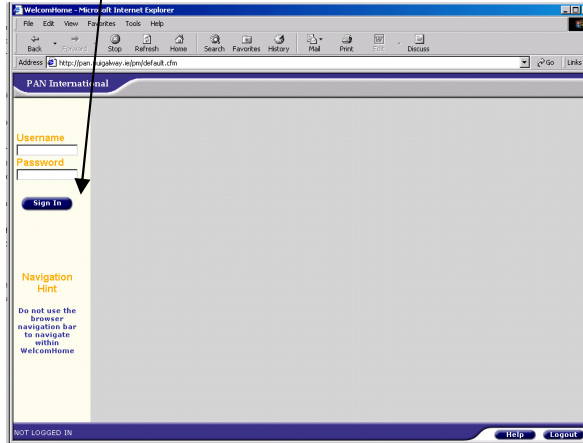


3. Click on “Login” on top right hand side of page to get to :

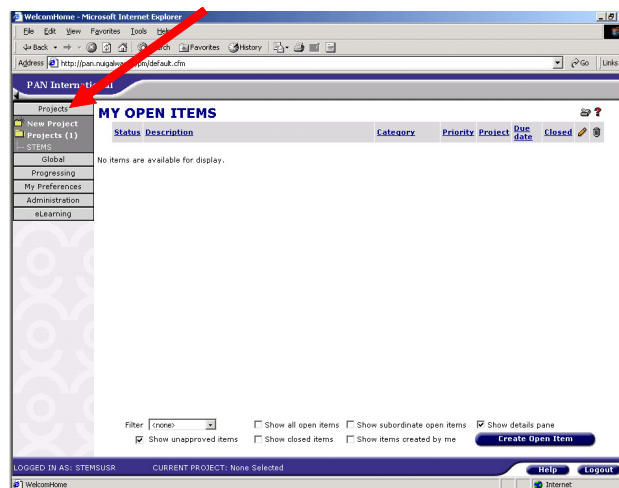


### 1. Instruction to access STEMS CVE (contd.):

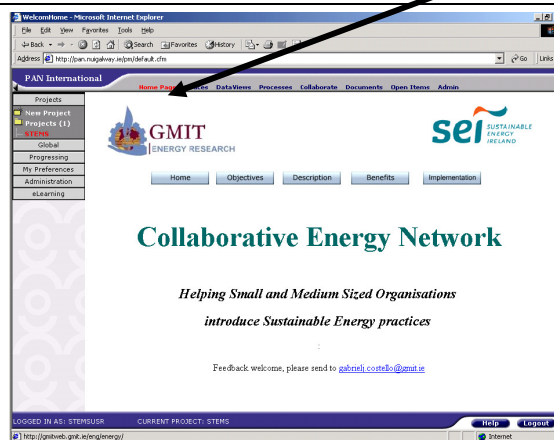
4. Enter *user name* : **stemsusr** and *password*: **company** and press "sign in"



5. Open list of projects on LHS



6. Click on project STEMS in list and then on **Homepage** on tab

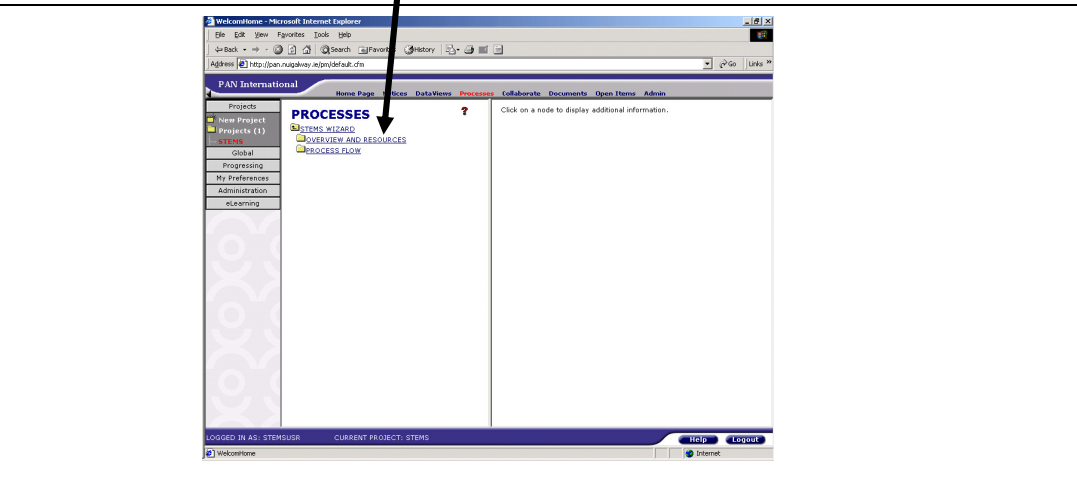


## 1. Instruction to access STEMS CVE (contd.):

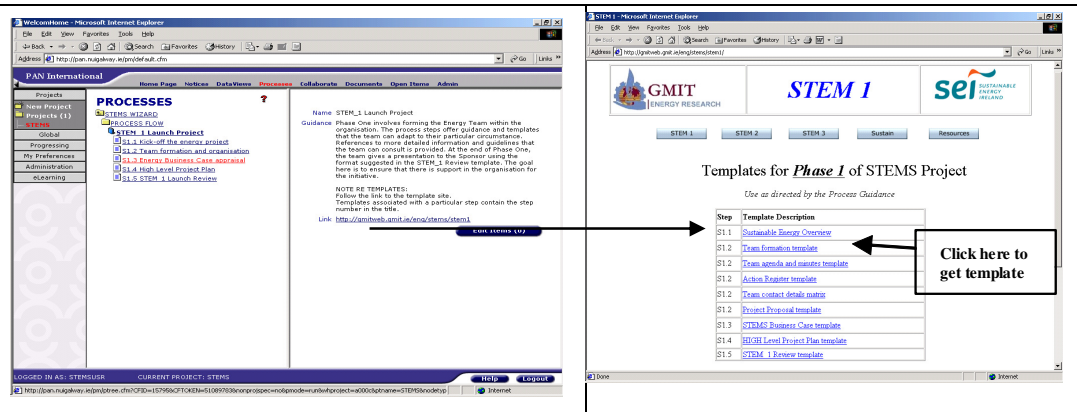
7. To use the STEMS workbench click on "Processes" tab



8. Follow the process flow and guidance to run the project.



9. Navigate to view guidance and link to templates



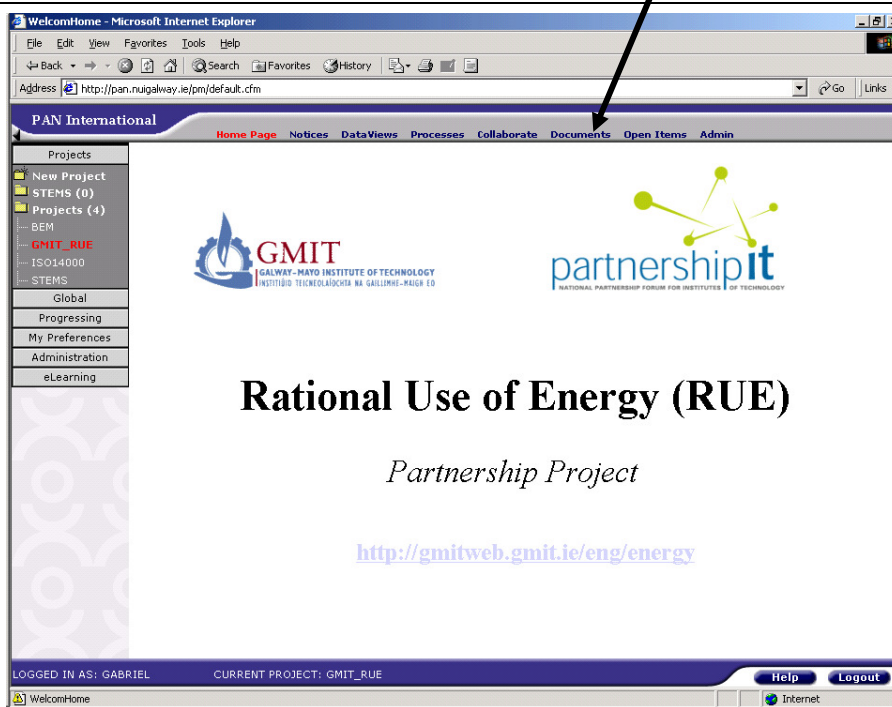


## 2. Instruction to access RUE CVE (contd.):

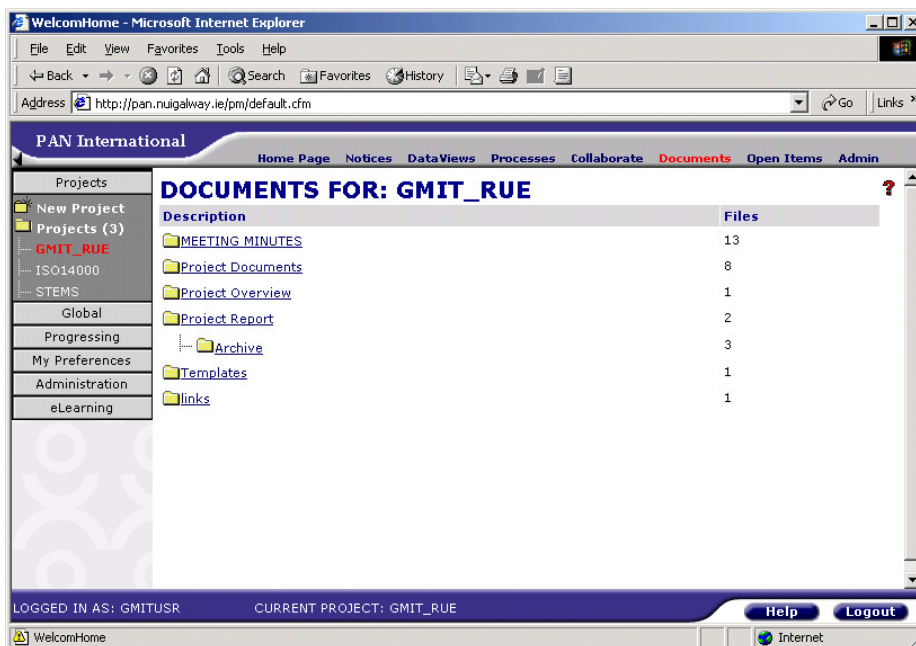
1. Follow the same instruction as for STEMS but with following changes:

username: **gmitusr** password: **rue**

- To access to project documents click on “Documents” tab.

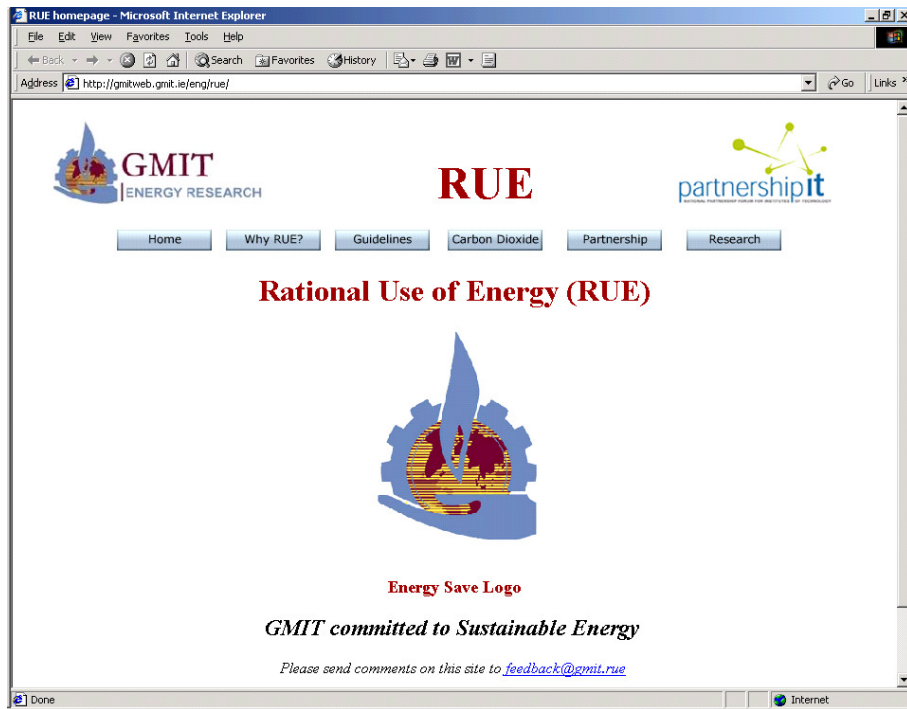


2. Open folders to view project documents.



### 3. Websites developed in course of research

GMIT Rational use of energy website : <http://gmitweb.gmit.ie/eng/rue>



GMIT energy research website : <http://gmitweb.gmit.ie/eng/energy/>

