

A regional Industrial Symbiosis methodology and its implementation in Geneva, Switzerland

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ABSTRACT

The Agenda 21 for the Geneva region is the results from a broad consultation process including all local actors. The article 12 stipulates that « the State facilitates possible synergies between economic activities in order to minimize their environmental impacts » thus opening the way for Industrial Ecology (IE) and Industrial Symbiosis (IS). An Advisory Board for Industrial Ecology and Industrial Symbiosis implementation was established in 2002 involving relevant government agencies.

Regulatory and technical conditions for IS are studied in the Swiss context. Results reveal that the Swiss law on waste does not hinder by-product exchanges. Methodology and technical factors including geographic, qualitative, quantitative and economical aspects are detailed. The competition with waste operators in a highly developed recycling system is also tackled.

The IS project develops an empirical and systematic method for detecting and implementing by-products synergies between industrial actors disseminated throughout the Geneva region. Database management tool for the treatment of input-output analysis data and GIS tools for detecting potentials industrial partners are constantly improved. Potential symbioses for 17 flows (including energy, water and material flows) are currently studied for implementation.

Introduction

Industrial ecology (IE) explores the idea that the industrial system can be seen as a certain kind of ecosystem. As natural ecosystems, the industrial system can be described as a particular distribution of materials, energy and information flows [1]. The analogy with the food chain concept in natural ecosystems is clear, leading to the idea of closing the loops within the traditionally linear industrial system. Lifset explains that closing the loops is diverting products and materials that would otherwise be designated for disposal into productive uses [2]. Deepening the concept products reuse appears to be the most environmentally efficient solution and leads to building industrial ecosystems. The reuse or sharing of by-products, energy and water resources among firms in a defined area is known as Industrial Symbiosis (IS) in the IE literature. IS engages traditionally separate industries in a collective approach to competitive advantage involving physical exchanges of materials, energy, water and/or by-product. The key elements are collaboration and the synergistic opportunities offered by geographical proximity [3].

Many regions in the world are applying the concept as regional scale IS is currently recognized as a tool towards developing more sustainable regions [4, 5]. However, many current symbiosis projects in the world tend to reproduce the well documented Kalundborg model [6] and focus on heavy industrial sectors like power production, petrochemical, chemical, cement, steel and metal processing or sugar industry [7, 8, 9]. As many regions do not host such type of activities, a new methodology for detecting appropriate potential synergies between industrial sectors in a defined territory is needed. Currently, very few methodologies exist to detect such diverse synergies at the industrial park or regional scales.

Geneva is a typical Swiss region without heavy industry but with high environmental awareness. Therefore, the regional program for Industrial Symbiosis in the Geneva region aims to develop such methods, in collaboration with the University of Lausanne, Switzerland, and the consulting company Systèmes Durables in Toulouse, France.

Regional policy context for IS in Geneva, Switzerland

The Agenda 21 for the Republic and Canton of Geneva (hereafter the «Geneva region») is the result of a broad consultation process, including all local actors. In 1999, more than 43 entities including private consultants and companies, Non-Governmental Organizations (NGOs), political parties and local communities were invited to present their own vision for a more sustainable region. Due to local awareness, the notion of Industrial Ecology (IE) was introduced in the law establishing the Agenda 21 for the Geneva Region: the article 12 of the law stipulates that « the State facilitates possible synergies between economic activities in order to minimize their environmental impacts », thus opening the way for Industrial Symbiosis. An Advisory Board for Industrial Ecology and Industrial Symbiosis implementation was established in 2002, involving six government agencies in a collaborative approach: the Geneva Region Government agencies for sustainable development, economic development, public buildings, energy and waste treatment, as well as the "Foundation for industrial land" – which manages most of the industrial areas in the region – constitute the backbone of the advisory board for IE and IS.

In order to set priorities for IE implementation, a regional assessment of resources was realized between 2002 and 2004 [10]. Because of time and budgetary constraints, it was decided to focus on 7 key indicative resources within the framework of this first assessment: water, energy, metals (iron, copper, aluminum), wood, plastics, food and building material. The results highlighted the potential for regional Industrial Symbiosis.

Prior to the project itself, objectives and regulatory factors for IS were studied in the Swiss context. Figure 1 describes the different types of opportunities studied. In addition to by-products exchanges (IS), utility sharing opportunities for supply and treatment are also considered. These elements are grouped together as under the name of resources synergies.

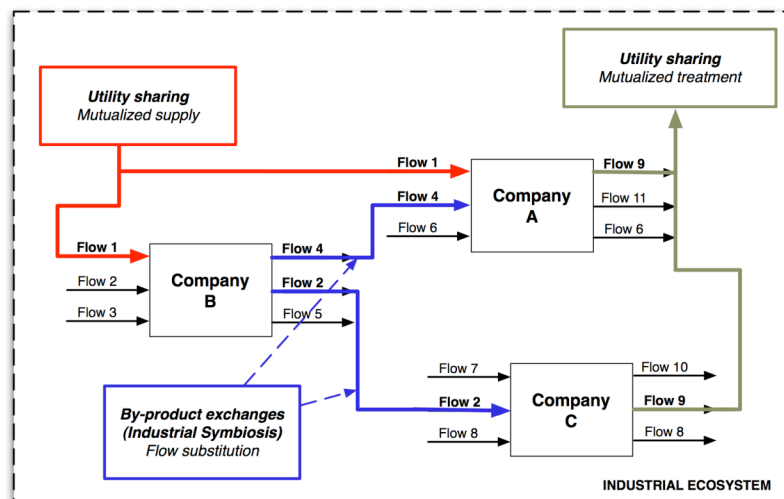


Figure 1: The resources synergies include by-product exchanges and utility sharing

By-product exchanges may be prohibited by national or local legislation intended to protect our environment. Studying the legislation revealed that the Swiss laws on waste does not hinder by-product exchanges [11], in contrast with the EU policy.

By setting up very restrictive environmental laws, Swiss policy tends to charge the companies for the real costs of supply, effluent and waste treatment. Therefore, the companies themselves are often searching for alternative outlets for their by-products in order to reduce their costs. The regional program for Industrial Symbiosis aims at assisting them by providing solutions, thus reducing resources consumption while increasing competitiveness.

Collaboration between the public administration and private partners exists for years. This results in to a high environmental awareness of the companies, facilitating new collaborative approach like IE and IS.

Regional industrial context

The Geneva region can be considered as a moderately industrialized area as the production sector means only 15% of global resources consumption compared to 35% for the service sector and 45% for households [10]. Geneva does not host any heavy industries but high added value manufacturing like watch, chemical and pharmaceutical industries. Activities like machines and equipment manufacturing, building materials and equipments, wood manufacturing, printing and agro-food industry depict the common industrial areas in the region (Figure 2).

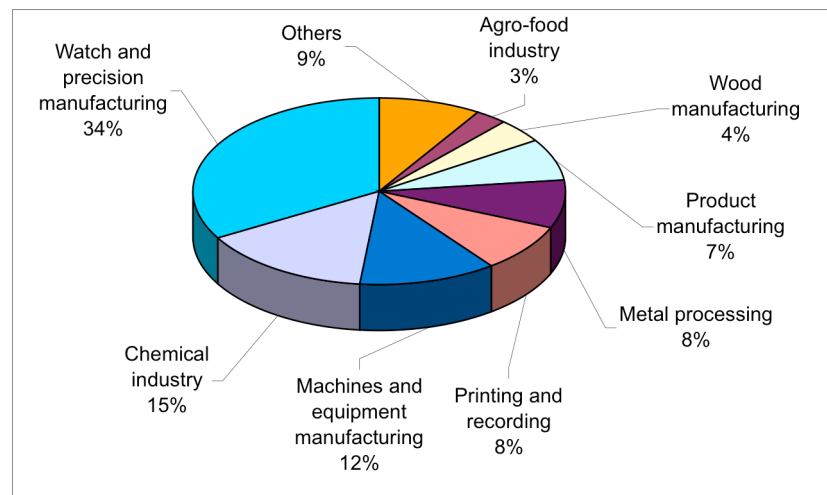


Figure 2: Main industrial sectors in the Geneva region

Methodology for detecting and implementing Industrial Symbiosis

C. Adoue first developed an empirical and systematic methodology for detecting and implementing by-products synergies between industrial actors disseminated throughout a territory in the first French PhD thesis on Industrial Symbiosis [12]. The Geneva regional program for Industrial Symbiosis, in collaboration with the University of Lausanne applies, develops and improves the methodology initiated by C. Adoue. A simplified methodology schema for synergies detection and implementation is presented in Figure 3 and detailed below.

Choice of first potential industrial partners is done in collaboration with the Department of Solidarity and Employment of the Geneva administration, in charge of managing the registry of companies established in the Geneva Region. Socio-economical data including name, activity, code of activity, industrial sector, address, contact, geographical positioning and number of employees are thus available for more than 3'000 companies. From the list, 40 companies are selected among the relevant industrial sectors from the region (Figure 2). The companies estimated to use the highest quantities of materials, energy and water were selected according to their activity and number of employees.

Among the 40 contacted companies, 19 accepted to join the project and to perform physical input/output analysis. The method chosen for the data collection calls for both empirical and systematic approaches. The empirical approach includes face-to-face meeting with companies and informational presentation of IS goals. During these meetings, data on physical input/output are also systematically collected through a questionnaire. The regional program guarantees the confidentiality of all data collected. This confidentiality and the central role of the state in the IS program are key to its success.

Data treatment is performed using a database management tool, called Presteo[®], developed by the consulting company Systèmes Durables in Toulouse (France). This mysql based tool allows systematic treatment of input-

output analysis data collected from the companies by comparing characters chains. The tool detects by-product exchanges (IS) as well as supply and treatment utility sharing potentials as described in figure 1.

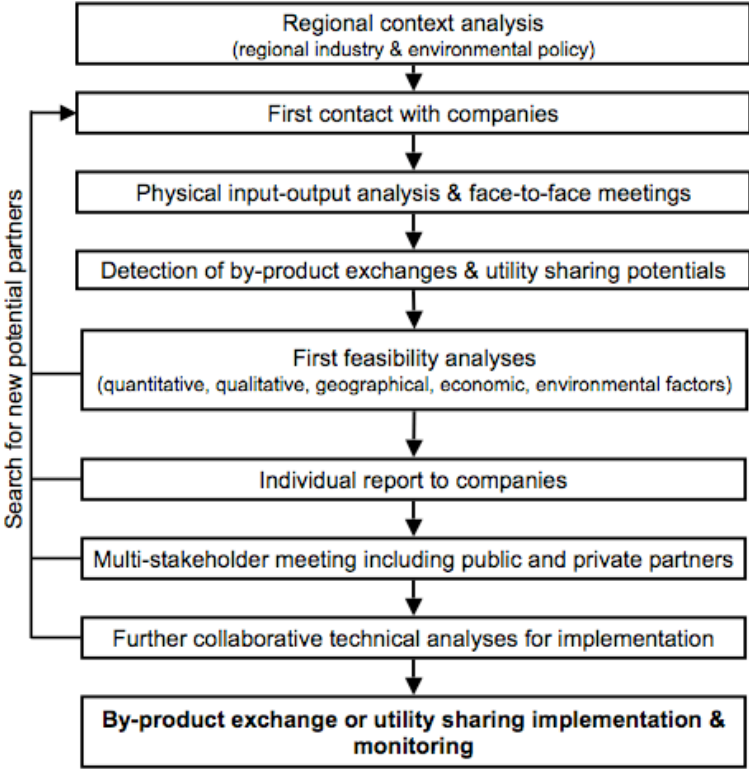


Figure 3: Methodology flow chart for detecting and implementing regional synergies

Results from both the empirical and systematic approaches include numerous potential synergies. The next step entails experts study of quantitative, qualitative, geographical, economical and environmental feasibility factors to evaluate the potential for implementation of identified synergies. Afterwards, the competition with waste operators in the highly developed Swiss recycling system is added to the evaluation, since competition with environmentally effective existing solutions is not desirable. The waste operators are approached in a participative way. Their importance as key third party operators and experienced collaborators on sustainability requirements is recognized in the project. The estimation of environmental benefits is performed estimating resources, treatment and transportation savings. The Life Cycle Analysis methodology offers the most precise diagnostic [11]. Regarding the economic point of view, only synergies allowing economic gains for companies are taken in consideration to focus on win-win opportunities.

However, resources synergies are not always the most environmentally desirable solution. The IS solution appears to be the best only if applying internal cleaner production and process optimization principles do not result in internal flow reduction or reuse. Therefore, IS must be considered as the last resort for flow management after internal process optimization.

Finally, a short list of potential resources synergies is edited. The remaining potential synergies, those overcoming all technical, economic and environmental constraints are then presented to the companies in individual reports.

In case of expressed interest by all partners, a multi-stakeholders meeting is organized and a funding proposal for further collaborative analysis and for designing the networks is presented to the Geneva administration. Collaborative funding between the State services and private partners for deeper studies is an incentive element for convincing companies. However, the state services are not a potential third party agent for running the networks. The private partners themselves should perform takeover for implementation. Waste operators and/or the companies themselves must take up technical and financial support for network management. The methodology can therefore be considered as a side approach between the top-down (first steps) and the bottom-

up (implementation) approaches.

Many of the project steps can lead to dead ends and only few opportunities may come to life. Thus, the detection of new potential industrial partners based on the first results is essential. Choice is performed by using a GIS tool linked to the regional industry database [13]. One of the interfaces created allows the search of new companies using sector of activity and geographical criteria. The application of this GIS tool for the detection of potential synergies is currently undergoing constant improvements at the University of Lausanne.

Potential synergies detected in the Geneva region

Currently, 19 companies from 10 industrial sectors are involved in the IS program and about 10 are about to join. Results from the first studies reveal by-product exchanges and utility sharing potentials for 17 types of flows [14]. They are currently examined for implementation and steering committee are set up. Material flows detected include building materials, food waste, raw and treated wood waste, inks and pigments, plastics, rubber, cardboard, sodium hydroxide and fly ash. Energy flows include raw and treated wood waste (if material reuse is not possible), heat, steam and different types of oils. Liquid flows are cooling water, deionized water, cutting fluids, solvents and acids.

Opportunities for the Geneva region

Studying the highly developed recycling system in Geneva reveals that some flows are already reused in the region. The current reuse and recycling processes and outlets respect the constraints of Swiss environmental laws on industrial wastes. Thus, as explained in the methodology, some of the potential synergies detected are not examined further. These results allow the comparison between industrial symbiosis networks and highly developed recycling systems. Some existing recycling processes can be considered as resources synergies. However, the Swiss recycling system is far from perfect and many opportunities remain for environmental improvements.

The results highlight interesting opportunities for one of the most compact industrial areas of Geneva that may lead to the creation of an Eco-Industrial Park (EIP). Cooling water and heat reuse is the spine of the project. Cooling water from agro-food and electronic industries may lead to a complex industrial symbiosis network involving the neighboring agricultural area. The water reuse and its heat extraction through co-generation or low temperature heating networks are two solutions currently undergoing study. Potential for compressed air networks and carbon dioxide reuse are also studied.

In the whole region, several flows under consideration allow either reuse through process improvement, the creation of exchange networks or the creation of new activities: cutting fluids network for shared recovery and reuse, exchanges of acids and bases, direct exchange or shared reprocessing of solvents, the shared processing and sorting of building material for reuse or agro-food waste reuse for methanization are the flows offering highest potentials.

The regional assessment of resources reveals that gravel extraction for building material is not sustainable in the Geneva Region, as current reserves only will last another 20 years [10, 15]. A network for building material exchange is already being implemented. Several shared processing crushing-calibration platforms are already in service or planned for recycling gravel and producing recycled building material. However, the IS program reveals several direct reuse opportunities throughout the region, like calcined clay and rubble.

Finally, the creation of new economic activities in the context of industrial symbiosis tends to increase the social and economic dynamism of the entire region by offering new business opportunities and services to industries and creating new industries. Shared material restoration or treatment facilities for cleaning material, solvents and cutting fluids present the highest potentials.

Conclusion

Several detected synergies have overcome the technical constraints and the initial scepticism of industrial partners. These synergies are currently being implemented. The project benefits from a high participation rate

and interest since its launch in 2006 due to high environmental awareness among Swiss companies and more companies are about to join. In a mid-term perspective, the main objectives are while increasing the number of companies participating in the program, implementing the most obvious synergies to prove the project's relevance. Implemented synergies will be used as flagship examples to communicate and involve more and more industrial partners in the future.

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References

- [1] Erkman S., Industrial ecology: an historical view, *Journal of Cleaner Production* 5 (1-2), 1 - 10
- [2] Lifest R., Closing the Loop and Honing Our Tools, *Journal of Industrial Ecology* 5 (4), 1 – 2
- [3] Chertow M., Industrial Symbiosis: Literature and Taxonomy, *Annual Review of Energy and the Environment* 25, 313 - 337
- [4] Mirata M., Emtairah T., Industrial symbiosis networks and the contribution to environmental innovation: the case of the Landskrona industrial symbiosis program, *Journal of Cleaner Production* 13 (10-11), 993 - 1002
- [5] Kurup B., Altham W., van Berkel R., Triple bottom line accounting applied for industrial symbiosis, 4th ALCAS Conference, Sydney, 2005
- [6] Jacobsen N., Industrial Symbiosis in Kalundborg, Denmark; A quantitative assessment of economic and environmental aspects, *Journal of Industrial Ecology* 10 (1–2), 239 - 255
- [7] Chertow M, Lombardi D. R., Quantifying Economic and Environmental Benefit of Co-located Firms, *Environmental Science and Technology* 39 (17), 6535 - 6541
- [8] Van Beers D., Corder G., Bossilkov A., Van Berkel R., Industrial Symbiosis in the Australian Minerals Industry, *Journal of Industrial Ecology* 11 (1), 55 - 72
- [9] Zhu Q., Côté R. P., Integrating green supply chain management into an embryonic eco-industrial development: a case study of the Guitang Group, *Journal of Cleaner Production* 12 (8-10), 1025 - 1035
- [10] GEDEC (Waste Management Service, State of Geneva), *Ecologie Industrielle à Genève; Premiers résultats et perspectives*, Report, 2005
- [11] De Jesus Carvalho A., Harbi S., Fonjallaz D., Verrey C., *Recherche de synergies éco-industrielles sur le territoire du canton de Genève; Aspects légaux et environnementaux*, Swiss Institute of Technology/University of Lausanne, Semester Project, 2006
- [12] Adoue C., *Méthodologie d'identification de synergies éco-industrielles réalisables entre entreprises sur le territoire français*, PhD Thesis, Université de Troyes, France, 2004
- [13] Plancherel A., *Valorisation des SIG pour la detection de synergies éco-industrielles*, Master of Science Thesis, Swiss Institute of Technology / University of Lausanne, 2006
- [14] Adoue C., *Recherche de synergies éco-industrielles sur le territoire du canton de Genève*, Technical Report, GEDEC, Geneva, report 2006
- [15] Rochat D., Erkman S., Chambaz D., 2006, *Le recyclage des matériaux de construction à Genève*, Technical Report, GEDEC, République et canton de Genève, report 2006