Mobilising IS to support the diffusion of Energy Management Practices outside of Ireland's LIEN (Large Industry Energy Network)

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Abstract

Ireland is under increasing pressure to reduce energy consumption to meet carbon emission targets and protect an economy that is almost totally dependant on imported energy. The implementation of no cost and low cost energy efficiency measures across all sectors of the Irish economy has significant carbon and cost saving potential. The Large Industry Energy Network (LIEN) is a voluntary network operated by Sustainable Energy Ireland (SEI) for eighty of the largest energy consumers in the country. The group accounts for approximately 10% of the state's total primary energy requirement (TPER). The task of implementing energy management practices outside the LIEN poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity. However supporting these organisations to become energy efficient is essential if Ireland is to meet energy policy targets. This paper argues that combining web-based environments with process methodologies can provide an information systems infrastructure to enable the implementation of energy efficiency in both private and public sector organisations. The paper proposes a two-tier model; with the first tier utilising a web-based process methodology to guide a novice energy team through formation, planning and auditing phases. The second tier would facilitate remote support from energy management experts via the collaborative environment. The study was undertaken using the approach of doing action research in your own organisation and the savings and cultural impact from implementing the model in a pilot study was encouraging.

Keywords: energy efficiency, Irish energy policy, energy teams, energy process, rational use of energy,

Mobiliser SI pour soutenir la diffusion des pratiques de gestion de l'énergie en dehors de l'Irlande LIEN (Large Network industrie de l'énergie)

Résumé

L'Irlande est sous la pression croissante de réduire la consommation d'énergie pour atteindre les objectifs d'émission de carbone et protéger une économie qui dépend presque entièrement des importations d'énergie. L'introduction de mesures, gratuites ou à faible cout, pour l'optimisation de la consommation d'énergie à travers l'ensemble de l'économie irlandaise a un important potentiel pour la réduction des coûts et émissions de carbone. « The Large Industry Energy Network » (LIEN) est un réseau volontaire géré par « Sustainable Energy Ireland » (SEI) qui regroupe quatre-vingt des plus gros consommateurs d'énergie dans le pays. Le groupe représente environ 10% des besoins en énergie primaire (BTEP) de l'état. La mise en œuvre de pratiques de gestion de l'énergie en dehors de la LIEN représente un défi important étant donné le nombre d'organisations impliquées, leur répartition géographique et les faibles intensités d'énergie utilisées. Cependant, aider ces organisations à devenir efficace en matière d'énergie est essentiel si l'Irlande veut atteindre ces objectifs. Cet article soutient que la combinaison d' environnements sur le Web et de méthodologies de processus peut fournir une infrastructure de systèmes d'information qui permet la mise en œuvre de l'efficacité énergétique dans les secteurs privés et publics. Le document propose un modèle à deux niveaux : le premier niveau utilisant une méthodologie de processus basée sur le Web qui permet de guider, une équipe novice en énergie, à travers la formation, la planification et les phases de vérification. Le deuxième niveau serait de faciliter l'assistance à distance par des spécialistes de la gestion de l'énergie à travers l'environnement de collaboration. L'étude a été réalisée selon la méthode qui consiste à faire une recherche-action dans votre propre organisation. L'économie et l'impact culturel de la mise en œuvre du modèle dans une étude pilote a été encourageante.

Mots-clés: l'efficacité énergétique, la politique de l'énergie en Irlande, les équipes de l'énergie, le processus de l'énergie, l'utilisation rationnelle de l'énergie,

1. INTRODUCTION

For every extra kilowatt per hour of electricity used by ICT equipment, the US economy increased overall energy savings by a factor of around 10. That was the conclusion of research by the American Council for an Energy Efficient Economy (ACEEE), which claims that the current focus on soaring IT energy use has distracted from the net energy savings IT systems deliver for other sectors of the economy. The report, *Information and Communication Technologies: The Power of Productivity,*[1] argued that IT's role in the design of new products and services and its ability to replace many energy intensive processes has led to a net improvement in energy use. It argued that the ICT systems were subject to an "energy paradox" whereby "more attention tends to be paid to the energy consuming characteristics of ICT than to the broader, economy wide, energy saving capacity that emerges through their widespread and systematic application."

Despite the fact that Green IT now holds a significant position on the strategic agenda of many large corporations and government agencies, relatively little has been published in the academic literature about either the theoretical or practical aspects of managing and measuring this nascent phenomenon. Academics are starting to look at Green IT from three viewpoints – (i) the Innovation Perspective where IS researchers[2] have drawn attention to the potential for IT Innovation (but in this case, Green IT Innovation) to contribute to company competitiveness (ii) Competitive Strategy Perspective where researchers such as Michael Porter[3] explore the concept of "innovation offsets" – where companies can "not only lower the net costs of meeting environmental regulations, but can lead to absolute advantages" over competitors. Banking on growing consumer demand for green products and services, some retailers have developed "sub-brands" with a green angle. Increasingly, manufacturers across industries will use green products and green corporate behavior as a way to appeal to this growing segment of customers and (iii) Corporate Social Responsibility

[1] Laitner, J., and Ehrhardt-Martinez K., "Information and Communication Technologies: The Power of Productivity -How ICT Sectors are Driving Gains in Energy Productivity", Report No. E081, American Council for Energy Efficient Economy, February 2008.

[2] Webster, Jane et al, A Call for Action in Tackling Environmental Sustainability Through Green Information Technologies and Systems, Panel Discussion at ECIS 2009 Conference, Tuesday 8th June, 2009

[3] Porter, Michael and Class Van Der Linde, Towards a New Conception of The Environment-Competitiveness Relationship, Journal of Economic Perspectives, Volume 9, Number 4, Fall 1996, pages 97-118

Perspective where researchers draw attention to the importance of information management in CSR initiatives. [4]

With rising energy costs, implementation of energy policy in Ireland is now a major priority driven by three primary objectives: environmental protection, security of supply and cost competitiveness (DPE, 1999; NCCS, 2000). The agreed target given to Ireland under a European Union (EU) burden sharing agreement resulting from the Kyoto Protocol limits annual greenhouse gas (GHG) emissions to 13% above the 1990 levels (Howley et al., 2003). However this target was breached in 1997 and current projections estimate that emissions will rise to almost 40% above the 1990 level if Ireland adopts a "business as usual" approach (NCCS, 2000). At 86%, Ireland's import dependency is the highest in the EU outside of Luxemburg (CEC, 2002) leaving the country vulnerable to increased energy prices and/or disruption of supply. Currently, approximately eighty major energy users are members of the Large Industry Energy Network (LIEN) but an estimated 4,500 other industries are not supported. The task of implementing energy efficiency outside the LIEN poses a significant challenge given the number of organisations involved, their geographic distribution and low energy intensity. This paper proposes to make a contribution by addressing the following question: What can be done to support the diffusion of energy efficiency in the geographically dispersed, low energy intensive organisations outside of the LIEN? The work argues that information systems (IS) have the potential to enable this sector to reduce energy consumption by supporting local energy teams through a structured e-learning process. Furthermore it is proposed that this work addresses a gap in the IS literature which, up to this point, has provided little contribution to the debate on the important issue of the rational use of energy (RUE). The paper now proceeds as follows. Firstly the background to Irish energy policy and CO_2 emissions targets is presented. Following this, a literature review of important cultural, organisational and technological aspect of RUE is carried out. The target area addressed by this study is then outlined. Next the action research approach and the theoretical framework of diffusion theory adopted in the work are discussed. Two field studies undertaken in the course of the work are then presented from which the proposed energy management model was developed. Finally the conclusions, implications and limitations of the study are considered.

[4] Pozzebom Marlei et al. Information Management Models for Corporate Social Responsibility Practices, Proceedings of AMCIS 2006.

2. BACKGROUND

This section will present the significant potential saving from the diffusion of energy management practices in Ireland against the background of energy policy, CO_2 emissions targets and key users.

2.1 Potential for energy efficiency in Ireland

Studies conducted by organisations such as Action Energy, the UK programme established to assist businesses and the public sector to reduce energy consumption, indicate that thousands of businesses have reduced energy consumption by up to 20% by availing of their services. 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% (Nifes, 2003). The total primary energy requirements (TPER) of the Irish economy, by sector for the year 2001, are shown in figure 1. 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.

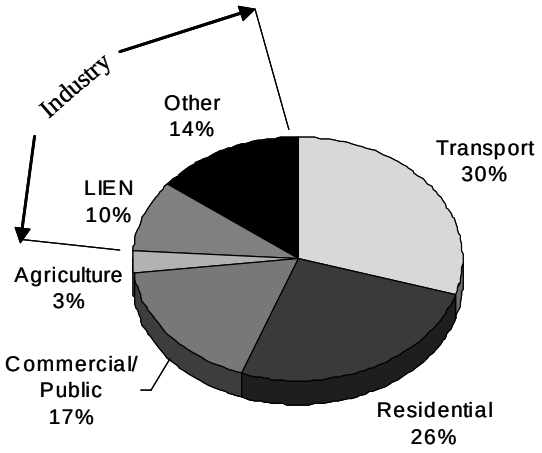

Fig.1: TPER by sector (Howley et *al.* 2003)

Sustainable Energy Ireland (SEI), charged with implementing Government energy efficiency and renewable energy policies, runs the Large Industry Energy Network (LIEN), which is a voluntary network of eighty of the largest energy consumers in Ireland. As shown in Figure 1, these companies account for approximately 10% of the country's 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_2 (Murray, 2003). However, SEI contest that 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. 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. This paper focuses on the challenge of implementing energy efficiency outside the LIEN and within the SME, Commercial and Public sectors and proposes a framework to address these sectors.

2.2 Irish Energy Requirements and related CO_2 emissions

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 consumed less energy due to the growth in the ICT (information and communications technology) sector. 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). The Kyoto target for Ireland translates into a reduction in CO_2 emissions of approximately 15 Mega-tonnes (MT). Two thirds of this target is to be met by measures affecting energy production, supply or use.

2.3 Irish Energy Policy

Over the past two decades Ireland's energy policy as a member of the EU and the International Energy Agency (IEA) has been driven by three primary objectives: security of supply, environmental protection and 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 success of the Irish economy in the 1990s resulted in an increase in energy demand with an associated to rise in greenhouse gas emissions. 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. The Green Paper concludes that most of the energy related CO_2 decrease would result from consumption reductions by the various energy actors including small consumers, industrial and large consumers, the transport sector and the power sector.

2.4 Irish Industrial Sector

The Industrial sector in Ireland spends over €600 million on energy per annum and accounts for almost 60% of GHG emissions. The distribution of energy use in the industrial sector is very uneven as is shown in Figure 2. There is considerable potential for emissions and cost reductions in this 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) .

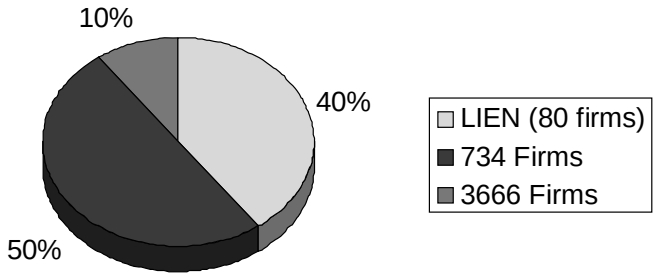

Fig.2: Distribution of Industrial energy use (EPSSU 2003)

2.5 Large Industry Energy Network

Within the policy context outlined above, the objective of the LIEN is to develop role model companies in the area of energy management for their own competitiveness, for the benefit of the Irish economy and to demonstrate environmental responsibility. These organisations typically have full-time Energy Management professionals as a member of staff. Cost of energy is a significant part of operational financial management.

2.6 Small and Medium–sized Enterprises (SME)

There is large scope for energy efficiency in SME (PIU, 2002) and in the industrial sector alone this accounts for over four thousand firms. 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 less than 3% of turnover (InterSEE, 1998). However, it must be remembered that these costs can be a much larger percentage of profits. The total estimated 150,000 SMEs in all sectors have the potential to make a very significant impact based on the experience in other countries. For example, the UK Performance and Innovation Unit (PIU, 2002) proposed setting up "advice centres" to assist SME develop productivity strategy that includes energy efficiency targets. The EU action plan aimed at the promotion of energy efficiency (EC, 2000) 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 by 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^3ST) in small and medium scale industries (Thiruchelvam et al., 2004). This paper builds on this theme by proposing a web-based collaborative energy network and by exploring the use of the Internet to provide energy services by energy management consultants. The above section of the paper has provided an overview of why there is a critical

need to address the use of energy in Ireland by all sectors. Now the cultural and organisational consideration will be reviewed in light of the literature.

3. LITERATURE REVIEW

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). A literature review will now be presented that considers the human, organisational and technological aspects of the rational use of energy (RUE).

3.1 Culture Change

SEI recognize that the implementation of energy policy requires a significant culture change in Irish organisations. Similarly, advocates of a systems approach to energy management maintain that it requires an organisation to "encourage culture change" by implementing a change management methodology and a structured approach (Reading, 2002). The scale of the culture change required to move towards a low emissions economy has prompted some researchers to propose that the real challenge is to look for ways of bringing about fundamental changes in society. 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). The National Centre for Partnership and Performance (NCPP) was established by the Irish Government to support and drive change in the Irish workplace. 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 these changes will require a complete remodelling of social partnership in Ireland and the development of an on-going culture of co-operation and change through managers, employers and unions working together. This situation will require a role alteration 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). The case study of an energy team described below was undertaken within a local structure of the national Partnership framework.

3.2 Energy teams

Teams have been described as the fundamental learning units in the modern organisation (Pedler et al., 1991) and are being used effectively in the areas of product development, process centred organisations, project management and also in the area of energy management. In Ireland, there are a number of successful case histories of the use of energy teams in companies such as Hewlett-Packard (Manufacturing), Masonite, Pfizer Pharmaceuticals and Bristol Myers Squibb (IEC, 2002). Internationally, 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 & 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) . Energy teams provide a pivotal role in bringing together the organisational, technical and people aspects of energy management (Ryan, 2004).

3.3 Structured Approach to Energy Management

In an international context, existing structured approaches to energy management such as the UK Action Energy Good Practice Guides 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 five stage approach to energy management with each stage consisting of a number of actions. The Norwegian Industrial Energy Efficiency Network (IEEN) successfully applies the methodology of “Business Excellence” to energy management in SME using a “Competence of Action Model” (Helgerud & Mydske, 1999). In Australia, the Sustainable Energy Authority of Victoria have developed an energy management module that 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 tackled in a systematic and planned way where the basic principles are presented as good management techniques. The approach outlined in this paper has been informed by these mature methodologies.

3.4 Web technologies supporting energy teams through a structured approach

This section argues that information and communications technology (ICT) and in particular web-based collaborative virtual environments (CVE) can support the diffusion of energy management practices. 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 project team. Project extranets are currently a "hot topic" within the construction industry (Kenny, 2003). Typical CVE software provides a framework to deal with the scope, quality, risk, communications, and integration of a project. A CVE enables 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).

Surveys by the Chamber of Commerce of Ireland indicate a significant level of utilisation of ICT in Irish SME (CCI, 2003) with over 90% access to the Internet. As a result, the Irish SME sector is well prepared to engage with web-based energy services. The conceptual model presented in section 6 of the paper will build on the literature discussed above.

4. METHODOLOGY

Having presented the literature context of the study, the following section will outline the research approach in terms of the target area addresses, the methodology emplyed and the theoretical framework.

4.1 Target Sector

The sector targeted by this study includes: industrial firms outside the LIEN, small and medium sized enterprises and public service bodies. These organisations typically do not have staff with energy management expertise or training. This sector encompasses 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 as shown in Figure 3. There are approximately 150,000 SME in Ireland. Because of the large number of these organisations, it is argued that the cumulative affect of their energy usage will have a considerable influence on the success of Irish Energy policy.

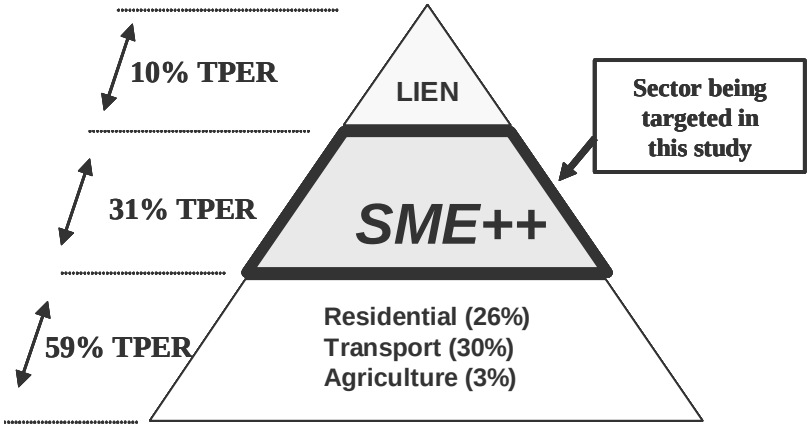

Fig.3: Profile of Energy users and identification of target organisations

4.2 Action Research Approach

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 & 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). The problem of implementing energy efficiency using team-based approaches and web-based technologies required the involvement of the authors so it was considered that the action research methodology would be suitable. The study was carried out as part of the RUE (Rational Use of Energy) project undertaken by a multi-disciplinary team in the Galway-Mayo Institute of Technology from January to May 2003. Furthermore, the study builds on the literature of "doing action research in your own organization" not just to understand and explain the phenomenon but also "to change it" (Coghlan & Brannick, 2005).

4.3 Theoretical Framework

Rogers (2003) defined diffusion as the process by which "an *innovation* is *communicated* through certain *channels* over *time* among the members of a *social system*". Furthermore, he classified adopters of innovation, developed during his doctoral research and first published in the Rural Sociology journal in 1958, into five major categories. This idealized taxonomy is approximately normally distributed over time and is summarized in Table 1.

Table 1: A presentation of Rogers' adopter categories

Type	%	Attribute	Typical Characteristics
Innovators	2.5	Venturesome	Control of substantial resources. Gate-keepers for complex technical knowledge
Early Adopters	13.5	Role-models	Widely respected opinion leaders
Early Majority	34	Evaluators	Good social contacts but not leaders
Late Majority	34	Sceptics	Motivated by economic necessity or peer pressure
Laggards	16	Suspicious	Lengthy decision processes Economically precarious.

It is important to note that, as pointed out in the work, the term "laggard" is used as a classification and not pejoratively. Most diffusion studies focus on individuals but it is interesting to note that Rogers' asks the researcher to keep and open mind on other attributes that could be important in the adoption of unique innovations. This work is

presented within the context of the challenge of the diffusion of a unique innovation (energy management practices) to a large sector of the population that are critical to the success of Irish energy policy. However, it is recognised the above taxonomy does not neatly fit the adopter categories of the study and suggests further work is required in order to examine the implications for diffusion theory.

5. CASE-STUDIES

In this section two case studies are presented: firstly to demonstrate the implementation of a pilot energy management model by a novice team and secondly to propose how these teams could be supported by energy management professionals via web-based environments.

5.1 Rational Use of Energy (RUE) action research project

The role of the third level educational sector is seen to be very important in meeting Ireland's stringent obligations under various international agreements. A Rational Use of Energy (RUE) project was undertaken by a multi-disciplinary team in the Galway-Mayo Institute of Technology (GMIT), a third level educational institute located in the West of Ireland, 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 and the team included six staff and one student. The objectives of the project included: increasing awareness among management, staff and students of best energy management practices and responding to the exhortations from national policy documents that third level institutions become role models in this area. 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_2 emissions.
- 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.
- Development of Power Saving Guidelines for personal computers (PCs) and Lights.

Results reported one year after embarking on this program 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_2. This result is even more significant considering that it was conducted during a period where the campus real estate grew by 40%. The focus on monitoring and targeting identified that 25-30% of electricity was used at night, when the college is closed, and a program was put in place to address this situation. The 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 using a web-based collaborative virtual environment facilitated the multi-site implementation and execution of the project. This case study resulted in the development on the energy management process described in Section 6 of this paper.

5.2 Energy Management Consultancy: Evaluation of electronic energy services

The main driver for the second case study was to investigate if an association of energy professionals could provide web-based technical support to users of the structure energy management process arising from the first case study. A second motive was based on the literature review that highlighted the emerging market for energy services and the priority of using information technology to provide these services. A prototype web-based energy service in a Collaborative Virtual Environment (CVE) was developed for an energy management consultancy. The company also wished to explore the viability of developing business through utilising the World Wide 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 were distributed around Ireland 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 within the same organisation. The specification for the web environment included ease of use, ability to control content and no requirement for software development skills. The trial was limited in its scope but provided a number of pointers that could be the basis of future work in this area. This point will be discussed in more detail in the next section.

6. DISCUSSION AND IMPLICATIONS

This section addresses the problem of implementing energy efficiency in the target sectors outside of the large industry energy network (LIEN). It builds on the results from the action research studies in the light of the literature and describes the design of the collaborative model. It proposes the implementation of team-based and process methodologies to facilitate 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 outlined. An overview of the topology and main features are presented together with the potential application. Finally the implications of the model for policy, practice and research are examined and the limitations are discussed. This facet of the study will be given a relatively large space in the overall context of the paper as an important phase of action research is “reflection on the process” (Coghlan & Brannick, 2005 p 35)

A process called the Structured Team-Based Energy Management System (STEMS) was developed to implement energy programs in organisations outside the LIEN. The model 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 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 shown in figure 4.

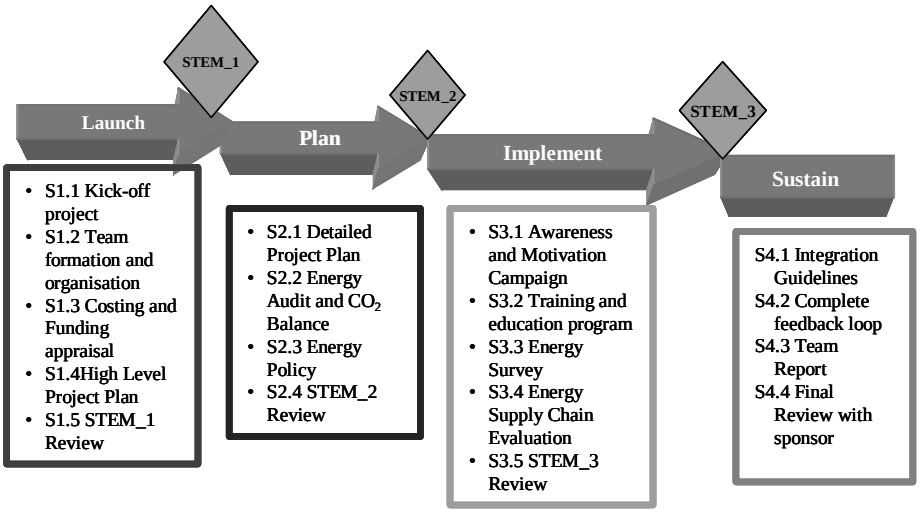

Fig.4: STEMS workbench and workflow showing Steps, Deliverables and Templates

An easy to complete template is provided for each process step. The process is delivered via a web-based collaborative virtual environment (CVE) as demonstrated in figure 5 below. Use of the web-based CVE can make the process accessible to a large number of organisations. Harnessing the Internet provides a mechanism where such organisations can avail of more complex energy advice that could in future be supplied electronically by associations of energy professionals or energy consultants. For example, national or international networks could provide technical support in a flexible cost effective manner as described in the next section.

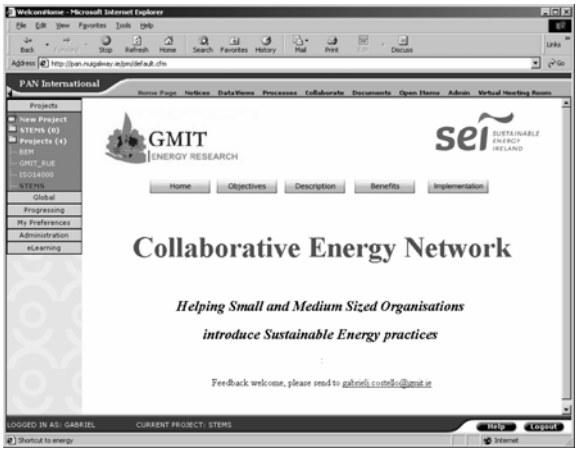

Fig.5: STEMS CVE Homepage

6.1 Second Tier of the Model

Presently there is a weak connection between policy makers and energy professionals within small and medium sized organisations. The figure below suggests the way in

which the STEMS process can provide a link between SEI and small and medium sized organisations particularly at the beginning of the process as outlined in Case Study I. It also indicates how energy professionals could link into this sector particularly in the sustain phase when an organisation has developed some energy efficiency experience as explored in Case Study II.

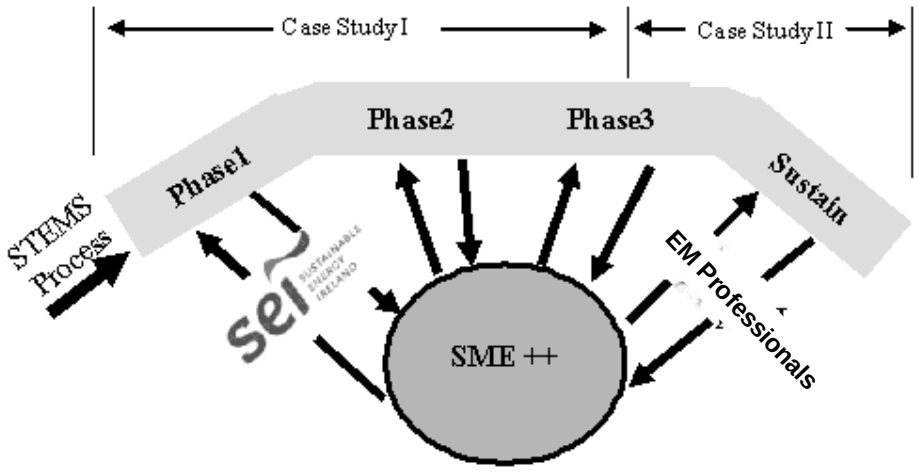

Fig.6: Proposed architecture of STEMS integrated with policy makers and professionals

6.2 Testing of Model

The authors 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 an entry-level 'easy to use' process for the SME sector and has

the potential to complement their existing web-based environmental support centre (EnviroCentre, 2006).

6.3 Implications for Practice

The Energy consultant viewed the World Wide Web as a means of increasing business opportunities in the EU in the context of forecasted growth in demand for energy services driven by policy, legislation and market demands. It was also seen as a means to increase business efficiency by removing duplication of work and unnecessary travel. However there was some hesitancy among clients to use web-technologies, as clients still preferred the familiarity of face-to-face meetings and personal contact. The World Wide Web environment was found to be conducive to managing a number of customers that can share common information while at the same time protecting sensitive information. Networking features of the CVE could be expanded to facilitate information sharing and communication between the energy consultant and client and between clients.

6.4 Implications for Policy

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. 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. It is argued that the Structured Team Based Energy Management System (STEMS) developed in the course of the has the flexibility to be adapted and applied to the needs of small and medium sized organisations in the industrial, commercial and public sectors and requires a basic level of computer literacy. Furthermore, while there is major focus on buildings as a means of energy reduction among policy makers such as the implementation of the EU Energy Performance of Buildings Directive (EPBD, 2006), it is argued that the ultimate success of Irish energy policy requires changing the attitudes of the people in the buildings.

6.5 Implications for Research

This study 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 builds on the literature in the light of empirical evidence from a study of energy management among both professional and "amateur" practitioners. 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 & 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. While diffusion theory was used as the academic framework for the study, it is recognised that concepts such as "energy efficiency" and "energy management practices" doe not fit neatly in the literature and require further exploration and development. Furthermore, although there have been academic studies on renewable energy policy in Ireland (Komor & Brazilian, 2005), there is a dearth of contributions to the area of RUE. Finally, it is suggested that the long-term development of research in this area requires some philosophical reflection. Since the whole area of the sustainable use of resources, and in particular energy, touches the area of justice and the future of society, perhaps the words of philosophers such as Jacques Maritain that such things "should be ordained to the common good and the common work for which the members of the city are assembled" need to enter the debate (Maritain, 2002).

6.6 Limitations

The studies undertaken in this research had a limited scope and duration. Also, due to time and resource issues there was no follow-up study to test the reliability and validity of the findings. The second field study also found some hesitancy to use web-technologies as clients has preference for the familiarity of face-to-face meetings and personal contact. This phenomenon requires more detailed examination. Testing of the model involved a small number of interviews, albeit from experts in the field, and requires more rigorous assessment. Future work is required to implement the web-

based structured approach outlined in this study in order to validate the process and provide data to further develop the system. 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 and these important points require further study.

7. CONCLUSIONS

This paper argues that the implementation of energy efficiency in organisations outside of Ireland’s Large Industry Energy Network (LIEN) must be given priority if Ireland is to meet challenging energy policy objectives and external carbon dioxide abatement commitments. It proposes that World Wide Web environments provide the mechanism to reach the large number of distributed organisations across the economy. Collaborative software can build on the success of the large industry network by creating virtual energy networks geared to specific sectors. The case studies demonstrated the suitability of a web-based collaborative virtual environment to support an energy team for both project management methodologies and multi-site implementation. The results in terms of cost and carbon savings, together with the positive cultural impact from implementing the model in a pilot study were encouraging. 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. The process would benefit organisations by facilitating the formation and training of energy teams that are immediately enabled to conduct a large amount of basic groundwork and achieve significant savings within a relatively short period of time. It also has the framework to provide on-line technical support and contact points as the team develops skills and competencies in the area of energy management and begin to tackle more challenging energy projects. Future work is required to implement the web-based structured approach outlined in this study in order to validate the process and provide data to further develop the system. Such studies

would provide information for performance measurement and benchmarking. This paper proposes that such collaborative energy networks, implemented in sectors outside of the LIEN, would facilitate coordination of projects and have the capability to access on-line professional support from energy consultants. Failure to implement such support networks could be detrimental to the vulnerable Irish economy entering an era of increasing energy costs and decreasing resources.

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