

Removing Barriers for Sustainable Industrial Estates

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1. Introduction

One of the main topics in the field of environment and industry for the coming years is the development of sustainable industrial estates. Within this concept companies aim not only to optimise environmental performance on a individual basis but also on a collective basis. This paper looks at developments in the Netherlands, where different government agencies have embraced the concept and started projects which seek collaboration between companies at industrial estates. However there is still much to learn about the scope of sustainable industrial estates. Is this concept really capable of reaching the kind of sustainable development which we are aiming for? The interest in the topic can mainly be attributed to increasing discussions on the concept of industrial ecology since the beginning of the nineties (Erkman, 1997). Although several definitions are in circulation (Boons & Baas, 1997; Oldenburg & Geiser, 1997) a frequently used definition is:

“an industrial ecosystem is the transformation of the traditional model of industrial activity, in which individual manufacturers take in raw materials to generate products to be sold, plus waste to be disposed of, into a more integrated system in which the consumption of energy and materials is optimized and the effluents of one process serve as the raw material for another process” (Frosch & Gallopoulos, 1989).

Several projects are currently in progress under the label of sustainable industrial estate, but not always do they fit into this concept of a more integrated system with effluents being used as raw material for other processes. In many cases, projects at industrial estates effectively will be able to reach a limited efficiency improvement, for example through collective handling of waste. Our focus will be on barriers for sustainable industrial estates with an emphasis on aspects of sustainability. We will try to answer the following questions in the paper:

1. *What can be gained with the development of sustainable industrial estates based on current experiences?*
2. *Which barriers exist for setting up sustainable estates, and which steps can be taken to remove these barriers?*

The first question is answered through an assessment of ongoing projects in the Netherlands. We identify both results of these projects (related to the definition of industrial ecology) and dominant factors explaining their (relative) success. Throughout our paper we elaborate on three relevant aspects for the development of sustainable industrial estates. The first assesses the technical requirements needed to develop sustainable industrial estates. The focus is on the optimisation of material and energy streams between companies. Companies need to adjust their use of resources and energy towards each other at the level of an industrial estate

and increase the share of renewable resources for materials and energy. The second aspect focuses on the methodology of identifying possibilities for optimisation of material and energy streams at the level of industrial estates. One of the options is to extend and apply methods regarding environmental management currently in use at the level of individual companies towards the level of industrial estates. The third aspect involves the management of industrial estates and the role of judicial factors and actors such as government agencies. Companies will have to co-operate and take collective decisions. One possible approach to facilitate the co-operation and collaboration of companies is to establish project agencies for industrial estates. There is still much to learn about the most effective and successful ways of setting up these agencies. In some projects government agencies have taken a leading role, while in others some leading companies have been decisive for the success of a project. Finally, we will elaborate on the way in which steps to initiate sustainable industrial estates can run parallel with the build up of a curriculum for education on this subject, based on experiences at CSTM with environmental management programs.

2. Experiences with sustainable industrial estates

In the Netherlands there are several ongoing experiences with sustainable industrial estates. Most of them have been well documented and analysed in terms of their successfulness and factors for success and failure (Rijk, 1996; Heidemij Advies, 1996; Baas, 1997; Kuiper, Glas & Dekker, 1997; de Vries, 1998; Brand & de Bruijn, 1998). We summarize some of these findings and focus on two aspects central to this paper in that process. The first one refers to the level of sustainability which has been, or is expected to be, reached at the specific industrial estate. Does collaboration lead to sustainability, in terms of a more or less closed system with renewable inputs and degradable outputs at the level of the industrial estate, or does it lead to an increase of efficiency of a per definition unsustainable practice? It becomes clear that for most projects outcomes have to be interpreted in terms of increased efficiency. In the INES project in the Rotterdam harbour area for example proposed and ongoing projects linking inputs and outputs of different companies in the area is expected to lead to efficiency increases varying from ten to twenty per cent (Baas, 1997). In this case this means an increase in efficiency of a petrochemical production network. It is difficult to argue that developments here lead to sustainable development, and from a macro perspective it is possible to argue that the increased efficiency of this petrochemical production network will lead to delay of the development of inherently cleaner technologies such as renewable energy. Further examples of 'industrial ecology' can be found at networks around the large multinational companies of Hoogovens (steel production) and AKZO (chemical production). In these projects supplier-client relationships have, driven by economic considerations, evolved towards integrated exchange of residual and energy streams between companies (Rijk, 1996). Other, more recent, projects concern existing industrial estates which mainly focus on collective waste handling or energy exchange. While most projects are in initial stages, a project regarding collective waste handling in Breda has led to increased recycling from thirty to forty per cent and to a decrease of removal costs by 20 to 30 per cent (Rijk, 1996; Kaalverink, 1997). Also recent projects tend to integrate different aspects at industrial estates and do not focus solely on environmental aspects. This is known in the Netherlands under the label 'revival or renewal' of industrial estates. Specific subsidies have been made available for industrial estates which through a 'revival' project tackle various aspects at estates, such as transport and logistics, utilities, waste/watermanagement etc. (Heidemij advies, 1996; de Vries, 1998)

When analysing factors which have led to collaboration of the companies at industrial estates the longest existing examples are those where a large company has created links with suppliers and customers located close by. A crucial factor explaining collaboration here is considered to be the largely dependent state of the smaller companies to the dominant company, together with the large residual, water and energy streams. Furthermore, in these cases economic advantages are significant because of the close proximity of the companies to one another. This is similar to the well known Kalundborg project where four companies exchange energy, water and materials (Graedel & Allenby, 1995). The relative simplicity also seems to be a contributing factor, in the Kalundborg case with the small number of companies involved, and in the AKZO and Hoogovens cases with the clearly dominant roles of these companies. In more recent experiences in the Netherlands the role of government actors together with active companies' associations at industrial estates has been decisive.

To sum up we conclude that virtually all of the experiences with industrial ecology, or sustainable industrial estates, have so far not resulted in a really sustainable industrial estate, as in our used definition of industrial ecology. In a number of cases, however, estates have developed towards higher levels of efficiency at the industrial estate. In the Netherlands several initiatives are ongoing under the heading of sustainable industrial estates, but in practice almost none of those initiatives can live up to the far-reaching notion of sustainability. However, those initiatives can be successful in decreasing environmental impact at the level of the industrial estate.

3. What are barriers for sustainable industrial estates?

We can distinguish both barriers for the *planning* of sustainable industrial estates and barriers for the *operation* of sustainable industrial estates. The importance of this distinction is also related to the scope of sustainability of industrial estates. For an existing industrial estate it will be much more difficult to attain sustainability if this will mean fundamentally changing relationships between firms and processes of those firms, as compared to the planning a new industrial estate, where it is possible to influence the type of companies and their processes to be located at the industrial estate. In this sense barriers for the operation of sustainable estates are more related to changes in the actual behaviour of companies at industrial estates, while barriers for the planning of sustainable estates are more related to attracting the right mix of companies (and their processes), willing to establish relationships which exceed those of individual firms.

Barriers for the planning of sustainable industrial estates

We will briefly describe some of the barriers associated with the planning of sustainable industrial estates before turning to barriers for developing existing industrial estates into more sustainable ones. The most important barrier is the difficulty to attract the right mix or composition of companies and their processes. In the case of Kalundborg this mix has turned out to be right for developing industrial ecology relationships between firms. The relative shortage of other successful examples shows that it is difficult to locate companies able to use one another output in close proximity. However now that we know these options exist, it is vital to plan new locations of companies with great care. Here we also have to deal with for example legal barriers. Is it possible to locate emerging companies in specific areas because

of the expected proximity to other companies possibly using their output. And is it possible to distract those companies from locating when they do not bring the right mix of inputs and outputs? Furthermore it has proven to be very difficult to plan these types industrial ecology relationships, because timing of the emergence of new companies or relocation of old companies is vital.

Barriers for the operation of sustainable industrial estates

We will give a brief overview of some main categories of barriers which can be identified. Barriers can be found on the following fields:

1. Barriers related to management of the individual companies: the level of environmental management and pollution prevention within the separate companies;
2. Barriers related to technical factors at the level of the industrial estate: to adjust material and energy flows for the mixture of companies which are located on the industrial estate and/or look for companies which fit into the concept;
3. Barriers related to management at the level of the industrial estate: to set up and maintain a management system for the industrial estate;
4. Barriers related to the role of government actors and to legal issues.

(1) First of all barriers exist at the level of individual firms with regard to their *willingness and ability* to co-operate. It is possible to draw a parallel between the creation of a (new) sustainable industrial estate and the implementation of environmental management. An important first step is to have commitment from the actors involved. Individual companies which (will) form an industrial estate, will have to commit to goals for collaboration. The prospect of engaging in a relationship with other companies also can be a (psychological) barrier. Companies are primarily focused on their own individual economic performance, and take autonomous and independent decisions in order to optimise this individual performance. Collaborating with other companies can lead to increased dependence, or decreased autonomy, of individual companies. Furthermore the ability of companies to participate will be hampered if they are not able or willing to provide information on their environmental performance in terms of quantitative and qualitative data on material and energy flows. Related to this are different levels of environmental management and pollution prevention in companies. Are companies involved in continuous pollution prevention, or were they involved in pollution prevention projects? If a company still has options to improve its internal material and energy flows it can be dangerous to connect the company in an exchange of for example waste. Furthermore barriers are likely to be higher with larger differences in the degree of environmental organisation between companies, or with regard to management systems such as ISO 9001, 14001 or with regard to safety. The relevance of this is also shown in the INES project which has started as a continuation of implementing environmental management systems for individual companies with the help of a project agency. The project agency was then extended to search for collective options and made use of data from the project (Baas 1997).

(2) Also barriers can be identified at the level of the industrial estate. At an existing industrial estate the random composition or mix of companies can make collaboration difficult. Sometimes companies willing to co-operate will be unable to do so because of the absence of nearby companies which they can be linked to. One example is a small estate with a manufacturer of valves neighbouring to a salad factory and a textiles producer, which have difficulties in finding exchange possibilities with mutual benefits. Still there are opportunities

for setting up joint facilities on existing industrial estates. In many cases however the integration of material and energy flows will be a very difficult process or even nearly a mission impossible. More profound options of linking companies together through cascades will have a more or less coincidental nature at those existing estates. Furthermore possible collaborations of companies are not likely to be neighbouring companies at estates, and will often need the construction of new infrastructure services. This can lead to problems in terms of the distribution of investments (costs) and benefits of possible linkages. Projects can give results that lead to a net environmental and economical advantage for a chain of companies as a whole. However the net economic advantages are in most cases not equally distributed over the companies that can be linked together. One firm has economic benefits where the other experiences relatively unfavourable results. One of the main organisational barriers therefore is the balance of power within the chain and the possible changes which can occur.

(3) The absence of management and networks at the level of the industrial estate, not only for environmental but also for other aspects such as safety, infrastructure etc. will also form a barrier for the development of sustainable estates. A lower degree of organisation between companies will increase barriers for collaboration. Companies already engaged in collaboration at the industrial estate, for example through an association of companies representing common interests, are more likely to be interested in looking for further options. The recent examples in the Netherlands show that active involvement from companies at estates and co-operation from companies at the estate level, for example through companies' associations, is an important factor explaining the development of recent projects at industrial estates.

(4) The absence of an active government actor and legal barriers for the development of projects. In most experiences regarding sustainable estates government actors play an important and sometimes decisive role. Often a third party such as a government will be necessary to bring together companies and provide information to them regarding possible co-operation. On the other hand, however, legal barriers such as the prohibition to transport materials labelled as waste under environmental acts have proven to be barriers which are difficult, and take a long time, to overcome.

4. Removing barriers

On the basis of the previous paragraph we will analyse some options to decrease barriers for companies to engage in industrial ecology relationships. In order to create both willingness and ability of companies to collaborate, projects can be identified which will establish fairly simple co-operation with collective benefits for firms. An example is collective handling of waste which can increase re-use of waste and decrease costs. Furthermore, in these cases pollution prevention projects or projects regarding environmental management systems for individual firms can be extended for industrial estates. These kinds of projects are now in progress in many different industrial estates in the Netherlands. At one industrial estate in Heerenveen, for example, waste management was registered for 59 companies. Before the start of the monitoring exercise companies did only have very limited insight in the amount of waste they produced and the costs associated. Therefore companies also had little interest in waste management. The results showed that the 59 companies used 53 different collectors of waste. Most of the waste collecting companies only picked up some waste streams for up to

one or two companies. Differences in costs were huge, in some cases up to 600 per cent for the same type and amount of waste. It was concluded that the collective management of waste can lead to significant financial savings and more structured discharge of waste (de Vries, 1998: 27).

Another avenue of reducing barriers for co-operation of firms at industrial estates is to extend co-operation for other areas than those related to the environment. Several experiences are now in progress in the Netherlands with regard to the 'revival or renewal' of industrial estates. These projects aim to improve the overall quality of industrial estates and try to build support from companies at the estates. The involvement of the companies at the estate in processes of change, restructuring, revival and renewal is crucial for the success of these projects, but eventually also for the scope of developing further projects where industrial ecology relationships play a more prominent role. Local government agencies are increasingly starting these kinds of projects in order to stimulate economic development and employment. Specific parts in projects are for example security and protection; improvement of the accessibility on and toward an industrial estate (infrastructure); start up of collective conferences facilities and catering services; and joint services for conditions of employment. Aforementioned projects leads us to the edge between private and public activities and projects. The local government agencies emphatically come forward as a partner which is willing and profitable to co-operate with. This leads to a next stimulus that can remove barriers for the development of sustainable estates.

Support by or co-operation with local government (agencies, like municipalities) will play an important role in removing barriers from developing estates towards more sustainable ones. The local government has an interest in well functioning industrial estates. Economic development and employment are main topics in politics, also on the level of municipalities. They also have certain responsibilities toward industrial estates. For example in maintaining the infrastructure of the estates and by taking care of the green space. Local government agencies legally keep up relations with separate firms for environmental standards, permits and other permits such as for building, and control aspects of spatial planning. And the latest developments in this area, as mentioned above, is that municipalities make management plans to improve the quality of deteriorated industrial estates. Dutch municipalities are also subsidised for developing such plans. These plans contain measures for the organisation and communication aimed at maintaining the achieved quality. A management plan developed by local governmental agencies, give enough opportunities to anticipate for the development of sustainable estates. As this is a relatively new development where government officials and others will have to gain expertise. The next section will give some insight in building a curriculum with regard to this. One further related aspect is also to increase research into types of production processes which fit well together for relationships based on industrial ecology, and pointing out the scope for these relationships at existing industrial estates.

5. Building expertise

It has become clear that a system of management at the level of the industrial estate is an important factor for successful collaboration between companies in industrial estates. Furthermore setting up this collaboration and system of management is a complicated process, for which specific knowledge and skills are necessary. We present here the contours

of an educational curriculum (developed by CSTM) which can provide some of the necessary skills for actors involved in designing sustainable industrial estates.

In order to bring companies to collaborate with each other at industrial estates it is sensible to establish a project agency. The INES-project has proven that, with the support of both individual companies, companies' association and government agencies, this is a viable strategy (Baas, 1997). This approach is now also embraced by the Ministry of Economic Affairs in the Netherlands which will subsidise project agencies within the framework of the development of "sustainable industrial estates" (Nota Milieu & Economie, 1997). It also offers opportunities to combine project activities for industrial estates with educational programs and research. Demand for people with knowledge and experience in the field of development and maintenance of sustainable industrial estates is expected to rise. Besides taking steps to implement a sustainable industrial estate, it is possible to simultaneously set up an educational curriculum. Preparation and implementation of the project activities can partly be supported by participants of the program which in this way learn by doing. Environmental knowledge in combination with knowledge on business management can be offered in a course or education which runs parallel to or is part of the set up of a sustainable industrial estate. In order to work towards sustainable management at an industrial estate, the following steps can be followed:

- Selection and acquisition of separate companies which are part of the selected industrial estate;
- Survey and advise each company on environmental issues;
- Advise the (companies' association of) industrial estate about the use of materials and energy;
- Study and advise for a suitable management structure ;
- Feasibility studies for optimisation of the use of materials and energy;
- To make the management structure operational;
- Carry out various projects, implementation of specific options to exchange energy, materials, water streams.

Knowledge is required on all these subjects: it involves knowledge on business administration, on (clean) technology and for judicial aspects, all applied to (groups of) companies, their production processes, and their environmental impact. Skills and experience can be simultaneously achieved when each step above is connected to specific projects at industrial estates. The groundings of educational programs for this, both through specific subjects as projects with companies, are already existing in various educational programs focused on environmental management systems, such as for example the Master of Environmental Business Administration at CSTM. We compare the main educational topics with the steps to develop a sustainable industrial estate. The result is given in the following table.

Table 1 Example of a curriculum for the management of sustainable industrial estates

Master of Environmental Business Administration	Program for Management/Development of Sustainable Industrial Estates
Main subjects on:	More specified towards:

<ul style="list-style-type: none"> • Business administration • Clean technology • Environmental policy 	==>	<ul style="list-style-type: none"> • Motivations for collaboration of companies, Project management, Logistics • (Clean) technologies linking different production processes • Policies relevant for industrial estates (Planning, Zoning, Emission trading, etc.)
Projects on Technical Analysis for Environmental Management	==>	Projects on the use of material, water and energy flows at industrial estates
Projects on pollution prevention in co-operation with companies	==>	Projects for Pollution Prevention / Collective Waste Handling at the level of the estate making use of data of individual P2 projects
Projects on organisational aspects of environmental management	==>	Projects on Management of Estates in co-operation with municipalities
Projects on setting up environmental management systems in companies	==>	Projects for setting up management systems for different aspects at industrial estates in co-operation with associations of companies

6. Conclusion

Relatively successful experiences with sustainable industrial estates have mainly occurred with the presence of a strong, large and dominant company which more or less incorporates smaller supplying and buying companies within their sphere of influence. Recent experiences concerning existing industrial estates with more or less random mixes of companies suggest that it is difficult to develop industrial ecology relationships based on integrated systems in more or less closed loops of material flows. Preliminary results indicate that projects can lead to improved efficiency at the industrial estate level. In order to induce companies to co-operate at the level of industrial estates, with the purpose of increasing sustainability of industrial estates, different forms of co-operation need to be established. Experiences suggest that development of co-operation in other areas can provide the necessary critical mass for companies to engage in ecological relationships. Projects focuses on for example revival of industrial estates can then be extended towards co-operation on environment related areas. In order to make these projects successful, expertise with regard to the development and management of industrial estates needs to be built.

References

- Baas, L., *Cleaner Production & Industrial Ecosystems, a Dutch Experience*, Paper for the European Roundtable on Cleaner Production, November 1997.
- Boons, F.A.A. & L.W. Baas, Types of industrial ecology: the problem of co-ordination, in: *Journal of Cleaner Production*, Vol. 5., No. 1-2, pp. 79-86, 1997.
- Brand, Ellis & Theo de Bruijn, *Sustainable Development for Industry, Putting sustainability at work at the regional level*, paper at the International Sustainable Development Research Conference, Leeds, 1998.
- Erkman, S. Industrial Ecology: A Historical View, *Journal of Cleaner Production*, Vol. 5, no 1-2, p. 1-10, 1997.
- Frosch, R.A., & Gallopoulos, N.E., *Scientific American*, pp. 144-152, September 1989

- Graedel, T.E. & B.R. Allenby, *Industrial Ecology*, Prentice Hall, Englewood Cliffs, 1995.
- Heidemij Advies, *Nieuwe kansen voor bestaande terreinen* (New chances for existing estates), Maart 1996.
- Kaalverink, R.K., *Afvalreductieprojecten op bedrijventerreinen: Succes of gedoemd tot falen?* (Waste reduction projects for industrial estates: success or prone to fail?), Regio Twente & NAO, Januari 1997.
- Kuiper, T.C., Glas, H., Dekker, R.C., *Duurzame ontwikkeling van bedrijventerreinen* (sustainable development of industrial estates), Kuiper & Burger in opdracht van de Provincie Noord-Holland, Maart 1997.
- Oldenburg, K.U. & K. Geiser, Pollution prevention and...or industrial ecology?, *Journal of Cleaner Production*, Vol. 5., No. 1-2, pp. 103-108, 1997.
- Rijk, R., *Een duurzaam bedrijventerrein* (A sustainable industrial estate), Rapport voor de Provincie Noord-Holland, Haarlem/Utrecht, Augustus 1996.
- Vries, E. de, Parkmanagement kan milieubesef op bedrijventerreinen bevorderen (parc management can increase environmental awareness on industrial estates), *ROM Magazine*, no. 4, pp. 25-27, april 1998.