SUSTAINABLE BUSINESS SITES IN THE NETHERLANDS: A REVIEW *

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ABSTRACT

The concept of eco-industrial sites or sustainable business sites is a noteworthy newcomer in the family of location types. The origin of this type may be considered as a consequence of two development trends, viz. the segmentation of the location market on the one hand (an outcome of changing locational tendencies) and the aim of government policy to integrate economic and environmental objectives on the other. In this article, both trends are analysed. Central aim is to establish the progress of implementing the newly developed location concept in practice and to identify factors of success and failure. The situation in The Netherlands is used as a frame of reference. After the outline of the background, the concept of sustainable business sites, including definition, will be considered and criticized. Then a tentative inventory is presented of the circa 60 eco-parks which have developed in the past ten years in The Netherlands, including the results of a questionnaire survey of these 60 parks. To get a better insight into the factors which determine success or failure, short case studies of a number of the parks are presented. Finally a number of conclusions is presented, including a discussion of an alternative view of the concept of eco-industrial sites which applies to the continuity of both firm and environment.

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Introduction

The concept of eco-industrial sites, sometimes also referred to as eco-parks or sustainable business sites, is a noteworthy newcomer in the family of location types. The origin of this type of sites may be considered as a product of two distinct development trends. The first one is the segmentation of the location market, which is a result of a gradual change in locational tendencies. The second trend is the aim of government policy to integrate economic and environmental objectives. In this article, both trends will be analysed. Central aim of the article is to establish what progress has been made in implementing the newly developed location concept in practice, and to identify the factors that determine success and failure of this implementation. We will use the situation in the Netherlands as a frame of reference, especially where the idea of integrating economic and environmental policies is concerned, which is not a very commonplace idea yet, although it is certainly not unique for the Netherlands.

After the outline of its background, we turn to the content of the eco-park concept. Being a relatively new concept, eco-industrial parks are not yet a very clearly defined category. We will discuss possible definitions. Ultimately, we have to choose one definition as a basis for the empirical survey which follows. The definition and categorisation of eco-parks suggested by the Memorandum *Sustainable Business Sites* of the Dutch Ministry of Economic Affairs (Ministerie EZ 1998) will be followed in a tentative inventory of eco-industrial parks that have developed in the past ten years in the Netherlands. After this, to get a better insight into the factors that determine success or failure of these parks, short case studies of a number of the parks are presented, and the results are discussed in the light of new ideas about consensus planning. Finally some conclusions will be presented, including a discussion about an alternative view of the concept of eco-industrial sites, in which the concept applies to the continuity of both firm and environment. This also leads to some comments on the possibilities for incorporating eco-industrial parks in urban landscapes.

Changing location tendencies

In the course of the 20th century the demand side of the location market has witnessed a gradual change in the dominance of individual location factors (figure 1). Three successive stages can be identified. The first stage, roughly corresponding with the maturity phase of the Industrial Revolution process, is characterized by the dominance of the costs of transport and labour as location factors. Both factors show vast spatial variations, which are reflected in the location choices of the traditional manufacturing industries as well as in the theories about location choice of this era. The industrial location theory of Alfred Weber (1909) is the leading example. In this theory, transport and labour costs are considered as the "primary location factors".

In the second half of the century, from the nineteen fifties onwards, the accent both in theory and practice shifts to the location factors which were earlier considered to be of "secondary" importance only. "Secondary location factors" is in fact a collective term for what is also and more generally known as the economies of agglomeration: the advantage of having clients and suppliers at a short distance, the availability of services and other facilities, and a concentrated labour market. The increasing importance of agglomeration economies in the middle of the 20th century, especially in highly developed countries, is not only a consequence of the agglomeration phenomenon itself. It also reflects the growing spatial extension and density of transport networks and the higher labour mobility, which diminishes the importance of transport cost and reduces the spatial variation of labour costs, the former "primary factors". With the rise of new dominant factors, we also witness the development of new theories about industrial location and regional economic development, theories which stress the importance of agglomeration economies, such as the growth pole theory (Perroux 1955, Vanneste 1967) and the cumulative causation theory (Myrdal, 1957). These theories are dominant in the nineteen fifties, sixties and seventies.

The nineteen seventies and eighties again have brought new ideas about the nature and development of the space economy, such as the restructuring geography (Massey 1979, Storper 1981, Peet 1989, Dicken and Lloyd 1992, Pickles and Watts 1992) and the geography of enterprise approach (i.e. Hayter and Watts 1983, Hayter 1997). These approaches

Figure 1
Changing location tendencies

Phase I industrial revolution	Phase II period after 1950	Phase III nineteen nineties
primary factors	***secundary factors***	***tertiary factors***
TRANSPORTATION COSTS (transport of raw materials and products) LABOUR COSTS	PROXIMITY OF MARKETS PROXIMITY OF SUPPLIERS AND SERVICES OTHER AGGLOMERA-TION BENEFITS	GOVERNMT INFLUENCE KNOWLEDGE and IT-INFRASTRUCTURES QUALITY OF LABOUR ***ENVIRONMENTAL ASPECTS*** REPRESENTATIVE SITES MENTALITY OF PEOPLE LIVING CONDITIONS etcetera
least cost location theory	*growth pole theory* *cumulative causation theory*	*behavioural location theories*
regional concentration	urban agglomeration	spatial diffusion

Source: Pellenbarg 1996

concentrate less on the importance of certain categories of location factors, mainly because they operate on a higher level of understanding of the spatial organisation of economic activity. However, looking at the results of empirical location studies in the nineteen nineties (i.e. EC/NEI 1993, Witzenburg et al 1995, Sloterdijk and Van Steen 1994, Pellenbarg 1998) it becomes clear that in the last 10-15 years of the century a new shift in the importance of location factors can be observed, which we may designate as a shift to "tertiary location factors", such as the availability of knowledge infrastructure and IT facilities, the representativeness/image of business sites, conditions for living and recreation, and last but

not least government policies and attitudes, and environmental aspects of location. In fact, the list of tertiary location factors is much longer than figure 1 suggests. The factors mentioned are just examples. We might have added factors such as facilities for distribution, logistic networks, educational infrastructures, public transport, parking facilities, presence of airports, landscaping of sites, crime conditions etcetera. The present phase of location choice development is essentially characterized by the increasing exigence of the location decision makers. Of course many of the factors that enter the list of tertiary factors are not really new, but have been able to grow to dominance to the degree that the old primary and secondary factors have become available over much wider areas than in the past. As is suggested in figure 1, the advancement of former trivial or even personal factors in the location decision makes the behavioural approach in location theory an appropriate basis of understanding what is happening, especially because the choice of leading location issues from the long list of tertiary factors is in practice a highly individual one.

Segmentation of the location market

Of course not every individual firm will need every factor on the list of tertiary location factors. And not every location can offer all conditions of possible importance at the same time. The combination of these two fundamental ideas is the basis for what we called in the introduction the *segmentation of the location market* (Bartels and Webbink 1987, Pellenbarg 1996). More and more different location types are developed to meet the growing specificity of location demands of firms in the third phase of location tendencies. The variation in demand is accompanied by a differentiation in supply, as a result of which the location market is becoming split up in different segments for distinct groups of firms that share the wish for sites of a certain type, equipped with distinct facilities attuned to a specific user group, or otherwise offering specific conditions geared to specific demands of specific firms. No longer the majority of firms can be satisfied with a supply of "general" or "mixed" type of business sites at the village or city fringe, as has been usual in many countries up till the nineteen eighties. Growing numbers of firms are no longer tied to low cost transport or labour locations or obliged to cling to urban nodes to benefit from agglomeration economies, but have become relatively *footloose* and ask for sites that will meet the specific

conditions of their type of firm, a site where they can locate amidst firms of the same type, create a basis for specific joint facilities, and enjoy the advantage of a certain "radiance" of a concentrated, well-balanced, good-looking and thus attractive cluster of similar firms.

The actors on the supply side of the location market - in the Dutch situation usually municipal governments, but sometimes also private developers or real estate firms - have understood the call of the market very well. At a great pace they have started to develop new types of business sites for the many distinct demand segments that can be identified. Special sites for heavy industry and offices were of course already very common in the past, but now we witness a growing number of *logistic centres, distribution parks, multimodal centres, technological centres, science parks, research parks, brainparks, teleports, agrocenters, medical parks, airparks and eco-parks.* The ingeniousness of the developers is practically endless, but these are up till now the most common location types which are developed as a response to the segmentation trend. The eco-park in this context is nothing more than a response to the request of a certain type or group of firms, namely firms that somehow include environmental aspects in their set of location demands and ambitions. But the rapid growth of this location type cannot be understood from the demand side development alone. Especially in the Dutch situation, on which we focus here, the popularity of the ecopark-concept, more precisely: the propensity of local governments to develop this concept, is very much enhanced by the striving of the national government to reconcile economic and environmental objectives of investment projects. Eco-industrial parks are one of the most ready examples of this policy aim, which of course has a broader scope than the single subject of business location projects.

Reconciliation of economy and environment

At first sight and according to the personal experience of many, economy and ecology are natural enemies. In many situations either business locations are prohibited altogether for environmental reasons, or environmental objectives oblige firms to additional investment, which may make a project less remunerative or even uneconomic, unless the environmental demands are mitigated. With economy and ecology, you always have more of the one and

less of the other, or vice versa, that is the common picture. This picture is accepted all the more because economy and ecology can be associated almost everwhere with two opposing political party types: the conservative and the progressive. So in reality confrontations about environment/economy issues are not only conflicts between ideas but also between recognizable groups in society.

In the Netherlands, the historical polarization between progressive and conservative politics ended - for the time being - with the formation of a coalition cabinet including both the PvdA (progressive/labour) and VVD (conservative) parties, in 1993. This coalition proved to be successful enough to continue after the general elections of 1998, and it can easily be understood that it tries to bridge traditional gaps, such as between economy and ecology. This intention materialized in the form of the Memorandum "Economie en Milieu" (Economy and Environment) in 1997, in which the cabinet outlines its wish to accomplish economic growth without environmental deterioration (Ministerie VROM 1997). The magic word is *win-win situation*, in other words: economic growth, more jobs, and competitive advantages can be combined with less environmental pressure, a lower usage level of fossil fuels and more bio-diversity. The idea is not to impose this in a top-down fashion, but to stimulate a bottom-up process by citizens, firms and governments on the local level by handing them creative ideas.

The description of the political situation in The Netherlands as a background for the development of eco-industrial sites is not meant as thesis or proof that political reconciliation is a necessary prerequisite. We can observe the tendency towards sustainable sites also in countries where no comparable political development took place. To be sure, what is needed is more a change of mind in the society at large than in politics alone. Ideas about reconciliation of environment and economy at the national (political) scale are important, but far more important is that parties on a *local* scale do *comply* with these ideas, that they really *wish* to act on their local level.

Next comes the difficult question: what does "acting on the local level" really mean? In the Memorandum Economy and Environment an impression is given of the changes that have to be brought about to accomplish the reconciliation of economic and environmental goals, by enumerating specific areas where much progress can be made. These areas are called "bow-statues" (in Dutch: *boegbeeld*) to symbolize their role as pioneer-fields. The pioneer

fields contain imaginative projects in different sectors, serving as examples, sources of inspiration, and catalysts. The complete list of sixteen pioneer fields is given in table 1. "Sustainable business sites" are high on the list.

The Memorandum doesn't give a very sharp definition of the concept of sustainable sites, but it mentions a number of aspects:

- joint use of facilities, collective facilities (for energy, water, recycling, transport);
- closing material cycles through the use of waste materials;
- relocating firms to achieve a more efficient use of space;
- clustering firms that are complementary both in terms of economy and ecology;

The Dutch government has made 7 million guilders ($ 3,500,000) available for actions concerning sustainable sites in the period 1997-2003, especially for study, inventory and information projects. The program applies both to new and existing business sites.

Table 1

Fields for joint action of the private and public sector to achieve sustainable production ("bow-statues" of the Economy&Environment policy in the Netherlands)

Strategic environmental management in the firm
International comparisons of environmental performance in industry
Stimulation of environmental technology
Programme for innovative and underground building
Sustainable business sites
Integrative environmental approach in food chains
Agricultural raw materials for glue and paint
Integrative environmental approach in agriculture and fishing
Financial services and sustainable development
Tourism and recreation as green coalition partners of nature and environment
Nature and market: combination of functions and finance
Door to door passenger transport
Efficient transport of goods
Knowledge centre traffic and transportation
Technology for innovative traffic and transportation systems
Air transport technology

Source: Memorandum "Economy and Environment", Ministerie VROM 1997

Eco-industrial parks: a multi-interpreted concept

The preceding paragraphs may have made clear how the concept of eco-parks or sustainable sites came into being as a result of interacting tendencies both in business location and policy development. However, the concept up to now is certainly not clear enough with respect to its *content*. Different definitions can be followed. First of all, segments of the location market such as we described in the preceding paragraphs are usually defined by the nature of the firms which are located on the site in question. A *Distribution park* is a location for firms engaging in distribution activities, a *Research park* houses R&D firms, and a *Medical park* is a gathering of firms with activities in the medical sector. Following this line, an *Eco-park* could be a site where firms engaging in "environmental activities" are gathered. The concept of "environmental activities" is very broad and covers waste recycling and incineration as well as the production of energy-saving or emission-reducing devices, and specialist environmental consulting activities. Environmental activities are in fact all activities where the product (or service) of the firm is somehow related to environmental protection or environmental management. It has become customary, at least in the Netherlands, to refer to the whole of these environmental activities with the term "the environmental sector". It is very difficult to estimate the size of this sector in terms of numbers of firms or employees. Because the concept is broad it embraces firms from different ISIC (International Standard Industrial Classification) branches. Also firms may have "environmental activities" only as ancillary products or services. The recycling-sector is the most clear-cut part of the environmental sector, and can be regarded as the hard core of the branch. According to Zijda (1997), who quotes the Rijnmond Regional Economic Council, the recycling sector in the Netherlands in 1994 consisted of circa 3000 firms with a total of 20,000 employees and a yearly turnover of 3 billion Dutch guilders ($ 1,500 million).

Notwithstanding the undeniably great and growing importance of the environmental sector it seems unwise to speak of "environmental sites" as a location type specially prepared to locate "the environmental sector". Not only is this sector too diverse qua nature and locational demands to benefit from a clustered location, but also the term "environmental

site" would be misleading since many of the activities of the environmental sector - and especially its hard core activities of waste storage, waste recycling, waste incineration - are environmentally burdening themselves.

A better way to approach the concept of eco-parks or sustainable sites is to start from the ecological value of the *behaviour* of the firm instead of from the ecological incidence of its *products*. For this behavioural approach the just mentioned Memorandum "Economy and Environment" offers a good starting point, with its reference to joint use of materials, energy and water, joint systems for waste management and transport, and more efficient space use for instance through multiple-usage of space or multiple story building (Ministerie VROM 1997). It is not the product or service that is the leading aspect here, but the joint ambition of firms located on the site to organise their activities strategically in such a way that environmental goals are served without obstructing economic performance, or even better: by enhancing this performance. Following from this, an eco-industral park could succinctly be decribed as *"a concept where different environmental strategies (of firms) are integrated on the scale of an industrial park"* (Van der Laak 1997). A wider definition, stressing the juxtaposition of economic and ecologic goals is *"a form of cooperation between firms, and between firms and governments, aiming at the improvement of the economic performance of firms, the reduction of environmental pressures and a more efficient use of space"* (Ministerie EZ 1998, p.9).

For the remainder of our analysis, including the empirical part in which an inventory and case studies of eco-parks in The Netherlands are presented, we will use this wider definition of the eco-park location concept, and use the terms *eco-park, eco-industrial park,* and *sustainable site* side by side without making difference between them. Of course one has to realize that the adopted EZ 1998 definition, although wider than the first mentioned alternative of a product-based concept, is not yet wide enough when considered in the context of the original meaning of the term sustainability, as put forward by the UN World Commission on Environment and Development (1987) chaired by Gro Harlem Brundtland. This comission used the sustainability concept especially to relate environmental issues to (potentially all) other relevant social issues, rather than confining it to the combination of reduced environmental pressure and increased economic performance. Moreover, in the EZ 1998 definition economic performance is conceived from the perspective of the firm only. A

more comprehensive approach would require that not only production but also consumption be taken into consideration, including the possibilities of product recycling. One example may serve to illustrate this point. In the Netherlands, the third chemical cluster next to Rotterdam and South Limburg is to be found in the port area of Delfzijl, the northernmost harbour of the country. The complex is dominated by the AKZO plant, which among other things, produces salt and salt-related chemicals. Although production processes are heavily integrated, a yearly surplus of 50,000 tons of chlorine is produced which has to be shipped off by train to Rotterdam two or three times every week. The environmental risks of these 250 km transports across the territory of 55 municipalities, which have been taking place since the 1960s, are quite severe. In a worst case scenario 5000 lives could be lost and 17,800 people injured as a result of a chlorine train accident (Aarden 2001). A solution which has been debated for many decades is the construction of an ethylene pipeline from Rotterdam to the Delfzijl port area, which would enable AKZO to use the chlorine in Delfzijl as a raw material for the production of pvc's, instead of transporting the chlorine to plastic producers in Rotterdam. This would fit quite well into the mission of developing the Delfzijl port industrial area as a sustainable business site as meant in the EZ 1998 definition. But in a more comprehensive judgment, the removal of the transport risk would have to be compared with the drawback of an increased output and resulting consumption of the (less sustainable) product pvc, the energy loss or gain incurred in the replacement of other products by the newly produced pvc, the alternative use of production facilities in Rotterdam that become redundant, etcetera.

Seen in this light, the EZ 1998 definition of an eco-industrial park clearly has it limitations. In fact, it describes an environmental management tool, not the operation of a business site within environmental limits. For that, the concept would have to be placed in the *industrial ecology* approach as advocated by Frosch and Gallopoulos (1989). This however would require a much more complicated judgement of activities on business sites, which is beyond the possibilities of the enquiry intended here. We just have to be aware of the limitations of the one-sided analysis. In the next paragraph, we will discuss in more detail the content of the actions that can be taken by firms and governments who wish to cooperate and integrate their environmental strategies in the sense of the EZ 1998 definition just given, to create a basis for the proposed inventory and classification.

Options for creating sustainable business sites

In the recent Memorandum *Sustainable Business Sites* (Duurzame Bedrijfsterreinen) the Dutch Ministry of Economic Affairs provides us with a good starting point for the classification of the potentially very divergent strategic behaviour of firms and governments with respect to sustainable sites (Ministerie EZ 1998). The Memorandum suggests first of all the classification of all possible activities in two broad categories, viz.

1) actions aimed at *sustainable production processes* and
2) actions aimed at *sustainable site arrangements*.

This categorization corresponds with the opposition of firm and environment, which is a basic idea in economic geography.
In the category of sustainable production processes the accent is on *physical streams* of i.e. goods, (waste) materials, electricity, heat and water. Also the physical mobility of people falls in this category. The purpose of coöperation between firms is to minimize these flows and thus to create at the same time a cost reduction and an improvement in ecological terms. Possibilities to achieve this goal can be found in the sphere of material exchanges between firms, in collective gathering and removal of waste materials, the joint use of utilities, and combined forms of transport of goods and people (figure 2).
In the category of sustainable site arrangements the accent is not on the physical streams incurred in the production processes, but on the *areas* where the production processes take place: this includes the firm's premises, the infrastructure, and the various facilities at the site. Coöperation between firms regarding design, development and management of the area may create a sustainable arrangement of the site, for instance by using space more intensively, creating public utilities with higher useful effects, joint commercial facilities, and opportunities for multimodal and public transport (figure 3).
Examples of the action fields illustrated in figures 2 and 3 are manifold. A detailed overview is given in appendix 1. For a well-written vision on the integration of all possible measures at the industrial park level we can refer to a recent publication by Grontmij and Kolpron Consultants (1998).

Figure 2
Options for sustainable production processes

STREAMS

exchange of energy, raw materials and water	joint use of utilities and firm functions
collective gathering and removal of waste materials	combining transport of goods and people

Source: Ministerie EZ/Ministry of Economic Affairs (1998) Duurzame bedrijventerreinen/Sustainable business sites

Figure 3
Options for sustainable site arrangements

AREAS

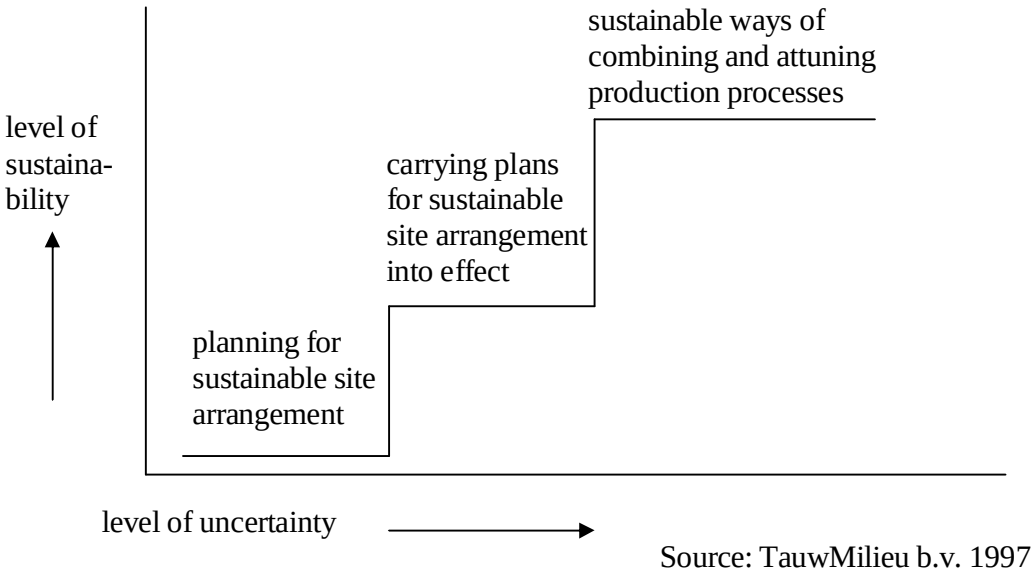
more intensive use of space	public utilities with high useful effects
joint commercial firm facilities	multimodal transport and high quality public transport

Source: Ministerie EZ/Ministry of Economic Affairs (1998) Duurzame bedrijventerreinen/Sustainable business sites

Although the government's Memorandum on Sustainable business sites doesn't mention this, it is obvious that the options for sustainable *production processes* represent a higher ambition level than the options for sustainable *site arrangement*. We can observe a kind of "staircase of ambitions", where a varying level of sustainability combines with a varying level of uncertainty as to the realization of environmental ambitions (figure 4). Sustainable arrangement of sites "on paper" i.e. as described in local plans, are the lowest step of this staircase; sustainable ways of adjusting production processes are the highest step. In between we can identify an intermediate level, concerning the implementation of sustain-

able site planning in the form of quality demands for building permits, instructions for the use of building and other materials, etc. For the sake of simplicity, we will in the remainder of this paper make no difference between planning and implementation, and consider both the first and second step of the staircase as belonging to the "area" option of fig. 3.

Figure 4
The relationship between sustainability and uncertainty



Source: TauwMilieu b.v. 1997

Inventory of sustainable business sites in the Netherlands

In the preceding parapraphs, we arrived at a definition of the concept of eco-park, and a description of the types of activities by which such a park can be recognized. Still, this doesn't make it very easy in practice to identify business parks as eco-parks. On the one hand, the concept has gained a degree of popularity in the past few years, and some municipalities are inclined to "glue" the eco-label to business parks that don't "deserve" the label in terms of our definition. On the other hand, there are sites which do fall partly or as a whole under the definition but where the label still isn't used. Sometimes this is caused by fear of the municipality that the eco-label will act as a deterrent for certain firms, and by consequence will slow down sales.

In spite of these practical problems an attempt was made, in 1999, to make an inventory of business sites in the Netherlands which can be labelled as eco-industrial parks or sustainable sites. For an extensive description of the field work for this project see Bakker et al 1999.

Two criteria for the selection of eco-parks were used:
1. The site satisfies one of the two conditions/options which are central in the Governments' policy regarding sustainable sites, viz. creating sustainable production processes, or creating sustainable site arrangements (figure 2 and 3).
2. At least two (or more) firms on the site are engaged in some form of cooperation (with each other, or with the local government) for environmental purposes.
The size of the firms (employees) or the size of the site (hectares) were *not* used as a selection criterion. The average size of the sites recorded in this study was slightly more than 100 hectares and only 6 were more than 150.
For the inventory a telephone survey has been made among the twelve Dutch Provinces (Departments of Spatial and/or Economic Affairs). Also a dozen consultancy firms with relevant expertise in the field of sustainable business sites were approached for information. The result of the survey was a list of 62 sites in 59 towns and cities throughout the Netherlands. Appendix 2 shows these sites in the form of a list and a map. Because of the problems incurred in the inventory which we just mentioned, we should regard this list as an *indication* of what is taking place in terms of eco-park planning, rather than as a definitive map of eco-parks. Nevertheless it is striking to see that the greatest number of initiatives is found in the provinces of North Holland and Utrecht, where the economy is very much dominated by the commercial service sector. The provinces of South Holland and North Brabant, the dominant industrial provinces of the country, are relatively underdeveloped in terms of initiatives for eco-parks.

A survey of developments on sustainable business sites in the Netherlands

For each of the 62 sustainable sites in the Netherlands a contact address has been made available, and as a follow-up of the telephone inquiry among the provinces and consultancy firms a written inquiry was send to these contact addresses, in an attempt to assemble more

information about the initiatives and developments on the parks in question (Bakker et al 1999). For each of the parks a number of key-data were asked, such as founding year, size of the site, number of firms established and persons employed, and of course: the official goals of the site in terms of its environmental design. Next came a long list of questions trying to establish what kind of actions could be found on the site in terms of the "streams" and "area"options (Appendix 1) and which factors were felt to bring success or failure.

Of the 62 parks 43 responded to the enquiry. These 43 constitute the research population, which we briefly describe in this section. Of the 43 sites, 26 were totally new developments, 10 were revitalisation projects of existing sites, and 7 were a combination of both. More than half of the 43 sites (24) are still in a stage of project development, ranging from initiative to orientation, decision making and design. This means that some projects are still in such a preliminary stage that it is difficult for the respondents to say which sustainable "actions" in terms of the Appendix 1 list are or will be practised. Eventually, 31 of the 43 respondents have been able to produce clear statements about the planned or performed options for sustainable production processes and/or sustainable site arrangements. This leads to a total score of 161 activities on the 31 eco-parks. The average of more than 5 distinct activities per park is high. It is an indication of the fact that on the average eco-industrial park the mission of combining economy and ecology is taken very seriously, and interpreted in a variety of actions.

Table 2 shows the breakdown of the 161 distinct activities into the categories of sustainable action which we distinguished earlier (figures 2 and 3). The first impression is that all categories are very well represented. On the whole, the options for sustainable site arrangements which represent the lower ambition level, are practised more frequently than the options for sustainable production processes, but the difference between both categories is certainly not too big. Joint use of facilities scores high in both the "streams" and the "areas" option categories, and thus seems to be relative "easy" to realize. Sustainable forms of organizing transport seem to be a more "difficult" category, judging by the number of times it is mentioned as one of the activities on the park.

Table 2
Activities of 31 eco-industrial parks in the Netherlands, by ecological category

	absolute number of activities	% of total
A. *Options for sustainable production processes ("streams")*		
1. exchange of energy, raw materials and water	17	11
2. joint use of utilities and firm functions	22	14
3. collective gathering and removal of waste materials	16	10
4. combining transport of goods and people	13	8
subtotal	*68*	*42%*
B. *Options for sustainable site arrangements ("areas")*		
5. more intensive use of space	25	16
6. public utilities with high useful effects	24	15
7. joint commercial firm facilities	27	17
8. multimodal transport and high quality public transport	17	11
subtotal	*93*	*58%*
Grand Total	161	100%

Source: Bakker et al 1999

Table 3
Top-ten activities on eco-industrial park

activity	*frequency*	*("streams")*	*("areas")*
Joint parking facilities	23		x
Joint safety systems	22		x
Joint maintenance systems	18		x
Separating sewer systems	18		x
Collective waste removal contracts	15	x	
Heat/power combinations	14		x
Use of warmth/cold surplus	14	x	
Collective car wash installations	13	x	
Joint energy systems	12	x	
Joint facilities for telematics	12		x
Hotel, restaurants, gas stations	12		x

Source: Bakker et al 1999

If we go beyond the level of the two "options" (streams/areas) and their 8 facets to the elaborate list of individual actions of Appendix 1, it becomes very clear that indeed the "easy" activities are most popular (table 3). Collective parking facilities are on top of the list,

mentioned by 23 of the 31 respondents (74%). No doubt it is a facet of sustainable site arrangement but certainly not the most appealing one, certainly not if we know that it is also part of the government's environmental policy to reduce mobility by pushing back the use of cars for travelling to work. Another observation from the list of table 3 is that collective actions (parking, safety, maintenance, waste removal) are a very important part of each sustainable site plan. Of the top five activities four are within this category.

Apart from the "hard facts" about sustainable activities practised on eco-parks it is interesting to see what sort of *feelings* the responding representatives of the 43 sites in the research population have about the eco-park concept. This was tested by putting a series of propositions before the respondents. Table 4 summarizes a selection of the resulting reactions.

Table 4
Reactions of respondents on propositions concerning eco-industrial parks*

Reaction (%):	Agree	Neutral	Disagree	No Reaction or missing value
1. A sustainable business site should have a park-like appearance	13	10	**72**	6
2. In future, sustainable business sites will be integrated with residential areas	17	9	**72**	3
3. On a real eco-park at least 50% of the firms engage in cooperation projects	13	38	**46**	3
4. On a real eco-park at least 50% of the options for sustainability are practised	21	26	**44**	11
5. Sustainability is an important location factor for firms on eco-parks	28	**32**	29	10
6. Eco-parks are a concept of luxury; it will decrease in times of economic recession	17	21	**54**	3
7. In future all business sites will be developed in the form of eco-parks	**48**	26	22	6
8. All existing business sites already have more or less a sustainable character	21	18	**59**	3
9. The concept of eco-industrial parks is still rather vague	**60**	19	21	0

Source: Bakker et al 1999

* highest numbers are **bold**

The reactions to the first two propositions clearly reflect the feeling that sustainable business sites should stay business sites in the true sense of the word, and not "degenerate" into mixtures of nature and business, or mixtures of residential and business areas. The reactions on proposition 3 and 4 moreover make clear that the ecological targets don't have to dominate in all respects: if less than 50% of all possible actions are practised, a site still may be considered to be "sustainable". There is some *doubt* about the importance of the sustainability label as an attraction factor for business sites, only minorities agree (28%) or disagree (29%) with the proposition about this, and 32% are unsure. The respondents are much more sure in their conviction that the eco-park concept is there to stay: 54% say that the concept will *not* dwindle in case of an economic recession, and a considerable 48% even think that in future *all* business sites will carry the eco-park label. We may question the reality of this supposition. At present, the eco-industrial parks obviously still are a very distinct category, witness also the reaction of the respondents on proposition 8. Distinct, but not always clear: 60% of the respondents think the concept of eco-industrial parks is still vague, which is a rather high score, considering this is a group of respondents who are working with the concept in practice.

Case studies of ecoparks

Within the limits of this paper, the possibilities for presenting case study material is restricted. We will present a small number (five) of short synopses of developments on sustainable sites in the Netherlands, selected from the inventory of 62 parks discussed before, and chosen in such a way that the different options for sustainable site planning are all present. Incidentally, impressive cases of eco-industrial parks in other countries are also mentioned by various authors (i.e. Visser 1997, Kolpron 1998 1,3) such as the Emscher Park in the German Ruhr Area, the industrial park of Brownsville USA, Burnside Industrial Park in Dartmouth Canada, and most of all Kalundborg industrial park in Denmark, which more or less serves as the mother of all eco-parks. Information about Kalundborg park can be found in many handbooks on industrial ecology and other publications (i.e. Garner and Keoleian 1995, Cosgriff Dunne and Steinemann 1998). A good schematic illustration of the

production plants that occupy the park, and the accessory materials and energy flows can be found on the park's website (http://www.symbiosis.dk).

Kalundborg park was already developed in the mid nineteen sixties and comprises an electric power plant, oil refineries, a pharmaceutical company, a fish nursery, a city heating works, a gypsum plate factory, and a cement factory. These industries take advantage in various ways from each others surplus heat and waste products. In the mid 1990s the firms on the park were reported to reach a yearly reduction of 130,000 tons of CO2 emission, 25,000 tons of SO2 emission, 1,200,000 m3 water, 30,000 tons of coal and 19,000 tons of oil. The re-use of waste products amounted to 135,000 tons of ashes, 80,000 tons of gypsum and 2,800 tons of sulphur (Gran 1994). This level of performance is certainly not the measure for the average Dutch eco-park. On a more modest level, the following cases of eco-parks in the Netherlands can be mentioned (Ministerie EZ 1998):

Moerdijk Industrial park

This project is an example of the "streams" option, more especially the exchange of energy and raw materials (fig. 2). The Shell refinery is the core of the project; this refinery disposes of a vast land reserve which has been made available as a site for chemical industries who want to optimise their use of raw materials and energy. The Montell company already uses ethene and other gases from the refinery, waste products are supplied back to Shell. The Kolb company (fine chemicals) uses ethene oxide from Shell as a raw material. The waste incinerator AZN supplies steam and electricity to the Shell refinery. Basell (joint venture of Shell and BASF) will get raw materials from the refinery. CO2 from Shell will be delivered to glass horticulture firms.

De Krogten, Breda

On this site, 150 firms founded a firms' association. Many possibilities for cooperation were discovered. The accent is on "stream" projects, especially in the field of collective gathering and removal of waste materials. A start was made with a scheme for joint waste collection. A contract was made for integral and separated waste collection with a waste company. For smaller firms a waste deposit scheme was installed. The next step will be a waste prevention scheme and an initiative for saving energy and water. This project is interesting because the

Krogten industrial park is already 35 years old, and the development of the initiative for sustainable production is at the same time a form of redevelopment of a park which has become obsolete and less attractive as a location for new investment. The initiative started from the wish to save costs and improve the site, but gradually there is a growing interest of the participants in the improvement of the business environment as a whole.

De Rietvelden, Den Bosch

This site serves as an example of the joint use of utilities and firm functions within the "streams" option (fig. 2). De Rietvelden/De Vutter is a vast industrial estate, where 400 firms are located. A steering group in which the firms, the municipality and the province are represented, has issued a Masterplan (1997) which specifies the mission statement and development possibilities for sustainable production on the site. A collective facility was created in the form of a "Utilities Ltd" which will take over the supply of water, energy and power from the original suppliers, striving for cost reduction as well as reduction of emissions for the participating firms. Important elements in the strategy are a combined heat/power installation which is available, and an anaerobic waste water purification installation which produces biogas. A key-factor is the presence of the Heineken beer brewery (initiator of the project) which at present is the sole user of the water extraction and water purification installations and the heat/power works, and wants to share it with the other firms.

Business Park IJmond, IJmuiden

This is an example of the "areas" option, especially the stimulation of a more intensive use of space (fig. 3). The site is a part of the original site of the big steel company Hoogovens in IJmuiden. New steel production technologies, using more compact high tech installations, have reduced the need for large reserve spaces, which are now made availabe for the establishment of other firms in the form of the "Business Park IJmond". Such newcomers may use the existing port and other infrastructure facilities and can be supported by various Hoogovens service departments. Especially the establishment of suppliers and sub-contractors of Hoogovens and other related industries is welcomed, but firms in the sectors of distribution and logistics, transport, and/or technical services are a target group as well.

The presence of such firms contributes to a more efficient/intensive use of the available land surface, infrastructure, and facilities.

The Ecofactorij, Apeldoorn

This fifth case study example is a new (1998) site of 90 hectares which is destined for large scale firms (each using 3 hectares or more) which comply with the ecological targets which have been set for this estate by the municipality of Apeldoorn, which develops the park. These targets are of various nature (building materials, flexible buildings, saving energy and water, creating a green environment, reduction of mobility and waste output) but one of the core elements is a joint facility for the supply of water and energy. This puts the project into the "area" option field, in the category of joint facilities (figure 3). An existing incineration plant is involved in the plans as a source of biogas. One of the most eye-catching aspects of the Ecofactorij-plan is the introduction of an "ecological points" system for the participating firms. This system consists of a basic "location package" of conditions which all firms have to comply with, and a "plus package" of measures taken voluntarily, which brings extra points. The location package contains collective firm transport systems, carpooling and joint waste removal. The pluspackage contains re-use of waste materials, waste water and collective use of energy. The more points are scored, the larger the profit for the firm becomes, i.e. in the form of lower land prices, higher subsidies, or getting a priority right to settle on the park.

Factors determining success and failure of ecoparks

From the rapidly growing literature about eco-industrial parks, and especially from case studies such as the ones we presented in our short selection above, insight emerges about the factors determining success or failure for this type of business site. The most crucial success factor no doubt is the *cooperation process* which is at the basis of the development of each eco-park: cooperation between firms, and between firms and local governments on the same site. As the EZ 1998 definition of the concept already showed, an eco-park has first of all to be considered as a form of cooperation, and the quality and intensity of this cooperation is decisive for the results to be gained. Next, it seems to be very important that the initiative for

cooperation comes from the *firms* and not from the government. The government is most successful when it takes an *enabling* position, viz. a position as a partner that creates conditions and delivers appropriate services. The availability of one big firm which *leads* (pulls) the cooperation process is also an important factor. And the cooperation process runs smoother when the participating firms are no direct competitors of each other (Dekker 1997). Other factors which are very important, mentioned by i.e. Van der Veeken (1998) and Kolpron (1998, 1), are:

- creation of *trust* among all participants;
- making ideas of *stakeholders* central to the project;
- showing respect for each others *interests*;
- assurance that all cooperation is *voluntarily*;
- creation of an *association* of firms engaged in the project;
- avoidance of a *too early start* start with the *implementation* of projects;
- creation of *support* both in politics and government;
- ensurance that the project is really *integrated* (environment, ecology, spatial quality);
- good *monitoring* to guarantee the ultimate ecological goals;

To these essential prerequisites a number of recommendations can be added:

- there has to be a chance of success in the *short run*;
- enough *financial means* have to be available for the plan;
- make use of *existing management means* of firms as much as possible;
- participating firms are located *at close distance;*
- the partipating firms best are of a *diverse nature*, with complementary material needs;
- take care of *good public relations*

The literature is less specific about factors which determine failure of eco-parks, but we can safely assume that the absence of factors and circumstances as specified above may be considered as failure-factors. More generally, the biggest risk of developing sustainable business sites is involved in the fluctuating supply of materials, water and energy which

have to be exchanged as part of the cooperation process (Kolpron 1998, 1). This exchange is the "strategic cycle" of the whole project, and contains 90% of the risk of each sustainable site project (Ministerie EZ 1998). This crucial risk can be avoided as much as possible by making agreements between firms concerning the availablity of reserve supplies.

Collaboration and consensus in eco-park planning

The practical experiences with respect to success and failure factors as outlined above find a theoretical underpinning in recent developments in planning theory. One can observe a gradual shift from a more technically oriented planning approach in the early twentieth century, via a comprehensive rational planning approach in the mid twentieth century, to more interaction-oriented types of planning in the last two decades (Healey 1997). Woltjer characterizes interaction- or communication-oriented planning as *consensus planning*, and argues that it has deep roots in the ideas about public participation which developed in planning literature since the late 1960s and early 1970s (Woltjer 2000). He distinguishes between three types of consensus planning, in which agreements are made on the basis of

1. a process of collaboration and learning; or
2. a process of bargaining and negotiations; or
3. a process of persuasion and will shaping.

The eco-industrial park literature, and the list of success factors emerging from that literature indicates that the first of Woltjer's three options is the more common, or at least the more rewarding one in case of eco-park planning. Woltjer states that "the main characteristic of this type of consensus planning is that planning products are created from opinions. An implication of this emphasis on opinion is that choices in decision making are founded on communicative rationality. Good solutions, then, are those upon which people come to agree" (Woltjer 2000, p. 27). These may be solutions other than would have been chosen on the basis of technical rationality, which is rejected in consensus planning. Compromising is not the point either: the process of collaboration and learning is not a competition where one party wins and one party loses or where both parties settle for a compromise. As argued by Gray, collaboration is "a process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond

their own limited vision of what is possible". It is designed to produce solutions that no actor working independently could achieve (Gray 1989).

Gray, like many others, identifies three stages in the process: preparation, determination, and implementation. She attaches much significance to the *second* stage in which parties identify the interests that brought them to the table, determine how they differ from the interests of others, set directions and establish shared goals (Woltjer 2000, p. 67). This clearly matches the leading position of the factors of interest and trust in the list of eco-park success factors. At the same time we have to stress, as many consensus planning authors do, the importance of the *first* stages of collaboration. Early involvement enables stakeholders to exert influence on basic goals of planning and possible alternatives. Goals and alternatives, which in case of entrepreneurs who consider a location on an eco-industrial park will normally be described in terms of the two leading ideas in all business decision making: profit and permanence. In the next section, we will consider the question whether these economic goals are sufficiently and adequately included in the present conceptualization of sustainable business sites.

A different perspective on sustainable business sites

Before entering the phase of conclusions, a critical note has to be discussed, which may lead to a different perspective on the concept of sustainable business sites than we have taken thus far. This critical note relates to the one-sided view on sustainable sites as projects which have to serve an environmental goal in the first place and in the best case create a win-win situation with respect to environment *and* economy. This sometimes leads to a fragmented utilization of the concept. One project is mainly about multiple space use, another mainly about waste management, and a third mainly about multimodal transport. This is not satisfactory. A clearer vision emerges, according to Donkers (1998) when the fashionable but worn out term *sustainability* is replaced by the term *continuity*. As Donkers argues, the sustainability of a site is only meaningful when it contributes to the continuity of the firms which are established there, and thus to the permanence of the location (site *and* firms) as a whole, which - for this - has to be both vital and flexible.

This different view on the nature of a sustainable site, which in fact implies the introduction of the *time* dimension, is also advocated in recent publications by Kolpron Consultants.

They argue that the real challenge is *to gain and retain a high quality of both public and private space* (1998, 2) and introduce the term *Park Management* as a general strategy to achieve this goal. Park Management in their view is the instruction to achieve a prolongation of a site's life cycle both in ecological and economic terms. Environmental measures in terms of the "streams" and "area" options alone are not enough to bring this about. The intensity of space use is important, but so is the lasting quality of infrastructure in all its aspects. Ecological chains and a reduction of material use and emissions are of interest, but the permanent efficiency of site organisation and the installation of rules governing processes on the site are also important. In fact, the shift from "sustainability" to "continuity" also moves our view from isolated (prestige) projects to the all-embracing question of sustainable industrial location planning for the economy as a whole. It makes us ascertain that sustainable sites are not just one more addition to the segments in the location market, but that they stand for a new vision on the management of *all* possible business sites, including existing sites, and most especially existing sites that have become obsolete and thus threatened in the continuity of their existence.

The alternative view of Donkers and Kolpron, which was recently shared by Cohen-Rosenthal and Smith (2001) in their plea for the "creation of value" through eco-industrial development, gives a more prominent place to economic goals in the concept of sustainable business sites. This is certainly defensible from the standpoint of developers or entrepreneurs who invest their money in a business site and have to consider the sustainability of their investment in terms of financial returns over a longer period. For them, the idea of continuity of both firm *and* environment feels attractive and it is hard to ignore their opinion; not only because we learned from Woltjer that consensus planning products are always created from opinions, but because the opinion of these actors is so crucial to get a project going. On the other hand, from the viewpoint of sustainability in pure ecological terms the same idea is highly debatable. Seen from this angle, a firm is only an organisational means for structuring human capability to make products and services, and eventually the idea of continuity should apply to this human enterprise and not to its organisational framework. The temporary nature of these frameworks - the average age of firms is much lower than that of people, with large numbers "dying" before the age of five -

is even one of the most critical aspects of the production networks which are being set up on eco-industrial parks.

Apart from the discussion about the proper place of the firm and its economic goals in the eco-park concept, the idea of using the concept in the context of *redeveloping* existing business sites is attractive. The problem of obsolete business sites is a vast and growing problem. For the Netherlands, it is estimated that one third of all existing business sites suffer from some degree of obsolence, ranging from overdue maintenance and accessibility problems to all kinds of environmental stress. Of the total area of all business sites in the Netherlands, which covers circa 58,000 hectares, some 10,000 hectares are in some degree of obsolence (Ministerie EZ/Heidemij Advies 1996). Cities with strong roots in the industrial era are having to cope with the problem of industrial sites becoming out of date. Problems of site deterioration are relatively big in harbour cities, industrial cities, textile cities, and cities in (former) mining areas. Next to the already mentioned maintenance and accessibility problems, the obsolete sites usually suffer from financial problems, lack of attention from governments, and a bad image. And: environmental problems are often a big part of the overall problem of obsolence.
Solving the problem of obsolete business sites becomes of more and more importance, certainly in the Netherlands, where a growing shortage of business sites is forecasted for the next decades. Until the year 2030 the demand for "space for work" will vary between 32,000 and 54,000 hectares, of which roughly three quarters (24,000 - 40,000 hectares) will be demanded in the form of business sites. Only 8,000 hectares are now available (Ministerie VROM 2001). An amount of 10,000 hectares of obsolete sites can hardly be neglected in such a situation. To the degree in which we succeed in solving the problems of deterioration on old and existing business sites, and re-introduce them in the location market, we can avoid using scarce space for the creation of new business sites. Such a mission fits very well into the perspective on sustainable business sites as *locations of permanence*. At the same time it puts the core of the effort in the *urban* environment, where the greater part of the obsolete business sites are to be found, and where immense opportunities can be utilized to upgrade urban areas through the practice of sustainable site planning.

Conclusions

Eco-industrial parks are a new location concept, developed on the crossroads of two trends, viz. the segmentation in the location market and the wish to reconcile economy and ecology. Witnessing the situation in the Netherlands the new concept is a powerful one. Within a few years a great number of sustainable site projects came off the ground. Judging from the preliminary results of our survey the ambitions of the stakeholders in these projects are ample, sincere, and promising. On average, the activity level on the parks with the eco-label is significant. A multitude of actions covering both the "site arrangement" and "production process" side of the eco-medal is practised. Still, a majority of the representatives of eco-parks think the concept is rather vague, which is hardly surprising for a phenomenon which is so recent.

The survey of eco-parks and the emerging literature about sustainable site planning together produce a number of insights as to the factors which determine success or failure. A crucial point is the interest of firms. Eco-industrial parks will only be successful if individual firms believe they will gather some sort of benefit in economic terms from their location on these parks. They underline that eco-parks should be viewed as *business locations* in the first place, and not as areas where housing or nature values are predominant and firms are only tolerated if they comply with certain regulations. Only if the business interest is clear enough, will firms be inclined to adapt their buildings, their functions and their processes.

The explicit wish of firms to participate in ecological schemes on the local level is important as a starting point, because it is crucial for the *implementation* of any plan for a sustainable site. Firms just will not buy land on a site in which they can put no trust. And local governments, who in most cases are the developers of business sites, will be reluctant to label a site as "sustainable" if there is a chance to be left with unsold land and thus suffer financial losses. In this context, it is also very relevant for a firm to have a clear picture of what is to be expected of the future relationship between the partners in an eco-park project. Will the agreements which are made at the start of an eco-park project bind the partners in any unforeseeable way in the future? This is what firms are instinctively afraid of. They realize the benefits of "ecological cascades" and "closed material circles" as they can be realized at a certain point in time. But will agreements which are made up now not change

into obstacles for necessary change in the future? Fear of not being free to adapt the firm's functions and processes to whatever changes are needed in the future business environment may prevent a firm to engage in cooperation projects on eco-industrial sites. The more complex the agreements are, the more this fear will grow. Very complicated cooperation-agreements or -systems, such as the ones working with points for "environmental effort" on the Ecofactorij site in Apeldoorn are suspect by definition, and only applicable where the sites are very attractive and/or scarce and the risk of non-selling is small.

Looking at the problems facing the development of sustainable business sites in practice, one more point which has to be considered is the composition of the group of firms on a site. On the one hand there is the undeniable tendency of segmentation in the location market, which leads to the wish of similar, *homogeneous* firms to group together on a site, which adds to the appearance and image of the site. On the other hand, the concept of sustainable sites requires the presence of different, *heterogeneous* firms, because they create possibilities for closing ecological chains by using each others by- and waste products (Dekker 1997). Between homogeneous firms, who produce the same products and waste materials, little exchange is possible. Heterogeneous firms hold bigger opportunities in this respect. Here the concept of eco-park becomes, in a way, contradictory in itself. As a response to location market trends, carrying a "label" which coresponds to a specific segment of that market, an eco-park could gain radiance by assembling firms of similar appearance and character. But as a sustainable site it needs firms of diverging nature, which doesn't add to the recognizibility and image of the site. In the previous sections, we mentioned public relations as a success factor. This issue of homogenity/heterogenity will prove to be one of the more difficult points to communicate!

Finally, we may consider the possibility of taking a different view on the concept of eco-industrial parks by adding a time perspective, as argued in the previous paragraph. In that case, the ultimate goal is not *sustainability* in pure ecological terms but *continuity* of the firm *and* its environment. We described this with the term *locations of permanence* and saw that the relevance of this view depends of the position one takes: an economic or a social one. In the alternative perspective, the attention shifts from firms to governments, and from

new sites to *all* sites. Redevelopment and revitalisation of existing but obsolete business sites becomes an important part of the mission to create sustainable business sites, especially in urban areas. The devotion of local governments is of special importance here. Normally, local governors are more interested in new sites than in old sites. They bring money and prestige, and once sold are out of concern. For existing sites, this attitude must change. Although not in the position of land owner or estate manager, local governments have to accept a responsibility for redevelopment, including financial obligations. If local governments are not inclined to invest interest and money in the revitalisation of obsolete sites, the firms established on such sites will not do this either, nor will new firms or relocating firms consider these old sites as possible locations.

Redeveloping obsolete business sites is all the more important because it contributes to the "anchoring" of firms in urban locations, and puts a brake on the continual flow of firms to new suburban and ex-urban business sites. In the Netherlands this process of economic suburbanisation has been going on for many decades now and is still growing in magnitude (Pellenbarg and Kemper 1998). Comparable developments can be observed in many other countries, especially in crowded urban areas. One of the problems arising from the suburban and exurban sprawl of economic activity is the growth of personal (car)mobility. Intensifying the activities aiming at the sustainability and continuity of existence of business locations in urban environments is of utmost importance to control this undesirable growth of mobility and thus contributes to one of the most important targets of spatial planning.

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Appendix 1

EXAMPLES OF OPTIONS FOR SUSTAINABLE PRODUCTION PROCESSES AND SUSTAINABLE SITE ARRANGEMENT

A. Options for sustainable production processes **(STREAMS)**

1. exchange of energy, raw materials and water
    - re-use of process water/waste water
    - use of warmth/cold surplus of production processes
    - use of rest-materials als raw materials
    - use of high-caloric waste materials as fuels
2. joint use of utilities and firm functions
    - joint energy systems
    - joint waste water purification
    - joint use of installations for compressed air
    - collective car wash installations
    - collective maintenance workshops
    - collective storage facilities
3. collective gathering and removal of waste materials
    - collective waste removal contracts
    - collective waste deposit
    - prevention teams and -circles
4. combining transport of goods and people
    - combining freight transports
    - combining out and back loads
    - regional freight terminals
    - collective bus services for employees (door to door)
    - collective coordination of car-pooling
    - collective sharing-systems for cars, taxi's and bicycles

B. Options for sustainable site arrangements **(AREAS)**

1. more intensive use of space
    - "piling" of firms/activities on the same floorspace, high rise building
    - collective buildings for small firms
    - joint parking facilities
    - collective storage of goods and materials
    - strategic land reserves
    - collective land reserves
    - redevelopment of land becoming vacant
2. public utilities with high useful effects
    - heat/power combinations
    - solar and wind energy for pumps, lighting, illuminations
    - process water from surface water and rain water
    - separating sower systems for re-use and drainage
    - pipelines for exchange of energy and material flows
3. joint commercial firm facilities
    - joint safety systems
    - joint maintencance systems for buildings and public green
    - joint facilities for telematics
    - joint facilities for banking and postage
    - joint facilities for meetings, education, flexible offices
4. multimodal transport and high quality public transport
    - public terminals with access to rail, water and pipelines
    - spatial concentration of shippers and transporters
    - transferia and free bus routes
    - combinations of train, light rail, bus and train taxi
    - site transport systems (share cars, -cabs and -bicycles)

Source: Ministerie EZ/Ministry Econ. Affairs (1998) Duurzame bedrijventerreinen/Sustainable business sites

Appendix 2
SURVEY OF SUSTAINABLE BUSINESS SITES IN THE NETHERLANDS, 1999
A. List **(province**/place/*site)*

Friesland
01 Heerenveen/*Heerenveen-Zuid*
Groningen
02 Groningen/*Milieuboulevard Groningen*
03 Delfzijl/*North Refinery Delfzijl C.A.*
Drenthe
04 Beilen/*Ossebroek*
05 Wijster/*Tweesporenland(VAM)*
06 Emmen/*Veenoord*
Overijssel
07 Kampen/*Haatland 7*
08 Zwolle/*Hessenpoort*
09a Deventer/*Colmschate Noord*
09b Deventer/*Bedrijvenpark A1*
09c Deventer/*Bergweide*
10 Hengelo/*Westermaat-Noord 2*
Flevoland
11 Emmeloord/*Ecobedrijvenpark*
12 Lelystad/*Noordersluis*
13 Lelystad/*Ecobedrijvenpark*
14 Almere/*De Vaart*
Gelderland
15 Apeldoorn/*De Kar/Ecofactorij*
16 Zutphen/*De Mars*
17 Barneveld/*Harselaar-West*
18 Arnhem/*Kleefse waard*
19 Arnhem/*Business Park Arnhem*
20 Arnhem/*Koningsplei*
21 Arnhem/*IJsseloord 2*
22 Arnhem/Nijmegen/*MTC Valburg*
North Holland
23 Alkmaar/*Boekelemeer Zuid fase 1*
24 Heemskerk/*De Trompet*
25 IJmuiden/*Business Park IJmond*
26 Zaanstad/*Westzanerpolder*
27 Zaanstad/*Achtersluispolder*
28 Zaanstad/*Hembrugterrein*
29 Amsterdam-Noord/*Cornelius Douwes terrein*
30a Amsterdam/*Lutkemeer*
30b Amsterdam/*Westpoort-Afrikahaven*
31 Hoofddorp/*Transpolis Schiphol Airport,*
32 Schiphol/*De Elzenhof*
South Holland
33 Europoort/*INES-CEATON*
34 Rotterdam/*Truckpark Waalhaven*
35 Rotterdam/*Spaanse polder*
Utrecht
36 Woerden/*Kantorenstraat*
37 Harmelen/*Glastuinbouw Harmel.*
38 Vleuten-deMeern/*Ouden Rijn*
39 Utrecht/*Leidsche Rijn*
40 Utrecht/*Lage Weide*
41 Amersfoort/*Isselt*
42 Amersfoort/*De Hoef*
43 Amersfoort/*Calveen*
44 Amersfoort/*De Wieken*
45 Amersfoort/*Vathorst*
46 Nieuwegein/*Het Klooster*
47 Houten/*De Bark*
48 Veenendaal/*De Batterijen*
North-Brabant
49 Oss/*Moleneind*
50 Moerdijk/*Moerdijkse Hoek*
51 Den Bosch/*De Rietvelden*
52 Dinteloord/*AgroIndustr.Complex*
53 Breda/*De Krogten*
54 Eindhoven/*De Hurk*
Zeeland
55 Goes/*De Poel, Goes-Zuid*
56 Middelburg/*De Mortier*
Limburg
57 Sittard/*Fortuna Park*
58 Heerlen/Aken/*Avantis*
59 Maastricht/*Beatrixhaven*

Source: Bakker et al 1999
Duurzame Bedrijventerreinen
FRW/RUGroningen

Appendix 2
SURVEY OF SUSTAINABLE BUSINESS SITES IN THE NETHERLANDS, 1999
B. Map

Source: Bakker et al 1999
Duurzame Bedrijventerreinen
FRW/RUGroningen