Establishing an Eco-Industrial Network for SMEs within the Mid-West Region of Ireland

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Abstract

It is estimated that SMEs are responsible for 70% of industrial pollution across the EU. This project aims to enhance and improve the environmental performance of SMEs in the Mid-West region of Ireland 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 better communication with policy makers and the local community would have a positive outcome for the companies involved, the environment and society as a whole within the region.

Since January 2005, 20 companies have committed to this project. Environmental audits and waste inventories have been completed on most of these companies. Researchers are also examining material flows and waste inventories of the participants to identify potential environmental and economic linkages. The successful completion of this project will result in a best practice blueprint for the development of eco-industrial networks in Ireland.

Industrial Ecology

In natural ecosystems materials flow cyclically from producers (plants) to consumers (animals) and are recycled by decomposers (fungi and bacteria) and scavengers (e.g. vultures). The concept of waste in a natural ecosystem is meaningless (Frosch, 1995).

Material flow in human industries is linear. It flows from manufacturer to consumer and when its use has been realised, then to the air or landfill. Energy is derived

from fossil fuels and the loop is left open. Wastes are not assimilated by scavengers or decomposers.

Industrial ecology (IE) is described as:

> "industrial ecology is all about connections: material connections, energy connections, organisational connections and human connections. It is the application in the world of commerce and industry of more cyclic and sustainable flows between businesses (and their communities), especially with regard to energy and materials. This should lead at the same time to less pollution and higher profitability, but, fundamentally, industrial ecology is a social construction. It deploys human intention to create more integration, more cycling of resources and better use. It draws on the natural world and impacts the natural world, but it is inherently a form of 'biomimicry" (Cohen-Rosenthal, 2003)

Boons and Baas, (1997) expand the biomimicry analogy further by highlighting the features of natural ecosystems which industrial systems should aim to mimic. They outline that energy requirements should be minimised, along with waste generation and consumption of scarce resources. By-products, wastes and discarded products should be reused as inputs in industrial processes and the industrial system should be diverse and resilient so that it can recover from unexpected shocks.

There is agreement amongst many authors (Garner and Keoleian, 1995; Ehernfeld, 1994; Korhonen, 2002) that Frosh and Gallopoulos (1989) pitched the concept of industrial ecology to a wider audience. The traditional model of industrial activity, where raw materials are used to produce products to be sold and wastes to be disposed of is a system which should be re-engineered into a more integrated model, an industrial ecosystem. A system based on this model would facilitate the optimisation of energy and materials consumption by functioning as an analogue of biological ecosystems. It is recognised that the cycling of materials through an industrial ecosystem would still result in unavoidable waste and hazardous by-products generation along with energy expenditure.

Eco Industrial Parks

There has been much emphasis on the development of Eco Industrial parks (EIPs). Examples include Kalundborg, Chattanooga, Cape Charles, Styria and Londonderry.

The Kalundborg situation evolved over time, the actors involved were not driven by environmental concerns, but more by economic viability, the material exchanges made good economic sense (Heeres et al 2004). Four neighbouring companies and the Kalundborg municipality co-operate to constantly explore new means of environmental improvement. The companies involved comprise Denmark's largest power plant, Denmark's largest oil refinery, a plasterboard manufacturer, a pharmaceutical industry and the Kaulundborg municipality. Some of the reasons attributed to Kalundborg's success are: the diversity of companies involved, linkages have a sound commercial basis, symbiosis has been voluntary, the group has the support of the authorities and communications and mutual management understanding are excellent between the industries involved (Garner and Keoleian, 1995).

Revisiting and redeveloping existing industrial parks, such as Burnside, to form EIPs has proved a popular venture (Coté and Hall, 1995). The advantages being: businesses are already in situ, there may be existing links between some companies such as a supplier consumer relationship, there are increased opportunities to centralise waste collection, revamp existing infrastructure such as roads, drains, signage and landscaping and to draw up a charter for companies wishing to stay in the park and new companies which may move in. In order for this to succeed all businesses in the park must be willing to be actively involved and share information. A co-ordinating body must be established. Some companies may not wish to participate fully; in this case the companies involved reap the benefits of being located in an eco industrial park without contributing to its establishment or maintenance.

The establishment of purpose built EIPs has received much attention. This involves the construction of new facilities using the most sophisticated construction and design methods to optimise energy savings, water use reduction, hazardous materials use reduction, recyclability at end of life and integration with natural surroundings. The park management usually draws up a charter and businesses are assessed to meet certain criteria before they are permitted to locate in the park. Cape Charles Sustainable Technology Park took this approach in its design (Hayes, 2003).

All these approaches have their merits, but what of existing businesses that wish to improve their environmental performance that may or may not be located in industrial

parks? 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 1).

> "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).

The possibility of establishing a VEIP was examined at Brownsville, Texas. This could also be described as regional industrial symbiosis. Co-location is not the driving force behind the project (Internet reference 2). A Microsoft Access database was used to gather information on companies in the region. The companies were then classified using Standard Industry Classification Codes (SIC codes). Materials were also classified by

code, therefore the database could match industries based on material and industry codes (Brown et al, 1997). Schwartz and Steininger (1997) outline criteria important for the development of secondary raw material markets. There must be a significant difference between virgin raw materials and waste prices, this must include the cost of transportation and processing. The waste must be of a constant quality, this will ensure that all waste is properly treated before its reused. There also must be a number of potential partners involved, this provides the system with redundancies.

The Project

Supply Network Shannon (SNS), an open sectoral network of engineering and electronics companies located in the Mid-West region, approached the Centre for Environmental Research with a view to improving the environmental performance of its member companies. To date twenty companies have agreed to participate in the project along with the Regional Waste Management Authority. Most of the companies are members of the SNS group and others have been recruited through contacts between existing participants or have expressed an interest in joining the project themselves. Therefore each participating company is a willing contributor. The companies are distributed within 43 km of Limerick City. Of the 20 companies 8 are located in Shannon of which 6 are in Smithstown Industrial Estate and 2 are within the Shannon Free Zone Estate. In the suburbs of Limerick City a further 7 companies are located, only 3 of these are located in the same industrial estate. County Limerick is home to the remaining 5 of the participating companies. Activities that the companies are involved in include; packaging, furniture, electronics, plastics moulding, engineering, printer ink manufacture and food production.

The National Competitiveness Council in its 2004 Annual Competitiveness Report indicated challenges facing Irish businesses as:

- In the three years to September 2004, electricity prices for industry have increased by approximately 40 per cent. A typical industrial user pays 40 per cent higher

electricity costs in Ireland than in the UK. Of ten countries surveyed Ireland is the second most expensive (behind Italy) for electricity for industrial users.

- Escalation in energy costs are partly a result of increases in international fuel costs which are a major input into Irish electricity prices
- Of the ten countries surveyed in January 2004, Ireland was the second most expensive behind Italy for firms purchasing 10 GWh of electricity per annum. The UK was the cheapest. By way of comparison, an Irish firm paid approximately €880,000 per annum for 10 GWh of electricity (before the latest price increases); while a firm in the UK consuming a similar amount of electricity pays €530,000. This amounts to a 40 per cent advantage in terms of costs for a UK firm over its Irish counterpart.
- A 16% gas price rise commenced on October 1st 2004
- Many SMEs in Ireland have been adversely affected by the escalating cost of personal liability insurance over recent years.
- Firms in Ireland have also experienced rapid increases in the cost of waste management services. IBEC has estimated that between 2001 and 2003 Irish companies experienced a cumulative 47 per cent rise in waste management costs.
- In 1999 Ireland was ranked 8th out of 10 countries in terms of the cost of land fill per tonne of municipal waste. Only Denmark and the Netherlands were more expensive. Since then there has been a dramatic escalation in local authority charges for landfill and this will have further undermined Irish competitiveness in this area.

Aims

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. In order to achieve this, a number of minor objectives had to be met. These included:

- The establishment of a steering group for the project which included representatives from the participating SMEs, policy makers, local community groups and researchers.
- The design of an auditing template that could be easily used by researchers and again by the companies themselves in monitoring their progress toward environmental responsibility.
- Utilised in all of the SMEs involved. This implied that the auditing template had to incorporate the differences between the companies in size, environmental awareness and sector.
- The execution of the assessments and completion of audit reports with recommendations for immediate improvements for all participants.
- The in depth analysis of all participants' processes, raw materials, by-products, wastes, and transportation aspects in order to identify links and synergies to be further developed and exploited.
- Identification of problem areas the companies face as individual entities and development of network based solutions to these problems.

Methodology

A steering committee was established in January 2005, with representatives from the participating SMEs, policy makers, local community groups and researchers. This group meets regularly to agree work schedules and discuss ideas or problems relating to the project. Some companies involved were already certified to ISO 14 001 standard. This had implications for initially assessing each company as some of them had initial environmental reviews, environmental policies along with registers of legislation completed as part of their environmental management system. Uncertainty on the part of the researchers as to the extent of the companies' environmental awareness led to the development of tailor made environmental audit questionnaire which encompassed 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 implemented an environmental management system. The questionnaire covered areas such as: general company information, legal requirements of

the company, environmental policy, organisation and staff, receiving environment, production processes, raw materials, transport, water use, energy use, waste generation, wastewater, releases to land, emissions to atmosphere, noise and health and safety.

The companies were contacted by the researchers and site visits were arranged. The companies were asked to have some information readily available for the research team such as energy bills and expenditure, an inventory of raw materials, water consumption rates and information on their waste generation and composition. The visits generally lasted 2 hours as most managers of SMEs are hands-on and tend to have less staff to delegate assignments to. A tour of the company's premises was the first step in the assessment process. The tour allowed researchers to view the overall activities of the company, the products and raw materials being used and the wastes being generated. The company representatives were interviewed using the audit questionnaire. The research team would then write an audit report for the company, which would make recommendations for immediate environmental improvements which could be implemented. The audit reports would then contain the information needed to proceed with establishing a network. However, 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 such an analysis. Therefore a second questionnaire was devised. It was decided to avoid further site visits as this would require a representative from the company to schedule time off to meet with the researchers again. Instead a Microsoft Excel spreadsheet incorporating the level of detail required was prepared. Completed data gathered through the site visits were included in the spreadsheet before sending them to the companies. In this way the companies which provided the most information at the site visit stage had to place minimal 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. The data will then be placed in a Microsoft Access database which will allow ease of analysis and the possible expansion of the network in the future.

Anticipated problems

A view that industry may use industrial ecology as an alternative to pollution prevention initiatives has been expressed by some authors (Cossgriff Dunne and Steinemann, 1998), especially if a profit can be derived from a waste stream. This may perpetuate increased by-product production or resource extraction. This scenario must be avoided. Therefore all companies will be encouraged to improve their own processes before attempting to engineer material exchanges. Using Life Cycle Analysis (LCA) and design for environment will aid in the identification of best linkages and process improvements. This approach may have limited success as some of the participants do not have control over design of their products.

There is a need to have biological type redundancies within the network, so that if a company goes out of business or changes its processes the company / companies linked to it will not suffer. This problem could be overcome by having a wide and diverse range of companies involved. Therefore constant recruitment or targeted recruitment of companies is necessary. A means of encouraging participation is to outline success stories from other cases (Heeres at al, 2004). In the case of Ireland this is not possible as there have been no similar initiatives undertaken. Macroom e, an environmental industrial park, has been an attempt to design and build an e-park, but its success or lack of has been undocumented. The research team has attended numerous meetings and events in the Mid West region aimed at SMEs. Through these events 3 companies were added to the group.

Lack of company interest may prove to be detrimental to the project. By providing regular updates of progress and achieving small “wins” for the companies involved should help to keep active company participation.

SMEs tend to lease their premises and therefore have little input or influence over building design. Implementing and promoting green design may be a problem. Through consultation with policy makers improved planning and management of existing and future industrial estates may be achieved. However there are improvements that the companies can make even if they do not own the premises that they are occupying.

Successful EIP approaches tend to be based on the Kalundborg EIP model of collocation and waste exchange, Styria, Austria is an example of the adaptation of this

approach (Schwartz and Steininger, 1997). However as this project focuses on SMEs distributed throughout a region, new challenges and problems are presented. It therefore is a more unique development and vision process.

Areas of possible success

The fact that the companies have voluntarily signed up and that we have the backing of an organisation such as SNS to use as a platform to educate and inform companies of the potential benefits which may arise as a result of participation augers well for the project. 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.

Through the audits and questionnaires we have been able to identify common suppliers and service people used by participants. Through meetings between participants and the suppliers involved it may be possible to arrange bulk buying and delivery to companies in the same area at the same time. An observation made by many of the SMEs was the amount of packaging waste arising from raw materials. Few SMEs have influence over their suppliers and are not in a position to ask them to reduce the amount of packaging which they ultimately have to dispose of. If some of the participants had a common supplier then they would be in a stronger position to compel that supplier to improve its environmental performance.

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.

Through the audits and questionnaire the companies have had to examine and quantify their wastes. Some of the participants were not segregating waste and using skips for waste disposal. An inventory of all waste contractors operating in the region has been compiled. When information regarding the exact composition of waste arising from the networks activities has been collected, the waste contractors will be contacted. Some of the companies have printed circuit boards as waste. These are a high value waste stream however the quantities produced in individual companies are low. There

may be potential to pool wastes together and companies may then reduce the cost of transportation of these to a waste treatment facility or even make a profit on them. A waste exchange might also be a viable option, the criteria to establishing a waste exchange need to be examined more carefully such as the value of a waste stream compared to virgin material, the costs of processing and transportation and the level of redundancy offered by the network.

Environmental awareness and training is an important aspect of the movement towards improved sustainability. A study on one of the first American installations to have gained ISO 14 001 certification revealed that an increased awareness of environmental aspects, regulations and impacts both at work and in the employee's homes was noted (Rondinelli & Vastag, 2000). This was attributed to environmental training programmes which were introduced as part of the EMS. Improved environmental awareness instilled a sense of responsibility on all employees and not just the environmental department. Most SMEs do not have enough revenue or activity to justify employing an environmental manager full time so they often use consultants to advise them on environmental issues. SMEs awareness of environmental legislation is generally poor and employees tend not to be trained in environmental awareness. Shared training would reduce the costs of consultants to SMEs and may shield them from fines or penalties resulting from ignorance of environmental legislation. Training may not be restricted to the environment alone. The network may provide opportunities for further collective training in IT, first aid and health and safety.

The involvement of policy makers in the project means that the network and its members will have an interface with them. It can be difficult for SMEs to find a voice and a forum for discussion with policy makers. The network will provide such a forum and help SMEs to exert some influence with respect to decisions and policies which may adversely affect them.

Conclusion

The commitment of the participating companies to the project is unwavering. The data collection phase of the project is taking longer than anticipated but this is not to be unexpected with a project of this nature (Mirata, 2004 p977). From the data that has been

gathered it is clear that there are plenty of opportunities to find network solutions for existing and potential problems presented. In order to develop a blueprint for sustainable development amongst SME clusters a number of approaches must be examined.

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