Ecopal - Dunkerque

Ecopal is an association that currently brings together 286 members, including companies, local authorities, institutions, civil society, and associations. 81% of the companies have less than 50 employees, and only 6% have more than 200. These companies come from a wide variety of sectors such as commerce, agri-food, printing, chemistry, and construction. Since 2009, the territory concerned covers a radius of 70 km around the Dunkirk basin, whereas at the beginning, it was only the Dunkirk basin itself. The expansion of the territory has made it possible to increase the number of members and thus the potential for synergies. Its objective is to promote sustainable local development by raising companies' awareness of the concept of industrial ecology, by proposing that they develop concrete projects and by orchestrating synergies between its members. To do this, Ecopal receives financial and technical support from its partners (CUD, CCI Côte d'Opale, Clubs d'entreprises de ZI, Dunkerque Promotion, Conseil Général du Nord, Conseil Régional, ADEME, DRIRE, CERDD, CPIE, Agur, Orée) in addition to the contributions of its members. Ecopal was one of the pioneers in France in industrial ecology and its experience with the COMETHE project of the Agence nationale de la Recherche, for which the Dunkirk basin was a pilot area, made it possible to design and improve methodological tools in order to encourage other territories to implement industrial ecology.

The method used to identify synergies is to carry out an analysis of the inputs and outputs of its members. When companies join the network, Ecopal's methodology is to systematically collect their inputs and outputs. This methodology was also adopted following the COMETHE research project. In the framework of this project, around 5,000 flows were identified from 150 companies, revealing thanks to the Prestéo software a potential for around thirty substitution synergies (e.g. methanization, steam, reuse of rainwater, reuse of acids) and several mutualizations. For example, a project for the mutualization of archive destruction has been implemented. The optimization of bins and the gains generated by the valorization of paper make it possible to cover the costs of transport and bin rental, making this project free for participants. In 2010, Ecopal estimated that the various mutualized collections had resulted in annual savings of €79,200 ($111,000) and 10 tonnes of CO2 (Ecopal, 2010b).

However, the tools resulting from the COMETHE project are little used due to lack of time on the part of the team. In addition, the association no longer uses Prestéo, but an internal database (Ricart, 2011). Thus, Excel spreadsheets are used to track projects and clients. However, work is underway to consolidate a more efficient management software from existing tools. When it comes to measuring progress or results, very few measures are in place. Companies are reluctant to disclose their economic data, due to confidentiality concerns, but also because they lack knowledge of their own expenses. Acquiring more comprehensive data, economic and environmental, but also social (job creation/maintenance) would allow for a more vigorous promotion of Ecopal's program.

Dunkirk is the third most important French port and constitutes one of the most heavily industrialized areas in France. This industrial density, mainly of heavy industries (steel, metallurgy, petrochemicals, chemistry, energy production), but also of nearly 800 SMEs, and its proximity to residential areas has highlighted the importance of environmental and sustainable development issues more directly than elsewhere in France. Before the launch of the project, Dunkirk's companies and local authorities had already undertaken extensive sustainable development initiatives since the 1990s. This pre-existing momentum linked to the Dunkirk territorial context therefore facilitated the grouping of different stakeholders around the Ecopal project. Furthermore, the density and diversity of the industrial fabric constituted two important conditions for the feasibility of this approach (Centre de ressource du développement durable, 2010).

Peggy Ricart, directrice à la coordination des projets

Ecopal benefits from both public and private funding. In a territory where mainly SMEs, PMIs, and TPEs (very small enterprises) are located, the approach must be adapted to encourage their participation and convince them to pay their annual membership fee, even if this fee is lower than for a large company (€150 compared to €2000-3000). According to Peggy Ricart, the main challenge is that the service provided by Ecopal is not directly aligned with the core business of these companies (e.g., shared collections) and seems rather abstract. This can be a challenge because small and medium-sized enterprises typically have limited staff and available time is prioritized for addressing primary issues. Conversely, large industries, who have more manpower and resources, have quickly been seduced by the services offered by Ecopal.

In order to reach SMEs and TPEs, continuous canvassing has been carried out with these companies over a long period. Regarding the arguments used, they were focused on the needs of each company, but mainly on the economic aspect. In addition, the use of data on the results of completed projects and an approach through large companies (often major clients in the region) made it possible to reach subcontracting SMEs with more weight. The message is centered around a probable gain in efficiency for subcontractors and therefore an improved competitiveness for the client thanks to Ecopal's services. Moreover, after a decade of activity, Ecopal's achievements have allowed it to gain the trust of Dunkirk's companies to the point that recruiting new members is now mainly done by word of mouth. This mark of confidence in the project is a success factor. Furthermore, Ecopal's network of administrators includes several company representatives, which stimulates their participation and fosters a climate of trust. Respecting confidentiality also helps maintain this climate.

One of Ecopal's strengths is its partnership with the University of Littoral Côte d'Opale (ULCO) to develop R&D projects for companies. ULCO collaborates on certain projects by mobilizing its research teams to identify outlets for industrial flows or to develop specific ecotechnologies. Innovation is therefore present in the approaches when the sector of activity allows it.

Regarding the types of projects, the synergies are mainly mutualizations since they are more easily implemented given that TPEs and SMEs do not have framework contracts with waste management service providers. Moreover, the benefits are rapid, as these synergies promote the capture of small residual material flows. Substitution synergies, where a virgin material is replaced by a by-product, are less frequent as they require numerous samples, significant investments, and a long process. However, Penny Ricart recognizes that the potential for benefits for this type of synergy can be very high. For example, the company ArcelorMittal recovers a by-product rich in iron and fuel from the company Sea Bulk, which allows the steelmaker to save around €100,000 (around $140,000) annually (Ecopal, 2010c).

Club d’écologie industrielle de l’Aube – Troyes

The Industrial Ecology Club of Aube is an association that brings together about twenty members across the department, including companies, institutions, local authorities, professional, academic, and research representatives. Its objective is to promote long-term development by reflecting on economic development and territorial planning, a major issue affecting most of the large peri-urban areas of industrialized countries. The Club also aims to raise its members' awareness of environmental management and industrial ecology. To this end, each member company must provide quantitative and qualitative information on all its input and output flows. The annual membership fee is between €150 and €300 ($210 and $420), depending on the member's status. This membership fee gives access to the Prestéo software, a computer tool that identifies potential synergies aimed at maximizing economic gains and minimizing environmental impacts.

A first example of a realized synergy is that of Cristal Union, which groups together sugar beet farmers, and APPIA Champagne, a subsidiary of EIFFAGE Travaux Publics specializing in road construction. APPIA needs between 400,000 and 500,000 tonnes of sand annually in Aube, while the cleaning of beets by Cristal Union produces a sand residue of 6,000 to 12,000 tonnes per year (Brullot, 2011b). The synergy has thus made it possible to substitute part of the sand used by APPIA with the sand residue from Cristal Union, generating an economy of resources on the one hand and a reduction of materials destined for landfill on the other.

Another example is that of AT France, a producer of andouillettes. In this case, the main expenses were in the disposal of grease in rendering and the gas bill. However, an investment of €900,000 allowed AT France to purchase a boiler capable of producing energy from grease and a water treatment system to recover grease rather than discharging greasy water to the wastewater treatment plant. This investment resulted in a 100% saving on rendering costs thanks to the energy recovery of grease, as well as a 30% saving on the gas bill. At that time, AT France had a surplus of energy and opted to add a laundry on its premises. This addition generates an annual saving of €15,000 compared to outsourcing the cleaning of employees' soiled clothing (Brullot, 2011b). In addition to making significant savings, AT France has reduced its environmental impact and reduced its vulnerability to subcontractors.

The objectives of the Industrial Ecology Club are aligned with the principles of sustainable development. Indeed, reducing environmental impacts is as important as maximizing economic gains in the search for synergies.

However, the Club's coordination team experienced some reluctance regarding the disclosure of flows. To remedy this, confidentiality agreements were signed in some cases to stimulate participation. In addition, it should be noted that flows that could constitute an industrial secret are not essential in the context of an industrial ecology approach, as the company concerned is likely to be the only one to use it. Its non-disclosure therefore does not hinder the search for synergies (Adoue, 2011b).

Another challenge faced by the Club was the lack of knowledge among its members. Indeed, there was no dialogue between the industrialists and consequently little knowledge of the industrial fabric. In addition, the recovery channels and the waste exchange were poorly known and little used. The emergence of leaders in the industrial sector, the general council, the Chamber of Commerce and Industry, and the university research center (CREIDD) made it possible to establish a project in a more informal way at the start, not intimidating the industrialists. Then, the rapid implementation of the beet sand synergy and the dissemination of the results helped to increase the interest of stakeholders in this territorial project.

Grégory Lannou, coordonnateur

In France, all territories with more than 50,000 inhabitants must produce Climate Plans and Carbon Balances. For many communities, industrial ecology has become an interesting avenue to address these

issues and develop action plans that encompass the industrial sector. To this end, the Industrial Ecology Club of Aube has a dual vocation. First, it's a reflection forum where only members can participate, although the actions implemented go beyond the members to reach the territory's companies. Then, the CEIA aims to act as a facilitator, bringing together the right stakeholders, raising awareness of the territory's challenges and of industrial ecology, and ultimately helping them to transform the territory's constraints into opportunities. In this regard, the CEIA acts as a bridge between public and private decision-makers. The challenge for the CEIA is that service providers must understand the principles of industrial ecology and the potential benefits for the territory, rather than seeing industrial ecology as a threat to their core business.

To encourage the membership of corporate members in the CEIA, the argument of return on investment is not used. Instead, the focus is on raising awareness of the added value of participating in a strategic reflection on the development of their territory. To this end, the membership fee requested from members is more symbolic. While the Club is already involved in trade fairs, conferences, and journals, the Club's long-term objective is to develop a French-speaking industrial ecology pole to provide feedback and compare available tools to help territories wishing to implement an industrial ecology approach. In this context, a sub-objective is that by making its activities of public interest, members could receive a tax credit in exchange for their membership, which could increase the number of members.

There are no real tools used to monitor projects. This information is managed by the coordinator who holds progress reviews six times a year. However, reports are produced for research projects (e.g., COMETHE) or for funders. For the management of flow information, the Prestéo software has been purchased because basic tools like Excel and Access were no longer sufficient. An ideal tool, according to Grégory Lannou, coordinator of the Club, would be a software like Prestéo with improved user ergonomics, connected to a GIS and allowing for flow modeling. However, expertise will always be necessary as the tool should remain a means, not an end.

There is no systematic analysis of flows due to lack of resources. There is also no approach by industrial zone because the industrial density is not high enough and does not gather enough heavy industries, according to Grégory Lannou, which does not generate sufficient flows. However, participation in the COMETHE project allowed to obtain the necessary financial resources to deepen the analysis of flows.

However, at the CEIA, the identification of potential synergies relies heavily on the intuition of the stakeholders, although they are based on feedback from projects where the actors were similar. According to them, this approach allows for rapid results, which stimulates the motivation of the group. In addition, to keep members motivated, the Club regularly organizes informal meetings.

Regarding the types of synergies, it is mainly a matter of substitutions since the results are more remarkable than for mutualizations and therefore more interesting for companies. At the level of the results achieved by the synergies developed by the Club, there are no real indicators put in place from the start of the projects. The data collected depends on the willingness of companies to share them, which can limit the type of information available.

Club des Entreprises du Parc Industriel de la Plaine de l’Ain

The Plaine de l'Ain Industrial Park is an ISO 14001 and EMAS certified industrial park covering approximately 900 hectares and housing 125 companies, mainly SMEs and PMIs in the sectors of large-scale automated production, logistics, and research & development. The Business Club is an association composed of company managers from the industrial park and has about sixty members. The Club's objective is to identify common improvement needs for the park and to develop inter-company communication in order to promote the development of the industrial park. Activities are mainly recreational or sporting, but some projects have an environmental dimension. For example, investments have been made to create shared services for waste management, water treatment, sanitation networks, and groundwater monitoring systems. However, some projects have had to be abandoned due to non-viability, such as a wood-fired boiler project that could not compete with Gaz de France's prices (Brullot, 2011b).

The Business Club has environmental impacts linked to the obligation to continuously improve ISO 14001 certification, but it is rather a project that promotes communication between companies, through recreational outings, sports activities, and collective training. The benefits for Club members include access to collective training, negotiated rates, and group purchasing. It is a project to generate savings and improve the attractiveness of the territory to attract a quality workforce. The main objectives are therefore not linked to the environment, which explains why there is no systematic analysis of flows, even though an environmental and safety database exists. However, although industrial ecology is usually evaluated based on the number of synergies implemented and the quantities of materials and/or energy saved, these indicators, although powerful, can be limited when a region has few technical complementarities at a given time. However, the Plaine de l'Ain Industrial Park is booming and plans to increase the number of companies in the coming years.

Cyril Adoue, directeur fondateur de Systèmes Durables

The methodology developed by Cyril Adoue and applied by Systèmes Durables can be summarized in four global steps:

1. Identification of flows
2. Identification of synergies
3. Feasibility study
4. Implementation

To manage information and projects, this firm uses the Prestéo software, developed by its founder. With the use of the software by stakeholders in Dunkirk (Ecopal) and Troyes (CEIA), for example, efforts are now being invested to improve the user experience through ergonomics to facilitate the use of this tool and thus save time. Functional improvements are also planned, but they are strategic and remain confidential.

However, the tool takes a secondary place compared to human relationships developed by the project stakeholders. Indeed, even if the stimulation of the participation of the territory's companies is not included in the four global steps, it remains essential. According to Cyril Adoue, the key to success lies in mediation and animation between the stakeholders of the approach, since "from a technical point of view, there are always possible synergies". To this end, a step-by-step approach is adopted. Thus, projects begin with the creation of a technical committee where public and private leading actors are invited (e.g., ADEME, representatives of trade unions, chambers of commerce and industry, managers of activity zones). These stakeholders are chosen based on the privileged relationship they have developed with local businesses. A key message is provided to them, along with enough supporting materials to interest the members of the technical committee in promoting the project to businesses. However, the information and training of these opinion leaders must be very rigorous to avoid generating the opposite effect.

Following this measure, the firm Systèmes Durables estimates that 90% of the awareness-raising work is completed with businesses.

The discourse used to encourage the adhesion of companies to the project concerns the degree of involvement of industrialists (e.g., necessary time investment), the management of confidentiality and the potential benefits. These potential benefits are illustrated based on the economic data of real cases of synergies in other territories in France. The choice of examples should be as local as possible (the Kalundborg synergy is evacuated because it is too far away) and should ideally be linked to the core business of the targeted industrial sector (e.g., using the synergy of beet sands from the CEIA for the agri-food sector, see chapter 3).

Discussions with Cyril Adoue also addressed the factors favoring the success of a project. Based on the example of the Vitré project, near Rennes (France), the elements that favored the project are:

- Strong political will of the president of the agglomeration;
- Strong will on the part of companies and industries;
- Financing of the departure at 100% by the intercommunality (public), then sharing between industries and communities;
- Real dialogue between the stakeholders of the territory and the companies for a decade;
- Operational perspective of economic development also aiming to create a positive environmental impact.

Thus, an industrial ecology club bringing together about twenty companies was created in 18 months, despite a geographically unattractive location.

A counter-example demonstrating the importance of a strong local political will is the failure of a project in the territory of the Marne et Gondoire agglomeration community (France). This territory-pilot of the COMETHE project brought together 200 SMEs and synergy tracks had been identified. However, the intercommunality abandoned the project even if the industrialists were motivated. The lack of support or support by a public body such as the town hall or the chamber of commerce and industry made this project fail.

According to Cyril Adoue's experience, the tracks of identified synergies are shared at 70% in mutualization synergies and 30% in substitution synergies, while at the implementation stage, this ratio passes to 50:50. The difficulty for the implementation of mutualization synergies is that they concern ancillary supplies, which are not part of the core business. In addition, the number of actors complicates the approach and questions arise as to the legal framework of this type of synergy. In the case of substitution synergies, these intervene in the core business and the returns are more visible, although the implementation often requires significant investments. The indicators of success of a project depend on the objectives set by the territory. It can be the number of participating companies, the number of synergies identified and then implemented, economic data (although difficult to obtain from industrialists) and data related to the creation or maintenance of jobs (difficult to measure).

Finally, as for the industrial fabric, its sharing between large companies and SMEs-SMIs does not seem to have a negative effect on the identification of synergies. However, a zone where too many tertiary sector activities are concentrated can reduce the number of potential synergies as the needs are limited mainly to the mutualization of paper and ink cartridge collections.

Landskrona Industrial Symbiosis Program (LISP) – Sweden

The Industrial Symbiosis Program of Landskrona is a pilot project launched by the International Institute for Industrial Environmental Economics (IIIEE) of Lund University, which began in 2002. The program brings together, within a radius of 4 km, 3 public organizations and 19 industrial companies from various sectors such as chemistry, waste management, metallurgy, printing, transport and logistics. Of these 19 companies, 18 had less than 250 employees. This project was mainly financed by the municipality of Landskrona and by the National Agency for Economic Development (NUTEK), but the participating companies also made a contribution to ensure their active participation in the project. The objective of the municipality was to revive the local economy, create jobs and reduce environmental impacts. This objective was complementary to that of the companies and consisted in increasing their competitive advantage by seeking collaboration to reduce their environmental management costs, their operational costs, to develop new sources of business and revenue, and to improve their image in terms of their environmental performance.

The methodology used consisted first in carrying out an exhaustive analysis of the territory while raising awareness among the targeted actors. From 2003, this initial portrait of the territory and its potential synergies began with interviews and awareness-raising activities with the actors, such as a common seminar, thematic working groups, lunches-conferences and company visits. This important mobilization has stimulated interactions between companies, fostered a climate of trust and mutual aid (Mirata, 2005). Then, the companies filled out an electronic questionnaire, then these data were analyzed and in-depth studies were launched in the most promising sectors. The main identified synergies were in the areas of energy, water, materials and chemical products, alternative fuels, logistics and management practices. For example, the residual heat of two companies made it possible to create a heating network (district heating), thus reducing the use of non-renewable resources for heating and consequently reducing environmental impacts and costs. However, some potential synergies could not be implemented as they did not meet the criteria of economic profitability. For example, although it is technically possible to reuse treated wastewater or to recover and reuse sulfuric acid, the costs exceed the use of a new material (Mirata, 2005). However, in view of the strong environmental values in Sweden, several companies were prepared to accept a return on investment up to 50% longer if the environmental benefits were significant (Mirata, 2005).

Several factors have favored the success of this project. First, the municipality of Landskrona had already been exerting strong pressure for 30 years for the companies of the city to improve their environmental performance following severe environmental problems in the 1960s and 1970s due to the massive production of fertilizers and sulfuric acid. In addition, the IIIEE had already carried out a project on clean production methods between 1987 and 1989 with some of the companies concerned, thus establishing a first contact with them. Eleven companies were already certified ISO 14001 while others were in the process of certification or had expressed an interest. The companies were therefore already very sensitized to environmental issues. Furthermore, some companies had already established relationships spontaneously before the start of the project. It should be noted that in Landskrona the economic turmoil of the 1980s seems to have created a certain solidarity between companies and the local community (Starlander, 2003). Without being a factor of success, this aspect could have played a role in the interactions between the stakeholders.

Another interesting factor is that all participants took part in a group discussion on environmental challenges at the beginning of the project. This exercise made it possible to establish a common basis of understanding and a collective commitment to a common objective. In addition, this seminar led them to reflect on environmental management collectively rather than individually. Regarding the sustainability of the project, a series of interviews conducted sixteen months after the start of the program highlights that the appreciation of the innovation generated by the project has been one of the elements that contributed to the desire of companies to continue to take part in this network (Mirata and Emtairah, 2005; Mirata, 2005).

Inter-Industrial Materials Flow Management Rhine-Neckar Experience (AGUM), Germany

This project began as part of research conducted by researchers at the Institute for Eco-Industrial Analyses (IUWA), located in Heidelberg, Germany. Inspired by the case of Kalundborg in Denmark, they created a pilot project to create an industrial symbiosis on the Heidelberg-Pfaffengrund site, a pre-existing industrial zone representative of industrial zones in general, in order to make the results of their project more transferable to other sites. Thus, it was a site of about 93 ha which had developed over decades and was mainly composed of SMEs from the metallurgy, chemistry, electronics and pulp and paper sectors. There was no particular environmental context on this territory nor pre-established relationships between the industrialists. The preliminary study took place from 1996 to 1998. It emerged that the limited number of companies in this industrial zone (14 participating companies out of the thirty present) hindered the search for synergies and the study area was extended to the Rhine-Neckar industrial region in 1999. Indeed, only four types of synergies were implemented, or at least tested, since only two of them have persisted, namely the pooling of wood pallet transport and the implementation of a platform for collecting and analyzing data on waste management. This platform has also allowed about 70% of the project members, who had to pay 10,000 DM ($7,230) for their participation, to have a return on investment of less than a year (Sterr and Ott, 2004).

At this stage, a round table called Arbeitsgemeinschaft Umweltmanagement (AGUM) was created to formalize these information exchanges. Financed by public funds, the AGUM network has developed to accommodate more industrial companies, but also service providers and companies specializing in recycling. Its objective was to promote the development and implementation of environmental solutions by providing a fertile ground for environmental innovation at the technical and organizational level, in addition to promoting the implementation of synergies. To achieve these objectives, partners from the IUWA and the University of Mannheim developed an Access database for waste management that meets the individual needs of companies for their need for information and analysis on these materials as well as their need for sharing information between them and coordination. This database was coupled with a software (Umberto) including a geographic information system (GIS) to optimize material flows based on costs, quantities and transport distances. In order to continue the expansion of its network, AGUM was restructured to become non-profit in 2003 to become UKOM, the German acronym for "Environmental Competence Center of the Rhine-Neckar region".

A key element of this project is its starting objective to verify if an industrial region, where no particular factor is present, can develop an industrial symbiosis thanks to an external catalyst to the industrial system rather than a spontaneous movement, as in the case of Kalundborg. It emerges that the regional level was the most appropriate for this type of project since it allowed a higher potential for the closing of flows and the redundancy of these loops, favoring a more stable system. However, a disadvantage of the regional level is that inter-company communication and transparency on residual materials are more difficult. This project also highlighted the need for at least two types of tools to be:

- A communication platform for experts and managers to create and stimulate mutual trust among the stakeholders and to discuss and prepare coordinated actions;
- The provision of reliable and low-cost data for companies to stimulate coordinated actions.

These tools are necessary because companies do not necessarily concentrate entirely on their objectives and do not necessarily realize that their residues can be similar to those of a neighboring company and that they share problems and responsibilities related to the management of almost identical residual materials. Furthermore, a stable eco-industrial region "rarely emerges as the result of ambitious planning on the part of regional authorities, but rather develops thanks to a solid foundation based on complete and transparent

information" (Sterr and Ott, 2004, p. 963). Finally, this IUWA project has highlighted that a regional approach makes it possible to improve the management of residual materials while maintaining a human dimension where employees have the capacity to contribute to the development of their region in a sustainable manner.

NISP – UK

The National Industrial Symbiosis Programme (NISP) is a private sector initiative (Business Council for Sustainable Development UK) overseen by the firm International Synergies.

Initially, it consisted of regional programs that were grouped together in 2005 under the national program to promote inter-company relationships in industrial ecology, here called industrial symbiosis.

In addition to promoting industrial symbiosis, its objectives are to standardize the development of regional programs and facilitate communication and interaction between regions.

In February 2010, the NISP, an autonomous and structured association, had 13,000 member companies spread across 12 regions of the United Kingdom, namely England, Scotland, Wales and Northern Ireland. For the entire project (except for Northern Ireland), funding comes from the non-profit government organization Waste & Resources Action Programme (WRAP). In Northern Ireland, it is Invest Northern Ireland, a regional business development agency (Regional Business Development Agency) that provides funding.

In this program, the role of practitioners (or coordinators) is essential. They intervene throughout the project (NISP, 2011b):

1. Building the network: recruiting new companies of various sizes, locations and sectors by participating in events and conferences, networking with business associations and targeted marketing.
2. Winning work sessions: stimulating the participation of companies from all sectors and facilitating the exchange of information regarding their needs and acquisitions.
3. Mapping resources: recording acquired resources and the resources needed by participants discussed during work sessions to facilitate potential synergies between members.
4. SYNERGIe Management System: use of this IT tool to save data on resources and contact information.
5. Facilitator of synergies: identify potential synergies, establish contact between the companies concerned and facilitate negotiations. Provide a report (Synergy Summary Report) to each party detailing the expected economic and environmental benefits of the synergy.
6. Implemented synergies and results: prepare a report on the results generated by the synergy (Outputs Report) which is then signed by the parties.

The methodology used to identify synergies initially consisted of collecting preliminary data only from companies open to participating in an industrial symbiosis project. The analysis of this data was carried out using a database tool initially created by IIIEE for the project to identify potential symbioses. This methodology was then refined to systematically collect data on the input and output flows of member companies. The analysis tool has also evolved to become a central NISP database called CRISP (Core Resource for Industrial Symbiosis Practitioners), then its improved version SYNERGie Management System. With CRISP, online access was open to all members via a secure code (Jensen et al., 2011). However, the poor quality of the data thus collected and the enormous need for training among members led the NISP to limit access to SYNERGie to local coordinators so that they could act as a filter to ensure data compliance (Laybourn, October 26, 2011). In addition, the recorded data is georeferenced using a geographic information system (GIS), making it possible to immediately know the distances involved when studying a potential synergy. Today, although each NISP member is not actively engaged in a synergy, all have contributed to the project by providing information on their resource and energy flows which have been added to SYNERGie. When a potential synergy is identified, industrialists are put in contact to work on synergy possibilities independently. A private office quantifies the environmental, social and economic benefits, thus integrating the principles of sustainable development. Thus, from April 2005 to December 2010, the NISP enabled (NISP, 2011a):

- Diverting 7.6 million tonnes of industrial waste destined for landfill
- Generating £177 million ($283 million) in additional sales for its members
- Reducing CO2 emissions by more than 6.8 million tonnes
- Saving its members more than £170 million ($272 million)
- Eliminating more than 399,000 million tonnes of hazardous materials
- Creating and maintaining 2512 jobs
- Saving more than 10.4 million tonnes of virgin materials used in the UK
- Saving more than 12.4 million tonnes of industrial water

It is important to study the context of the creation of the NISP. Initially, several similar regional initiatives were already working to facilitate industrial networking through industrial ecology symbiosis. The creation of the NISP brought together these regional offices, while leaving a lot of room for local initiative in their governance scheme. This allows projects to evolve according to the geographical and socio-economic contexts of each of the twelve regions while preserving coherence with the national economy and politics, such as tax incentives. Moreover, the political system of the United Kingdom is parliamentary, like in Canada, with an economic policy favoring sustainable development supported by economic incentives and taxes such as the Landfill Tax and the Climate Change Levy. In addition, incentive policies aimed at increasing the use of renewable energies, the reuse of waste and the use of alternative fuels are in place. Finally, Regional Development Agencies allocate subsidies to promote sustainable development. The positive feedback from the first pilot projects, in addition to these financial incentives, have created a favorable context for industrial ecology in the United Kingdom.

An interesting element in the case of the NISP is the "non-factor" of distance. Indeed, the number of companies is very high and they are spread across the country, although more than 90% of synergies take place within a radius of 75 miles (about 120 km) (Jensen et al., 2011). This shows that an industrial ecology project can be successful even at the national level. The great openness of the NISP to the creation of links, interactions and innovations between industrialists has made it possible to create the platform for sharing and exchange necessary for the realization of symbioses. Obviously, the goodwill of companies and above all profitability remain at the heart of their implementation.

Peter Laybourn, créateur du NISP, directeur du programme et P-D.G. d'International Synergies

The NISP approach is distinguished by its focus on the business world. According to Peter Laybourn, it is necessary to speak the language of business to establish a real dialogue with companies, gain their trust, and ensure the project's credibility. This is achieved through the presentation of case studies illustrating real advantages. However, it is important to note that the context of landfill in the United Kingdom differs from that of Quebec. Indeed, the landfill tax, which is added to the site's fee, is £48 per tonne (nearly $100 per tonne) and is expected to increase to £70 per tonne in the coming years, while the fees payable for the disposal of residual waste in Quebec are currently $20.38 per tonne (Regulation respecting fees payable for the disposal of residual waste, 2011). Companies therefore had every interest in paying close attention to this project, which had the potential to reduce their quantities of residual waste. However, Peter Laybourn argues that once companies became familiar with NISP, this type of incentive was no longer a primary concern, as they saw the other benefits of the approach and the overall picture.

NISP is 100% publicly funded. To demonstrate the program's added value for the government, NISP has shown the return on investment of these funds in the Pathway to Low Carbon Sustainable Economy report. This government funding allows NISP to offer its services to companies free of charge, 95% of which are

SMEs. However, in exchange for this free service, companies sign a contract committing them to evaluate the impacts of the synergies implemented based on nine predefined indicators, namely:

- **Economy:** Reduction in operating costs for the company, Additional sales for the company, Tonnes diverted from landfill, Reduction in GHG emissions
- **Environment:** Savings on virgin materials, Quantity of hazardous waste eliminated, Water savings
- **Social:** Jobs created, Jobs preserved

The program's credibility, climate of trust, and management of confidentiality are essential assets. At the end of each project, a report is produced detailing the results (based on the information required to be provided by the company). To ensure the credibility of this data, an independent external firm (Databuild Ltd) verifies the information according to a rigorous audit process.

To encourage company participation in the program, the message focuses on the economic benefits. As shown in Table 4.7, over the years NISP has demonstrated its ability to reduce operating costs and emissions (of pollutants, including GHGs), increase sales and asset utilization, create jobs, and attract foreign investment through industrial ecology symbioses.