

Östergötland: Towards a sustainable region on the basis of industrial symbiosis and renewable energy

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0. Abstract

The role of industrial symbiosis is analyzed in the application process of renewable energy in the Östergötland region in Sweden.

The care for nature has a long history in Sweden. The related forestry industry's tradition of integrated diversification for efficient resource use fits in that mode. Uncovering and mimicking existing symbioses seems to fit better in the Swedish business concept than intended developments to eco-industrial parks.

It is concluded that the strong link between the industry, government and academia with respect to innovative approaches for applying renewable energy and industrial symbiosis plays a strong role at the macro level in the Östergötland community.

Key words: Industrial symbiosis; renewable energy; Swedish business cases; integrated production

1. Introduction

The re-emergence of the Industrial Ecology (IE) concept [1] covers more than two decades currently. The most illustrative IE example world-wide is the Kalundborg industrial site, an organically developed and still developing application that, once recognized and acknowledged by some local plant managers, was actively promoted by those local plant managers under the label of Industrial Symbiosis (IS). Kalundborg became the illustration for many IS-initiatives world-wide. However, the – in practice – long incubation time [2] was often unknown or neglected in IS activities world-wide and led to questions whether the complexity of the IS development concept can be effectively dealt with in practical applications. [3] Time is a very important variable in that process. [4] It is a slow development in Northern industrial countries (where the decision-making processes include many different actors [5]), showing different

characteristics. However, new examples and initiatives are there: the described developments in the Östergötland region in Sweden in this article is an illustration for that.

2. State-of-the-art of Industrial Symbiosis in Östergötland

Industrial Ecology (IE) in industrial estates has a geographic, resource, and/or industry sector focus. [5] In such geographic and/or industry sector settings IE is often labelled as Industrial Symbiosis (IS), for instance by linking utilities and waste/by-product exchange, the organization of a resource chain such as in the case of biomass, or of linkages around a key-organization.

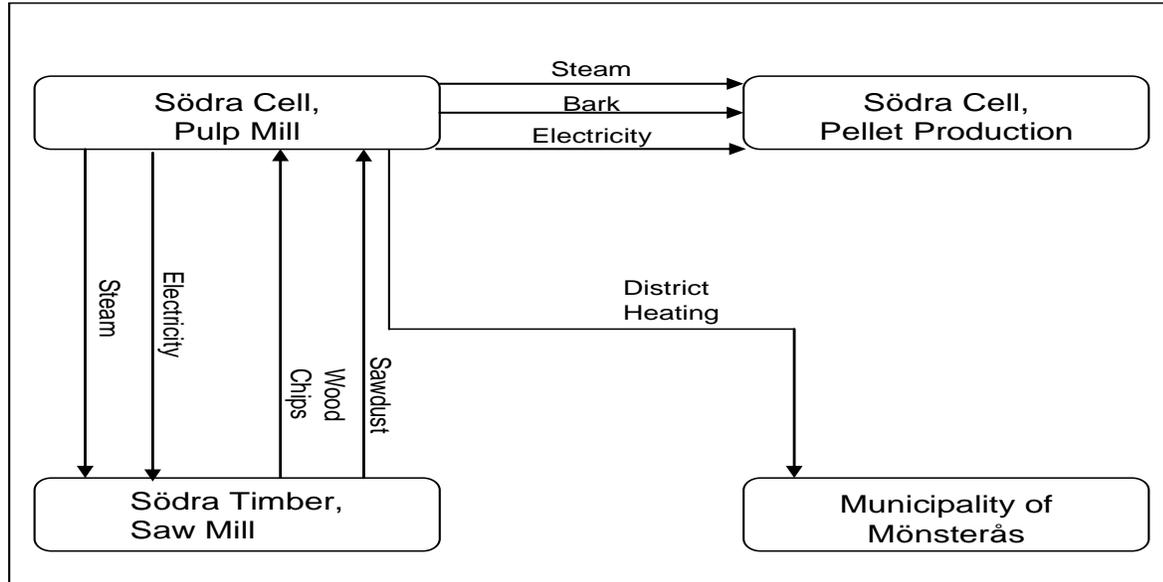
During the recent decade, several such initiatives can be detected in Sweden. Sweden has a tradition in caring for the environment, such as the more than a century old slogan “The nature is everyone’s” illustrates. Nevertheless, production-oriented forest policies were dominant since early 20th century; a fundamental changed when timber production and maintenance of biodiversity became of objectives of equal dignity in Sweden’s forestry policy in 1993 [6].

Cascade flow management has been practiced in some cases in the Swedish forest industry for a long time. However, in the 1960s and 1970s many companies became too much diversified despite creating more value [7]. In the 1990s, the argument for changing the strategy of many larger corporations to focus on more limited number of forest products seems to be influenced by globalization trends and the need for decreasing bureaucracy and higher coordination costs [7]. Despite this, the integrated diversification for efficient resource use is still involved in several companies.

The forest industry is one of the most important industries in Sweden. The sector employs 11 – 12% of the industrial labour force and generates approximately 12% of the GDP. The forest industry forms strong clusters of different companies that fit each other. An inventory [8] found 15 By-Product Exchange (BPX) networks; none of them were deliberately planned or labelled as Industrial Symbiosis. Integration of pulp and paper is more energy efficient – 65% of the pulp is used in such system of integrated production. As long as the forestry is sustainable, the forest industry production is based on renewable raw materials. Besides that 14% of the pulp production comes from recycled fibre, and is the industry an important user of woody biomass. The forest industry is involved in bio-fuel production (by-production); the expanding bio-fuel market leads to both business opportunities and competition.

The inventory of Wolf and Petersson [9] of the existing exchanges of material and energy in the Swedish forest industry illustrates that IS in the form of by-product exchange networks exist in the forest industry sector as more than a third of the investigated companies have some kind of material or energy exchange with adjacent entities. According to Chertow, [10] uncovering existing symbioses has led to more sustainable industrial development than attempts to design and build eco-industrial parks incorporating physical exchanges. The Swedish forest industry shows ultimate illustrations of integrated IS in business practices as in the Mönsterås network in Figure 1 [8]:

Figure 1 Mönsterås network

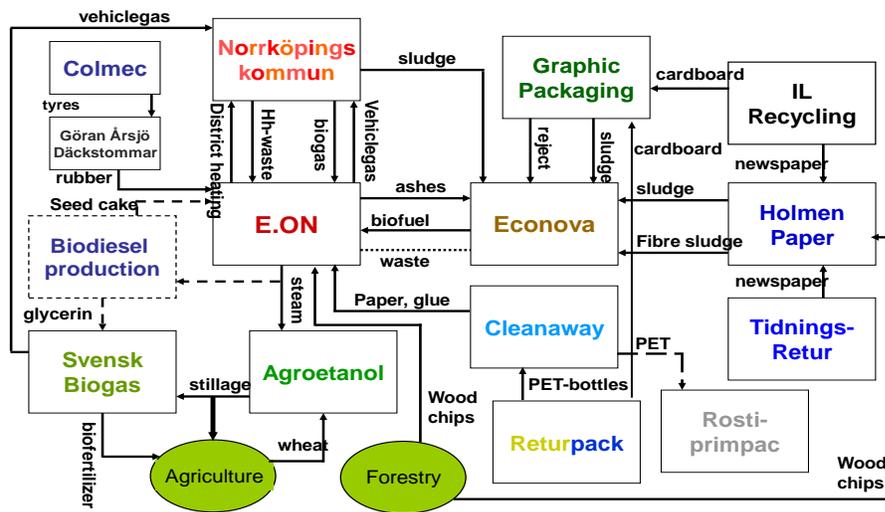


In several Swedish regions an intermediary organization for co-operation between different societal actors are designed such as the intermediary organization Processum in Örnköldsvik and CleanTech/Östergötland in the Östergötland region. Processum organizes cluster collaboration between companies within the processing industry, Örnköldsvik municipality and universities and colleges. [11] This form of co-operation within Processum with clear goals and allocated resources offers huge opportunities for making use of the strong development potential in the industry. The level of knowledge of process chemistry, process engineering and process control in the companies in Örnköldsvik is advanced. Processum functions as a driving force for the promotion of new development opportunities, mainly alongside the core activities of the member companies. Although, IS is not mentioned, the nature of activities are similar.

A similar development can be seen in the Östergötland region by the start of the CleanTech/Östergötland - an organisation with as members the municipalities of Linköping and Norrköping and 80 industrial organizations - in 2008. The IS concept is "marketed" as an umbrella for environmentally driven regional development in Östergötland and is defined as *business practice: .."Characteristic for industrial ecology is to turn environmental problems into business opportunities by applying wide system boundaries, using resources efficiently and co-operate through resource sharing"..* [12]

Several IS activities were already developed such as the 1.7 kilometer pipeline for the utilization of nutrient rich waste water from the slaughterhouse in the biogas production facility. CleanTech/Östergötland will stimulate such activities as business cases. Along that line, district heating companies such as Tekniska Verken in Linköping and E-On in Norrköping are stimulating IS as driver of regional sustainability innovation. The bio-gas production as affiliated or linked facilities of the district heating companies are providing bio-gas for all public bus transport and taxis in both cities. In addition to the 5% average bio-fuel use in Sweden, the 5%

Figure 3 Norrköping industrial ecosystem



3. Intentional (IS labelled) projects

In paragraph 2 is reflected to the business case type IS that seems to fit several IS cases in Sweden. Despite developed conceptual models of an eco-industrial park based upon ecologically mimicked relationships, [14] it is not easy to generate the needed links between actors and organizations in intentional projects. This is illustrated by the Landskrona IS project “created” by the Lund University as part of Ph.D. research. [3] The *creation* approach of the IS Landskrona project for networks was based on the following definition: ..“a collection of long-term, symbiotic relationships between and among regional activities involving physical exchanges or materials and energy carriers as well as the exchange of knowledge, human or technical resources, concurrently providing environmental and competitive benefits”.. [15]

The involvement of some anchor organizations and key persons in the field provides important drivers for the dissemination of IS activities in a region. It is very important to detect them as “owners” of the project when the project is initiated from the outside. Unfortunately in the Landskrona project, the IS initiative phased out when the research project budget including external IS management was finished in 2006. Although, the Landskrona industrial park was leading in the introduction and dissemination of cleaner production in Europe in the period 1987-1989, [4] the industrial ecology concept did not found such basis.

Besides academic uncovering industrial symbiosis activities such as renewable energy and efficient material use [16] also intended approaches are developed in Östergötland.

A 4-year Sustainable Norrköping programme will research the IS development of the energy cluster and a logistics centre in the Händelö Eco-Industrial-Park in combination with nearby new living area construction and Natura 2000 conservation areas. A visualization centre for popular science communication of industrial symbiosis through visualization of material flows and connections in the Händelö Eco-Industrial-Park is also part of the project. It is argued that the

citizen's willingness, commitment and support for these changes are very important dimensions for further developments; their empowerment, continuing engagement and support are essential to ensure that this region continues on its transition journey.

Furthermore, the Linköping district heating company Tekniska Verken and Linköping University agreed upon funding a 10-year Industrial Ecology Research Programme by Tekniska Verken connected to a new chair in Industrial Ecology. [17] The Long term Industrial Ecology Research Programme 2009 – 2019 will contribute to focused research, education, and knowledge dissemination with respect to clean technology, industrial symbiosis, waste to energy, and bio fuel applications on a sound economic basis through the results of Ph.D. research and continuous evaluation of sustainability projects in practice. In the Industrial Ecology Research Programme, *“Industrial symbiosis is seen as a process whereby materials, water, energy and informational flows between and among companies are investigated with the objective of developing and improving co-operative links between/among them”*. [17] Research projects such as the utilization of rest heat, CO₂ and nutrients from the district heating company in greenhouses, bio-fuel synergies and urban mining are starting in 2010.

4 Analysing IS observations and conclusions

Firstly, strong IS links are found in the historical attitude for caring for nature and its spin-off to the Swedish forestry integrated industrial activities.

Secondly, the issue of trust is a very important variable in the Swedish society. The trust level is very high, and lead to many links between government, industry and knowledge centres to develop common solutions. In this context the local authority is on the one hand a very strong actor because they are involved in many decision-making processes effecting economic activities. Their important position in the Swedish tax system provides strong economic power incentives for having a role as co-ordinator of local integration projects. On the other hand in analogy of Selman's "Canons of sustainability" analysis [18], such role is impeded by the weak integration of different divisions in the municipality's organisation.

It is suggested that companies with integration as their business concept can be key actors when developing more integrated networks. Along that line, the district heating systems in Östergötland since the 1950's and increased bio fuel applications in the early 21th century are today's basic elements in IS development. Also, later policies on landfill tax and landfill ban have strengthened the waste incineration system's transformation in a "Waste to Energy" philosophy. The philosophy is going from linear to circular approaches, where waste turns to being "resources" as part of the new way of business case thinking.

Thirdly, continuous academic research and energy supplying companies' initiatives are exploring how to increasingly effectively apply renewable energy. Also regional sustainability programmes such as the CleanTech/ Industrial Symbiosis programme are stimulating the industrial symbiosis concepts and renewable energy. Fortunately, past and ongoing initiatives have resulted in the expanded consciousness that clean technology and industrial symbiosis provides a synergy mode for innovative approaches beyond the adaptive capacity of single organizations.

Summarizing, it is concluded that the historical positive nature attitude, the high level of trust in the Swedish society, and the industrial power structure including a strong sustainability innovation focus, are positively influencing factors for IS development.

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