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Pilot Project
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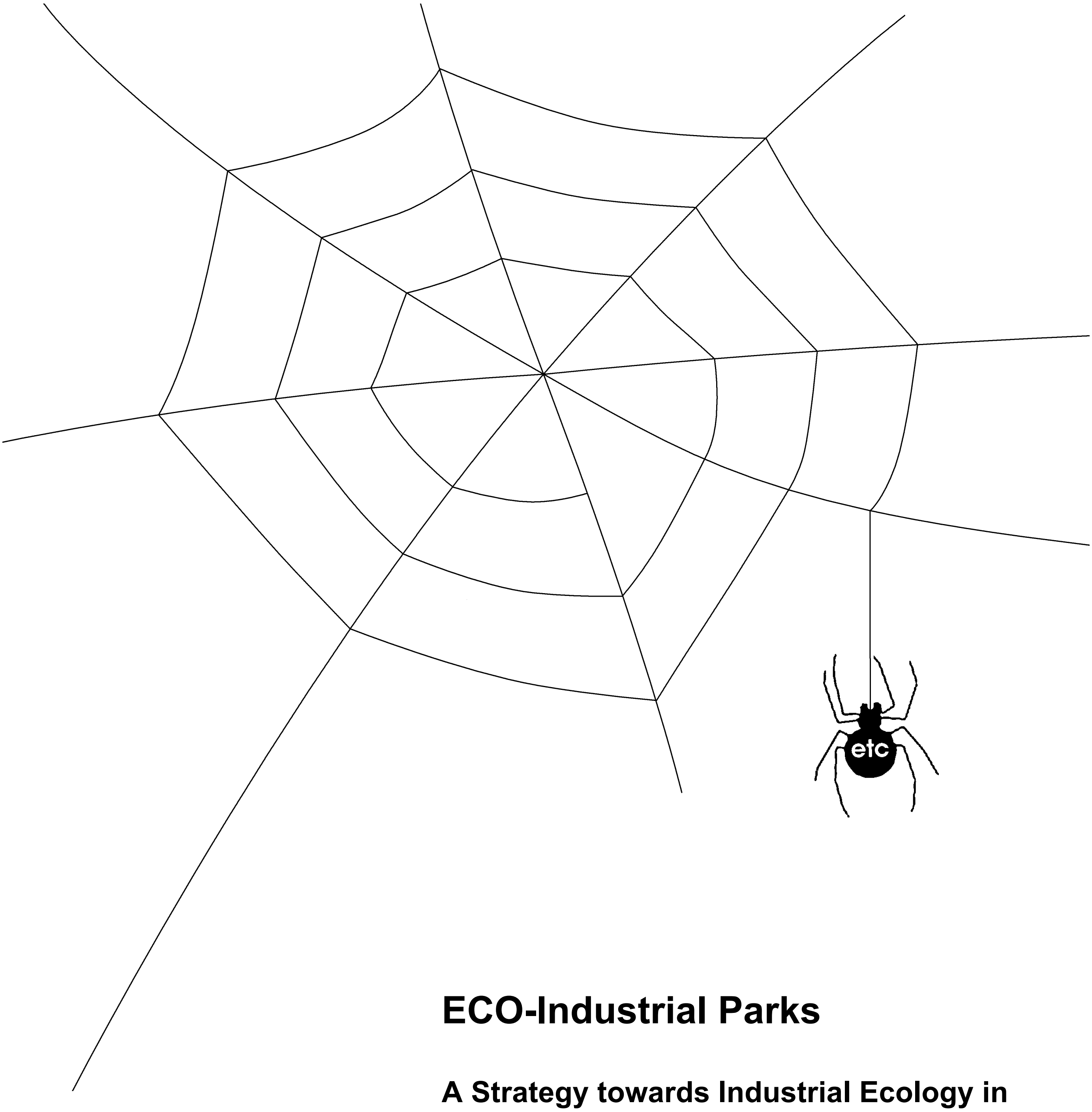

ECO-Industrial Parks

A Strategy towards Industrial Ecology in Developing and Newly Industrialised Countries

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH

Pilot Project
Strengthening Environmental Capability in Developing Countries (ETC)

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A Strategy towards Industrial Ecology in Developing and Newly Industrialised Countries

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Introduction

Eco-Industrial Parks represent a promising strategy to promote sustainable industrial development and implement industrial ecology concepts. They also provide a new model for local economic development.

The benefits Eco-Industrial Parks provide may serve as incentives for companies to improve their environmental performance in terms of management of materials, energy and waste. The potential they offer in terms of local development is already encouraging communities to invest in concepts incorporating this approach to industrial development.

This paper considers how Eco-Industrial Parks relate to the generic concept of Industrial Ecology and examines their viability. In particular, this paper looks at the future role of Eco-Industrial Parks in developing and newly industrialised countries.

Given that Eco-Industrial Parks lay emphasis on local and regional industrial development and the environment, they offer a number of areas where the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH – German Technical Cooperation – can play a role. This is especially true for the BMZ-GTZ pilot project "Strengthening Environmental Technological Capability in Developing Countries (ETC)". The pilot project ETC brings together decision-makers from state and private sector institutions in China, India, Indonesia and Thailand to promote environmental technological capability. Advanced technological capability is indispensable for coping with environmental issues and problems. Technological capability is the result of both individual efforts and close interaction among the state (**S**), industry (**I**), financing institutions (**F**), research (**R**) and education (**E**) sectors within every country. In order to promote Environmental Technological Capability, the ETC project — within the framework of initiatives for environmentally benign production processes and management systems — supports:

- a common understanding of environmental technological capability among the main players in developing countries,
- proposals for new forms of information exchange between developing countries and partners from German industry,
- information events, contact meetings, and the planning process of cleaner technology initiatives,
- advice on financial investment strategies for environmental technology.

A number of schemes are already underway to introduce Eco-Industrial Park approaches into South-east Asia. The ETC project supports, at present, the appraisal mission on implementing Eco-Industrial Park concepts in Thailand. The facts and recommendations of the mission report will again stimulate discussion among ETC partner organisations on engaging in further initiatives to evaluate experiences with EIP and to draw conclusions on future developments.

Our thanks go to all the experts who have contributed to this paper and in particular to Ms. Fleig, who compiled all the relevant information and gave support to a highly important strategic discussion among projects and partners of German Development Cooperation.

Bernhard Zymla Ulrich Stöhr-Grabowski

GTZ-Group 4454, Eco-efficiency in Business and Industry
Pilot Project: Strengthening Environmental Technological Capability (ETC)

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Abbreviations

CP	Cleaner Production
DC	Developing Country
EIN	Eco-Industrial Networks
EIP	Eco-Industrial Park
EPA	United States Environmental Protection Agency
EST	Environmentally Sound Technology
ETC	BMZ-GTZ Pilot Project: Strengthening Environmental Technological Capability in Developing Countries (under Section 44 of GTZ)
IE	Industrial Ecology
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Technical Cooperation)
NIC	Newly Industrialised Country
P3U	BMZ-GTZ Pilot Project for the Promotion of Environmental Management in the Private Sector of Developing Countries (under Section 44 of GTZ)
PPP	Public Private Partnership
SME	Small and Medium-scale Enterprises
TC	Transformation Country

1. Industrial Ecology

1.1 Background

The term Industrial Ecology has become widespread since 1989, when Frosch and Gallopoulos introduced their concept of industrial ecosystems in the Scientific American (Frosch & Gallopoulos 1989).

Increasing pollution of the environment, growing pressure on natural resources and the resulting demands for sustainable development formulated in Agenda 21 have led to a growing interest in new technologies and industrial development approaches. Thus "… industrial ecology is emerging as an exciting approach to the application of environmentally sustainable economic development." (Côté & Rosenthal 1998).

1.2 Definitions

It is difficult to come up with a single definition for “Industrial Ecology” since the term is being used at various levels with slightly different meanings. It may denote a specific area of scientific research, a philosophy / framework / umbrella (Cohen-Rosenthal 1996), or a movement.

As a **scientific subject**, Industrial Ecology has been defined as follows:

"The study of the physical, chemical and biological interactions and interrelationships both within industrial systems and between industrial and natural ecological systems." (A. Garner and G. A. Keoleian, 1995).

Research in the field of industrial ecology aims at finding strategies and methods to minimise the negative impacts of industrial systems on surrounding systems which occur through exploitation of resources as well as disposal of used products, by-products and wastes.

Industrial Ecology as a **framework** tries to give guidance towards the transformation of industrial systems. The basic philosophy is to change linear production processes (raw materials are converted into products, by-products and wastes) into loops (used products, by-products and wastes of one process are used as resources for another) by imitating the cyclical use of resources in natural eco-systems. Thus the goal is that of "bringing the industrial system as close as possible to being a closed-loop system with near complete recycling of all materials" (E. Lowe 1993).

As a **movement**, Industrial Ecology has evolved out of the ideas mentioned above. Like the concept of bionics, which also looks at natural models, Industrial Ecology seems to have created catalytic effects. It has led to a paradigm shift, stimulating research, discussion, new ways of thinking and actual implementation (Lifset 1997 / Cohen-Rosenthal et al. 1998 / Lowe 1995), and encouraging communities, companies and scientists to work on what some people call "the next industrial revolution" (Lifset 1997).

Looking at these definitions and descriptions of aims, one might ask: **"What is new about it?"** — In fact, there were many attempts to reduce negative impacts of industrial production a long time before the term Industrial Ecology evolved. In many cases, industries exchange by-products due to economic advantages or interact via ”by-product trading agents” without using the label of industrial ecology.

The revolutionary idea beyond these already existing practices in the concept of industrial ecology is the systems-oriented approach and the link with natural eco-systems in a twofold manner:

1. <u>Analogy</u>: Natural systems are seen as a "… model of highly efficient use of resources, energy, and waste" (Lifset, 1997), which industrial systems should try to adopt.

2. <u>Integration</u>: Industrial systems are viewed as only one part of the surrounding systems, with which they have to be in concert (Jelinski et al. 1992).

In these approaches, Industrial Ecology "differs both from current **economic practice**, where only phenomena that can be quantified and are captured in the price structure are deemed to matter for most resource allocation and consumption decisions and from current **environmental regulation practice**, which emphasises nonsystemic, single dimensional definitions of, and responses to, environmental perturbations" (Allenby 1992).

2. Eco-Industrial Parks (EIP)

2.1 Background

Eco-Industrial Parks are one of the strategies to implement the concept of industrial ecology by inter-company collaboration. The idea of Eco-Industrial Parks has been first described during a presentation at the United Nations Conference on Environment and Development (UNCED), Rio de Janeiro 1992, and has become well-known from 1993 on in the USA through the introduction of Indigo Development to the US-EPA (Lowe et al.1998).

2.2 Definitions and Interpretations

The concept of Eco-Industrial Parks tries to mirror — in an industrial context — the inter-linkages and material / substance flows observed between organisms in natural ecosystems. There are different definitions describing EIPs and similar structures, distinguished by the level of geographic concentration and fields / complexity of co-operation:

<u>Eco-Industrial Park</u>
"… a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water, and materials. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realise if it optimised its individual performance only" (Lowe et al. 1998).

Use of the term Eco-Industrial Park usually encompasses geographic co-location of the collaborating companies (compare "Virtual Eco-Industrial Park"). Thus, the main differences between Eco-Industrial Parks and “usual“ industrial parks are:

⇨ enhanced co-operation / exchange between companies, park management and local / regional decision makers
⇨ these actors’ common striving towards a vision of industrial activities which are of utmost sustainability in terms of economic, ecological and social aspects.

<u>Virtual Eco-Industrial Park</u>
"… a region, in which industries are not necessarily co-located, but linked through exchange of waste" and collaboration at different levels” (Cohen-Rosenthal et al. 1996).

By-product Exchange Network

a community or network of companies and other organisations in a region who choose to interact by exchanging and making use of by-products and / or energy in a way that leads to reduction of resource inputs needed and by-products / pollution produced (following Gertler 1995 on Industrial Ecosystems).

Industrial Ecosystem

a system in which the consumption of energy and materials is optimised, waste generation is minimised and the effluents of one process … serve as the raw material for another process (Frosch & Gallopoulos 1989).

Industrial Symbiosis

highly inter-dependent relationship between two firms, exchanging materials and energy in a mutually advantageous manner, each contributing to the welfare of the other (Manahan 1999).

Some authors use the terms "Industrial Symbiosis", "Industrial Ecosystem", "By-Product Exchange Network" and "Eco-Industrial Park" as synonyms. However, the terms "Industrial Ecosystem" and "Industrial Symbiosis" as well as the term "Eco-Industrial Network" are usually used as an umbrella for a number of co-operation structures, e. g. Eco-Industrial Parks and By-Product-Exchange Networks, as well as for systems on higher levels, e. g. national or even global.

The understanding of how companies in Eco-Industrial Parks should interact as well as the resulting strategies cover a wide range of features. While some authors merely refer to connecting material and energy flows (S. Manahan 1999 / Schön & Kunze 1999), others go far beyond that, addressing e. g. integration into the surroundings, construction technologies and the management (Lowe et al. 1998, see Box 1). Others additionally include the social factor, pointing out the fact that "Valuing natural resources means also valuing human resources" (Cohen-Rosenthal et al 1998), thus arguing in line with the three components of sustainability outlined in the Agenda 21 (UNCED 1992) - the economic, ecological and social components (Côté & Cohen-Rosenthal 1998).

In order to emphasise the high-quality approach in the concept of Eco-Industrial Parks, there have been some suggestions on avoiding the already widespread inflationary use of the term “Eco-Industrial Park”, stating that its approach goes beyond the types of industrial clusters mentioned below (Lowe et al. 1998):

- a single by-product exchange pattern or network of exchanges
- a recycling business cluster (resource recovery, or recycling companies)
- a collection of environmental technology companies
- a collection of companies making "green" products
- an industrial park designed around a single environmental theme (e. g. a solar energy driven park)
- a park with environmentally friendly infrastructure or construction

  a mixed-use development (industrial, commercial, and residential).

STRATEGIES FOR DESIGNING AN ECO-INDUSTRIAL PARK (EIP)

Several basic strategies are fundamental to developing an EIP or industrial ecosystem. Individually, each adds value; together they form a whole greater than the sum of its parts.

Integration into Natural Systems

Minimise local environmental impacts by integrating the EIP into the local landscape, hydrologic setting, and ecosystems;

Minimise contributions to global environmental impacts, i. e. greenhouse gas emissions.

Energy Systems

Maximise energy efficiency through facility design or rehabilitation, co-generation[1], energy cascading[2], and other means;

- Achieve higher efficiency through inter-plant energy flows;
- Use renewable sources extensively.

Materials Flows and 'Waste' Management for the Whole Site

Emphasise pollution prevention, especially with toxic substances;

Ensure maximum re-use and recycling of materials among EIP businesses;

Reduce toxic materials risks through integrated site-level waste treatment;

Link the EIP to companies in the surrounding region as consumers and generators of usable by-products via resource exchanges and recycling networks.

Water

Design water flows to conserve resources and reduce pollution through strategies similar to those described for energy and materials.

Effective EIP Management

In addition to standard park service, recruitment, and maintenance functions, park management

- Maintains the mix of companies needed to best use each others' by-products as companies change;
- Supports improvement in environmental performance for individual companies and the park as a whole;
- Operates a site-wide information system that supports inter-company communications, informs members of local environmental conditions, and provides feedback on EIP performance.

Construction/Rehabilitation

New construction or rehabilitation of existing buildings follows best environmental practices in materials selection and building technology. These include recycling or reuse of materials and consideration of life-cycle environmental implications of materials and technologies.

Box 1: E. Lowe et al. 1998

[1] Co-generation is the capturing and using of otherwise "wasted" heat from the electricity generation process.

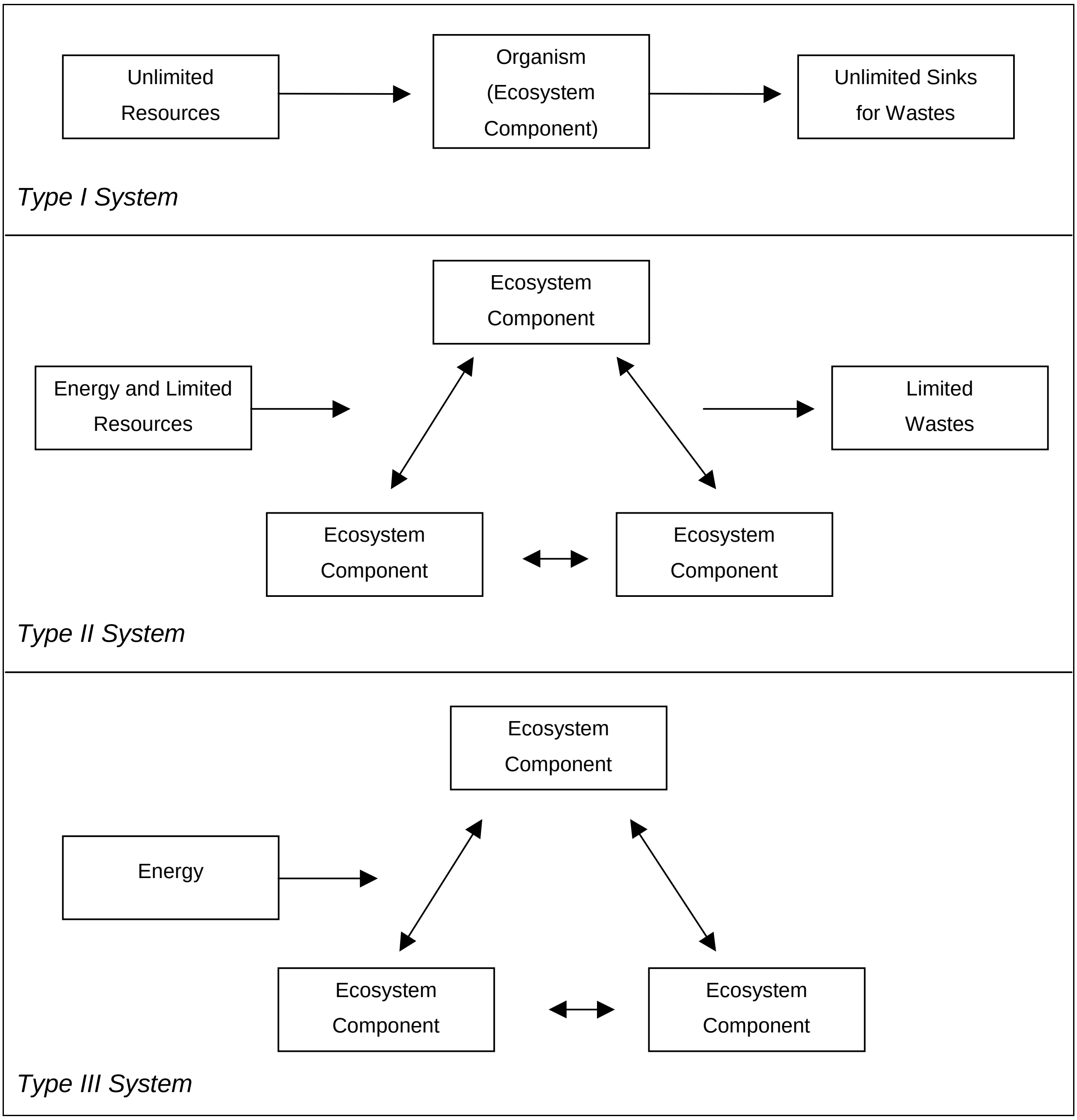
[2] Energy cascading is using residual heat in liquids or steam from a primary process to provide heating or cooling to a later process. For example, steam from a power plant is used in a district heating system.

2.3 Cyclical Loop Systems and Co-operation

<u>Closing the loop</u>

As mentioned above, moving from linear throughput to closed-loop material and energy use is a key theme in industrial ecology (Ehrenfeld & Gertler, 1997) and is also one of the characteristics of what is discussed as a "mature" Eco-Industrial Park.

This process, described as a change from a Type I to a Type III System (Allenby, 1992) is seen as the evolution towards industrial ecosystems (see Box 2)



Box 2: Braden R. Allenby 1992

Allenby describes a Type I System as a linear constellation, where energy and resources enter the system and products and wastes leave it. Many early stages of industrial development show characteristics of a Type I System. However, this concept could only work in a situation with unlimited resources to feed the system and unlimited space to deposit wastes and used products leaving it.

The characteristics of a Type II system are: reduced input of resources, limited amount of waste leaving the system, and collaboration of ecosystem components exchanging energy and materials. This type represents high-technology industrial systems with a certain degree of pollution prevention and waste recycling.

"A Type III system represents the dynamic equilibrium of ecological systems, where energy and wastes are constantly recycled and reused by other organisms and processes within the system. This is a highly integrated, closed system. In a totally closed industrial system, only solar (or other renewable) energy would come from outside, while all by-products would be constantly reused and recycled within. A Type III system represents a sustainable state and is an ideal goal of industrial ecology." (Garner & Keoleian 1995).

While the Type III System seems to be an ideal goal at a higher level (as discussed by Allenby), a closed cyclical loop system is not achievable at the level of Eco-Industrial Parks, and would most probably not make sense, anyway. At least the fabricated products do have to leave the park, diminishing the amount of materials circulating within the system and thus requiring new material inputs (which, of course could be redistributed products for recycling). "The goal is not hermetically sealed "biospheres" but real world solutions to improving business and environmental performance simultaneously." (Cohen-Rosenthal 1996).

Similarly, on company level the closing of loops and "the belief in the perfection of the circle can not be taken too far" (Esty & Porter 1998). The closing of certain loops may result in costs exceeding the benefits, even if increased company reputation, social and ecological benefits are taken into account.

At Kalundborg, where interconnections are highly developed and which is the most often cited example of a well working industrial ecosystem (apart from water-steam loops), there are no real *cyclical* **material flows** between the collaborating companies (according to schematics of Ehrenfeld & Gertler 1997/ Lowe et al. 1998 / Manahan 1999). The achievement within the "Kalundborg Symbiosis" is that companies communicated and co-operated so that all main by-product flows could be directed *forward* to further users converting them into products, which then leave the system.

Looking at **energy flows** and exchange between collaborating companies, what is actually practised is called **energy cascading**. It "… involves the use of the residual energy in liquids or steam emanating from one process to provide heating, cooling, or pressure for another process" (Ehrenfeld & Gertler 1997).

Although the focus of collaboration in many EIP-projects has been on developing inter-firm exchange of by-products and energy cascading, experts state that this is only one characteristic of a full Eco-Industrial Park concept (Lowe et al. 1998 / Côté & Cohen-Rosenthal 1998). More areas for co-operation in EIPs have been identified (Cohen-Rosenthal 1999, see also Box 3) and the general opinion is that communication and interaction among the respective companies and with the co-located community are fundamental characteristics of EIPs.

Potential Areas of Eco-Industrial Networking

Materials	- common buying - customer/supplier relations - by-product connections - creating new material markets
Transpor-tation	- shared commuting - shared shipping - common vehicle maintenance - alternative packing - intra-park transportation - integrated logistics
Human Resources	- human resource recruiting - joint benefit packages - wellness programs - common needs (payroll maintenance, security) - training - flexible employee assignment
Information/ Communication Systems	- internal communication systems - external information exchange - monitoring systems - computer compatibility - Joint MIS system for Park Management
Quality of Life/ Community Connections	- integrating work and recreation - co-operative education opportunities - volunteer and community programs - involvement in regional planning
Energy	- green buildings - energy auditing - cogeneration - spin-off energy firms - alternative fuels
Marketing	- green labelling - accessing green markets - joint promotion - joint ventures - recruiting new value-added companies
Environment/ Health/Safety	- accident prevention - emergency response - waste minimization - multimedia planning - design for environment - shared environmental information systems - joint regulatory permitting
Production Processes	- pollution prevention - scrap reduction and reuse - production design - common subcontractors - common equipment - technology sharing and integration

Box 3: Cohen-Rosenthal 1999

Besides co-operation *within* the EIP, most authors put emphasis on the interdependence with and necessity of linking EIPs to other structures, webs and / or networks, also at higher levels (Bringezu 2000). There are possibilities for collaboration at local (e. g. the natural environment and the co-located towns), regional (e. g. by-product exchanges with regional but not co-located companies) and even higher levels (e. g. recycling loops on national level).

2.4 Establishing Eco-Industrial Parks

As the field of strategy exploration for the development of Eco-Industrial Parks is very young and dynamic, there is a very lively discussion about a large variety of impulses, proposals and appropriate proceedings.

At present, there seem to be two basically different approaches in the field work on Eco-Industrial Parks - the self-organising and the engineered system (Côté & Cohen-Rosenthal 1998):

Those supporting the **self-organised system** approach argue that facilitated organic growth (without any overall engineering design) of connections between companies provides better results, as the companies keep ownership of the process and the system gradually develops towards being an organism with its own character.

The **engineered system** approach relies on detailed analysis of data as well as local / regional resource and energy flows. It assumes that once possibilities to maximise efficiency in interaction have been demonstrated, intelligent profit-maximising firms will seek to operate accordingly (Côté & Cohen-Rosenthal 1998).

Concerning the <u>starting points</u> for Eco-Industrial Parks, different models have been discussed and put into practice (see Table 1).

Type of model	*Approach*	*Initiators*
ex-nihilo model	Designing an Eco-Industrial Park on a green field and "out of nothing"	public entity developer
anchor tenant model	Identifying an already existing and interested "core-company" and designing an Eco-Industrial Park complementing this "anchor" by establishing a network of businesses needed to supply materials and use by-products	public entity developer company
business model	Attracting a number of tenants in order to develop a certain area and then facilitate network linkages	developer
stream model	Analysing different material/resource flows in an existing industrial system and creating a (Virtual-) Eco-Industrial Park by networking the users of complementing streams	public entity developer companies
business-stream model	A combination of the above-mentioned ones: analysing flows in an existing system, networking users and attracting additionally needed businesses to an available development area	public entity developer companies
redeveloping model	analysing material and energy flows, communication gaps and possibilities of collaboration in a fully established industrial park, enhancing environmental per-formance, cleaning up past pollution, presenting possibilities of improvement and facilitating communication and collaboration (Lowe et al. 1998)	public entity companies, park management

Table 1: Starting Points for EIPs, according to Chertow 1999 and Lowe et al. 1998

In addition to the meta-level discussion of approaches in establishing Eco-Industrial Parks, there are a lot of practical examples and two handbooks available which may help communities and developers consider the development of Eco-Industrial Parks. One of those handbooks describes precise practical steps as to how Eco-Industrial Park projects can be planned and implemented (Lowe et al. 1998), and the other emphasises codes and covenants in the context of eco-industrial development (Cohen-Rosenthal 1999).

The development of Eco-Industrial Parks is viewed as a continuum which takes place in different overlapping steps beginning with improving environmental performance at company level. Five scenarios have been described as follows (Research Triangle Institute 1994):

Scenario 1 - Baseline:

Baseline EIP members and production activities

Scenario 2 - Pollution Prevention

Members implement non-co-operative pollution prevention activities

Scenario 3 - Pollution Prevention plus Industrial Symbiosis

EIP members develop symbiotic relationships with other EIP members and remote partners.

Scenario 4 - New EIP Members

New symbiotic relationships develop as a result of new EIP members.

Scenario 5 – Co-location and Joint Services

Remote partners locate within the EIP. EIP provides environmental services.

Especially in the process of redeveloping already established industrial parks, it is of major importance to analyse and improve material flows as well as to promote a minimum of environment conscious management at company level, before establishing inter-firm exchanges of materials and energy (Bringezu 2000).

2.5 Practical Examples in Industrial Countries

In the following, some examples for Eco-Industrial Park projects are listed and briefly described in order to show practical implementation of the different approaches mentioned above. As a detailed description is not possible in this context, references for further information are added.

a) Eco-industrial parks in the USA (Côté & Cohen-Rosenthal 1998)

Sites	Characteristics
1. Port of Cape Charles, Virginia	Sustainable technologies, natural coastal features (see also: Lowe et al. 1998)
2. Fairfield, Baltimore, Maryland	Transformation of an existing industrial area, co-generation, waste re-use, environmental technology (see also: Lowe et al. 1998)
3. Brownsville, Texas	Regional/virtual approach to waste material exchange, marketing (see also: Lowe et al. 1998)
4. Riverside, Burlington, Vermont	Agricultural industrial park in urban setting, bio-energy, waste treatment
5. Chattanooga, Tennessee	Redevelopment of inner city and former military manufacturing facilities, green areas, environmental technology (see also: Lowe et al. 1998)
6. Green Institute, Minneapolis, Minnesota	Inner city, small scale green business incubator, waste material re-use
7. Plattsburgh, New York	Redevelopment of a large military base, resource and waste management
8. East Shore, Oakland, California	Resource recovery based park, landscaping, energy efficiency
9. Londonderry, New Hampshire	Small scale, community-based park
10. Trenton, New Jersey	Redevelopment of an existing industrial area, clean industries
11. Civano, Tucson, Arizona	New development integrating commercial and residential use, environmental businesses, natural features
12. Franklin, Youngsville, North Caroline	Commercial complex with renewable energy and environmental technologies
13. Raymond, Washington	New park within a second growth forest, recycling of solid and liquid wastes
14. Skagit County, Washington	New park with support systems and centres, environmental industries
15. Shady Side, Maryland	Renovation of existing facility, maintaining jobs, small scale environmental and technological businesses
16. Resource Recovery Park Project, Arecibo, Puerto Rico	Eco-Industrial Park project; advanced waste-to-energy and materials recovery plant as anchor - still at a planning stage (Lowe 2000)

Table 2: Côté & Cohen-Rosenthal 1998 - except No 16

b) Eco-Industrial Parks in Canada

Site	**Characteristics**
1. Burnside Industrial Park, Nova Scotia, Canada	Research and development subject of a university; large site, 1,200 small and medium sized companies; creation of materials and energy cycles, imbedding into the natural environment, renewable energy use, information centre, communication loops (Côté & Hall, 1995 / Lowe et al. 1998)
2. Sarnia, Ontario, Canada	Industrial symbiosis between oil refineries, a synthetic rubber plant, petrochemical facilities and a steam electrical generation station (Côté & Cohen-Rosenthal 1998)
3. Bruce Energy Centre, Ontario, Canada	park organised around a nuclear power station in order to use its waste heat and steam generation capacity for processes such as dehydration, concentration, distillation etc. (Côté & Cohen-Rosenthal 1998)
4. Portland Industrial District, Toronto	Research and development on an industrial area involving enterprises in a variety of sectors in manufacturing and services with the potential of material and energy exchange (Côté & Cohen-Rosenthal 1998)

Table 3: Côté & Cohen-Rosenthal 1998

c) Eco-Industrial Park projects in other industrial countries

Site	**Characteristics**
Kalundborg, Denmark	Highly evolved industrial symbiosis, characterised by a network of inter-firm material exchanges and energy cascades - developed during the past 25 years without influence from outside (Lowe et al. 1998)
Rotterdam Harbour Industrial Ecology Project, Netherlands (ENIS)	Project to explore the potential of creating by-product exchange amongst 60 companies; training for participating companies (Lowe et al. 1998)
Ecopark Moerdijk, Netherlands	Redeveloping an existing industrial site - decontamination of polluted ground (Carstensen 1999)
Recycling Network Styria, Austria	Highly evolved recycling network, including power plants, building materials industry, paper and plastic production and others (Schwarz & Steininger 1997)
Eco-Industrial Park Karlsruhe, Germany	Virtual Eco-Industrial Park; about 40-50 companies; exchange network for organic and mineral by-products, information and communication networking; dematerialization chains (Hiessl 1998 / Schön et al. 1999)
Verwertungssystem Ruhrgebiet, Germany	Highly evolved recycling network; steal plant, power station, building material industries and different other companies exchanging by-products, steam and energy (Schwarz 1996)
Bioenergie und Rohstoffzentrum Dormagen	Virtual Eco-Industrial Park; by-product exchanges and energy cascades, information and research entity; extended collaboration between companies, university and public entities (Denaro 1999)
Gewerbegebiet Henstedt-Ulzburg/Kaltenkirchen, Germany	Eco-Industrial Park project; inter-firm material and energy exchanges, common water treatment approaches, public and private entities collaboration and co-financing (Großmann et al. 1999)
Fujisawa Factory Eco-Industrial Park, Japan	Combination of industrial, commercial, agricultural, residential and recreational components, including technologies and features in energy conservation and cascading, renewable energies, solar greenhouses, waste water treatment using wetlands and reuse of treated water, conversion of wastes into cement and ceramics, reuse and recycling of materials etc. (Côté & Cohen-Rosenthal 1998)

Table 4: EIP-examples by different authors

2.6 Opportunities, Problems and Experts' Outlook on Eco-Industrial Parks

Opportunities and Benefits

Most experts consider Eco-Industrial Parks as one of a number of strategies that could lead to sustainable industrial development (Côté 1998) and as a very helpful tool towards implementation of industrial ecology ideas, resulting in much more environmental protection and, simultaneously, creating a new model for local economic development (Chertow 1999).

"Numbering more than 12,600 around the world, industrial parks have become features of the global landscape, with the potential for significant economic, environmental, and social impact." (Côté 1998). They are "concentrating hundreds of thousands of industries and millions of workers into relatively compact areas. On the one hand, this concentration can increase environmental health and safety risks, while on the other, this co-location can facilitate management of materials, energy and wastes." (Côté & Cohen-Rosenthal 1998).

Thus, exploring and further developing the strategies of creating Eco-Industrial Parks or re-developing existing industrial parks bears an enormous amount of potential to steer the above mentioned impacts - economic, environmental and social - into a sustainable direction.

However, the opportunities created by the concept “Eco-Industrial Parks” are not only manifold in terms of global sustainable development. On the contrary, most authors put emphasis on the positive effects of eco-industrial development at local and regional level — in terms of social and environmental improvement as well as in terms of the advantages for the collaborating companies (Cohen-Rosenthal 1999, see also Table 5):

Communities	**Environment**	**Business**
Expanded local business opportunities	Continuous environmental improvement	Higher profitability
Larger tax base	Better resource use	Enhanced market image
Community pride	Reduced waste	High performance workplaces
Reduced waste disposal costs	Innovative environmental solutions	Improved environmental efficiency
Improved environmental health	Increased protection of natural ecosystems	Access to financing

Recruitment of higher quality companies	More efficient use of natural resources	Regulatory flexibility
Improved health for employees and community		Higher value for developers
Improved environment and habitat		Reduction of operating costs (energy, materials and water)
Partnership with businesses		Reduction in disposal costs
Minimise impact on infrastructure		Income from sale of by-products
Improved tax base		Reduction of environmental liability
Enhanced quality of life in areas near eco-industrial development		Improved public image
Improved aesthetics		Increased employee productivity
Good jobs		

Table 5: Potential Benefits of Eco-Industrial Development (Cohen-Rosenthal 1999)

Once communicated and discussed, these advantages would appear to be very promising incentives for companies to enter into the process of improving environmental performance and joining an industrial symbiosis. The prospects for local development encourage communities to invest in such development designs.

Thus embracing win-win-strategies, the concept of Eco-Industrial Parks has the potential to play a crucial role in spreading sustainable industrial development ideas - much more so than a command and control approach or discussions about environmental protection.

Difficulties / Problems

Even though enthusiasm about Eco-Industrial Parks may be high, to the extent that in some articles they are considered THE strategy towards sustainable industrial development, there are a number of difficulties and problems with this concept.

A general danger of well-established eco-industrial structures lies in their **potential as an obstacle to further evolution** in technologies (Bringezu 2000) and a continued reliance on toxic materials (Lowe, 1998) within the co-operating companies.

In a complex network, each company has a certain part to play, delivers and receives certain materials. If companies, due to the structures they are working in, can easily "get rid of" hazardous materials, thereby avoiding deposit costs, incentives to replace harzardous by non-hazardous materials are low.

If companies working with outdated technological standards can still make profits, due to competitive advantages through networking, and if their public image is positive, due to their being part of an "Eco"-Industrial Park, the pressure to improve technological standards is buffered (Bringezu 2000).

Of course, if companies use outdated technology they will most probably cause less harm to the environment working in an eco-industrial system rather than in isolation, because at least some of their by-products may be used by other companies. However "the pollution prevention solutions of materials substitution or process redesign should take priority over trading toxics within an EIP site." (Lowe et al. 1998)

Another problem often discussed in the context of Eco-Industrial Parks is the creation of complex **inter-firm dependencies**. The higher the level of co-operation, the higher the interdependence and the risks for collaborating companies.

"Companies using each other's residual products as inputs face the risk of losing critical supply or market if a plant closes down. To some extent, this can be managed as with any supplier or customer relationship, (i. e., keep alternatives in mind and write contracts insuring reliability of supply). However the risk to companies increases if they must invest in process changes or transport infrastructure to accommodate exchanges." (Lowe et al. 1998).

However, this risk does not only occur at the level of individual inter-firm relationships. It has also to be taken into account as far as the stability of the park as a whole is concerned, which can tumble if a crucial element is lost (Stoldt 2000).

Additionally, the planning and implementation of new Eco-Industrial Parks bears **the risk of higher development costs** (e. g. from the design process, the site preparation, infrastructure features, construction processes, aspects of building design, see Lowe et al. 1998), due to higher standards, and thus payback periods may be extended compared to traditional parks.

When discussing Eco-Industrial Parks, there also seems to be the danger to **exaggerate the demands in terms of ecological advantages** and to come up with unrealistic "wish lists" (Chertow 1999) and resulting costly and uneconomic development plans. This is the "dimension of Eco-Industrial Parks that the fascination with internal efficiencies tends to ignore. The success of an eco-industrial park will not be simply a function of its environmental record but its ability to compete in the marketplace." (Côté & Cohen-Rosenthal 1998).

Most authors emphasise the importance of public-private partnerships in developing Eco-Industrial Parks. Nevertheless, a major difficulty here appears to be **too much dependence upon public agencies** and too little leadership from real estate developers and other private sector players, although those projects run by private developers seem to be making good progress (Lowe 2000).

Some authors give warnings not to **overemphasise closing material flow loops**, mentioning the inequity of costs and benefit balances resulting in competitive disadvantages of companies: "The tendency of some industrial ecology advocates to overstate their case and insist on the superiority of entirely closed-loop systems is self-defeating." (Esty & Porter 1998).

Although there is a lot of enthusiasm about EIP concepts, it is necessary to remember that they are just one of several strategies towards improved environmental performance within an industrial system. As "**island solutions**" they are not sufficient to enhance sustainable industrial development, but have to be connected with other strategies in different fields and on higher levels (Bringezu 2000).

Outlook

Even though the implementation of Eco-Industrial Park projects has proved difficult in some cases (Andrews et al. 1998 / Chertow 1999), many promising examples have been identified.

Therefore, most experts seem to be very optimistic about the concept of Eco-Industrial Parks, emphasising that "there is growing excitement about the possibilities reflected in EIPs" (Cohen-Rosenthal et al. 1996), and that the idea is definitely spreading in the USA as well as throughout the world (Lowe 2000 / Deppe 2000).

The first demonstration sites in the USA were designated only six years ago, in 2000 there are "over 30 - 40 communities planning, building or operating eco-industrial developments" (Deppe 2000) and experts are confronted with increasing numbers of interested communities and developers.

In Canada, a recent study about the potential for Eco-Industrial Parks identified 40 sites, while industrial ecosystems are already in operation at a number of sites (Côté & Cohen-Rosenthal 1998). Also operational in the development stages are Eco-Industrial Park projects in France and Japan (Côté & Cohen-Rosenthal 1998), Austria (Schwarz & Steininger 1997), Germany (Schön & Kunze 1999), India, Australia and China (Deppe 2000).

Additionally, "Eco-Industrial Parks are being considered in a number of other countries, including Thailand, Indonesia, the Philippines, Namibia and South Africa" (Côté & Cohen-Rosenthal 1998) as well as in Zimbabwe (Lahmeyer Internatonal 1997).

According to experts, the EIP projects presently being planned and implemented just mark the beginning of a development:

"The initiatives being undertaken to date, should be considered more or less immature industrial ecosystems … the complete picture is not yet evident" (Côté 1998). "We are at the earliest stages of industrial symbioses … To borrow an analogy from the software industry, we are at the Visicale stage and Lotus 1-2-3 and Microsoft Excel have not yet arrived." (Chertow 1999).

Thus, looking at the already visible achievements of the EIP concept today, there is huge potential for development and the opportunity to take giant steps towards the creation of sustainable industrial systems in the near future.

3. Eco-Industrial Parks in Developing and Newly Industrialised Countries

3.1 Framework Conditions

Since framework conditions vary considerably from site to site even within a single country, it is hard to conceive of general guidelines on how to transfer the concept of Eco-Industrial Parks from industrialised countries to developing and newly industrialised countries (DC / NIC). Therefore, it is crucial to conduct site specific exploration and adapt the EIP vision to the economic, ecological, social, and cultural characteristics of the respective community and region (Lowe et al. 1998).

Nevertheless, in the following the attempt is made to outline some factors and framework conditions - favourable or adverse - which may influence the transfer of EIP-concepts to DC / NIC:

One of the most basic preconditions for the success of an EIP project is the opportunity to offer **competitive advantages for participating companies**. This may be the case in terms of improved efficiency, lower costs or raised value created during the production process (Esty & Porter 1998). Only under circumstances where legal - and other - framework conditions allow for such advantages, the transfer of EIP concepts should make sense.

In a context, where
- resources like water and energy are highly subsidised,
- raw materials are cheaper than respectively usable recycling materials,
- the depositing of wastes or polluting the air do not raise any costs
- and, additionally, no public or customers' pressure to improve environmental performance exists,

it may be difficult to convince a company to put any effort into becoming part of an EIP.

However, places where such framework conditions prevail are progressively phased out. Thus, the **general opportunities** to transfer the concept of Industrial Ecology and EIPs to DC / NIC are good (Lowe 2000, Côté 2000, Deppe 2000, Hauff & Wilderer 2000).

Due to continuously deteriorating environmental conditions, interest in **increasing environmental performance** is growing world-wide. It is obvious that public awareness and public pressure have increased - within producing countries as well as overseas from customers of exporting companies (Lowe 2000 / Hauff & Wilderer 2000). In East Asia, for instance, "the stage is set for potentially exciting applications" of Industrial Ecology's various dimensions, as Cleaner Production (CP) programmes have been developed in nearly all East Asian Countries (Hamner 1998).

In many developing and newly industrialised countries, **legislation to promote environmental protection** is rather progressive, although implementation is often deficient, as e. g. in India, where water and energy for industrial use is highly subsidised - with the result of lacking incentives for efficient management of these resources (Kühr 2000).

On the other hand, pollution control agencies in some countries use **drastic "control-and-command" measures**, such as the closing down of thousands of industrial companies recently in India, or the threat of harsh prison sentences and heavy fines for polluters in some other countries (Pantumsinchai 1998 / Hauff & Wilderer 1999). In such a context, there may be problems to encourage companies to make their material and residues flows transparent.

Framework conditions for improved environmental performance **in transition countries in Eastern Europe** seem to be especially favourable, as the EU is already insisting on EU environment-guidelines being observed for larger investment projects in applicant-countries. Assimilation to EU standards is also taking place in terms of environmental legislation, thus providing the ground for industrial ecology strategies such as the EIP concept (Ahrens 2000).

"Unlike North America and Europe, perhaps, the **governments of East Asia** have very strong industrial development and management ministries. ... most of them regulate the siting and development of industrial estates. ... This creates an exciting opportunity for industrial ecology. A quite small community of energetic and powerful people controls the growth of industry in East Asia" (Hamner 1998).

While transferring the EIPs to other areas of the world, it is also of crucial importance - apart from looking at the legal background - to carefully analyse the **social and cultural framework** conditions as well as the market situation. Simple presumptions that may be most valid in western industrialised nations may result in a disaster, or at least project failure, when transported to other areas.

Two examples may serve to illustrate this: In a big south-west Indian city, a waste treatment and power plant was designed by an international organisation according to latest technological achievements in order to produce energy and at the same time solve the waste problems of that town. The project was implemented, huge boilers and turbines were installed. Only when it came to putting the plant into operation was it realised that the arriving waste contained hardly anything but stones. In order to prove that the plant could work, huge amounts of straw had to be bought from surrounding areas to start it up. Afterwards, normal operation has never taken place due to lack of combustible wastes. The presumption that big cities produce big amounts of waste was correct in a western industrial country context. In that area in India, however, thousands of informal sector people earned their living by extracting and selling any material that could be reused or recycled from the waste (Kuß 1999).

Another project, in Fiji, applied the strategy to use organic by-products as a substrate for mushroom growing. Production went off well, and the mushrooms grew. Unfortunately, the presumption that mushrooms are a delicacy was not valid for that context: there is no tradition of using mushrooms as food in Fiji. Accordingly, interest in this new product was less than low (Kühr 2000).

Many developing countries' economies are characterised by a huge "informal sector" with millions of small and individual enterprises in place of the large factories that are seen in industrialised countries. "The collective consumption of materials (and the resultant problems of pollution and waste) in this 'informal sector' is often larger than in the formal sector (Ramaswamy & Erkman 2000). Thus, there will be particular need for considerable adaptation measures to EIP-concepts, when trying to apply it to a region characterised by these factors.

3.2 Eco-Industrial Park Projects in Developing and Newly Industrialised Countries

A few Eco-Industrial Park and environmental impact reduction projects in DC/NIC/TC are listed in Table 6. They might serve as entry points for the spreading of Industrial Ecology approaches. Examples marked with an asterisk have been adopted from a list established by Marian Chertow.

Site	Country	Characteristics
Chong Yuan	China	- agro-industrial project connected to immense maize production in that area - all by-products of the maize industry are re-used in different companies producing oil, pellets, starch, ascorbic acid (Kuß 2000)
Taihu Baisin	China	- fast developing and highly industrialised area creating huge amounts of polluting wastes - Eco-Investment Promotion for EST combined with capacity building and networking activities (Shi Han 1998)
Helwan Industrial Site, south-east of Cairo	Egypt	- energy and by-product exchanges for enhanced resource efficiency were planned - however, the project is still at the level of implementing very basic steps like material flow analysis, promotion of environmental conscious management and material balancing within the companies (Bringezu 2000)
Suva*	Fiji	- development of an agro-industrial cluster around a brewery with the goal of utilising as much of the by-products as possible and achieving zero emission of pollutants into the surrounding environment (ZERI)
Tirupur, Tamil Nadu	India	- "embryo" of an Eco-Industrial Network (Erkman 2000)
Naroda Industrial Estate, near Ahmedabat, Gujarat	India	- "embryo" of an Eco-Industrial Network (Erkman 2000) - huge estate of about 30 km², hosting approximately 1,200 companies - research project to develop an adapted approach for the concept of EIN in Asia (Hauff & Wilderer 2000)
Industri Zona Manis, outskirts of Jakarta	Indonesia	- industrial zone hosting about 150 companies - research project to develop an adapted approach for the concept of EIN in Asia (Hauff & Wilderer 2000)
Tsumeb	Namibia	- development of an industrial cluster around a brewery with the goal of utilising as much of the by-products as possible and achieving zero emission of pollutants to the surrounding environment (Côté 1998 / ZERI)

ChemCity, Salosburg	South Africa	- EIP project at a chemical industrial cluster with high quality standards - not yet implemented (Lowe 2000)
Bangkok*	Thailand	- Eco-Industrial Park aiming at sustainable managing of agro-industrial piggery waste (Panapanaan 1999)
Willowale Industrial Zone, Harare	Zimbabwe	- project still at planning stage - objective: to bring together private industrial and public enterprises in order to jointly implement measures for eco-efficient and commercially viable optimised uses of resources and energy (Lahmeyer International 1997)

Table 6: practical examples by different authors

3.3 Opportunities, Difficulties and Problems in Transferring EIP Concepts

Generally speaking, the factors mentioned under 2.6 will most probably also apply to EIPs in DC / NIC / TC. Nevertheless, one has to consider additional aspects, which are mentioned below:

Opportunities and Benefits

The concept of Eco-Industrial Parks might be a very helpful strategy to support environmentally and socially **sustainable development without hampering economic growth** in DC / NIC / TC:

"Developing countries are very important areas for the creation of industrial ecosystems. They need development, industrial in particular. We can promote environmentally sustainable development and the latest technologies and practices without restricting the construction and operation of industries." (Côté 2000).

Large numbers of SME are gathered in many industrial parks or business agglomerations e.g. in India. Due to lacking personnel and financial resources, the enhancement of their environmental performance is often very difficult (Hauff & Wilderer 1999). Additionally, they often have a problem in gaining access to information, consultation and know-how (Adesioye 2000). Thus, the integrative approach of EIP concepts can support such enterprises in overcoming these barriers once the information needed and access to credit facilities for investments is provided.

In many newly industrialised countries the development of industrial estates is a booming market creating excess capacities. In this context, the concept of EIPs can also create **competitive advantages for developers** (Hamner 1998, König 2000) and offer an immense opportunity to involve optimising aspects right from the beginning (Stoldt 2000).

Park and cluster approaches included in the EIP concept also offer a great opportunity to **improve efficiency of spreading information and consulting services in the context of development co-operation**. This close-to-company approach seems to be much more promising than consulting approaches at higher levels, such as at industry federation or association level, as the direct contact to the respective company as well as integrating development activities at park and community level are simultaneously enhanced (Schneider 2000).

Difficulties / Problems

As mentioned above, "the primary effect of an EIP on a business has to be asset maximisation - the highest yield possible for the least possible set of inputs" (Côté & Cohen-Rosenthal 1998).

Thus, a major problem in introducing the EIP will occur in those countries where **air, water and soil pollution entail little costs**, and the supply of energy and raw material is priced at a very low level (Kaiser 1998).

Detailed and context specific analysis would be necessary to prove that EIP-services other than by-product exchanges and energy cascading would yield enough advantages to serve as incentives.

Another problem is shown by the above-mentioned example of the Indian waste treatment and power plant. In many countries, an extended **informal sector profits from wastes** and by-products. Establishing recycling or by-product exchange networks amongst companies could destroy the subsistence of numerous families (Stoldt 2000 / Hauff & Wilderer 2000).

Part of the developing process of an EIP is the improvement of environmental performance at company level, which in many cases may require the **introduction of new technologies**.

As new technologies are connected with investment costs, there is a danger of creating additional competitive advantages for those companies which are already in a privileged situation and dispose of the money needed for such an investment. Especially small and medium-scale companies are often not in a position to undertake larger investments, even if - in the long run - these may pay off.

The **lack of investment capital** might prevent the participation of small and medium-sized industries (SME) in an EIP project and the related benefits, unless – as mentioned above – financing services have been provided (Adesioye 2000).

Another problem in the context of introducing new technologies is "**technology consumption**" as known e. g. from the automotive sector in several newly industrialised countries: new technologies have been imported from industrial countries without advancing local know-how to maintain these technologies (Schneider 2000). Thus the creation of high-quality jobs and the capacity-building services of EIPs mentioned by many experts (e. g. Lowe et al. 1998, Cohen-Rosenthal 1999, Maier 2000) gain additional importance in DC / NIC.

When looking at project approaches in order to introduce EIP concepts to new contexts, the **deficiencies of long-term planning** might become a problem as the development of EIPs requires a long-term perspective. A short-term project could deliver an initial impulse towards a favourable development, which may show its full benefits only after 5, 10 or even 15 years (Kühr 2000).

It is also very important to avoid the **risk of designing an EIP-project in a "state-controlled economy" manner**, as artificially created locational advantages are not economically sustainable in the long run (Stoldt 2000).

A big problem hindering the introduction of more systemic approaches such as EIP concepts is "**end-of-pipe mentality and legislation**", and also the pressure from industrialised countries to sell their end of pipe technologies and services (Erkman 2000).

End-of-pipe, cleaner production and cleansing approaches are the main focal points in the context of sustainable industrial development. Little emphasis is given to ***clean*** **production**, pipe-to-pipe technologies and systemic approaches and re- or up-cycling technologies instead of down-cycling ones (Kühr 2000).

Especially in DC and NIC, where small local industries often produce a bulk of pollution, due to out-dated technologies and inefficient resource uses, it should be of utmost concern **not to restrict Industrial Ecology concepts to industrial estates**, but to chose a broader, at least regional approach.

Although this list of problems and risks seems to be rather long, it should not discourage the adoption of EIP-concepts for development purposes, but just serve as a reminder not to ignore certain factors.

3.4 Experts' Outlook on Introducing Eco-Industrial Parks to DC / NIC

According to various experts, the concept of EIPs / EIN has been well appreciated and found a lot of interest wherever it has been proposed in DC / NIC (Lowe 2000 / Erkmann 2000, Hauff & Wilderer 2000). However, operational EIP in DC / NIC which might serve as practical examples are still rare.

In the **Philippines**, a project to initiate by-product exchange at one estate was expanded to five additional estates, and growing interest in developing new EIPs led to a conference for Industrial Estate Developers in November 1999. A team from Thailand also attended this conference and presented their project for a petrochemical park (Lowe 2000).

An EIP project in **India** has gained a lot of interest and public discussion (Hauff & Wilderer 2000). In **Malaysia**, a workshop on environmental management of industrial estates (including EIN) is scheduled for September 2000.

The Asian Development Bank will develop an EIP Handbook for Asian developing economies (Lowe 2000). The World Bank, too, seems to be supportive towards this kind of initiative (Côté 2000).

In **China** a growing interest in improving environmental performance noticable. A publication on industrial ecology was translated and published last year (Erkmann 2000). A workshop on certification of sustainable industrial production took place in July 2000.

In **Eastern Europe**, experts are expecting a wide range of opportunities for the implementation of EIP concepts. Since complete industrial plants have to be replaced in certain sectors of industry, quantum leaps towards sustainable industrial development can be achieved, thus enhancing the ideas of industrial ecology and related strategies, such as the concept of EIPs (Ahrens 2000).

"Industrial Ecology is at least as relevant in developing countries as in industrialised countries. Simply and mainly, because these countries are facing severe constraints on the availability of resources." (Erkman 2000).

In addition, most EIP experts are convinced that transferring the EIP concept into DC / NIC / TC is possible on a much larger scale in the future and bears immense prospects. These prospects comprise both the industrial development of the respective countries as well as the social and environmental sustainability of their industries. (e. g. Côté 2000 / Lowe 2000 / Erkman 2000 / Deppe 2000 / Hauff & Wilderer 2000).

4. Contributions of GTZ and ETC-Project

4.1 Background

The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH (German Technical Cooperation) is a Federal owned limited liability company which is responsible for planning and implementation of projects and programmes in the field of technical co-operation with developing countries.

ETC is the abbreviation for "Pilot Project Strengthening **E**nvironmental **T**echnological **C**apability in Developing Countries". This pilot project responds to requests from developing countries for the transfer of environmentally sound technology. Experience has shown that technology transfer requires a parallel strengthening of environmental technological capability. Technological capability is the result of both individual efforts and close interaction among the state, industry, financing institutions, research and education sectors within every country. Close interaction and agreement upon targets are the preconditions for learning processes, the key element in technological development.

The ETC project aims at developing the initial stages for support of environmental technological capability. It is to elaborate proposals for improving interaction among state, industry, research and education by integrating the private sector as a partner in the effort to further development of its pilot partner countries. Additionally, the pilot project ETC attempts to intensify networking amongst actors in industrialised and developing countries.

So far, the pilot partner countries of the project have been India, Indonesia and Thailand, but there are discussions about extending the pilot project to further partner countries.

4.2 Compatibility of ETC and Eco-Industrial Park concepts

This report would like to emphasise the high compatibility and potential synergy effects in various fields, which could be born out of an adoption of EIP approaches into ETC strategies:

As EIP concepts aim at involving different groups and actors within a society, their integrating aspects seem to make them **highly compatible with ETC strategies** and most suitable to enhance the ETC approach (Stoldt 2000).

In this context, the promotion of public-private partnerships as one of the often mentioned vital factors for successful EIP projects is also in line with ETC's promotion of the private sector as an additional motor for further development in the respective countries.

The ETC definition of the term "environmental technology" indicates the proximity to EIP concepts:

"The expression "Environmental Technology" encompasses *all* technologies employed in avoiding residues, e. g. preventing the pollution of media, reducing the incurrence of waste substances, or treating / recycling / disposing of wastes, extending from "end-of-pipe" technologies (i. e. remedial / curative technologies) to loop-closure and cleaner production technologies" (Kaiser 1998).

Furthermore, the ETC concept can supplement the development of EIP in countries, where the necessary **knowledge to formulate technology demand is not yet established**. During the process of developing EIP, the ETC project can support the needs-oriented identification, selection of and investment in suitable environmental technologies and can point out areas of necessary research and improvement.

Last but not least, the implementation of EIP projects has the potential to integrate concepts of other German Technical Cooperation pilot projects such as the tools developed by P3U, notably the "Profitable Environmental Management Training tools"[3], and by PDI, a pilot project concentrating on environmental policy advice and institutional development in the environmental sector.

4.3 How ETC-Project may support EIP Concepts in Developing Countries

1. As detailed analyses on material and energy flows, financing and investment requirements, market potentials and barriers for service providers in different fields, collective as well as individual benefits and costs / constraints of current EIP-approaches in DC / NIC are not available, a **comparative study** on these and other factors in ongoing projects, including a "lessons learnt" and "best practices" section, should be conducted.

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[3] PREMA is an integrated concept for the promotion of environmental management designed for micro, small, and medium-sized enterprises (SME) in developing countries; it comprises, however, various instruments which can also be applied independently

2. A **country report** on EIP potentials for each of the ETC partner countries could be elaborated, indicating the respective framework conditions (see also chapter 3.3 on chances / difficulties / problems), not only in terms of e. g. legislation, ongoing initiatives to improve environmental performance, and market conditions, but also looking at social and cultural issues (interdisciplinary team). In this context, it seems to be helpful to involve the local civil society and/or international NGOs as "watchdogs" since, particularly in the field of technology and industrial development, social issues are often neglected.

3. Assuming that ETC activities may further support the development of Eco-Industrial Parks, country-specific **baseline concepts** building on the above mentioned country reports as well as on existing guidelines (e. g. Lowe et al. 1998) could be elaborated. There should be concepts for developing new sites on the one hand and on the other hand strategies for the transformation of existing ones.

   These concepts have to describe how – within the local framework conditions - an Eco-Industrial Park should be designed in order to provide maximum advantages to industrial estate developers (e. g. in terms of attracting companies and selling services), to involved companies (e. g. reduction of costs and logistic / organisational / administrative benefits; access to information / consultancy on energy concepts and environmental performance, technology providers, credit facilities and certification procedures; support on marketing/ export strategies; capacity-building opportunities), and the respective region / province (e. g. improved environmental performance of companies, creation of job opportunities).

   These concepts should put special emphasis to the promotion of *clean* production approaches instead of end of pipe or curative approaches (see also chapter 3.3 difficulties / problems).

4. Then, at national level in partner countries, **awareness and information activities** ought to be organised in order to spread the ideas amongst industrial estate developers, representatives of companies, local pollution prevention institutions, research organisations and decision makers.

   Preferably, this should be done by organising 2- or 3-day workshops which would offer a general introduction to the Eco-Industrial Park idea and the above-mentioned baseline concepts and then provide a frame to further elaborate and fine-tune the baseline-concepts together with selected participants. These activities ought to be effected in close co-operation with other GTZ-supported projects in the field of environment and their local partner organisations, who could act as further multipliers.

5. The next activity to enhance EIP projects in DC / NIC / TC would be to support implementation of **pilot projects** according to the concepts elaborated. The activities of ETC should include the following steps:

    a) Choose partner countries with different framework conditions and levels of industrialisation.

       In this context, ETC should consider to extend its activities to sub-Saharan Africa and Latin America, where very few such approaches have been adopted so far, although the need may well exist.

    b) Identify local partner institutions or organisations which provide staff to take part in the pilot project. Information and experiences on EIP-projects shall be collected and further developed in such organisations. Thus they could act as local competence centres for future EIP projects, providing e.g. information and support as well as links to international expertise.

    c) Identify industrial estate developers / companies / regional authorities as strategic partners interested and in a position to start / support an EIP pilot project.

    d) Recommend EIP experts / institutes / organisations with expertise in implementing EIP projects to pilot project partners for collaboration.

    e) Encourage the complementation of pilot projects with professional public relations concepts and exhibition / information centres, offering guided tours, presentations and a discussion forum as well as links to further information in order to create multiplication effects.

    f) Create an internet platform dedicated to EIP, providing a forum for exchange of experience, interactive education and training facilities as well as links to further information and contact to international expertise.

6. It could be a very efficient approach for ETC - apart from initiating EIP pilot projects - to look for other projects which are already working towards improved environmental man-

agement in industrial areas and contribute to these by topping them off with EIP concepts (e. g. Willowale, Zimbabwe / Taihu Basin, China / "Project for reduction of environmental impacts in industrial zones", Thailand).

7. Another interesting entry point for ETC could be to work together with German industrial investors in the partner countries, acting as an "anchor" and encouraging eco-industrial networking in its surroundings (Stoldt 2000).

8. In order to create additional incentives to adopt industrial ecology strategies for countries, industrial estates and companies, ETC may also support efforts towards an international label for sustainable industrial production, similar to the French PALME approach, which awards the label to industrial parks that meet a specific set of design and operating requirements (Côté 1998 / Côté & Cohen-Rosenthal 1998). It is important, however, that only one such commonly agreed mechanism should be developed (e. g. comparable to the Forest Stewardship Council) in order to avoid abuse and confusion about a number of circulating labels (Maier 2000).

9. As Eco-Industrial Park concepts and other Industrial Ecology strategies are not yet widely known, ETC ought to disseminate first “success stories” once they are available, “among international agencies like World Bank, UNDP, UNEP, UNIDO and various multi- and bilateral development agencies, so that they start to really integrate this approach in their strategy and field activities” (Erkman 2000).

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