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Establishing an Eco-Industrial Network for Small to Medium-Sized Enterprises in the Mid-West Region

STRIVE

Environmental Protection Agency Programme

2007-2013

SSTI
Strategy for Science, Technology and Innovation

Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

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EPA STRIVE Programme 2007–2013

Establishing an Eco-Industrial Network for Small- to Medium-Sized Enterprises in the Mid-West Region

(2004-SD-MS-19)

STRIVE Report

End of Project Report available for download on http://erc.epa.ie/safer/reports

Prepared for the Environmental Protection Agency

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The EPA STRIVE Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Appendix 1 **A1**

Executive Summary

A key feature of the Irish economy is the strong presence of small- to medium-sized enterprises (SMEs). It is estimated that SMEs are responsible for 70% of industrial pollution across the European Union (EU). This project aimed to enhance and improve the environmental performance of SMEs in the Mid-West Region of Ireland through the development of an eco-industrial network (EIN). 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 communications with policy makers and the local community, had a positive outcome for the companies involved, the environment and other stakeholders within the region.

Supply Network Shannon (SNS), an open sectoral network of engineering and electronics companies located in the Mid-West Region, approached the University of Limerick (UL) Centre for Environmental Research (CER) with a view to improving the environmental performance of its member companies. Twenty companies together with the Regional Waste Management Authority (RWMA) agreed to participate in the project. Activities that the companies were involved in include packaging, furniture, electronics, plastics moulding, engineering, printer ink manufacture and food production. This was a diverse group and is typical of the types of activities that SMEs are engaged in in this region. Rising costs, especially in the areas of energy, transport and waste, were of concern to the SMEs involved and establishing an EIN, if successful, was envisaged by them as offering possible solutions both to economic and environmental problems.

This research applied an innovative approach to identify best environmental practice and measure the contribution of participating SMEs to sustainable development. It was actively led by a Steering Committee comprising individual company representatives, RWMA, local and national policy makers and UL-based researchers. Site visits, environmental reviews, surveys and individual environmental reports were completed for each of the 20 participating SMEs. The data collected provided an invaluable insight into the operations of each company in the network. Using the principles of industrial ecology, the most viable and realistic collaborative opportunities were identified. This was communicated to the participants through a workshop and followed up by the companies themselves. New business opportunities were also identified based on the data gathered and common environmental problems that SMEs in the region face. As legislation and government policies evolve, pressure on companies to become more environmentally responsible will lead to more collaboration and innovation opportunities.

The ecological footprint (EF) of the companies was calculated, and plausible, company-specific, cost-effective scenarios for reducing their footprints were provided to each company. The project was successful in commencing the development of an EIN among the participating companies and in gaining clear improvements in environmental management within these companies. However, more time and resources would be required to fully develop a functioning EIN. Table 1 provides a summary of the key research findings and outcomes. Appendix 1 provides a guide to establishing an EIN.

Table 1. Summary of the key research findings and outcomes.

	Key findings and outcomes
1	The role of the CER was crucial and provided administrative infrastructure and technical expertise
2	The participation of SNS ensured success as it encouraged its member companies to participate and provided researchers with helpful, interested contacts. Member companies already worked together in projects and therefore the necessary mutual trust was already present
3	The SMEs that participated in this project recognised their individual and collective responsibility for SD
4	The interest and commitment of senior management within the SMEs was invaluable in the success of the project
5	The mutual trust between the SMEs, policy makers and the researchers resulted in the sharing of information about possible innovations
6	The establishment of the Steering Committee provided a platform for SME management and policy makers to interact
7	The network provided an arena for cross-sectoral interaction between companies
8	The environmental review reports and recommendations provided the participants with clearly defined and achievable environmental efficiency measures
9	The review procedure encouraged companies to examine their own processes and operations to identify environmental improvement opportunities
10	The review templates were provided to the companies so that they could use these to monitor their own progress over time and after the project had ended
11	The contribution that each SME makes towards achieving SD was measured quantitatively using the EF
12	Some SMEs expressed an interest in participating in a car-pooling scheme in order to reduce transport EFs
13	Quantified EF reduction scenarios were successfully applied to the EFs of each SME to demonstrate the reductions in environmental impact that can occur as a result of implementing 'best' or better practice
14	Waste reduction, reuse, and recycling were important to all the SMEs
15	The SMEs were aware of the need to reduce the use of energy and natural resources by improving designs, use of technology and reducing packaging
16	Participating companies would be supportive of using the EF in a regional certification or award scheme
17	Daughter projects such as the EPA-funded *Pallet Exchange Demonstration Project* have resulted directly from the success of this project. It is hoped that this will grow and develop into a broader materials exchange
18	At the end of the project two of the SMEs were planning on improving their environmental management by implementing ISO 14001
19	SD appraisal techniques can be used to distinguish between those SMEs that future-work towards improving their environmental performance and those that do not
20	The UL CER SNS Committee continues to have regular monthly meetings with stakeholders to discuss possible paths of future development of the eco-industrial network project

CER, Centre for Environmental Research; SNS, Supply Network Shannon; SME, small- to medium-sized enterprise; SD, sustainable development; EF, ecological footprint; EPA, Environmental Protection Agency; UL, University of Limerick.

1 Introduction

One of the greatest challenges facing modern society is the need to combat present unsustainable trends, both in the consumption of resources and in the production of waste. The Brundtland Commission (WCED, 1987) gave momentum to the concept of sustainable development (SD) and this momentum was further added to by the Rio Summit through its Agenda 21 in 1992. Regardless of the range of definitions of sustainability and the lack of agreement over the precise interpretation of the concept, there seems to be general agreement that it involves simultaneous satisfaction of economic, environmental and social concerns.

1.1 National and European Union Sustainable Development Policies

In 2006, the European Union (EU) adopted the *Sustainable Development Strategy* and in it the EU Commission recognises that the EU and its Member States have a critical role to play in SD, but that governments cannot be the sole caretakers of the SD agenda. It emphasises that all stakeholders will need to act decisively – businesses, regional and local authorities (LAs), universities and schools, citizens and consumers – for the successful implementation of many SD policies (http://europa.eu.int/comm/sustainable/sds2005-2010/index_en.htm). The EU best procedure project *Consultation with Stakeholders in the Shaping of National and Regional Policies Affecting Small Business* published its report in October 2005 (DG Enterprise and Industry, 2005) and concludes that:

1. involving and consulting relevant stakeholders at an early stage
2. employing a variety of consultation methods
3. conducting regulatory impact assessments and ensuring specific provisions for assessing the effects of new legislation and policies on small business
4. allowing sufficient time for consultation to reach its objectives, and
5. providing feedback after consultation and publishing results of consultation

should influence governments in the process of shaping new legislation and policies. This will allow the integration of all stakeholder ideas and views into the process of policy development, and creates a situation in which stakeholders have ownership of such policies and are thus more likely to alter behaviour patterns towards sustainability. Increasingly, EU policies and directives incorporate sustainability principles. Policies such as the *Extended Producer Responsibility* (EPR) have become part of a framework for moving towards a closed-loop society. The EPR policy is driven by 'take-back legislation' which requires manufacturers and suppliers to accept materials and products back after use (Mellor *et al*., 2002). Examples include the *Waste Electrical and Electronic Equipment* (WEEE) *Directive* (2002/96/EC) and the *End of Life Vehicles* (EoLV) *Directive* (2000/53/EC). Supply chain management remains a facet of the emergent *Integrated Product Policy* (IPP) (Ehrenfeld, 2003, 2004). The EU recognises that micro-, small- and medium-sized enterprises (SMEs[1]) in particular often struggle with policy and regulatory changes. Small- to medium-sized enterprises are seen as a key part of the *EU Community Lisbon Programme,* which sets out to modernise the EU economy in the face of the economic stresses of globalisation and ageing population by investing in education, research and innovation, improving infrastructure and developing skills. The 2005 *SME Policy for Growth and Jobs* proposed proactive screening of legislative proposals, taking SME concerns into consideration (for example simplifying the application of the Registration, Evaluation, and Authorisation of CHemicals (REACH)

1. The EU defines the category of SMEs as "*made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro*" (http://europa.eu.int/comm/enterprise/enterprise_policy/sme_definition/sme_user_guide.pdf).

legislation for SMEs) and simplifying EU procedures (Euroabstracts, 2005).

1.2 Small- to Medium-Sized Enterprises and Sustainable Development

Small- to medium-sized enterprises play a central role in the European economy; their work is strongly customer orientated; they are a possible source of innovation and entrepreneurial spirit and they create competition and are the seed for businesses of the future (Hillary, 2000). In the enlarged EU of 25 countries, some 23 million SMEs provide around 75 million jobs and represent 99% of all enterprises (European Commission, 2005). In Ireland, more than 90% of registered companies are SMEs, employing roughly half of the workforce (http://www.bitc.ie/csrforsmes.htm), and contribute to trade in three ways (McGloin and Grant, 1998):

1. Small firms act as suppliers and sub-suppliers to larger multinational firms
2. New SMEs constitute the base from which larger export-oriented indigenous companies grow and emerge, and
3. The sales and market share that new SMEs hold in local markets act as substitutes for potential imports, thus contributing to the strength of the local economy.

Therefore, engaging SMEs in the drive towards sustainability is vital because they constitute the majority of companies and, taken as a whole, they have the largest environmental impact (Ries *et al.*, 2003), contributing perhaps as much as 70% of all industrial pollution (Ammenberg and Hjelm, 2003). Small- to medium-sized enterprises are thus an essential contributor to reaching obligations set down in various treaties such as the *Kyoto Protocol to the United Nations Framework Convention on Climate Change* and to reaching policy targets. As they are often mobile, flexible and innovative, they are critically important in realising cleaner products and services and, therewith, in putting agendas such as the *International Declaration on Cleaner Production* or strategies such as IPP into practice (Kuhndt and von Geibler, 2002). However, many SMEs have outmoded ways of looking at environmental policy and they often perceive their own environmental impact as negligible, comparing themselves with larger firms and not recognising cumulative impacts (Ammenberg and Hjelm, 2003). Indeed, most SMEs perceive environmental improvement as a costly burden. As they are primarily concerned with short-term economic survival, they are not motivated to ask for or use environmental information or support (Starkey, 1998). Biondi *et al.* (2000) identify five groups of drivers to the adoption of environmental management systems (EMSs) by SMEs:

1. Regulatory
2. Economic
3. Strategic
4. Events, and
5. Managerial.

The stakeholders identified as the main drivers for the adoption of a formal EMS are, in order, the customer, local government, the local community, regulators and employees (Hillary, 2000). However, Petts *et al.* (1999) report how the regulatory domain may be a more powerful influence on SMEs than the market and possibly the social domains, a view also shared by O'Laoire and Welford (1998). Small- to medium-sized enterprises have lower levels of resources, fewer staff and less time to become familiar with legislative obligations or the assistance available. Whereas larger companies can afford their own environmental units or environmental managers, SMEs often do not have appropriately trained staff to address problems and opportunities in the environmental field (Starkey, 1998; Kuhndt and von Geibler, 2002; Ammenberg and Hjelm, 2003; Clement and Hansen, 2003). As a consequence, smaller companies continue to miss opportunities through lack of information, being unaware of the benefits of undertaking environmental or SD activities, and through risk aversion, anticipating poor rates of return from undertaking environmental projects (Clement and Hansen, 2003; Perez-Sanchez *et al.,* 2003). For example, existing international EMSs are often too complex for them to successfully assimilate and it is evident that SMEs need more pragmatic and tailored assistance (Kuhndt and von Geibler, 2002).

Government agencies have for some time been concerned to deal with this, both because of the substantial proportion of SMEs within national economies and their significant role in job creation, stimulating competition and developing new technologies and products. Previously emphasis was placed on regulation to push SMEs towards environmental awareness, aiming for so-called 'win–win' scenarios (Clement and Hansen, 2003). The European Environment Agency (EEA) considers that the role of local intermediaries to deliver reliable information is crucial to aiding SMEs improve their environmental performance. The particular role of intermediaries can vary from facilitator, to information or service provider, to regulator and others such as LAs. Other effective intermediaries are supply and purchasing chains, and business associations. Offering subsidies to business and industry can be a controversial policy measure, prompting objections on the grounds of unfair competition, distortions to international trade and inefficiency (Starkey, 1998). In addition, in the environmental arena, pressures on government and industry have increased with the introduction of the polluter pays principle (PPP), and the assertion that polluting companies should bear the cost of measures to reduce pollution has meant that the legitimacy of environmental subsidies has been questioned. Nevertheless, environment ministers from OECD countries have accepted that various forms of economic instruments must be used in working towards environmental policy goals (Clement and Hansen, 2003).

Supporting SMEs is now more important in the current globalised and increasingly competitive economy in which the attractiveness of Western Europe as a manufacturing location is being questioned while the development of Eastern Europe and China gains momentum. While a KPMG survey (KPMG, 2004) suggests that Western Europe has a strong competitive advantage in high value-added manufacturing goods due to its key strengths of high product quality, strong labour productivity and close proximity to existing customers, it also demonstrates that mounting competitive pressures are forcing European manufacturers to source an increasing proportion of their components from suppliers based in low-cost countries. This trend will have environmental implications in terms of transport impacts, but also for the host countries if environmental obligations are less stringent than their Western European equivalents and open to abuse. According to the KPMG survey, nearly a third of the companies undertook three-quarters or more of their production in the EU-15 in 2004, but this was expected to fall to just 19% by 2007, with the primary beneficiaries of this trend expected to be China and Eastern Europe. The need to reduce labour costs was cited by 65% of respondents, whereas the drive to rationalise manufacturing operations was given by 48% as the reason behind these trends, and another reason cited was to be close to key sales markets (KPMG, 2004).

The importance of disseminating appropriate information to encourage the 'greening' of SMEs is virtually unchallenged. The United Nations Environment Programme (UNEP) Division of Technology, Industry and Economics in its 1997 report *Developing Better Systems for Communicating Environmental Best Practice in Business – Final Report* emphasised this as a primary strategy for encouraging the involvement of SMEs in improving environmental performance. Following this model, information campaigns are most effective in reaching SMEs when the dissemination occurs through existing information channels, such as local business organisations, LAs and supplier chains (Kuhndt and von Geibler, 2002). Campaigns directed at industries, especially SMEs, *via* other information routes from the international level, for example, do not have the same success.

Larger companies (as well as governmental organisations) could promote improvements in SMEs by taking measures such as green purchasing policies, reward schemes, certification and mentoring (Kuhndt and von Geibler, 2002). For example, the *Business to Business (B2B) Green Mentor* is a 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 Regional Waste Management Office (RWMO), representing Limerick City Council and Limerick, Clare and Kerry County Councils. The project encourages larger companies to become Green Mentors, by providing assistance on

waste prevention to smaller companies in their sector or geographical area, or to their suppliers (http://www.managewaste.ie/docs/may2005/Green%20Mentor%20Press%20Release%2010%20May%2005.doc). The result is the dissemination of waste prevention, minimisation, and improved waste management information through practical demonstration, whilst also facilitating networking among the participating companies (Margaret Murphy, RWMO, personal communication, 2006). Another example of encouraging networking for environmental and economic benefits is the National Industrial Symbiosis Programme in the UK (http://www.nisp.org.uk/).

1.3 Small- to Medium-Sized Enterprises and Environmental Management

Continual management of environmental impacts requires a structured approach. Environmental management systems provide a way for businesses to do this. Many organisations choose to operate in-house or informal EMSs to manage their environmental impacts. Others use recognised standards such as ISO 14001 or the EU *Eco-Management and Audit Scheme* (EMAS). Environmental management systems require an organisation to have:

- A clear understanding of its environmental impacts
- An environmental policy statement detailing the environmental principles adhered to by the company
- Environmental goals and the roadmap to their attainment, and
- A review procedure to ensure maintenance and continual improvement of performance.

Uptake of EMSs has been driven by larger companies, with SMEs lagging behind (Jayne, 2001). Many large firms require or announce that they will soon require their contractors/suppliers to use EMSs, which means that EMSs are being pushed back along the supply chain from large companies to SMEs (Ammenberg and Hjelm, 2003). However, it is argued that management concepts designed for large organisations may not be effective for SMEs (Palmer and van der Vorst, 1997; Perez-Sanchez *et al.*, 2003). The available literature contains a plethora of benefits and potential costs associated with implementing an EMS, and barriers specific to SMEs. Hillary (2004) and O'Regan and Moles (1996, 1997) summarise these and they are reproduced in Appendix 5 of the End of Project Report.

Figure 1.1 is a schematic description of the factors that influence environmental management in SMEs (Swedish Agency for Economic and Regional Growth (NUTEK), 2003). There are a number of driving forces that are influenced by attitudes to environmental issues. Barriers that impede environmental work exist and various types of tools and aids are required to overcome these. The figure also highlights that environmental management can bring about a number of positive results which can be internal or external in nature. Collaboration with other SMEs often makes it easier for small companies to overcome these barriers and may enhance the benefits. NUTEK (2003) identifies the most important driving forces behind environmental management in small companies in order of importance as:

- Management commitment
- Consumer demands
- Reduced resource consumption
- Competition
- Legislation
- Demands on subcontractors, and
- Expected future legislation.

While an EMS may lead to efficiency improvements, which are the first steps towards sustainability, these in themselves will not be sufficient for a radical breakthrough toward SD. Currently, the most appropriate guiding model for industrial development is assumed to be the eco-industrial network (EIN) model (Wallner, 1999; Korhonen, 2004). By taking networks of industries as the setting for advancing SD, the concepts of industrial symbiosis and EINs offer the opportunity for enhancing the progress towards sustainability (Lambert and Boons, 2002). Product chain networks may offer similar opportunities.

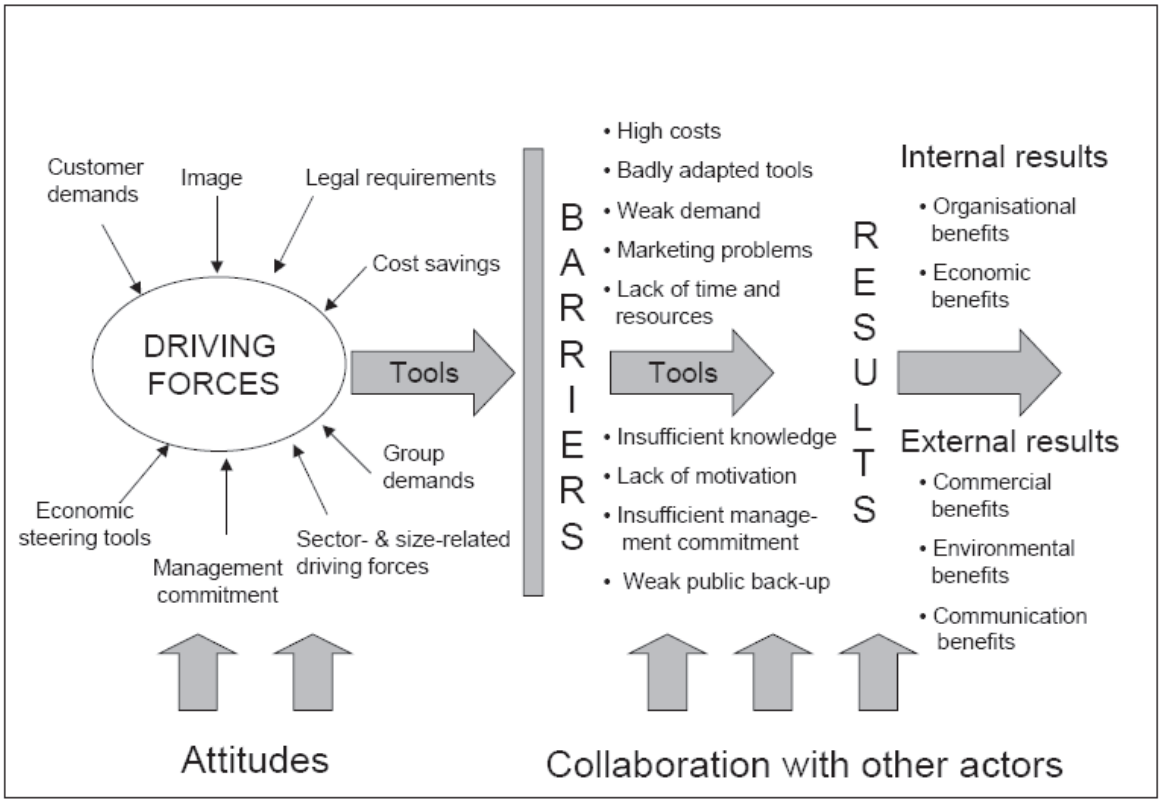

Figure 1.1. Environmental management in small- to medium-sized enterprises (SMEs) (NUTEK, 2003). Pressure down the supply chain is an important driving force in promoting environmental management in SMEs. This is manifested through 'customer demands'.

1.4 Industrial Ecology

New paradigms of production and consumption are necessary if society is to restore and maintain stable natural ecosystems, and industrial ecology (IE) is argued by some to be the framework for this change (Opoku, 2004; Roberts, 2004). The article by Frosch and Gallapoulus (1989) is seen as the initial trigger for IE. Over the past decade IE has emerged as a new approach and framework for the analysis and design of public policy, corporate strategy, and socio-technical systems and products. The aim of this is to reduce environmental impacts of industrial systems and to contribute to SD (Von Malmborg, 2004). Industrial ecology can be considered a third paradigm of corporate environmental management, after end-of-pipe pollution control and pollution prevention (Andersen, 1997). A transformation from traditional linear to cyclic material flows is of fundamental importance in the IE concept (Andersen, 1997; Welford, 2004), and the co-location and integration of firms which can use or reprocess the waste of other industries in the same locality is critical to the success of regional varieties of IE (Roberts, 2004). The industrial metabolism approach encourages the analysis of the flows of matter and energy in the industrial system, their transformation, and their recovery back into the system (Welford, 2004). Finding use for wastes can both become a challenge and an opportunity for businesses (Andersen, 1997).

This principle of closed material and energy loops reducing society's pressure on the environment has, however, been recently contested as recycling itself requires extra input of resources and may increase entropy, production and emissions (Von Malmborg, 2004). However, instead of exclusive focus on collaboration or co-ordination in terms of by-product exchange and waste utilisation, IE also covers collaboration with regard to joint training, co-ordination of provision of utilities and waste management among the actors in a 'symbiotic network' (Von Malmborg,

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 ISO 14001. 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 with traditional individual certification. Advantages cited for the SMEs are:

- Easier to receive contracts
- Improved business relations
- Centralised waste collection, facilitating recycling
- Material substitution (more environmentally benign)
- Improved transportation
- Improved storage of chemicals, oils
- Reduced energy usage, and
- Dematerialisation.

An eco-industrial park (EIP) has been defined as "*a community of businesses that cooperate with each other and with the local community to efficiently share resources (information, materials, water, energy, infrastructure and natural habitat …. leading to economic gains, gains in environmental quality and equitable enhancement of human resources for the business and local community*" (Cohen-Rosenthal, 2003).

Industrial ecology is an interdisciplinary approach which recognises that many industrial systems are highly complex (Welford, 2004). The close proximity of businesses taking part in an industrial ecosystem is important to reduce the required transport of waste and raw material. Proximity generates externality savings and economies of scale, which reduce operational costs for companies sharing common suppliers or services (Roberts, 2004). A result of this is that industrial ecosystems mostly occur as clusters often surrounded by one or a few 'core' industrial facilities (Andersen, 1997; Seuring, 2004). There are several examples of these in the literature, the most well-known example being Kalundborg in Denmark.

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). Table 1.1 summarises the benefits and difficulties associated with the development of EIPs.

Eco-industrial parks may be actual sites engineered to accommodate compatible types of industrial activity or 'virtual sites' or networks 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 EIN may include EIPs or it may be a network of stand-alone firms (Lowe, 2001). It may also include the elements described for EIPs (sharing services and training, etc.).

Local authorities are recognised as key players in supporting the development and management of industrial ecosystems, by providing education, information and social infrastructures as well as physical infrastructures (for example recycling schemes). In the process of knowledge transfer, LAs can play two roles – they can act as knowledge banks or as knowledge brokers (Von Malmborg, 2004). Concerns about complex environmental and social consequences of industrial activity have provoked the need for more frequent and meaningful engagement between companies and stakeholders, resulting in a network that provides a wider input of information, ideas and legitimacy from sources beyond the traditional business model (Roome, 2001). Networks link actors together providing a seedbed for technological and social innovation due to knowledge exchange and development amongst the actors which will encourage a more sustainable development (Roome, 2001). The concept of IE does imply some problematic issues for dispersed SMEs. The establishment of IE where wastes from one process

Table 1.1. Benefits and difficulties associated with the development of eco-industrial parks (EIPs) (Lowe, 2001).

Benefits to industry associated with the development of EIPs	Difficulties associated with the development of EIPs
• Decreased production costs through increased materials and energy efficiencies	• Companies using each other's residual products as inputs face the risk of losing a critical supply or market if a plant closes down
• Common business services (waste management, training, purchasing, energy management teams, environmental information systems and other support services) may be shared, thus reducing costs	• Exchange of by-products or waste could encourage continued reliance on toxic materials
• 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	• Some companies are not accustomed to working 'in community' and may fear the interdependence this creates
• Open niches for new or expanded local ventures	• SMEs may be unable to afford any technologies that may be required to improve their environmental performance and may find themselves outside the loop

SME, small- to medium-sized enterprise.

can be used as raw materials for another industry is essential in obtaining efficient material exchange but if companies are not co-located the wastes must be transported over longer distances with concomitant negative impacts on the environment (Andersen, 1997). Indeed, some see co-location of companies within an industrial symbiosis as a prerequisite (Seuring, 2004). Extensive recycling can imply more transportation and larger environmental problems following the demands for energy and the infrastructure to support transportation. For some products it can cost up to nine times as much to recycle the product (reverse logistics), compared with producing it from virgin materials and transporting it to the customer (Andersen, 1997).

1.5 Ecological Footprint

Attaining corporate sustainability means that companies must measure and report all their environmental impacts in a way that is consistent, transparent and easily understood. The ecological footprint (EF) is an environmental indicator that measures environmental/ecological impacts (Barrett and Scott, 2001). Economic activity and productivity require ecological inputs of raw materials, energy and social inputs of labour and human-made capital, and the ecosphere's ability to absorb wastes and pollution (Holland, 2003). Fundamentally, social well-being and the economy are subsystems of a larger ecological life-support system and therefore social and economic decision making cannot ignore ecological limits (Barrett and Scott, 2001). Ecological footprint analysis (EFA) is based on the concept of the ecological carrying capacity, and is defined as "….*the area of biologically productive land and water ecosystems required to produce the resources for and assimilate the waste produced…"* by the study subject (Costanza, 2000). An 'Earthshare' is the average amount of ecologically productive land (and/or sea) available globally *per capita*. This has been calculated on the premise that every individual in the entire world has an equal right to land. By adding up all the productive land types, 1.9 ha of biologically productive space are available per person (Barrett and Scott, 2001). If the EF is bigger than the assigned Earthshare, then 'overshoot' has occurred and the carrying capacity or biophysical limits have been exceeded (Costanza, 2000). Ecological footprint analysis has been applied at many levels to products, organisations, individuals, and right up to the global and is a powerful tool for measuring, managing and communicating SD. Using it to measure SD scenarios can assist in making effective policy decisions. The concept and methodology of the EF provide a mechanism for companies to develop an environmental information management system that will help them to measure and assess their environmental performance (Holland,

2003). The EF of a company (Rees, 2000; Holland, 2003):

- Gives insights into the key contributors to its eco-footprint and which ones are more important to manage
- Allows testing of different scenarios to reduce the eco-footprint as a basis for developing improvement plans, and
- Provides a means of annually calculating the impact of improvement plan implementation, and the first calculation establishes a baseline from which improvements can be measured.

As with all sustainability metrics, EFs have limitations. However, the EF was selected as an indicator in this research because of the simplicity of its message, its global recognition, and its appeal to a broad range of stakeholders, particularly the management of the participating companies.

1.6 Establishing an Eco-Industrial Network for Small- to Medium-Sized Enterprises in the Mid-West Region

Supply Network Shannon (SNS) is an industry-led initiative aimed at representing, promoting, developing and connecting together sub-supply SMEs in the Mid-West Region of Ireland. Supply Network Shannon was incorporated as a limited liability company in 1999 and is driven by an independent Steering Committee whose officers are drawn from nine member companies and two development agencies, Shannon Development and Enterprise Ireland. Shannon Development has provided financial and other support to assist the development of SNS. The University of Limerick (UL) has also supported SNS through its Centre for Environmental Research (CER), Small Business Research Unit and Technology Transfer Unit.

The aim of this research was to carry out an environmental performance assessment and identify and evaluate performance improvement measures using the principles of IE as well as to carry out a sustainability appraisal of SMEs in the Mid-West Region using the EF metric. To achieve this it was essential that a number of objectives were met (Table 1.2).

These objectives were revised and updated from the original proposal during the project due to initial findings and feedback from industry and policy makers (through the project Steering Committee). This revision was necessary as the baseline

Table 1.2. Project objectives.

	Project objectives
1	To establish a project Steering Committee which included representatives of the participating SMEs, policy makers, local community groups and researchers
2	To design, test and validate an environmental review document for SMEs and to provide guidance on legal responsibilities
3	To establish an environmental review procedure for SMEs
4	To identifyenviron mental problems faced by individual SMEs and recommend potential environmental improvement options available to them individually and as a network
5	To carry out an EF analysis of the SMEs for the purpose of raising environmental awareness and to demonstrate how the implementation of best environmental practice scenarios can enhance the SME environmental performance
6	To calculate the EF reduction potential that might be achieved through the implementation of best environmental practice in specific areas of each of the SME activities
7	To assess the value of the EF as a tool for measuring sustainability in SMEs
8	To use the principles of IE to identify ways of improving the environmental performance of the individual SMEs and the network
9	To report on findings to individual companies, the EPA and industry bodies (as agreed by the EPA)

EF, ecological footprint; EPA, Environmental Protection Agency; IE, industrial ecology; SME, small- to medium-sized enterprise.

environmental knowledge of the companies and resources available to the project team determined to a considerable extent the limits of what was feasible within the time frame.

1.7 Structure of Report

This report is divided into five sections. Chapter 1 provides the context for the project. Chapter 2 of this report describes how the environmental performance of each participating SME was assessed and how each SME was provided with feedback. It includes a description of the methods adopted to calculate an EF of each of the SMEs, and to generate scenarios to aid companies to identify ways of reducing their footprints.

Chapter 3 presents the results from the overall research project. Chapter 4 discusses all aspects of the findings of this research and their implications in policy development and future work. Appendix 1 provides a guide to establishing an EIN.

2 Methodology

All companies that participated in this study were guaranteed confidentiality. Each company was assigned a letter, and is referred to as Company A, Company B, through to Company R. The companies were diverse in their activities and geographically dispersed throughout the region (Table 2.1), so that there were both sectoral and location-specific issues to consider in terms of their individual performance and collaboration opportunities.

2.1 Summary of Methodology

This section of the report describes the methodologies employed for the management and promotion of the project, the information and data collection, analysis, individual company assessment, and identification of networking opportunities. Figure 2.1 is a schematic of this process.

2.2 Project Set-Up

The initial links between SNS and UL were established in 2003 and, following a consultation period, a successful submission was made by UL CER to the EPA to fund this project under the Environmental Research Technological Development and Innovation (ERTDI) programme in 2004. Inter-company collaborations on sourcing materials, training and marketing/advertising were already operational between a core group of about 30 companies in SNS and this established the crucial advantage in network projects – mutual trust – and facilitated the formal commitment of SNS member companies. In total, 20 SMEs formally committed to the project, while 18 of these provided detailed data. These companies were from a diverse range of sectors, including packaging, plastic moulding, electronics, furniture production,

Table 2.1. Company geographic locations and industry sector.

Company	Location	Estate	Industry sector
A	Shannon	East Park	Electronics
B	Shannon	East Park	Electronics
C	Shannon	Smithstown	Electronics
D	Shannon	Shannon Free Zone	Engineering/tool making
E	Limerick	Galvone	Packaging
F	Limerick	Roxboro	Packaging
G	Limerick	Crosagalla	Engineering/tool making
H	Limerick	Annacotty	Toner production
I	Limerick	Ashbourne	Electronics
J	Limerick	Corcanree	Electronics
K	Limerick	Raheen	Packaging
L	Limerick	Raheen	Electronics
M	Limerick	Raheen	Electronics
N	Limerick	Raheen	Engineering/tool making
O	Co. Limerick	Hospital	Food
P	Co. Limerick	Hospital	Packaging
Q	Co. Limerick	Ballylanders	Furniture
R	Co. Limerick	Ballylanders	Furniture

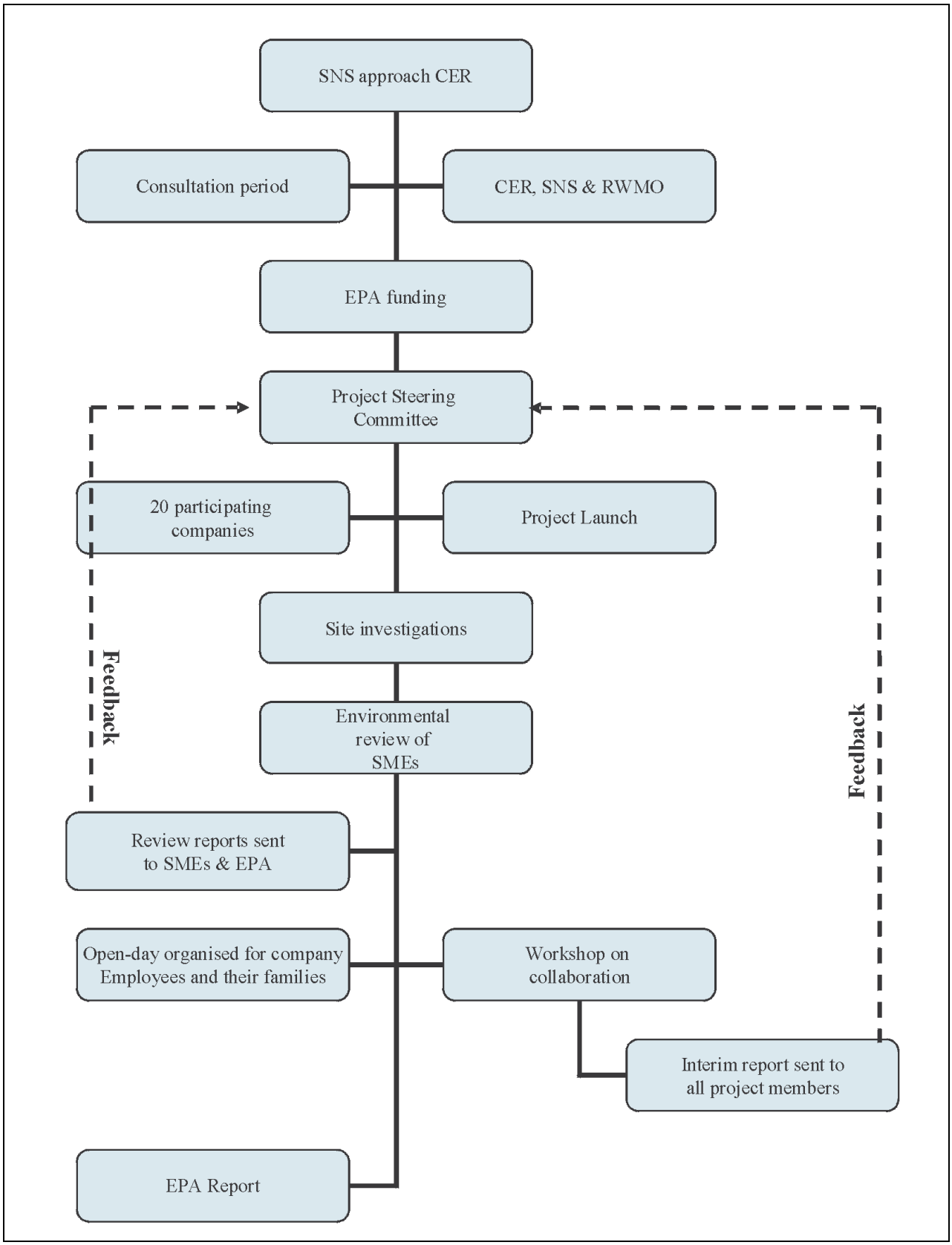

Figure 2.1. Summary of the research methodology (CER, Centre for Environmental Research; EPA, Environmental Protection Agency; RWMO, Regional Waste Management Office; SME, small- to medium-sized enterprise; SNS, Supply Network Shannon).

food, waste management and light engineering. They were located within a 43-km radius of Limerick City. Of the 20 companies, eight were located in Shannon, six of which were in Smithstown Industrial Estate and two of which were in the Shannon Free Zone. Seven companies were in Limerick City and the remaining five were located in rural County Limerick (see the End of Project Report for maps of company locations).

Within UL, five researchers worked on the project. The EPA funded two of these to work full-time on the project for 18 months. A project Steering Committee was established with three representatives from the CER, two from SNS, one from the RWMO, two from the EPA and five from the participating SMEs. This committee was partly in place prior to the commencement of this project as it was formed by the CER, SNS and the RWMO when the initial communications began. On commencement of this project, the committee was expanded to include project researchers, company representatives and the EPA. Environmental Protection Agency representatives were invited to attend every third meeting. The Steering Committee met on the first Thursday of every month in UL and its role was to:

- Agree work packages
- Address any issues that had major implications for the project
- Ensure the project maintained focus as emergent issues drove adaptation of initial plans
- Balance conflicting priorities and resources
- Facilitate free flow of information and ideas between all members, and
- Review progress of the project.

All decisions, documents and reports were approved by this committee prior to being finalised. Therefore the project was not expert led or indeed industry led, it was a partnership between three groups of stakeholders and justification for all decisions and choices was discussed and agreed at the monthly committee meetings.

2.3 Project Launch and Information Dissemination

The project launch was held on 10 March 2005 in conjunction with the SNS Sub-Supply Exhibition in Bunratty, Co. Clare. University of Limerick CER researchers prepared 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), posters and presentations.

In order to promote involvement in the project and provide information to the participants, a website was developed (http://www.ul.ie/~cer/econet/index.htm).

2.4 Environmental Legislation

Through SNS and company representatives on the Steering Committee, it was made known to researchers that the SMEs urgently required guidance on their regulatory obligations as there was a perceived lack of information on which regulations pertained to them, and the SMEs did not have the resources to investigate this for themselves. It was therefore decided that this should be the first task for the researchers. Relevant data on environmental, health and safety legislation were gathered and stored in a database on CDs. The legislation was divided into six main categories: air, chemicals, noise, planning and development, waste, and water.

Within each category was listed the relevant legislation, together with explanatory notes and links to the full text where possible. The first draft of the database was circulated to EPA representatives for review and their comments were received before finalising the database. The legislation included in the database was as broad as possible in an attempt to cover all company circumstances. This database was subsequently used following each site visit to identify the legislation that the researchers believed to be relevant to each specific company. A copy of this CD was provided to each participating company.

2.5 Assessments of Environmental Performance

While the initial project proposal aimed to carry out environmental reviews for the purpose of determining material and energy flows only, it was decided by researchers and the Steering Committee that extending the review process to include all aspects of company operations would be of greater benefit to the individual SMEs and might encourage additional companies to participate in the project. The review process was expanded to involve:

- The preparation of an environmental review questionnaire
- Arranging and conducting site visits
- Collation of relevant information
- Ecological footprint analysis and alternative policy scenario development
- Researching and recommending possible environmental performance improvements or technologies, and
- Reporting to the individual companies.

2.5.1 Environmental review document

In designing the environmental review questionnaire, each company was first contacted by telephone to ascertain its existing environmental management status. Of the 20 companies, only two had an environmental management system in place, both certified to ISO 14001, 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 significantly less developed. This situation led researchers to conclude that the environmental review questionnaire would need to include elements of an initial environmental review for the companies with no EMS, together with elements of an environmental audit for those companies which had an EMS in place. The environmental review questionnaire is reproduced in full in Appendix 3 of the End of Project Report.

2.5.2 Environmental review procedure

As part of the environmental review process each company was visited by three researchers and this generally lasted 2–3 h, depending on the company size. As most managers of SMEs are hands-on and have few opportunities to delegate tasks, this was usually the maximum amount of time that could be assigned to any one visit.

The site visit was divided into two parts:

1. A tour of the company's premises which allowed researchers to view and record the overall activities of the company, the resource materials and intermediates being used, the production processes in place, the wastes being generated, the receiving environment, and
2. An interview with the company representative structured around the questionnaire.

Site visits typically began at the goods inward area (to assess materials used, packaging and any handling or storage issues) and, where possible, followed the production process as it operated through to goods outward. This allowed researchers to better understand the production process, observe material changes and waste production, and identify any possible inefficiencies. 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 through which issues such as energy efficiency, water conservation measures, waste minimisation and segregation measures were examined. The visit concluded with a tour of the exterior of the premises where issues such as building design, insulation, lighting, general housekeeping, oil storage, and potential for contamination of drains were assessed.

Use of the environmental review questionnaire ensured that all companies were asked the same questions thereby ensuring consistency in assessment. Table 2.2 lists the areas covered by the environmental 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

Table 2.2. Summary of environmental review.

Section	Rationale	Summary of questions
General company information		
	In order to understand the business	• Management background • Products • Building • Employees and operating hours • Certifications • General housekeeping practices
Environmental policy		
	In an effort to understand the level of environmental understanding/concern within the company	• Written environmental policy, where present • Copy of written environmental policy, where present • If company had an environmental policy – determine if it was implemented and communicated to all employees • If and how it needed to be improved
Legal requirements and voluntary practices		
	To understand the level of regulatory awareness amongst firms	• Register of legislation • Permits or licences • Obligations under permits or licences • Voluntary codes of conduct • Voluntary standards such as ISO 14001 or ISO 9000
Staff organisation		
	Identify the staff (if any) responsible for environmental management in the company and the means by which information is communicated through the firm	• Organisational charts • Staff training • Training needs
Raw materials		
	To identify possible material exchanges. Ensure that companies are handling materials safely	• Raw materials • Quantities used • Storage and Handling • Material safety data sheets
Transport		
	To maximise efficiency of trips and identify possible collaboration in transport	• Goods in • Goods out • Transport mode of materials and employees • Employee travel for business purposes
Water consumption		
	To encourage water consumption reduction companies will be metered on their water use in accordance with The National Water Pricing Framework	• Metering • Consumption patterns • Leak detection procedures
Waste water		
	To reduce waste water from participating companies	• Nature and composition of waste water • Waste-water treatment facilities • Management of facilities where present • Permits or discharge licences
Energy		
	To reduce energy consumption and identify opportunities for renewable sources of energy	• Energy use • Fuel use • Consumption patterns • Energy policy • Measures employed to reduce energy consumption • Modifications to building to conserve energy

Table 2.2 ***contd.***

Section	Rationale	Summary of questions
Waste generation		
	To encourage waste reduction and identify opportunities for waste exchanges and reuse	• Nature, composition and quantity of waste • Storage and handling • Disposal methods • Segregation of waste types • Recycling facilities • Waste management cost
Emissions to atmosphere		
	To identify sources of emissions and treatment requirements	• Types and sources of emissions
Noise		
	To identify noise sources and personal protective equipment (PPE) required	• Noise sources • Noise monitoring • PPE available
Accidents and occupational health		
	To ensure compliance with health and safety legislation and improve safety standards for employees of participating firms. To identify collaborative training opportunities	• Safety statements • Safety representatives • Risk assessments • Potential scenarios • PPE for employees • Training provided

from some of the companies was adequate, others failed to provide the level of detail required for the study, particularly to calculate the EF. Therefore, a second questionnaire was devised and a Microsoft Excel spreadsheet, outlining the detailed level of data required was prepared, in which data gathered through the site visits were included and data gaps were 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. Several follow-up phone calls and e-mails were necessary to gain the information required.

Companies that did not provide all the necessary information, were visited again by the researchers 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, and oil and gas bills were analysed to retrieve the necessary information.

Having gone through this process (summarised in Table 2.3), two companies still did not furnish sufficient quantitative information and were therefore excluded from subsequent analyses.

2.5.3 Environmental review report

Following the environmental review, a detailed company-specific report was generated that collated available information on the company, calculated the company's EF and made company-specific recommendations for immediate environmental improvements, longer-term improvements and possible collaboration areas for each review section. These recommendations were as far as possible costed and their likely impact on the EF was calculated. The report 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 the CD of environmental legislation and the legislation that was thought to be applicable to the company was identified. All company environmental review reports are attached in Appendix 6 of the End of Project Report.

2.6 Collaboration for Improvement

Having identified areas for improvement in environmental performance for the companies as

Table 2.3. Data collection process.

Company	Site visit date	Spreadsheet	Simplified survey	Phone calls	E-mails	Revisits
A	11 April 2005	Completed	Not required	01 May	01 May	No
B	06 April 2005	Completed	Not required	05 October	>10	No
C	22 June 2005	Completed	Not required	>10	05 October	? November 05
D	04 May 2005	Incomplete	Completed	>10	05 October	08 December 2005
E	15 March 2005	Completed	Not required	05 October	05 October	02 November 2005
F	07 February 2005	Incomplete	Completed	05 October	>10	20 December 2005
G	28 April 2005	Incomplete	Completed	05 October	05 October	04 November 2005
H	07 June 2005		Completed*	01 May	05 October	No
I	28 March 2005	Completed	Not required	05 October	05 October	05 June 2005
J	22 April 2005	Incomplete	Completed	>10	>10	No
K	14 March 2005	Incomplete	Incomplete	>10	>10	16 November 2005
L		Incomplete	Incomplete*	>10	05 October	No
M	18 February 2005	Incomplete	Completed	>10	>10	24 November 2005 20 June 2006
N	22 February 2006	Incomplete	Completed	05 October	05 October	08 December 2006
O	18 April 2005	Incomplete	Completed	>10	05 October	No
P	28 January 2005	Incomplete	Completed	>10	05 October	No
Q	29 April 2005	Incomplete	Completed	05 October	05 October	No
R	24 January 2005	Incomplete	Completed	>10	05 October	29 April 2005
S**	X	Incomplete	Incomplete	>10		
T**	X	Incomplete	Incomplete	>10		

*Simplified survey sufficient for outstanding information. **Insufficient information supplied.

individual entities, the next phase of the project involved assessing possibilities for the application of industrial ecology concepts as a means of achieving network-scale environmental improvements.

2.6.1 Identifying domains for inter-company collaboration

Following the environmental review of each company, the information was assessed to identify common problems and needs, and possible opportunities for collaboration to overcome these. Most opportunities for collaboration were identified in relation to:

- Waste management
- Transport
- Energy
- Training and services.

Possible new potential business opportunities were also identified. For example, waste plastic might be processed to produce products for use in road safety, home gardening, building, and so on. The common problems and possible collaborative opportunities identified are listed in Table 2.4. It was considered that many of the collaborative opportunities identified might both improve the environmental performance of the companies and reduce costs.

Table 2.4. Common problems and possible collaborative solutions.

	Common problem	Possible collaborative solution
Waste management		
	Disposal of potentially valuable material resources	• Closed-loop production • Material exchange website • New business opportunities
	Insufficient critical mass for plastic recycling	• Pooling plastic waste stream • Centralised waste collection facility • New business opportunities
	Escalating waste management costs	• Establishing a waste minimisation club • Tendering for waste collection
	Significant quantities of organic waste and concomitant disposal costs, diversion of organic waste from landfill	• On-site composting, collective purchasing of composters • Co-located companies pooling organic waste for collection for anaerobic digestion
Transportation		
	High freight costs	• Shared transportation ensuring full containers • Encouragement of intermodal transport
	Regional traffic congestion	• Car-pooling scheme
	Travel costs and associated environmental impacts from business meetings	• Collective purchase and sharing of teleconferencing equipment
Energy		
	Escalating energy costs; security of supply	• Co-operative investment in energy solutions • Battery-operated forklifts and associated solar recharging • Anaerobic digestion and combined heat and power plants • Production of wood pellets from wood waste • Production of renewable crops in the surrounding hinterland – new business opportunities
	Packaging waste; environmental soundness of raw materials	• Collective purchasing, pressuring suppliers to reduce packaging and take back end-of-life items and packaging
Training		
	Difficulty in organising training for small workforce; costs of same	• Shared training and information sharing – group implementation of ISO 14001 • Group organisation of frequently required training: first aid, health and safety, forklift operation • Website to advertise events and share information
Services		
	Cost of services; companies within same business park using different service providers – inefficiency aspects	• Collaboration to identify common service requirements and put out to tender – reduce transportation impacts. Common services include forklift maintenance, pest control, photocopier/printer/ computer maintenance, cleaning

2.6.2 Workshop on inter-company collaboration

A half-day workshop was organised to bring together as many participating companies in the project as possible to discuss ideas for networking and collaboration between the companies, their feasibility and the likelihood of uptake, and to obtain feedback on project progress. The workshop was organised by the CER at UL on 23 March 2006. Representatives from SNS, the RWMO, and from each participating company were invited to attend. In total, 19 people attended and representatives from nine companies were present. Each participant provided background information on their organisation and their input to the project. The uniqueness and success of this UL–Business–LA relationship was highlighted, and in particular the willing participation of companies was commended. Each company was presented with a certificate of participation in 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 and an evaluation survey was distributed. The company representatives were provided with time to discuss possible collaboration opportunities amongst themselves after the presentations and this resulted in a number of companies identifying possible partnerships in training and other services. The results of the workshop are discussed further in Chapter 3. A copy of the workshop report on Inter-Company Collaboration is attached in Appendix 7 of the End of Project Report.

2.6.3 *Feedback on collaboration from the small- to medium-sized enterprises*

Following this workshop, the company representatives were asked to fill out an evaluation survey on the review reports and the collaboration and networking process (Appendix 8 of the End of Project Report). Those who did not attend the workshop were posted these evaluation forms with a stamped addressed envelope, followed by an explanatory phone call.

2.7 Ecological Footprint Methodology

At this stage of the research, the main aim of using the EF was to raise awareness and communicate to the participating SMEs the significance of their environmental impacts. Essential prerequisites for an accurate EF analysis of business are data collection and clearly defined boundaries (Chambers *et al.*, 2000).

2.7.1 *Data collection*

The required data were retrieved as part of the environmental review while the subsequent spreadsheet and survey were designed with data requirements for the EF specifically included. The spreadsheet is reproduced in Appendix 5 of the End of Project Report. The survey is attached in Appendix 4 of the End of Project Report. A blank template for the EF calculation is attached in Appendix 9 of the End of Project Report.

2.7.2 *Study boundary*

The participating SMEs tended to be in the middle of a supply chain, where they consume goods and services in the production of other goods and services, which are either sold to a consumer, or sold to other companies along the supply chain. The SMEs are therefore both producers and (intermediate) consumers and this created complexity in defining the boundaries of the EF. It was decided that all activities relevant to the day-to-day functioning of the company would be included. These included:

- Energy use
- Freight transport inbound and outbound
- Waste transport
- Passenger travel for work purposes
- Employee travel to and from work
- Waste landfilled, recycled and incinerated
- Land use
- Water use.

2.7.3 *Data availability and proxy data*

Not all data required to calculate the EF were available and where this was the case, best estimates, based on national or international values published in the literature were used. These are referred to as proxy data. Every attempt has been made to minimise their use, and to ensure that proxy data as closely as possible reflect the activities of each company. However, the use of proxy data tends to hide important unique attributes of a company's resource consumption, and this should be taken into account when considering the results presented here.

2.7.4 *The ecological footprint calculation*

Data availability proved to be the limiting factor in determining which method could be adopted in EF calculation. Due to the unavailability of some data, the method adopted in this study was an aggregate method, incorporating elements from both compound and component methodologies. The approach employed in this study was based primarily on that of the York Report (Barrett *et al.,* 2002), which was selected as the most appropriate method as

conversion factors were published for the majority of components of relevance to this study. See Appendix 9 of the End of Project Report.

2.7.5 Ecological footprint components

As energy, transport and waste were the components of most importance both in terms of their contributions to the EF and their economic importance to the companies, methodological aspects to these three components are further elaborated upon in the following subsections. For the final EF results, land-use and water-consumption components were omitted as they were of negligible impact for all of the participating SMEs. See the End of Project Report.

2.7.5.1 Energy

This component of the EF includes the consumption of electricity, gas and other fuels by each company. These data were retrieved from utility bills and meter readings.

2.7.5.2 Transport

- **Passenger transport**
  In order to provide an assessment of the environmental impact of passenger transport for each of the participating companies, an analysis of the main transport modes used by employees was undertaken. The EF was calculated to measure the impact of travelling by air, bicycle, bus, car, motorbike and train. The impact of walking was considered to be negligible. Two types of passenger travel existed for all of the companies: employee travel to and from work and employee travel for work purposes, such as meetings and conferences. For each mode, the passenger-kilometres (pass-km) travelled per employee per day were calculated. These were then multiplied by 247 (average number of working days *per annum*) to give the pass-km per year value. The average commuting distance for each mode of transport used within each company was calculated.

- **Freight transport**
  The EF for freight transport was divided into three sub-components:

  (i) Freight in

  (ii) Freight out, and

  (iii) Waste freight.

  For raw materials entering each company's premises, the tonnages, origin and modes of transport for delivery were determined. Likewise for products out, the tonnages, destinations and modes of transport were determined. For waste, the tonnages and the waste contractors' locations were identified, thus allowing for the distance travelled by the waste to be determined.

2.7.5.3 Waste

Each company indicated the tonnage of waste produced as well as the method of disposal for each waste type. Where exact values were unknown, estimates were calculated. These values were then multiplied by the corresponding conversion factors based on the York Report (Barrett *et al.*, 2002). Where waste was sent to landfill for disposal, there was no recovery of energy and no embodied energy savings could be assumed. Where waste was recycled, it was assumed to reduce the need for virgin resource consumption and thus embodied energy savings were made (Barrett and Simmons, 2003). The EFs of recycling and composting were calculated by subtracting the energy required to recycle the product from the embodied energy within the product.

2.7.6 Scenario methodology

Scenarios as employed in this study are EF analyses of hypothetical future situations based on explicit assumptions (Global Footprint Network, 2006). A number of scenarios were identified, based on practical actions that might be undertaken by the company to reduce environmental impacts (Table 2.5). The EF reduction associated with each improvement scenario was calculated. For example, if one company switched from landfilling aluminium cans to recycling them, the associated EF would reduce almost 17-fold. The business-as-usual (BAU) scenario was then compared with the total potential EF savings through implementation of best environmental practices. This analysis was made available to each company in the individual company environmental review reports (see Appendix 6 of the End of Project Report).

Table 2.5. Some common scenarios developed.

• Substitution of motorised employee transport with non-motorised transport
• Implementation of a car-pooling scheme
• Substitution of air transport of goods with water transport
• Investing in teleconferencing equipment
• Using energy generated from renewable resources (wind)
• Implementing a waste segregation and recycling scheme for canteen waste
• Changing packaging design so as to reduce cardboard waste

3 Results

3.1 The Steering Committee

The Steering Committee regularly provided input to all decisions, and feedback on all findings from the research. This was extremely valuable as the committee consisted of all relevant stakeholders, i.e. the individual industries and industry representative body, policy makers at local and national levels as well as experienced researchers.

The Steering Committee successfully negotiated inclusion of the participating companies in the *Business to Business (B2B) Green Mentor Programme*, which encourages larger companies to become Green Mentors by providing assistance on waste prevention to smaller companies in their sector or geographical area, or to their suppliers. The result is the dissemination of waste prevention, minimisation, and improved waste management information through practical demonstration, whilst also facilitating networking among the attending companies. Through the RWMO, the Steering Committee helped in providing input to the Waste Auditing Tool being developed by the *Race Against Waste* team.

3.2 Website and Dissemination of Information

Throughout the project, researchers participated in a range of events designed to raise the profile of the research as well as to disseminate research findings. This was done through presentations, information stands and the press. The project website was designed to include a home page, and pages describing the project, outlining the participants with links to their respective websites, providing project outputs such as conference papers, providing information on EMSs, giving useful links and contacts.

3.3 Individual Small- to Medium-Sized Enterprise Environmental Review Reports

The company-specific environmental review report issued to each company detailed findings of present status and recommendations for improvement under each of the review themes and also included the EF of each of these, where data availability made this possible. The structure of the reports was as follows: in Sections 1–13, the review findings were presented, followed by recommendations to improve environmental performance and legal compliance while at the same time reducing costs; in Section 14, the EF of the company was calculated and, having identified the areas of greatest environmental impact, alternative scenarios that could reduce these impacts were examined. See Table 3.1 for details of the Appendices included in the individual environmental review reports.

Table 3.1. Supporting appendices included in the individual environmental review reports.

• Guidance notes on writing an environmental policy statement taken from a range of sources
• Additional information on composting which was relevant to the treatment of canteen waste
• Details of the key elements necessary for a successful environmental management system
• Questionnaires used in the company review
• Conversion factors and spreadsheet for calculation of the ecological footprint
• Contacts for sourcing suppliers. Direct contacts were not given because of the potential for inadvertently omitting some suppliers
• Guidance on fuel storage
• CD of environmental legislation and within each report, Section 3.1, the legislation that was deemed relevant to the company at the time of the review was listed

The individual environmental review reports are attached in Appendix 6 of the End of Project Report, while an overview of common findings is presented in Section 3.5 of the End of Project Report.

3.4 Environmental Performance Assessment of Small- to Medium-Sized Enterprises

Tables 3.2 and 3.3 provide a summary of the participating company attributes identified through the environmental performance reviews.

3.4.1 Company size

Company size was an important factor in explaining the differences between the SMEs with respect to setting and achieving environmental goals. The results show that larger SMEs were more likely to work actively towards environmental goals. Knowledge of how effective environmental work is carried out is an important condition for setting environmental goals in SMEs, and it was found that insufficient knowledge amongst personnel could result in poor environmental progress. Often the SMEs viewed environmental activities as peripheral to core business issues.

3.4.2 Environmental policy

Of the companies that participated in the project, nine had written environmental policies in place. Only three of the environmental policies in place could be considered as proactive. The others were not thorough or specific enough, but rather were a broad statement of aims. It was therefore decided to include a tailored suggested environmental policy statement in each report along with guidance notes in the form of an appendix.

3.4.3 Environmental management systems

The level of EMS structures in place within companies ranged from haphazard to fully certified internationally recognised systems (Tables 3.2 and 3.3). This reflected human resource availability and/or customer or parent company pressure (those companies certified to ISO 14001 tended to be large SMEs, and daughter companies of larger multinationals). A register of legislation was a requisite of an EMS and hence the need for the CD. While the other SMEs indicated that they were examining the idea of implementing an EMS, there did not appear to be a sufficient awareness of the potential benefits of implementing such a system. The general perception was that the process was costly, bureaucratic and not

Table 3.2. Summary of company attributes (Companies A–I).

	Company								
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Environmental policy	●				●	●		●	
Register of legislation								●	
ISO 14001								●	
ISO 9000		●			●			●	
No. of employees	25	50	30	90	120	23	30	80	5

Table 3.3. Summary of company attributes (Companies J–R).

	Company								
	J	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**
Environmental policy		●		●	●	●			●
Register of legislation		●							
ISO 14001		●							
ISO 9000			●	●					
No. of employees	25	80	20	300	35	12	12	16	100

good value for money. The lack of time, and human resources, along with some financial constraints, were found to be the major internal barriers to implementation of an EMS. The availability of grants from Shannon Development for the implementation of ISO 14001 was previously unknown to the majority of the SMEs, and some were keen to investigate this avenue. External barriers to implementation seemed to be uncertainty regarding marketing possible benefits as well as a lack of supplier pressure. It was evident that from the perspective of the companies participating in this research that internal barriers were more important than external ones.

3.4.4 Environmental legislation

An adequate awareness of environmental legislation pertaining to the companies' activities was only evident in the two companies certified to ISO 14001. The remaining companies expressed doubts on whether they were fully aware of or adhering to all relevant legislation. To aid with this process, a CD of legislation was attached to each report and a section of the report was dedicated to identifying applicable legislation based on the information supplied by the companies. There are few specific allowances made for SMEs in terms of environmental legislation, as the same requirements are applicable to all companies irrespective of size. Compliance with legislation was regarded by companies as a burden rather than as a tool that can motivate the company's environmental awareness. Some of the SMEs found the complexity of legislation a major barrier to compliance.

3.4.5 Staff organisation

Apart from the ISO 14001-certified companies, the SMEs did not have anyone designated with responsibility for environmental management. In general, responsibility for environmental management lay with the company manager, or an employee usually working in quality or health and safety. This reflects both the lack of emphasis on the environment within some companies and the lack of easily accessible training courses.

3.4.6 Training

Expertise in EMS implementation, chemical/oil storage and spill control, and energy conservation in particular was found to be poor. 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. In Ireland, the *National Competitiveness Council – Statement on Skills* (December 1998) identified the need for a significant increase in the level and quality of training and learning undertaken by employees within companies. In particular, increased levels of management development and training were found to be required, especially among SMEs. This was particularly obvious as most companies were not aware of their environmental responsibilities.

3.4.7 Performance indicators

As the environmental agenda appeared to have a relatively low priority, performance indicators had not been established by the SMEs. For example, energy use, waste output and water consumption were not monitored, and 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 (MSDSs), and appropriate personal protective equipment (PPE) was available.

3.4.8 Transportation

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. Another transport 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 pooling transport to ensure fully loaded delivery trucks, 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. An increase in car sharing, encouraged through offering a car-share matching service, would result in a reduction in each company's transport EF. It is likely

that the implementation of a car-sharing scheme or similar would be well received by staff, especially considering rising fuel costs.

The offer of incentives for using public transport for employees travelling long distances to work will become more attractive as fuel prices rise. If a successful public transport discount programme were offered and it succeeded in encouraging those interested in using public transport half the time, there would be a significant drop in the distance travelled by private car. For those who live within 2 km of their workplace, the provision of showering facilities and other similar incentives could encourage those who live close to the office to walk or cycle rather than drive to work.

A more environmentally friendly approach to purchasing in SMEs can play a key role in reducing the negative environmental impacts of transportation by focusing on reducing the frequency and amounts of purchases and selecting greener alternatives. Currently the SMEs generally follow a policy of 'Best Value' with respect to purchasing, whereby goods at the lowest price are purchased with no reference to the supplier or the location of the source, and environmental considerations are not usually an issue. Due to limited budgets, it is difficult for SMEs to restrict the companies from which they purchase goods to those in their region or country. Pressure from SMEs on suppliers and distributors to supply goods that have been produced locally whenever possible will reduce the environmental impacts from transporting the products. Small- to medium-sized enterprises may also be able to influence the modes of transport used to deliver the goods.

3.4.9 Water consumption

Water consumption as a rule was not a major issue for most of these companies as it was not used in the production process but only for domestic purposes. In such instances, there was a fixed annual charge for water, a policy which has meant that companies were unaware of and apathetic to water consumption levels. Where water is used in the production process, it is 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 water in recent years. While there was an awareness, this however had not translated into any significant conservation measures. Details of 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 and so on, were provided. Waste-water discharges were carried out under 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 were rather poor, as was monitoring of drains for contamination.

3.4.10 Energy

Most companies were acutely aware of energy use given the recently increasing costs associated with this. Due to the obvious financial incentive to increase energy efficiency, companies were most interested in taking action and some companies had already initiated energy-conservation measures. 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).

3.4.11 Buildings

As the buildings were generally 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, such as 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, and replacement of old or faulty motors with modern energy-efficient types.

3.4.12 Waste

Waste generation and treatment was 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 common. Some companies employed different waste contractors for separate waste streams as it was found that some waste contractors collected some materials at no cost while charging for others, but it was difficult for researchers to obtain information from waste contractors on costs and specific services. Recommendations were made to the companies on minimising and/or preventing waste production in the first instance, and for waste produced, best practice was identified for its segregation, storage and treatment.

3.4.13 Emissions to atmosphere

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 found to be in place.

3.4.14 Health and safety

Health and safety requirements were in many cases well adhered to by the companies. Good systems of safety management were in place and, as stated, any necessary PPE was made available to employees and visitors. However, in some instances, issues were identified where improvements were required in the case of chemical and oil storage facilities.

3.4.15 Capability transfer

At the start of the project, researchers were asked by the companies to take a strong role in directing the project. However, by the end of the project, all the knowledge regarding auditing, calculation of EF and legislation was transferred to the companies and indeed one company employed a graduate from our research group with expertise in calculating EFs. There was significant transfer of capability to the participating companies in terms of auditing and review templates and procedures, provision of a simplified EF methodology to monitor progress and provision of relevant legislation on CD with links to relevant websites so that information could be regularly checked for changes and updates.

Information and technical expertise was provided in individual reports tailored to each company. However, in addition to this transfer of capability, the companies requested that the Steering Committee stay in operation and all the companies were keen to have continuing access to the researchers

3.5 Possible Collaboration Opportunities for Small- to Medium-Sized Enterprises

The environmental performance assessment allowed sufficient information to be collected on each company to identify the major material flows, material sources and destinations, transportation use, training and information-sharing requirements. Collation and analysis of these data allowed the identification of common problems, opportunities, and the possibility for collaboration to overcome or achieve these more effectively and/or at a reduced cost. These collaboration opportunities are outlined in Table 3.4. The initiatives put in place in order to facilitate the identification of areas of collaboration differed functionally and included use and output from the inter-company workshop on collaboration.

3.5.1 Inter-company workshop on collaboration

At the workshop, priority environmental challenges were identified and plausible ways of addressing these challenges collectively were explored. Collaborative opportunities with anticipated good levels of economic return were focused on. Initial contacts between companies were established.

As part of the workshop, companies developed ideas for co-operation in tendering for services, such as pest control, forklift maintenance, IT support and cleaning, to reduce costs for the companies concerned, and create environmental benefits. Shared training was also identified as having significant potential for co-operation. A mechanism for information sharing among the group with respect to training requirements and training events was set up as part of the SNS website. Other information sharing on other topics will also be facilitated through meetings and e-mail. Where

Table 3.4. Collaboration opportunities.

Opportunity	Details
Greening supply chains	• Companies with common suppliers could collectively put pressure on those suppliers to: – reduce packaging – devise ways to take back and recycle end-of-life items and packaging – furnish an environmental policy and evidence of practical implementation • Sustainability benefits will arise from responsible procurement and purchasing
Shared training	• Companies could share training for: – ISO 14001 (group implementation) – health and safety – energy efficiency/auditing – forklift operation – chemical handling, storage – spill handling
Shared services	• Co-located companies could share the following services: – forklift maintenance – pest control – photocopier maintenance – cleaning, etc.
Energy	• Explore opportunities for biofuels/biogas in the region such as: – anaerobic digestion – combined heat and power plants – production of wood pellets from wood waste – production of renewable crops in the surrounding hinterland (new business opportunities) – joint applications for funding to Sustainable Energy Ireland
Waste	• Improving material reuse through: – a materials exchange website – establishing reuse and repair businesses – centralised waste collecting facilities for pooling waste streams to reach critical mass for recycling – establishing a plastic reprocessing business – putting out waste collection as a group to the waste contractors – organic waste management (co-located companies to share skip for subsequent anaerobic digestion, bulk purchase of composters where organic waste production is small)
Transport	• Establishing a green travel plan for the region, advantages include: – exchange of information, ideas and good practice – provide encouragement and practical support for those engaged in Green Travel Plan development – make viable the provision of services relating to travel plans on a collective basis – bring together companies to generate an effective bargaining force – car-pooling (develop a car-pooling database) – teleconferencing (group purchase of mobile unit) – encouragement of intermodal transport for freight

SMEs have found that introduction of an EMS is required (mainly by customer pressure), shared training may be an economically efficient way to achieve it, particularly for companies in similar sectors. Companies, with assistance from the CER and SNS, investigated the possibility of co-operating to implement an EMS in phases, providing mutual support and encouragement in applying for funding,

carrying out reviews, writing the policy, joint implementation and certification.

Another outcome of the workshop was a strong consensus that the owners/management of industrial estates need to take a more proactive role in providing the infrastructure to facilitate environmental initiatives and improvements. The fact that most of the companies did not own their premises was a limiting factor in developing environmental management. Green building design and centralised waste collection facilities were identified as being especially important

Centralised waste collection facilities allow plastic and other recyclable waste materials to reach a critical mass for free collection. As a first step, it was agreed that better records of waste streams will be kept by each of the companies to determine plastic types and quantities available. It was recognised that there could be a new business opportunity in the region for plastic reprocessing, and this will be further investigated by the network. Small- to medium-sized enterprises are also in the process of collaborating on solutions to organic waste management. Initiatives include joint purchasing of composting technologies and co-located SMEs arranging a shared skip for organic waste collection by a waste management company which operates an anaerobic digester as part of a combined heat and power (CHP) plant.

A car-pooling system is currently (2007) being organised through the SNS website, on which a software package matches drive-shares. It is anticipated that this will be successful within the larger industrial estates and, if successful, the initiative will be extended to include freight through using the website to advertise available space on containers.

Feedback from the companies at the workshop was very positive with all those present indicating that the project had raised their environmental awareness, not only of current environmental challenges (for example the diversion of organic waste from landfill), but also of the potential benefits that could be gained by working collectively.

3.5.2 Participant evaluation questionnaire

Following the distribution of the environmental review reports and the workshop on collaboration reports, each company was sent an evaluation questionnaire. These questionnaires were company specific and based on the recommendations made in their individual environmental review report. All respondents agreed that participation in the project was useful and only one said that their environmental awareness remained unchanged while the remaining respondents indicated that their environmental awareness improved. Many of the companies were so far behind in terms of organisation and knowledge that the initial actions were mostly doing internal environmental management jobs to facilitate the possible future IE actions. Recommendations from the environmental review process which were implemented by individual companies are outlined in Table 3.5.

3.6 Summary of Footprint Results

The EF for each company under BAU and the potential reduction in EF in the event of the implementation of the scenarios are summarised in Fig. 3.1. It can be seen that substantial reductions are possible in the company EFs. A worked example of EF calculations and reduction scenarios is provided in the End of Project Report Section 3.8. Ecological footprint calculations for each individual company are provided in Section 14 of Appendix 6 to the End of Project Report for each company report.

Table 3.5. Recommendations implemented by participating companies.

Company code	Recommendation implemented
A	• Established an environmental policy • Established an environmental action plan • Set targets for environmental performance • Compiled a register of environmental legislation • Delegated environmental responsibility to an employee • Identified environmental training needs • Developed environmental performance indicators • Developed an approved supplier system • Tried to source as many as possible raw materials locally • Replaced solvents with water-based alternatives where possible • Reviewed MSDSs to ensure compliance with storage and handling • Installed reflectors on fluorescent lights • Improved waste segregation
B	• Established an environmental policy • Established an environmental action plan • Set targets for environmental performance • Compiled a register of environmental legislation • Developed environmental performance indicators • Developed an approved supplier system • Reviewed MSDSs to ensure compliance with storage and handling • Purchased spill kits • Developed an energy policy • Reusing waste cardboard for shipping • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures
C	• Delegated environmental responsibility to an employee • Developed an approved supplier system • Tried to source as many as possible raw materials locally • Reviewed MSDSs to ensure compliance with storage and handling • Replacing light bulbs with more efficient types • Installed reflectors on fluorescent lights • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures • Employees elected safety representatives
E	• Updated existing environmental policy • Developed an approved supplier system • Tried to source as many as possible raw materials locally • Replaced solvents with water-based alternatives where possible • Reviewed MSDSs to ensure compliance with storage and handling • Adopted a water-conservation plan and measures to reduce water use • Trained more employees in the operation of the waste-water treatment plant • Developed an energy policy • Replacing light bulbs with more efficient types • Installed motion sensor to lights • Investigated improving insulation and installing skylights • Noise monitoring • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures • Employees elected safety representatives

Table 3.5 *contd.*

Company code	Recommendation implemented
F	• Updated existing environmental policy • Set targets for environmental performance • Identified environmental training needs • Developed an approved supplier system • Tried to source as many as possible raw materials locally • Replaced solvents with water-based alternatives where possible • Reviewed MSDSs to ensure compliance with storage and handling • Investigated using plastic or cardboard pallets • Purchased spill kits • Tested drains for contamination • Developed an energy policy • Replacing light bulbs with more efficient types • Investigated improving insulation, heating and installing skylights • Purchased new more efficient compressors • Improved waste segregation • Started to compost organic waste • Noise monitoring • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures
G	• Delegated environmental responsibility to an employee • Identified environmental training needs • Developed environmental performance indicators • Replaced solvents with water-based alternatives where possible • Adopted a water-conservation plan • Has made plans to replace lighting with more efficient types • Improved oil storage • Started to compact cardboard waste • Noise monitoring • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures
H	• Adopted a water-conservation plan and measures • Teleconferencing to reduce travel • Energy policy • Replacing lighting with more efficient types • Improved heating system • Reduced wattles units consumption • Reusing waste drums and pallets
L	• Established an environmental policy • Environmental action plan and targets will be designed in 2007 • Delegated environmental responsibility to an employee • Developed an approved supplier system • Reviewed MSDSs to ensure compliance with storage and handling • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures • Employees elected safety representatives
P	• Installed reflectors on fluorescent lights • Installed motion and occupancy sensors on lights • Investigated increasing cladding for insulation and additional skylights • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures • Employees elected safety representatives

Table 3.5 *contd*.

Company code	Recommendation implemented
Q	• Established an environmental action plan • Set targets for environmental performance • Identified environmental training needs • Developed environmental performance indicators • Developed an energy policy • Increased insulation • Adopted a water-conservation plan • Noise monitoring • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures
R	• Set targets for environmental performance • Delegated environmental responsibility to an employee • Identified environmental training needs • Compiled an inventory of lacquers and thinners • Tried to source as many as possible raw materials locally • Installed a new dust extraction system • Improved wood boiler • Installed bunding to oil tanks • Improved waste segregation • Carried out a hazardous waste review • Found alternative means of sawdust disposal • Improved housekeeping • Measured air quality • Compiled a written safety statement including risks and hazards in the workplace • Wrote safe operating procedures

MSDS, material safety data sheet.

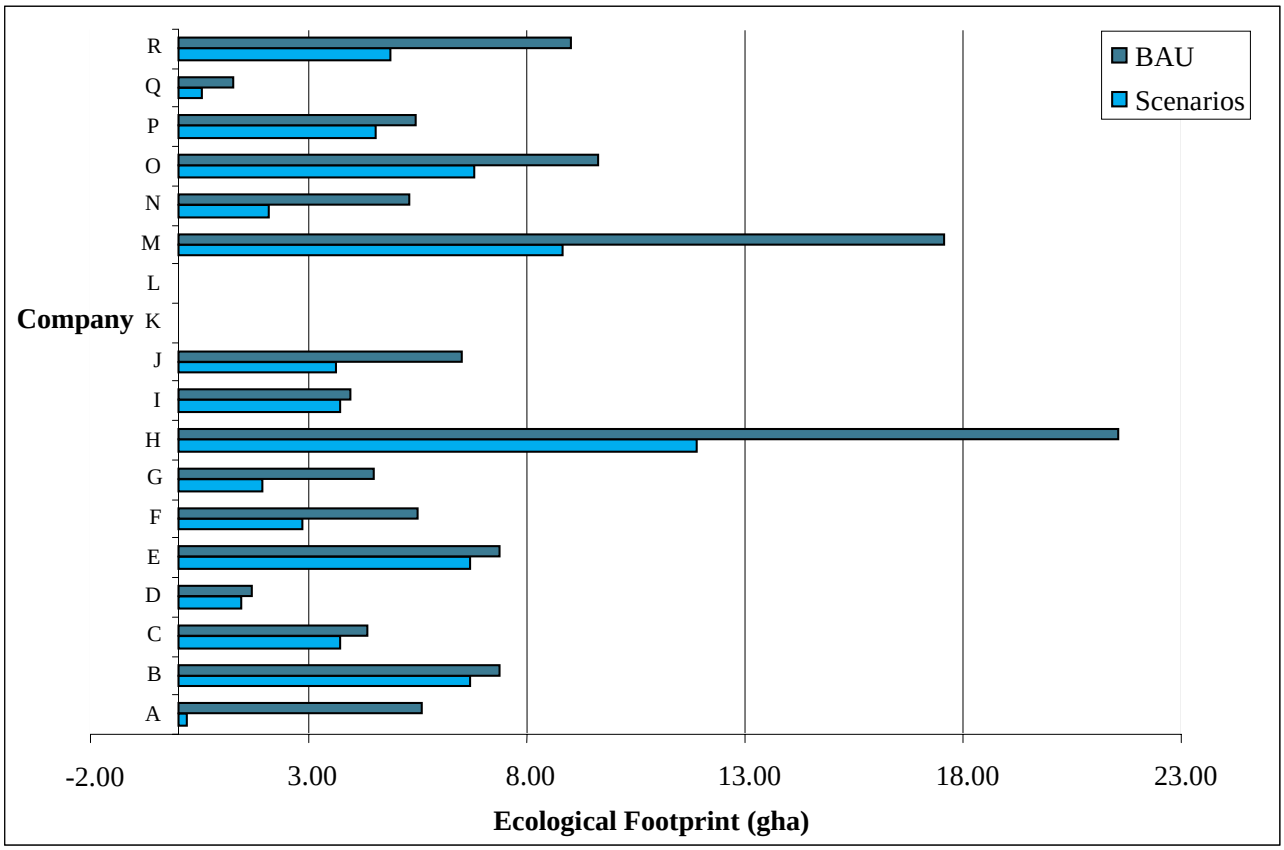

Figure 3.1. Summary of business-as-usual (BAU) and scenario ecological footprints.

4 Discussion

This project adopted action research methods that emphasise the generation of practical knowledge in a local context and in partnership with practitioners (in this case representatives from the participating SMEs, the RWMO, UL and the EPA). As this project was concerned with company networks, it focused on the plurality of experiences and the capacity in the network as a possible driver for enriching the environmental performance of all participating companies.

As the project was of such a short duration it was necessary to quickly identify options and then present them to the Steering Committee for approval. Ideally from a research perspective it would have been interesting to examine each possible choice and to review all relevant literature to identify all benefits and disadvantages. However, we were under significant time pressure and each choice made had to be approved by the Steering Committee as being both workable and acceptable to both industry and policy makers under local conditions.

4.1 Motivation to Participate

Small- to medium-sized enterprises had a variety of reasons for participating in the project. Supply Network Shannon, which operated as an intermediary between the businesses and the researchers, was an invaluable asset. As SNS had previously managed a number of co-operative initiatives, there was an existing mutual trust between the companies and SNS management. Typically, SMEs do not have an environmental budget and human resources are usually scarce. The fact that the initiative did not require SMEs to bear the costs was important for initial uptake and participation.

The majority of the SMEs expressed the view that there was a lack of advice and information relating to sustainable development within the business community and considered that by collaborating they could all benefit from one another's knowledge. The fact that the SMEs volunteered to participate was very important as they were prepared to share confidential information on their respective businesses and recognised the need to improve their environmental awareness and performance.

4.2 Small- to Medium-Sized Enterprise Environmental Perception

It is evident from this research that while the SMEs recognised that the environment is an important issue and that they accepted a responsibility for safeguarding it, the awareness and allocation of human resources for environmental management in SMEs is relatively low. This reflects the perception by SMEs that their own environmental impact is negligible, as they compare themselves with larger firms, and they fail to recognise cumulative impacts (Hillary, 2000). In essence, while SMEs recognise the importance of environmental performance, they do not consider it a core business issue for themselves as individual entities. In this sense, the findings were similar to those of NUTEK (2003) and Ammenberg and Hjelm (2003). Often the positive personal attitudes towards the environment held by SME managing directors failed to be translated into actions in SMEs.

Some SMEs were initially sceptical about the benefits, cost savings and customer rewards associated with positive environmental actions, as was found in studies by Clement and Hansen (2003) and Perez-Sanchez *et al.* (2003). However, following receipt of the environmental review report with recommendations for improvement and cost savings, and the workshop report, more positive attitudes, understanding and awareness were apparent in many of the SMEs.

Because many SMEs operate in rented buildings, they are often unable or unwilling to make structural and infrastructural investments. The owners of industrial estates need to become more proactive and supportive for such initiatives. A fundamental obstacle, identified by the SMEs themselves, to improving environmental performance of the SME sector is a lack of knowledge and information concerning environmental issues. Starkey (1998) found that SMEs were not motivated to ask for or use information on

environmental issues, though this was not the case in this project. The SMEs reported difficulties in gaining access to environmental information. There was no single comprehensive environmental information resource relating to environmental issues that SMEs could access prior to the legislation CD and company reports provided by this project.

4.3 Eco-Industrial Networks

It seems likely that customer indifference to SME environmental performance is often a key reason why environment is low on the agenda for these enterprises. Small- to medium-sized enterprises work in very competitive markets and are understandably slow to divert funds and human resources to environmental management unless there is regulatory or market pressure to do so. For future network initiatives, it would be important to include a number of larger companies (anchor tenants), preferably customers of the SMEs, for their input as both mentors and as a means of encouraging SMEs to improve their environmental performance, thereby effectively greening the supply chain.

It is increasingly recognised that cluster and network formation amongst SMEs is one of the best ways to influence SME behaviour (Shannon Development, 1999; Morosini, 2003). Governments struggle to disseminate environmental information to SMEs through a wide variety of media and agencies. In this research it has been found that SMEs prefer more hands-on approaches when dealing with environmental issues. They are slow to look for information themselves as they do not have time to search through data which are not directly applicable to them. In this way, the environmental reports were of great benefit to the companies as they were tailored to their individual needs and situations.

The principles of IE allow for a heterogeneous mix of industry sectors to work together towards SD. The Mid-West Region is characterised by the presence of companies involved in information and communications technology (ICT) and software, digital content, and access, warehousing and distribution activities. Therefore companies in different sectors (especially the minority sectors) were afforded the opportunity to work together. Increased diversity increases the chances of finding materials exchange opportunities. Although this did not occur in the course of this project, the differences between the companies led to new ideas and shared knowledge, as for example, best practice in one sector could be applied to another.

4.4 Ecological Footprints as an Indicator of Sustainable Development in Small- to Medium-Sized Enterprises

Due to the increasing recognition that the EF of SMEs is indeed significant, the environmental practices of this sector have become an emerging field of inquiry in the UK (Revell, 2003). Irrespective of size or sector, the contribution that an SME makes towards SD can be measured quantitatively by using the EF. The application of the EF could be used to distinguish between those SMEs that are moving towards SD and those which are not.

By assessing resource inputs and waste discharges, the EF proved to be a valuable tool for SMEs, to analyse business operations and technologies. By knowing about what enters and leaves a company, as well as the company processes, unnecessary costs and possible opportunities for improvement can be detected. The EF was very well received by the SMEs and most thought it would be a good indicator of progress towards SD. One SME participant expressed an interest in applying the EF to a regional certification process. On an individual level each SME can apply the EF at various time intervals to demonstrate their progress towards SD. The greatest value of the EF is as a communication tool. It provided a measurement that the SMEs understood and encouraged the idea that the individual SMEs should aim to reduce their consumption of resources and production of wastes.

An important part of this research was to demonstrate to the SMEs their role in influencing the consumption habits and choices of their staff. For instance, they can influence how an employee travels to and from work through offering incentives to use alternative modes of transport (Fincham *et al.*, 2004). The offer of incentives for using public transport for employees travelling long distances to work will become more attractive as fuel prices rise. It is likely that the implementation of a car-

sharing scheme or similar would be well received by staff, especially in the context of rising fuel costs.

From the results of the EF calculations for the SMEs, it is evident that the freight transport component is the largest for the majority of the SMEs. This is in essence due to the peripheral location of the SMEs, requiring longer transport distances for freighted material, and just-in-time purchasing policies, which in effect make freight trucks act as moving warehouses. At present, the SMEs generally follow a policy of 'Best Value' with respect to purchasing, whereby goods at the lowest prices are purchased irrespective of the supplier or the location of the source. Environmental considerations (consideration of Green Procurement Policies and distances travelled) are not usually a priority.

One of the main contributions to the SMEs environmental impact was energy consumption. For the majority of the SMEs it was the second largest contributor to the overall EF. In most instances, there was no documented formal energy policy in place. By formulating an energy policy and communicating it to all employees, the EF would be expected to be reduced significantly.

4.4.1 Procurement policies

As stated, it is evident that the freight transport component of the EF is the largest for the majority of the SMEs due to Ireland's location. A more environmentally friendly approach to purchasing in the SMEs could play a key role in reducing negative environmental impacts of consumption by focusing on reducing the frequency and amounts of purchases and selecting greener alternatives (Environmental Data Services, 2002). Small- to medium-sized enterprises may be able to influence the modes of transport used if they take advantage of their network status though bulk purchasing/delivery and possibly centralised warehousing.

4.4.2 Scenario development

Scenarios were employed in this study to provide an insight into hypothetical future situations based on explicit and plausible assumptions. While many factors affecting the size of a company's footprint are beyond the control of the company itself, there are a number of environmental management initiatives that might be taken to reduce their impact without impeding company goals or increasing costs. The construction of scenarios played an important role in illustrating the effect of implementation of such initiatives, and communicating this to participants.

4.5 Findings and Conclusions

The project duration was 18 months. As far as possible the principles of IE were applied within the individual assessments and identification of collaboration opportunities. However, as the participating SMEs were geographically scattered, their operations and survival were so dynamic that it was possible only to commence the development of a functioning IE network in this time. One company moved operations to China, two companies closed down, one shed a large number of jobs and two others changed the nature of their business entirely during the project. Indeed, without planning from the stage of industrial park construction, membership of companies coming into parks and provision of support services, a functioning IE network is unlikely to arise in Ireland under such dynamic, uncertain conditions.

4.5.1 Factors that increased the impact of the project

Given the resources and time frame of the project, it was possible only to qualitatively measure the success of the project in terms of changes implemented. Table 4.1 identifies the factors that acted to increase the impact of this project.

4.5.2 Factors that acted to reduce the impact of the project

The expectation of successful and sophisticated collaborations is low when companies, such as this sample group, have low levels of management knowledge and organisation in the area of environmental management. Developing internal management structures and procedures is often seen as a prerequisite for moving beyond the company boundary to inter-company collaborations. Also, the number of participating companies, the lack of participation of waste companies and industrial estate planners limited the success of the project. See Table 4.2 for details of the factors that limited the success of this project.

Table 4.1. Factors that increased the impact of the project.

Funding	SMEs typically do not have an environment budget and human resources are usually scarce. The fact that SMEs did not have to bear the costs of this intervention due to EPA support encouraged initial uptake and participation. Once a network is established and operational, SMEs may be in a position to sustain the network, particularly as savings from the various initiatives are acquired. An initial investment from the companies may enhance company commitment.
Support	The support provided to the companies by the CER team in the form of vital technical guidance and advice provided the companies with an active resource of information. UL provided a venue for meetings and other infrastructural support. Funding for the project was gained by the CER.
Voluntary participation	The participating companies initiated this project, approached UL and participated in the initial research proposal. Company representatives sat on the Steering Committee and were involved in every decision made regarding the project. The fact that the SMEs volunteered to join the project was of crucial importance. Thus, the SMEs were willing to share often sensitive information on their respective businesses, and recognised the need to improve their environmental awareness and performances from both economic and environmental responsibility perspectives.
Intermediaries	SNS, which operated as an intermediary between the businesses and the researchers, was an invaluable asset to the project. As SNS had previously operated a number of joint initiatives, a mutual trust had developed between the companies and SNS management. This facilitated recruitment of companies into the project.
Steering Committee	The multidisciplinary and multi-sectoral Steering Committee was particularly important to the functioning of the network. This provided input from stakeholders thus facilitating useful discussion, ideas and modes of recruiting further participants and raising issues with relevant agencies and organisations. Recruitment through personal contacts was most effective and representatives from companies that operate within a range of sectors (for example, packaging) were especially useful. The project was initiated by the participating companies and all decisions were made with full input from the companies and policy makers. In fact, many choices that the researchers would have made were overridden as unworkable by the other members of the Steering Committee. While the Steering Committee acted as a co-ordinating body, a more widely representative and adequately funded co-ordinating body would be required for long-term, large-scale interaction for SD.
Information gathering	Information was essential to the network development process. The information gathered ultimately determines the nature and number of impact mitigation projects that can be applied to the network. The necessary information can be gathered through a (mailed) survey and/or personal interviews with future network members and participants. Researchers in this project found that while companies were willing to provide information, retrieving data was a protracted process as records were incomplete and pressing business issues took precedence. Researchers e-mailed the information required from the companies in advance of the interviews and this was found to be often effective in preparing the company representatives for the environmental review. The site visit and interview enabled the researchers to become familiar with each company. Follow-up phone calls and site visits were most effective for retrieving outstanding information.
Ecological footprint	The EF provided the companies with a standard, transparent and easily understood method of measuring their progress towards SD. Company management and policy makers wanted an indicator that was easy to communicate, would resonate with all stakeholders and would be comparable across companies in the network. After discussion, the EF was selected as an assessment tool as the other options presented to the participating companies were dismissed as 'too technical' and the EF was seen as instantly recognisable and understandable by most people within the companies, from management to shop floor workers. Also, policy makers were in favour of EF.

Table 4.1 ***contd.***

Workshop on inter-company collaboration	The workshop environment, in which representatives from all project partners and companies were represented, allowed open and frank discussion on collaborative opportunities, their feasibility and likely uptake. This setting was seen by all participants as an excellent means to improve awareness and knowledge, exchange ideas and technical expertise, and most importantly as a motivational tool for the companies to pursue further improvements.
Building on small wins	From a theoretical perspective, one might form the impression that the establishment of by-product exchanges, energy cascading and water infrastructures are an essential element of the initial network development process. In practice, the initial network development in this study focused on the establishment of environmental performance improvements and increased efficiencies and cost reductions in areas of shared training, waste management and transport and simple resource-saving initiatives. Such projects are perceived as being low risk with a potentially substantial economic and environmental benefit. When these projects prove to be a success, companies often become more enthusiastic about further network development and become more willing to invest in projects with a greater economic risk and benefit. During the life of this project, several SMEs commenced the ISO 14001 accreditation process, one company decided to move into the supply of environmental technology, and a daughter project (a material exchange based on reusing wooden pallets) championed by an SME was funded by the EPA.
Awards and recognition	Each of the companies was presented with certificates for their participation in the project. This proved that they had taken positive steps to improve their environmental performance. Companies are interested in maintaining a good public image and the provision of such incentives is encouraging especially for SMEs. A further encouragement tool would be to reassess each company and give awards for those that have improved the most as this would encourage companies to implement more of the recommendations. The project won an Environmental Achievement Award from Limerick County Council for environmental innovation. Recognition of this kind was very important for all concerned: framed copies of the award certificate were given to all participating companies.
Interaction with policy makers	The involvement of national policy makers (EPA) and local policy makers (RWMO) proved to be essential for the success of this research. The SMEs gain by having input to future policy which will affect them. Policy makers gain through first-hand understanding of issues of concern to the SMEs.

CER, Centre for Environmental Research; EF, ecological footprint; EPA, Environmental Protection Agency; RWMO, Regional Waste Management Office; SD, sustainable development; SME, small- to medium-sized enterprise; SNS, Supply Network Shannon; UL, University of Limerick.

Industrial ecology principles were applied at company as well as network level wherever possible in this project (see individual company reports). Industrial ecology principles are not restricted to groups of companies and the literature makes it clear that application of IE principles will also include actions at site level in addition to network level. The companies were so far behind in terms of organisation and knowledge that the initial actions mostly involved internal environmental management actions to facilitate possible future IE actions, which were identified in the collaboration workshop. Towards the end of the project, when the companies were more aware of environmental management issues, inter-company collaborations were explored at the workshop organised by the Steering Committee.

4.6 Policy Relevance

This project was unique in the Irish context and raised many policy issues that need to be tackled if Irish industry is to progress towards SD. Small- to medium-sized enterprises have a substantial environmental impact when viewed cumulatively. There is still significant scope for Government to develop effective policy with a specific focus on SMEs and it would be important for the Government to take intermediaries, such as universities and industry bodies, into the consultation process when developing these policies.

Table 4.2. Factors that reduced the impact of the project.

Barriers to network development	• Technical (material exchanges were not technically feasible under current circumstances) • Economic (an exchange or collaborative opportunity might be economically unsound or economically risky from a company perspective) • Informational (insufficient detailed information availability) • Organisational (the collaborative/sharing opportunity might not be easily organised with current resource availability) • Regulatory/Legal (with the existing complex set of environmental laws and regulations the legality of some possible waste exchanges could not be established with certainty)
Lack of company interest	While this is something that researchers have no control over, it is significant to network development because ultimately it is the company that will have to invest and work with the designed and planned changes. During this study, three companies opted out of the project. While there is no direct evidence of this, it may be that companies with greater environmental impacts may be more likely to engage in projects similar to this one.
Limitations of Steering Committee	To be most efficient and to reflect the regional character of the network would require input from planners, transportation, energy and economic personnel, development agencies, and politicians. The more proactive involvement of industrial estate owners and planners in future environmental initiatives was particularly highlighted during this project.
Limitations of the ecological footprint	There were a number of limitations associated with the EF of the SMEs. Along with the problems recognised in the literature for EFs in general, there were some specific to this project. It was often difficult to compare the aggregated EFs as the SMEs were heterogeneous in size and sector. The sample size was relatively small, limiting comparisons between SMEs from the same sector. However, the components (waste, transport, etc.) of the EFs could be compared, as could the results on a *per capita* employee basis.
Limited network size	The network size achieved (20 companies), while being adequate for research and investigation of the applicability of the network, restricted the number of practical initiatives that could be implemented. A successful EIN would require the involvement of a larger number of companies, preferably selected on their potential contribution to waste exchanges and other collaborative opportunities.
Restricted to SMEs	SMEs alone were recruited. For the practical operation of a regional EIN, larger industries need to be involved. Due to their position in the hierarchy, larger companies as customers of SMEs could use their position to encourage green supply chains. For initiatives within individual industrial estates, such as car-pooling, the involvement of larger companies would be particularly advantageous.

EF, ecological footprint; EIN, eco-industrial network; SME, small- to medium-sized enterprise.

This project demonstrated that the active involvement of such intermediaries that are trusted by the SMEs would be a useful method for reaching the heterogeneous SME sector. As Palmer and van der Vorst (1997) point out, SMEs should not be seen as 'small large organisations' and techniques developed or tested in larger organisations may not be suitable for these small companies. While SMEs are increasingly aware of environmental issues, there is still a gap to be bridged between awareness and action, so that future policy needs to better target SMEs and to provide additional support services. European Union policy needs to assist SMEs in their compliance with environmental legislation.

Policy that encourages and facilitates the establishment of networks may be an important guiding principle. This project supports the concept that the network is probably one of the most suitable frameworks available for achieving SD at the regional level, as more can be achieved when SMEs act collectively rather than individually. The network concept also advances the sustainable development agenda by involving information exchange and

collaboration between academia, LAs, local interest groups and industry. A key task for policy makers is therefore to facilitate the networking process. Networks in which a range of interconnected companies and associated institutions are linked by commonalities and complementarities will help SMEs build critical mass and knowledge in key areas. The network involves stakeholders and allows consensus to be built on key issues and provides a platform for public/private alignment. This may, over time, allow more policies to be formulated from the bottom up and, due to the high level of participation by stakeholders, should make these policies more acceptable and successful. Policy makers have an important role to play in improving the preconditions for enhanced environmental management in SMEs. Networks should also enhance competition and regional competitiveness but the experience here suggests that there should be a minimum commitment of 3–4 years for networking programmes to allow time for change in behaviour patterns. In addition, there will be a need for adequate resourcing for the management of the network programme to provide it with sufficient flexibility to evolve over time. The EF is a reliable policy tool and may help decision makers, scientists and other stakeholders to better understand the relationship between competitive business and associated environmental impacts.

4.7 Evaluation

As this research was innovative in nature, there were no published methodologies to follow for the initial stages of the project. 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 approximately 20 companies. The review document was designed to have broad applicability. While EF conversion factors adopted were not generated to be specific to Irish conditions, the methods used in this study were deemed the best available. Since this study, the CER has developed Irish conversion factors, which may be more relevant and may be used in future similar studies. As a result of the spatial proximity of the companies, almost invariably company representatives were already acquainted and were aware of others involved in the project. This mutual awareness added considerably to the success of the workshop and the overall project.

By participating in this project the companies agreed that they have:

- Gained a better knowledge and recognition of relevant environmental issues and concerns
- Developed understanding of the possibilities for collaboration with other companies in gaining further efficiency
- Learned about the advantages and disadvantages of ISO 14001, and
- Gained information that will result in cost saving through enhanced efficiency and reduced environmental impacts.

It is essential that SMEs can measure their impacts if they are to manage them. The EF was found to be an effective and acceptable means of doing this. All methodological details, templates and details for calculating EFs have been provided to each company. This will allow them to measure and benchmark their future progress. This study highlights potential best practices that can be implemented by companies. The scenarios and opportunities identified do not purport to represent a comprehensive list, but some measures are identified which, if prioritised and implemented, would result in a significant reduction in the EF for each of the companies.

The EF was adopted to analyse scenarios to assist in future SD and environmental strategy formulation for the companies. There was a general consensus amongst the participating SMEs that the EF could act as a baseline data set from which future analysis could be performed. The aim of the EF analysis focused on communication with a view to educate and raise awareness as well as to aid in more effective policy targeting. Calculating the carbon emissions of the SMEs encourages the companies to consider the environment and stimulates early action to reduce these emissions.

The network was successful in its aim of attempting different forms of co-operation for the exchange of

knowledge and expertise between the SMEs, the RWMO and researchers in the CER. The collaboration workshop proved to be an important form of interactive participation; thus, future work in this area should involve arranging further workshops to build on successes to date. While certain issues, such as energy, waste management, transportation management and ISO 14001 implementation, may be more or less important to various companies depending on their individual circumstances, a further possibility within a larger network would be to establish subgroups of companies working on these themes and if used in tandem with an online information management system would facilitate knowledge transfer between subgroups and all participants. It would also be desirable for additional relevant actors to be brought on board such as industrial estate owners/management, waste management contractors, representatives from transportation- and logistics-related companies. The dynamic nature of SMEs and the uncertainty in their markets needs to be considered when developing networks; this became obvious when a number of participants closed, changed their location, or their business during the project. This makes it necessary for functional redundancy to be built into any network. From discussions with the stakeholders, it is clear that it would be very beneficial if an anchor tenant could be identified in each industrial estate. Ideally, the anchor tenant would be a customer of most of the SMEs and would be in a position to have a positive influence on greening the supply chain.

4.8 Future Work

The project was successful in bringing the different stakeholders together into an effective environmentally based network. However, as the duration of the project and funding was short, very significant changes could not be achieved within this time. Future work should refer to the *Best Practice Guide for Establishing an EIN* in Appendix 10 of the End of Project Report. This identifies the efforts required to help networks of companies develop into an EIN. Continued support should be provided to the current network and it should be expanded by bringing in transport logistics companies, waste management companies and other selected SMEs.

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Appendix 1 Establishing an Eco-Industrial Network

Establishing an Eco-Industrial Network

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International and Irish experience indicates clearly that environmental performance may be enhanced and cost savings made by companies operating in partnership with others: the general term used for such arrangements is 'Eco-Industrial Networks'. An Eco-Industrial Network is more than an informal arrangement amongst companies: it is intended to be a long-lasting arrangement with some formalised rules in which participating companies share information which allows them to actively seek out ways in which environmental and cost-effectiveness may be increased over time. They vary greatly in scale and purpose: for example, some may be established simply to share information on new technologies, legislation or training opportunities; others may co-operate to attract new companies that can use the waste products of existing companies as resource materials. In some networks, environmental performance and competitiveness are achieved by actions taken by individual companies; in others, action is taken to create facilities or access services for groups of companies to achieve economies of scale. Examples of such actions are provided throughout this guide. Networks are often managed by steering committees, which include representatives of national- and regional-scale decision makers, such as Regional Waste Management Offices and Local Authorities. This has been found to increase company awareness of policy concerns and increase decision makers' awareness of the needs of industry. While there are many international examples of successful Eco-Industrial Networks, few have been established in Ireland.

Introduction

This guide is aimed at industries that might see benefits for themselves in being part of a Network, but are unsure how to go about setting one up, or joining an existing one. As both Eco-Industrial Networks and individual companies vary in size, location, sector and purpose, it is not possible to provide a 'one-size-fits-all' list of steps to be taken to establish such a Network. In practice, a range of alternatives has to be considered, and choices made, on the basis of the particular needs, available resources and location of a company. This guide is structured around a set of key questions, and it is intended that in answering these questions a company will be aided in deciding whether it is worthwhile for it to either plan to set up a Network, or join an existing Network.

What are the aims of establishing the Network?

Different Networks will have different aims: there needs to be clarity in setting out aims at the outset, but with the understanding that these aims are likely to evolve through time as both the Network and the economy develop. Aims that justify the establishment of Eco-Industrial Networks include one or several of the following:

- To make the supply chain more cost-efficient and to enhance environmental performance. For example, to use a nearby source of raw materials or sub-components, thus reducing transport costs and carbon emissions; to find a source of less toxic raw materials, reducing waste disposal costs; to adopt

modern cleaner technologies that save on energy and water consumption.

- To enable companies located close to one another to share services and facilities, to reduce costs and enhance environmental performance. For example, to share freight transport so as to ensure containers are full more of the time; to move pallets on or off site as required by a group of companies; to centralise waste collection for more recycling so as to reduce landfill costs.

- To enable geographically dispersed companies, often operating in diverse sectors, to reduce costs and enhance environmental performance. For example, to share information on cheap and efficient waste contractors; to share training opportunities; to learn more about relevant environmental legislation to avoid accidental breaches of laws and regulations.

- To help comply with environmental legislation.

What type of activity is of greatest interest to the planned Network?

Networks vary greatly in the range of activities through which companies are linked. The types of activity that are most important relate to what are considered to be the most important shared needs. Three overall activity types may be recognised; however, these are not mutually exclusive:

1. The Network may function primarily to exchange knowledge and information (e.g. legislation, regulations), and efficiencies are to be achieved through actions by existing individual companies.

2. The Network may function primarily to create functional links among existing companies (such as sharing transport and waste management facilities), and efficiencies are achieved through several or many companies acting in concert.

3. The Network may function to facilitate new business start-ups within a designated site, greenfield or brownfield.

Arising from the choice of activities, it is necessary to identify incentives that will encourage companies to participate. Companies need to see clear advantages in establishing or joining a Network. These advantages vary amongst companies but include: finding new sources of resource materials or sub-components, cutting production costs, finding new markets for existing output, identifying new outputs, getting information on new technologies, saving money on pooled transport and employee training, keeping up to date with changing environmental laws and regulations, help in gaining accreditation to ISO 14000 standards, possibilities for positive PR.

Which company or organisation is going to lead the Network?

All Networks require a champion. A crucial job is the review of candidate companies and the selection of appropriate members (this point is covered in more detail in Questions 4 and 5 overleaf). Another crucial job is the collection, safe storage and analysis of (often confidential) information regarding Network members' activities. Often Networks are established by companies working in partnership with universities and technical colleges, which provide technical expertise and initial neutral chairing of meetings.

Existing Networks established to exploit joint actions to enhance profitability or market access have often evolved additional functions related to enhancing environmental performance. Different Networks have different champions: international experience shows that successful champions may be:

- Existing commercial Networks
- Property developers
- Larger businesses
- Local Authorities
- Universities
- Trade associations.

What types and numbers of enterprises should be involved in the Network?

Networks established in the past have linked different types of enterprise.

These enterprise types include:

- Larger indigenous companies
- Multinational companies
- Subsidiaries
- Manufacturing companies
- Service providers (e.g. transport, waste management, energy)
- Micros and small- and medium-sized enterprises (SMEs)
- Sole traders.

Choices have to be made in relation to which of these, or which mixes of these, are to be included in a Network. Networks have been formed with different numbers of partner companies, from 20 to 150. Bigger numbers of participating companies can prove more difficult to manage, and contact amongst companies may fail to develop. However, there are also important advantages in bigger numbers. A Network may depend on a particular company for delivery of a function, such as collective waste recycling. If this company closes down, then the Network loses this service. It is therefore better to have more than one participant company providing (in this case) waste management services. Bigger numbers also mean that a wider range of industries and services can be included, which provides more opportunities for a company to find partners that offer services appropriate to its needs.

Which companies should be invited to participate in the Network?

From the perspective of enhancing environmental performance, it is clearly advantageous to include service companies operating in areas such as energy, transport, solid waste and waste-water management.

Networks have failed in the past when participating companies have not been able to initiate or maintain meaningful co-operation with other companies. The attributes of companies that have been successful in benefiting from, and contributing to, Networks usually include the following:

- Strong commitment to the project from top management
- Strong commitment to the project from an array of personnel (e.g. middle management, unions, social clubs, etc.)
- Where relevant, parent company awareness and encouragement

- Companies planning accreditation to ISO 14001 or the EU *Eco-Management and Audit Scheme* (EMAS)
- Companies interested in entering environmental management or technology
- Companies prepared to provide adequate time and resources to Network membership.

The geographical boundary of the Network needs to be considered. Networks of companies located close together offer more opportunities for synergies and other co-operation than do Networks formed by more dispersed companies. Not all companies are located close to others, but they may still benefit from Network membership. However, as a general rule, to aid communication and co-operation, distances greater than ~20 km should be avoided.

How is the Network to be funded?

Initial set-up funding is required. International experience shows that this may be provided in part or in total by:

- Participating companies
- A Local Authority
- A State agency.

Within contemporary Ireland, as a rule, resources are not available from the last two listed. After the set-up phase, if successful, the participants will fund the Network as membership confers cost savings.

Are there particular issues with Micros and SMEs as Network members?

Inclusion of smaller companies in Networks has special benefits. Smaller companies stand to benefit greatly from Network membership. This is because:

- They often do not have time or resources to acquaint themselves with up-to-date information on regulations and laws, for example in relation to the environmental legislation.
- They often regard themselves as too small to have an appreciable environmental impact, though together they may have a significant cumulative impact.
- Their small size and relative isolation often leaves them prone to being charged high prices for materials and services (e.g. waste disposal, transport).
- They have the ability to change practices quickly and decisively (some argue especially if owner-managed).

However, consideration should also be given to the fact that it is not always easy for smaller companies to maintain Network membership or inputs over the longer term as:

- They may change location more frequently.
- They may change function more regularly.
- They may close down more frequently.
- Departure of a single key person may greatly affect their ability to participate effectively in a Network.

How will the Network be managed?

Networks in Ireland and other countries have been managed by Steering Committees formed of some of the following:

- Representatives from participating companies
- Third-level researchers
- Representatives of Local Authorities, Regional Waste Management Offices, etc.
- Intermediaries, e.g. pre-existing Network representatives
- Representatives of national organisations, e.g. the EPA.

Each has a potential role to play: participating company representatives provide information on the attributes and needs of these companies; third-level researchers bring expertise on new technologies and management systems, provide a neutral setting for meetings, and provide facilities for the safe storage of often confidential information; Local Authority representatives bring to the committee information on local environmental initiatives, planning regulations and constraints; pre-existing Network representatives have invaluable information on contacts already established amongst participating companies, and other companies in the region that might be interested in joining the Network; national organisation representatives bring crucial information on national policy and funding opportunities to enhance environmental sustainability.

What information is usually needed on Network members?

This varies with the function of the Network, but will usually include:

- Information on buildings, heating, services employed
- Products and markets
- Employee numbers, travel to work modes and distances
- Raw materials, components
- Waste streams and treatment
- Water use and costs
- Energy sources and costs
- Environmental impacts
- Freight modes and costs
- Training needs
- Health and safety issues.

Should Network activities just involve key representatives?

No, as one of the crucial, though often neglected, aspects of Network functioning is the 'social side'. Facilitating communication on shared experiences, hands-on approaches, etc., is of great importance in engendering trust and encouraging companies (especially smaller companies) to act on advice and introduce innovation. It is perfectly possible to use the Network as a vehicle for involving employee families in environmental awareness-raising social activities.

How fast can the Network develop?

It must not be anticipated that a Network can become established very quickly; 18 months is the usual minimum time for successful start-up. Steps that take time but are crucial usually include:

- Identifying and assembling membership

- Collecting information on each member's activities
- Reviewing this information to identify common issues and problems
- Identifying opportunities for site-specific or concerted actions
- Finding practical and efficient solutions.

What benefits can be achieved by Networked companies in the short and longer terms?

The example benefits listed here will both enhance environmental performance, and result in significant financial savings.

Short-term benefits include, for example:

- Shared training and knowledge of training opportunities
- Increased knowledge of environmental legislation
- Increased recycling, less waste to landfill
- Reduced water consumption
- Better freight transport efficiency
- Better energy use efficiency
- Canteen waste reduction
- Better use and reuse of pallets.

Longer-term benefits include, for example:

- Shared energy generation (e.g. combined heat and power (CHP))
- Shared transport arrangements (always full containers)
- Using waste and by-products as resources for partner companies
- Pooled waste collection, sorting and recycling
- Relocation of companies to form clusters
- New company set-ups to exploit new Network opportunities.

For Further Information

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The full report *Establishing an Eco-Industrial Network for Small- to Medium-Sized Enterprises in the Mid-West Region* by Dr Bernadette O'Regan and Prof. Richard Moles is published by the Environmental Protection Agency and is available from http://erc.epa.ie/safer/reports.

An Ghníomhaireacht um Chaomhnú Comhshaoil

Is í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) comhlachta reachtúil a chosnaíonn an comhshaol do mhuintir na tíre go léir. Rialaímid agus déanaimid maoirsiú ar ghníomhaíochtaí a d'fhéadfadh truailliú a chruthú murach sin. Cinntímid go bhfuil eolas cruinn ann ar threochtaí comhshaoil ionas go nglactar aon chéim is gá. Is iad na príomh-nithe a bhfuilimid gníomhach leo ná comhshaol na hÉireann a chosaint agus cinntiú go bhfuil forbairt inbhuanaithe.

Is comhlacht poiblí neamhspleách í an Ghníomhaireacht um Chaomhnú Comhshaoil (EPA) a bunaíodh i mí Iúil 1993 faoin Acht fán nGníomhaireacht um Chaomhnú Comhshaoil 1992. Ó thaobh an Rialtais, is í an Roinn Comhshaoil agus Rialtais Áitiúil a dhéanann urraíocht uirthi.

ÁR bhFREAGRACHTAÍ

CEADÚNÚ

Bíonn ceadúnais á n-eisiúint againn i gcomhair na nithe seo a leanas chun a chinntiú nach mbíonn astuithe uathu ag cur sláinte an phobail ná an comhshaol i mbaol:

- áiseanna dramhaíola (m.sh., líonadh talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh., déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- diantalmhaíocht;
- úsáid faoi shrian agus scaoileadh smachtaithe Orgánach Géinathraithe (GMO);
- mór-áiseanna stórais peitreail.

FEIDHMIÚ COMHSHAOIL NÁISIÚNTA

- Stiúradh os cionn 2,000 iniúchadh agus cigireacht de áiseanna a fuair ceadúnas ón nGníomhaireacht gach bliain.
- Maoirsiú freagrachtaí cosanta comhshaoil údarás áitiúla thar sé earnáil - aer, fuaim, dramhaíl, dramhuisce agus caighdeán uisce.
- Obair le húdaráis áitiúla agus leis na Gardaí chun stop a chur le gníomhaíocht mhídhleathach dramhaíola trí comhordú a dhéanamh ar líonra forfheidhmithe náisiúnta, díriú isteach ar chiontóirí, stiúradh fiosrúcháin agus maoirsiú leigheas na bhfadhbanna.
- An dlí a chur orthu siúd a bhriseann dlí comhshaoil agus a dhéanann dochar don chomhshaol mar thoradh ar a ngníomhaíochtaí.

MONATÓIREACHT, ANAILÍS AGUS TUAIRISCIÚ AR AN GCOMHSHAOL

- Monatóireacht ar chaighdeán aeir agus caighdeáin aibhneacha, locha, uiscí taoide agus uiscí talaimh; leibhéil agus sruth aibhneacha a thomhas.
- Tuairisciú neamhspleách chun cabhrú le rialtais náisiúnta agus áitiúla cinntí a dhéanamh.

RIALÚ ASTUITHE GÁIS CEAPTHA TEASA NA HÉIREANN

- Cainníochtú astuithe gáis ceaptha teasa na hÉireann i gcomhthéacs ár dtiomantas Kyoto.
- Cur i bhfeidhm na Treorach um Thrádáil Astuithe, a bhfuil baint aige le hos cionn 100 cuideachta atá ina mór-ghineadóirí dé-ocsaíd charbóin in Éirinn.

TAIGHDE AGUS FORBAIRT COMHSHAOIL

- Taighde ar shaincheisteanna comhshaoil a chomhordú (cosúil le caighdéan aeir agus uisce, athrú aeráide, bithéagsúlacht, teicneolaíochtaí comhshaoil).

MEASÚNÚ STRAITÉISEACH COMHSHAOIL

- Ag déanamh measúnú ar thionchar phleananna agus chláracha ar chomhshaol na hÉireann (cosúil le pleananna bainistíochta dramhaíola agus forbartha).

PLEANÁIL, OIDEACHAS AGUS TREOIR CHOMHSHAOIL

- Treoir a thabhairt don phobal agus do thionscal ar cheisteanna comhshaoil éagsúla (m.sh., iarratais ar cheadúnais, seachaint dramhaíola agus rialacháin chomhshaoil).
- Eolas níos fearr ar an gcomhshaol a scaipeadh (trí cláracha teilifíse comhshaoil agus pacáistí acmhainne do bhunscoileanna agus do mheánscoileanna).

BAINISTÍOCHT DRAMHAÍOLA FHORGHNÍOMHACH

- Cur chun cinn seachaint agus laghdú dramhaíola trí chomhordú An Chláir Náisiúnta um Chosc Dramhaíola, lena n-áirítear cur i bhfeidhm na dTionscnamh Freagrachta Táirgeoirí.
- Cur i bhfeidhm Rialachán ar nós na treoracha maidir le Trealamh Leictreach agus Leictreonach Caite agus le Srianadh Substaintí Guaiseacha agus substaintí a dhéanann ídiú ar an gcrios ózóin.
- Plean Náisiúnta Bainistíochta um Dramhaíl Ghuaiseach a fhorbairt chun dramhaíl ghuaiseach a sheachaint agus a bhainistiú.

STRUCHTÚR NA GNÍOMHAIREACHTA

Bunaíodh an Ghníomhaireacht i 1993 chun comhshaol na hÉireann a chosaint. Tá an eagraíocht á bhainistiú ag Bord lánaimseartha, ar a bhfuil Príomhstiúrthóir agus ceithre Stiúrthóir.

Tá obair na Gníomhaireachta ar siúl trí ceithre Oifig:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig um Fhorfheidhmiúchán Comhshaoil
- An Oifig um Measúnacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáide

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag ball air agus tagann siad le chéile cúpla uair in aghaidh na bliana le plé a dhéanamh ar cheisteanna ar ábhar imní iad agus le comhairle a thabhairt don Bhord.

NDP
National Development Plan 2007 - 2013

Science, Technology, Research and Innovation for the Environment (STRIVE) 2007-2013

The Science, Technology, Research and Innovation for the Environment (STRIVE) programme covers the period 2007 to 2013.

The programme comprises three key measures: Sustainable Development, Cleaner Production and Environmental Technologies, and A Healthy Environment; together with two supporting measures: EPA Environmental Research Centre (ERC) and Capacity & Capability Building. The seven principal thematic areas for the programme are Climate Change; Waste, Resource Management and Chemicals; Water Quality and the Aquatic Environment; Air Quality, Atmospheric Deposition and Noise; Impacts on Biodiversity; Soils and Land-use; and Socio-economic Considerations. In addition, other emerging issues will be addressed as the need arises.

The funding for the programme (approximately €100 million) comes from the Environmental Research Sub-Programme of the National Development Plan (NDP), the Inter-Departmental Committee for the Strategy for Science, Technology and Innovation (IDC-SSTI); and EPA core funding and co-funding by economic sectors.

The EPA has a statutory role to co-ordinate environmental research in Ireland and is organising and administering the STRIVE programme on behalf of the Department of the Environment, Heritage and Local Government.

epa
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An Ghníomhaireacht um Chaomhnú Comhshaoil

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