Designing and Implementing an Eco-Industrial Network for Small to Medium Sized Enterprises (SMEs) in the Mid-West Region of Ireland

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Abstract

It is estimated that as a sector SMEs could contribute up to 70% of industrial pollution. Efforts have been made to encourage SMEs to improve their environmental performance through the adoption of environmental management systems formally or informally, however the uptake of environmental management systems by SMEs has been low. SMEs often do not have the resources, staff or expertise to implement an environmental management system. Identification of environmental issues and environmental legislation affecting SMEs coupled with certification, validation and consultant’s fees are just some of the problems encountered by SMEs. This project aims to enhance and improve the environmental performance of SMEs in the Mid West region through the development of an eco-industrial network. The establishment of such a network through information and resource sharing, waste minimisation and reuse, water and energy conservation, shared transportation, centralised waste collection and treatment as well as increasing the influence of SMEs within regional planning through improved communication with policy makers and the local community would have a positive outcome for the companies involved, the environment and society as a whole. To date 20 companies have formally committed to this project, a steering committee has been established, an environmental audit and review questionnaire was designed and environmental audits and waste inventories have been completed on most of these companies through site visits and communications with the participants. Examination of material flows and waste inventories of the participants to identify potential environmental and economic linkages is on-going. The successful completion of this project will result in a best practice blueprint for the development of eco-industrial networks in Ireland.
1. Introduction

It has long been recognised that SMEs are responsible for much employment and job creation. In the enlarged EU (25 countries) approximately 23 million SMEs provide around 75 million jobs and represent 99% of all enterprises (European Commission 2005). It is demonstrated that SMEs seldom regard their environmental impacts as significant, although cumulatively they could contribute as much as 70% of all industrial pollution (Ammenberg and Hjelm, 2003). Encouraging SMEs to become more sustainable is essential as they constitute the majority of companies and if considered as a whole they have the largest environmental impact (Ries et al 2003). A number of driver toward the adoption of EMSs by SMEs have been identified: regulatory, economic, strategic, events and managerial (Biondi et al. 2000). Yet the uptake of EMSs amongst SMEs remains low (Hillary, 2004).

Benefits of EMS implementation in SMEs are: organisational improvements, cost savings through better waste management, increased employee motivation, increased employee skills through training and innovation, better communication within the company, improved safety, positive company image, new customers, stronger relationship with existing customers, gains against competitors through marketing, reduced insurance premiums, assured legal compliance, improved environmental performance by increasing energy and material efficiencies, increasing recycling and reducing pollution, better relationships with regulators and administrators and better relationships with customers (European Directorate-General, 2004; Hillary 2004). Many larger firms require or will soon require their suppliers to have EMS, in this way EMSs are being pushed back the supply chain to SMEs. 61 outline benefits associated with implementing an EMS specifically related to SMEs drawing upon available literature: Hillary (2004), O’Regan and Moles (1996, 1997) Roberts (1995). However there can be downsides for SMEs adopting EMSs. There have cases in which negative outcomes resulted or anticipated outcomes failed to materialise. Some SMEs have found that more resources such as time, skills and finance than anticipated were needed to get the EMS established. In some cases the EMS did not integrate easily with pre-existing quality systems. Some SMEs were unprepared for audit cycle requirements. The financial implications of gaining accreditation and paying consultants have discouraged many SMEs from considering the formation of an EMS for its operations (Hillary, 2004).
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<th>Organisational</th>
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<th>People</th>
<th>Commercial</th>
<th>Environmental</th>
<th>Communication</th>
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<tr>
<td>Possible to combine with quality systems</td>
<td>Cost savings from material, energy and waste reductions and efficiencies</td>
<td>Increased employee motivation awareness and qualifications</td>
<td>Gain new customers and satisfy existing customers</td>
<td>Improved environmental performance</td>
<td>Positive public image</td>
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<td>Improved training quality</td>
<td>Improved economic condition of SME</td>
<td>Improved employee morale</td>
<td>Gain competitive/ marketing advantage</td>
<td>Assured legal compliance</td>
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<td>Improved working conditions and safety</td>
<td>Improved control and monitoring</td>
<td>Better company image among employees</td>
<td>Reduced insurance premiums</td>
<td>Increased energy and material efficiencies</td>
<td>Better cooperation and relationships with regulators and administrative bodies</td>
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<td>Improved quality of environmental information</td>
<td>Provides a forum for dialogue between staff and management</td>
<td>Develop more environmentally friendly products</td>
<td>Increased reuse and recycling</td>
<td>Improved communication with stakeholders</td>
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<td>Documentation and demonstration of legal compliance</td>
<td>Stay in business</td>
<td>Reduced pollution</td>
<td>Improved planning</td>
<td>Lead the way for other companies in a sector</td>
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<td>Encourage innovation; stimulate process changes in transport, raw materials and packaging</td>
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<td>Provide a strategic overview of environmental performance</td>
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<td>Recognise a problem at its initial occurrence or even prior to occurrence</td>
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Table 1. Benefits of adopting an EMS
Supply Network Shannon (SNS) is an industry-led initiative aimed at representing, promoting, developing and connecting together sub-supply companies in the Shannon Region of Ireland. SNS approached the CER based in UL in with a view to improving their environmental performance. Following a consultation period between the CER and various public and private sector parties in 2004, particularly SNS and the Regional Waste Management Office (RWMO), a successful submission was made to the Environmental Protection Agency (EPA) to fund this project under the ERTDI programme. Organically developed inter-company collaborations were already operational in the Mid-West Region under the auspices of SNS. In total 20 SMEs participated in the project from a diverse range of sectors including packaging, plastic moulding, electronics, furniture production, food, waste management and light engineering. The companies are distributed within a 43km radius of Limerick City (Fig. 1 & Fig. 2). Of the 20 companies, 8 are located in Shannon, 6 of which are in Smithstown Industrial Estate and 2 of which are in the Shannon Free Zone. Seven are located in Limerick City and the remaining 5 are located in rural County Limerick.

Fig. 1. Mid-West Region of Ireland (Internet Reference 1)
2. Industrial ecology

Industrial ecology takes a systems view of production and consumption activities rather than focusing specifically on an industry by industry basis. The effluent of one industrial process serves as input for other industrial processes (Frosch and Gallopoulos, 1989). The principles of industrial ecology have been in existence within the petrochemical industry for many years, although the first documented example was Kalundborg (Ehrenfeld and Gertler 1997). The concept of industrial ecology has diffused and evolved into other models including industrial ecosystems (Baas, 1998) (Baas and Boons, 2004) eco-industrial parks (Bennett, et al. 1999), virtual eco-industrial parks, (Brown et al. 1997), industrial symbiosis (Chertow and Lombardi, 2005) and waste minimisation clubs (Ackroyd et al. 2002).

The driving forces behind industrial ecology should be:

1. Promotion of opportunities to form genuine partnerships and interaction with communities and government in order to develop a more responsive outlook towards sustainable industry practices.
2. Locating industries strategically to capture and concentrate wastes, by-products and energy surplus for use by other industries.
3. Co-location of industries that would benefit from trade of waste or by-products
4. Application of waste and energy recovery practices to provide an opportunity to add value in industrial systems.
5. Provide a catalyst and appropriate environment for adopting technological advancements, cleaner technologies, waste management and sustainable industry development and creating synergies.
6. Provision of ‘smart infrastructure’ to continue growth of eco-industries supporting sustainable industrial practices as a means of maintaining high degrees of innovation as a basis for their competitive edge.

7. Supporting industrial policies and incentives that encourage innovation, collaboration and commercialisation of new and improved product developments using materials, water and energy surplus to the system (Roberts, 2004).

The economic and environmental benefits of industrial ecology include reductions in consumption patterns of natural resources (as natural resources become scarcer their price rises), lower emissions to air and water, reductions in waste disposal costs, reduced transportation costs where by-products are exchanged between co-located firms and less tangible benefits such as improved company reputation (Chertow and Lombardi, 2005). Materials that were previously regarded as wastes on closer examination may find a use, thus emerges opportunities for niche industries to fill gaps between other industries to sell/utilise waste materials. (Cosgriff Dunn and Steinemann, 1998). Instead of exclusive focus on collaboration in terms of by-product exchange and waste utilisation, IE also covers collaboration with regard to joint training, coordination of provision of utilities and waste management among the actors in a ‘symbiotic network’ (Korhonen, 2004). For example, Ammenberg and Hjelm (2003) describe a successful joint EMS and group certification of 26 SMEs in an industrial district of Sweden. Each enterprise within the group has an EMS of its own and is certified to ISO14001. However the EMSs are quite similar and much of the administration is handled by a central organisation. This group certification has led to environmental improvements and cost savings compared to traditional individual certification.


“Some developers and communities have used the term EIP in a relatively loose fashion. To be a real eco-industrial park a development must be more than:

- A single by-product exchange or network of exchanges
- A recycling business cluster
- A collection of environmental technology companies
- A collection of companies making ‘green’ products
- An industrial park designed around a single environmental theme (i.e. a solar energy driven park)
- A park with environmentally friendly infrastructure or construction
- A mixed use development (industrial, commercial and residential)

Although many of these concepts may be included within an eco-industrial park, the vision for a fully developed EIP needs to be more comprehensive. The critical elements are the interactions among the parks member businesses and the community’s relationship with its community and natural environment.”

The goal of an EIP is to improve the economic performance of the participating companies while minimising their environmental impacts. Components of EIPs include environmentally conscious design of park infrastructure and buildings (new or retrofitted), cleaner production, pollution prevention, energy efficiency, and inter-company partnering. The EIP also seeks benefits for neighbouring communities
to ensure that the net impact of its development is positive (Lowe, 2001). Industry benefits by Lowe (2001):

1. Decreased production costs through increased materials and energy efficiencies.
2. Common business services (waste management, training, purchasing, energy management teams, environmental information systems and other support services) may be shared, thus reducing costs.
3. The EIP collaborative nature can help SMEs overcome barriers such as gaining access to information, consultation and know-how, and gaining access to new investments.
4. Open niches for new or expanded local ventures.

However, there are a number of difficulties associated with the development of EIPs including (Lowe, 2001):

1. Companies using each others’ residual products as inputs face the risk of losing a critical supply or market if a plant closes down.
2. Exchange of by-products or waste could encourage continued reliance on toxic materials.
3. Some companies are not accustomed to working “in community” and may fear the interdependence this creates.
4. SMEs may be unable to afford any technologies that may be required to improve their environmental performance and may find themselves outside the loop.

EIPs may be actual sites engineered to accommodate compatible types of industrial activity or ‘virtual sites’ or networks arranged based on existing industrial infrastructure. In either case, the objective is to identify or develop frameworks to facilitate sustainable industrial development in a predefined geographic area (Parto, 2000, Helling et al., 2005). An eco-industrial network (EIN) may include EIPs or it may be a network of stand-alone firms (Lowe, 2001).

Since the companies are not located in the same industrial estate, town or city the approach taken is that of a virtual eco-industrial park (VEIP) (Internet reference 2).

“The virtual EIP, is a network of related regional companies that are not physically located in the same park. Companies in a virtual park can create economies of scale for cooperative buying or sharing employees’ services. Firms participating in waste exchanges may pay lower prices for secondary raw materials and may realise savings in hazardous waste disposal charges. Networked businesses that are located in the same region can enjoy reduced transportation costs, whether the firms are industrial, commercial or retail establishments.”

The Kalundborg model is altered in the VEIP approach as firms do not have to be in close proximity of each other. If some waste streams can cost effectively support their transportation then a VEIP can be formed to practice industrial symbiosis on a larger scale. EIP development usually involves construction of a new park or redevelopment of an existing park. EIPs entice responsible businesses to co-locate resulting in costs for an existing company that chooses to relocate to an EIP. Although co-location is advantageous where exchanges of non transportable entities (like latent heat, steam, cooling water or low value materials) occur, companies would also have to contribute to the capital costs of setting up infrastructure to support exchanges. Establishing an EIP of this type means that specific tenants have to be
identified and locked in. In the event that a particular tenant should leave the network the whole group may suffer as a result. The infrastructure that has been put in place does not lend itself to flexibility. Finding a replacement company can be an extremely difficult if not impossible task. VEIPs draw elements of EIPs and waste exchanges together to reap both economic and environmental benefits without the constraints of co-location. Companies can disengage from the network with fewer consequences and there is lesser reliance on individuals for system stability. Capital investment required is much lower or in some cases unnecessary (Brown et al, 1997).

3. Aims and Objectives

The ultimate objective of the research is to establish an eco-industrial network or VEIP in the Mid-West region, together with a supportive framework to help solve problems faced by SMEs in implementing innovative sustainability measures to improve environmental performance based on the principles of IE, resulting in a blueprint for sustainable development among SME clusters which could then be used by other clusters in Ireland and across the EU. The fundamental objectives to realise the ultimate objective are:

- The establishment of a steering group for the project to include representatives from the participating SMEs, policy makers, local community groups and researchers.
- The design of an auditing template to be used for initial review of companies and again by the companies themselves in monitoring their progress toward environmental responsibility.
- The assessment of the environmental aspects and performance of each individual company and completion of detailed audit reports accompanied by recommendations for immediate improvements.
- Detailed analysis of all participants’ processes, raw materials, by-products, wastes, and transportation aspects in order to identify links and synergies that may have potential for further development and exploitation.
- Ensuring that areas selected for collaboration are financially and environmentally sound.
- Identification of problem areas the companies face as individual entities and development of network based solutions.
- Provision of a forum for companies to meet, interact and share ideas.
4. **Methodology**

4.1 **Steering Committee**

A Steering Committee was established for the project with three representatives from the CER, two from SNS, one from the Regional Waste Management Office (RWMO), two from the EPA and five from the participating SMEs. On commencement of this project, the committee was expanded to include project researchers, company representatives and the EPA. The Steering Committee met on the first Thursday of every month at the University of Limerick to review progress, identify opportunities and resolve difficulties, and facilitate a free flow of information and ideas between all team members to ensure capability development and knowledge transfer. EPA representatives were scheduled to attend every third monthly meeting owing to time and travel constraints. Through the RWMO representative, the project group became involved in the Business to Business (B2B) Green Mentor programme that focuses on waste prevention for companies in the Mid-West Region of Ireland. The programme is funded under the EPA’s Cleaner Greener Production Programme and is managed by the RWMO. The CER research team co-ordinated the research and the identification and development of symbiotic connections, with input from Steering Committee members.

4.2 **Project Launch**

The work programme included an official Project Launch in order to promote the research and sponsors held in March 2005. This event included seminars as well as trade stands and attracted a large audience. A number of information leaflets for distribution (which included background to the project, tips for improving environmental performance in the areas of energy, waste and transportation; guidance on implementing an EMS and the benefits of same, and so on), posters and presentations were prepared. While several companies expressed an interest in the project only five signed up for further consultation on participation. These were contacted via email and telephone calls and of these three participated in the project, the remainder citing other more pressing commitments and lack of time as reasons for deciding not to participate at that point in time.

4.3 **Register of environmental legislation**

Through SNS and company representatives on the Steering Committee it was made known that the SMEs urgently needed guidance on their regulatory obligations as there was a dearth of information on what regulations pertained to them while at the same time SMEs did not have the resources to investigate this for themselves. It was therefore decided that this should be the first task and that a collation of environmental and health and safety legislation onto one CD would be the preferred means of doing this. Such pieces of legislation had the explanatory note typed and inserted into the CD. The legislation was divided up into 6 main sections: air, chemicals, noise, planning and development, waste and water.

Within each section were lists of the relevant pieces of legislation together with explanatory notes and links to the full text where possible. The legislation included in the database was wide-ranging in order to cover all company circumstances. This database was subsequently used following each site visit to identify the legislation that was believed to be relevant to each specific company.

4.4 **Website**
In order to promote the project and provide information to the participants a website was developed for the project. It was also intended to use the website to establish a waste exchange and information sharing website. Website was designed which included a home page, a page describing the project, a page outlining the participants with links to their respective websites, a page with project outputs such as conference papers, a page with information on EMSs, a page with useful links, and a contacts page (http://www.ul.ie/~cer/econet/index.htm)

4.5 Environmental reviews
While the initial project proposal proposed to carry out environmental audits for the purpose of determining material and energy flows only, it was decided by researchers and the Steering Committee that extending the auditing process to include all aspects of company operations would be of greater benefit to the individual SMEs and could perhaps encourage more active participation in the project. The review process involved the preparation of an environmental review questionnaire, arranging and conducting site visits, collation of relevant information, calculating company ecological footprints, researching and recommending environmental performance improvements/technologies, and issuing reports.

4.6 Environmental review document
In designing the environmental review questionnaire, each company was first contacted by telephone to ascertain their existing environmental management status. Of the twenty companies only two had an environmental management system in place, both certified to ISO14001 and therefore had already completed environmental reviews, environmental policy statements, and registers of legislation. This contrasted with the remaining 18 companies where the level of environmental awareness and procedures in place were markedly less. This situation led to the conclusion that the environmental review questionnaire would need to include elements of an initial environmental review for the companies with no environmental management system intertwined with elements of an environmental audit for those companies which had an environmental management system in place.

4.7 Environmental review procedure
Each company was contacted to arrange a site visit at which point it was also indicated to the company representative the type of information that would be sought and what would be beneficial to have available for inspection on the visit such as energy bills, raw material inventories, water consumption rates, waste composition and quantities and any certificates or permits. The visits generally lasted 2–3 hours depending on the company size. The site visit was broken down into two aspects:

1. A tour of the company’s premises which allowed for recording the overall activities of the company, the raw materials being used, the production processes in place, the wastes being generated, the receiving environment and so on.
2. An interview with the company representative using the questionnaire as a guide.

On touring the premises, the company representative was advised to begin at the goods inward area (to assess materials used, packaging and any handling or storage issues) and where possible to follow the production process as it operates right through to goods outward. This allowed for better understanding of the production process, observe material changes, waste production and question any possible
inefficiency. This was then followed by an examination of any waste segregation and storage facilities, lighting and heating fixtures and controls, office, canteen and toilet facilities where issues such as energy efficiency, water conservation measures, waste minimisation and segregation measures were examined. The tour was concluded by a tour of the outside of the premises where such issues as building design, insulation, lighting, tidiness, oil storage, potential for contamination of drains and so on were assessed. This process allowed answers to several of the review questionnaire questions to be recorded and provoked other relevant questions allowing the review to be more comprehensive while also expediting the following interview process.

Use of the review questionnaire ensured that all companies were asked the same questions thereby ensuring consistency in assessment. A description of the areas covered can be found in table 3.
General company information
In order to understand the business, questions were asked on each company’s management background, products, building, employees and operating hours, certifications and general housekeeping practices.

Environmental policy
In an effort to understand the level of environmental understanding / concern within the company, the representative was questioned on the written environmental policy, where present, and asked to provide a copy. Where a company had an environmental policy, it would be determined if it was implemented and communicated to all employees, and if and how it needed to be improved.

Legal requirements and voluntary practices
The companies were asked if they had a register of environmental legislation, if they had to comply with permits or licences or if they had implemented any voluntary codes of conduct or standards such as ISO9000 or ISO14001.

Staff organisation
This part of the interview sought to identify the people responsible for environmental issues in the company and the means by which environmental awareness was communicated through the organisation. The training needs of employees were also ascertained.

Raw materials
This section of the review was important as it helped identify possible material exchanges as well as some of the industrial ecology linkages. Raw materials, quantities used, and their origin were listed. The use of hazardous materials was examined and Material Safety Data Sheets (MSDS) inspected.

Transport
Transport of raw materials, finished products and employee travel were examined in this section. Quantities of materials being transported were examined with the aim of maximising efficiency of trips and reducing empty space in trucks. Employee travel to and from the workplace, as well as travel for business purposes were assessed.

Water consumption
While all businesses pay water rates, not all premises are metered. Information sought in this section included consumption rates and costs, uses, and any water conservation measures in place.

Wastewater
The participants were asked about the composition of their wastewater, permits and any wastewater treatment facilities that they had.

Energy
The energy consumption of each company was examined. Any energy conservation measures, or obvious inefficient practices were noted.

Waste generation
Waste handling, storage, composition and quantities were examined in detail. Where available, details on these wastes, the waste contractor used and fees incurred were recorded.

Emissions to atmosphere
Information on types, sources and quantities of emissions to air was addressed.

Noise
Noise sources, noise levels and compliance with regulations were examined.

Accidents and occupational health
The companies were asked to provide their safety statements for viewing. Information on past and potential scenarios was assessed as well as regulatory compliance.

Table 3. Areas assessed in review
Following the site visit and having collated and assimilated the information received, it was found that while the standard and detail of information received from some of the companies was adequate, others failed to provide the level of detail required for the study. Therefore, a second questionnaire was devised. A Microsoft Excel spreadsheet incorporating the level of detailed data required was prepared in which completed data gathered through the site visits were included in the spreadsheet before sending them to the companies with missing data flagged for attention. In this way the companies that provided the most information at the site visit stage had to provide minimum input to complete the spreadsheet. Additional data requested included sources of raw materials and destinations of finished products and
quantitative data that were not available during the site visits such as electricity, gas and water consumption, and waste generation data. In designing this spreadsheet, a copy was sent to selected companies for pilot testing and changes were made to the spreadsheet based on the feedback received. The spreadsheet was emailed to the companies with a request for completion and return. However, it was found that some companies still did not comprehend or had difficulty in supplying the necessary information. As some companies did not provide all the necessary information, these were visited again to reiterate the importance of receiving the data, what it would be used for and how it would make their company-specific report more complete and beneficial, not only for the research project but for their own use. During such site visits, items such as company electricity bills, oil and gas bills, etc were analysed in detail to retrieve the missing information. This was a very lengthy process as utility bills over a period had to be examined. Having gone through this process two companies still did not furnish sufficient quantitative information and were excluded from the subsequent analyses.

4.8 Environmental review report

Following the environmental review, a detailed company-specific report was generated that collated available information on the company, which made company-specific recommendations for immediate environmental improvements, longer-term improvements and possible collaboration areas for each review section. The report also included a number of appendices which included guidance documents on writing an environmental policy statement, composting canteen waste, implementing an EMS, oil storage, and contact details for suppliers or service providers of various environmental technologies in an effort to find solutions to some of the most common problems that companies faced. The report also included a CD of environmental legislation and within the report the legislation that was thought to be applicable to the company was listed.
5. Results

5.1 Individual SME performance

The level of specific environmental management systems and structures in place within companies ranged from haphazard to fully certified internationally-recognised systems. This reflected human resource availability and/or customer or parent company pressure (those companies, two in total, certified to ISO14001 tended to be large SMEs, and daughter companies of larger multinationals). While the other SMEs indicated that they were examining the idea of implementing an EMS, the driver here also seemed to be customer pressure, there did not appear to be a great awareness of the potential benefits of implementing such a system. The general perception was that the process was costly, bureaucratic and not good value for money. Again the driver would be if it became a requirement from customers.

Of the companies that participated in the project nine had environmental policies in place. A large proportion (6) of these were not thorough or specific but rather were a broad statement of aims and as such were deficient. It was therefore decided to include a tailored sample environmental policy statement in each report along with guidance notes in the form of an appendix. In the situation where bland statements were observed it was likely that poor implementation and communication of environmental initiatives would ensue. This was evidenced by the absence of documented environmental action plans and monitoring programmes. Only in the two companies with ISO14001 in place was there an awareness of all the legislation applicable to the company operations. The remaining companies expressed doubts on whether they were fully aware or operating to all applicable legislation. To help with this process the CD of legislation was attached to the back of each report, potentially applicable legislation was listed based on the information supplied by the companies.

With staff organisation it was again found that, apart from the ISO14001 companies, the SMEs did not have anyone designated for environmental management. Generally responsibility for environmental management fell on the company manager or an employee usually in the quality or health and safety areas. This reflects both the lack of emphasis on environment within some companies as well as the lack of easily accessible training courses. Training in the areas of EMS implementation, chemical/oil storage and spill control, and energy conservation in particular were identified as needed. As formal training was quite poor among management staff this had a trickle-down effect to operatives and therefore it was recommended that training programmes be implemented for employees also. As the environment agenda appeared relatively low in priority, performance indicators had not been established. For example, energy use, waste output, water consumption etc were not being monitored and tracked and again this was an area where improvements were recommended.

The raw materials used in the production processes were mostly dictated by customers and not amenable to replacement by alternatives. Generally materials were handled, stored and disposed of in accordance with the material safety data sheets (MSDS) and appropriate personal protective equipment (PPE) was available.

Companies used a mixture of couriers, licensed hauliers or company owned vehicles for road transport of materials and goods. Shipping and air transport were used for importing and exporting. Most employees from each company travelled to work by car and while there were no formal car-pooling schemes in place, there was evidence of some informal arrangements amongst employees.
impact arose from travel for business and this included using car, rail and aeroplane modes. Again recommendations were made to reduce transport impacts such as use of teleconference equipment, formal car-pooling schemes for each industrial estate using a drive matching website, and promotion of more sustainable transport modes over flying.

Water use was for the most part not a major issue for most of the companies where it was only used for domestic purposes. In such instances there was a fixed annual charge for water, a policy which has meant companies were unaware and apathetic to water consumption patterns. Where water was used in the production process water was metered and charged for accordingly. In these instances companies were more aware of their consumption and particularly where they had noted an increase in cost for same in recent years. While there was awareness, this had not translated into any significant conservation measures. Possible means of conserving water for the companies such as installing rainwater harvesters, grey water recycling systems, various tap, flushing and cistern systems, trigger valves on hoses etc. were listed.

Wastewater discharges were carried out under Local Authority (LA) permits where required and the indication from companies was that compliance with these was good. There were no designated firewater retention facilities identified at sites visited and generally spill containment equipment and contingency planning was rather poor as was monitoring of drains for contamination.

Energy was an area that most companies were acutely aware of given the increasing costs associated with this in the past two years in particular. Due to the obvious fiscal incentive to increase energy efficiency this was an area where companies were most interested in taking action and some companies had already initiated some improvements. However, such initiatives were not documented nor was there any written energy conservation policy in place that could be distributed and communicated to all employees. Oil storage for heating was often inadequate with poor or no bunding and poor storage practices (oil tanks on roofs or inside the building and placed over the boiler, for example). As the buildings were most often rented there was little incentive to improve building insulation (such as installation of double-glazed windows or wall insulation) or to make any significant investment in improved heating systems and technologies. There was also potential to improve efficiency through investment in new more energy efficient equipment and controls. For example, replacement of older type fluorescent light tubes with new slimline tubes; use of presence detectors to allow automatic control in areas which are not in permanent use; fitting photocells to outside lights; installation of thermostats; operating compressors on a ‘demand-controlled’ basis; replacement of old or faulty motors with modern energy efficient types, and so on.

Waste generation and treatment was the second area of major concern due to the costs associated with its disposal. The management of waste on site depended to some extent on the waste contractor employed. Some waste contractors took unsegregated waste. Others required waste to be segregated – plastic, cardboard, metal and canteen/mixed waste categories being most commonly found. Some companies had employed separate waste contractors for certain waste streams as it was found that some waste contractors collected some materials for free while charging for others, it was difficult to obtain information from waste contractors on costs and specific services. Recommendations to the companies on minimising and/or preventing waste production in the first instance and for waste produced best practice for its segregation, storage and treatment were made.
Emissions to atmosphere and noise were generally not of concern to the participating companies due to the nature of their operations, but where required monitoring regimes and compliance measures were in place.

Health and Safety requirements were very well complied with by the companies. Good systems of safety management were in place and any necessary PPE were made available to employees and visitors.

5.2 Identifying areas for collaboration

Following the environmental review of each company, the information to identify common problems and needs, and possible areas of collaboration to overcome these were assessed. Each report section for every individual company was examined in parallel to identify common problems and opportunities were identified for collaboration in the following areas in particular:

- waste management
- transport
- energy
- training and services

Possible new potential business opportunities were also identified. For example waste plastic could be processed to produce products with uses in road safety, home gardening, horticulture, building, domestic, entertainment, agriculture, furniture, marine engineering, plumbing and drainage, education, sports, waste industry, transport, office etc. The common problems and possible collaborative opportunities are listed in Table 4:

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<tr>
<th>Common Problem</th>
<th>Possible collaborative solution</th>
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<tr>
<td>Waste management</td>
<td>Disposal of potentially valuable material resources</td>
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<td>Insufficient critical mass for plastic recycling</td>
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<td></td>
<td>Escalating waste management costs</td>
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<td>Significant quantities of organic waste and concomitant disposal costs, proposed diversion of organic waste from landfill by end of 2006.</td>
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<tr>
<td>Transportation</td>
<td>High freight costs</td>
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<td></td>
<td>Regional traffic congestion</td>
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<td>Travel costs and associated environmental impacts from business meetings</td>
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<tr>
<td>Energy</td>
<td>Escalating energy costs; security of supply</td>
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<tr>
<td></td>
<td>Packaging waste; environmental soundness of raw materials</td>
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<tr>
<td>Training</td>
<td>Services</td>
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<td>-------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Difficulty in organising training for small workforce; costs of same</td>
<td>Cost of services; companies within same business park using different</td>
</tr>
<tr>
<td></td>
<td>services providers – inefficiency aspects</td>
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<tr>
<td></td>
<td>Collaboration to identify common service requirements and put out to</td>
</tr>
<tr>
<td></td>
<td>tender – reduce transportation impacts. Common services include: forklift</td>
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Table 4: Common problems and possible collaborative solutions

Many of such collaborative opportunities were envisaged to improve the environmental performance of the companies while simultaneously reducing costs. It was therefore decided to hold a workshop in order to bring together as many participants in the project as possible to discuss ideas for networking and collaboration between the companies, their feasibility and likelihood of uptake, and to obtain feedback on project progress in general. The workshop was organised by the Centre for Environmental Research at the University of Limerick on March 2006. Representatives from Supply Network Shannon (SNS), the Regional Waste Management Office, and from each participating company were invited to attend. Each member gave a background to their organisation and their input to the project. A presentation by the CER researchers covered aspects of waste management, transportation, energy, shared training and suppliers, and new business opportunities for the participating companies as a network. The opportunities identified in the presentations were discussed by all those present and an evaluation survey was distributed to all.

5.3 Feedback on collaboration from the SMEs

Following the workshop, the company representatives were asked to fill out an evaluation survey on the review reports and the collaboration and networking process. Those that did not attend the workshop were posted these evaluation forms with a SAE for returning them. Most participants felt that participation in the project had increased their environmental awareness and some had implemented recommendations made in their review report.

6. Conclusions

As this type of research is innovative in nature, there are no established methodologies to follow as such. Researchers were not active in the selection of most of the participating companies as these were companies from within SNS that were willing to volunteer and due to time and resource constraints the study had to be limited to around twenty companies. The review document was designed to be very comprehensive giving it broad applicability, albeit probably cumbersome for those SMEs in which some questions were found not to be applicable.

The voluntary participation of companies in the project and the backing of an organisation such as SNS is positive. This point was highlighted by Heeres et al, 2004 when comparing eco-industrial park initiatives in the USA and the Netherlands.
They argue that the initial success of the Netherlands based projects can be attributed to these two factors.

All the companies received individual environmental reviews and reports. Each recommendation was carefully planned and achievable, if companies implemented these changes and put in place the procedures which were recommended they would be in a strong position to implement an environmental management system and gain accreditation. Many companies expressed anxiety that stricter environmental requirements from their customers could place their companies in jeopardy.

The areas for collaboration that were identified are promising and many of the companies involved have expressed an interest in participating. A number of possible areas for collaboration require negotiations with other parties previously uninvolved in the project, it is planned as part of future work to integrate more with these stakeholders in an effort to maximise opportunities

<table>
<thead>
<tr>
<th>Area for Companies to Collaborate</th>
<th>Areas Requiring other organisations to collaborate with companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car pooling</td>
<td>Freight transport</td>
</tr>
<tr>
<td>Composting</td>
<td>Renewable energy</td>
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<tr>
<td>ISO 14001 accreditation</td>
<td>Centralised waste collection</td>
</tr>
<tr>
<td>Pallet exchange</td>
<td>Improvements to buildings/estates</td>
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<tr>
<td>Waste exchange</td>
<td>Water harvesting systems</td>
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<tr>
<td>Shared plastics recycling</td>
<td>Public transport</td>
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<td>Shared services and training</td>
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</tbody>
</table>

Table 5: Collaboration opportunities

Shared transportation of employees, products and raw materials is a viable option for many of the companies involved. A website has been established and preparations are being made to have a message board format so that the companies can exchange information on transport, wastes, and raw materials.

Most companies made some of the changes recommended in the review reports and expressed an interest in further participation in the project. Nearly all the companies agreed that their environmental awareness has improved since participation in the project.

A pallet exchange system is in the early stages of formation by members of SNS and a car pooling website is also under development. ISO 14001 accreditation was not viewed by participants as a viable option as some companies do not feel that gaining accreditation is justified for them at this time. Shared plastics recycling is being investigated through a questionnaire where interested companies could send samples of plastics together with quantities to be analysed.

7. Future Work

- To develop the network further by increasing the number of participants and measuring progress of companies already involved.
- To integrate more with policy makers, government bodies and industrial park management to further develop collaboration areas. This will also open up new collaboration opportunities.
- To use back-casting and forecasting approaches in identifying key policy and regulatory changes necessary for successful industrial ecology initiatives in Ireland.
Where collaboration opportunities are successful, to measure their impacts, economically, environmentally and socially and identify the climate which facilitated their realisation in the hope that these collective experiences can form the blueprint for other future initiatives.
References


Internet References