Eco-Industrial Park Development

A Guide for North America

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April 2009

Adapted from *The Eco-Industrial Park Development: A Guide for Chinese Government Officials and Industrial Park Managers July 2005*
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The Eco-Industrial Park Development Guidebook, 2009, is adapted from an earlier version (2005) of the Guidebook originally produced by Andreas W. Koenig for Chinese officials and industrial park managers.

The 2009 Guidebook is produced by Peter Lowitt, AICP, of the Devens Enterprise Commission and Andreas Koenig, of Eco-Industry.org with assistance of the Environment, Natural Resources and Energy Division (ENRE) and Economic Development Division (EDD) of the American Planning Association.

2009

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FOREWORD

Many Eco-Industrial Park (EIP) projects are managed as that, "*projects"*. However, eco-industrial development in an industrial park is a process. A project is a means to meeting an objective within a limited time and budget, often with a dedicated project staff. Projects can be extended, may have phases, but eventually they come to end.

EIP development is an **open-ended process**, where at the beginning the objectives are often not clear, even less the content and the resources needed. The ultimate objective is the sustainable use of resources, a local circular economy. EIP development needs to be exercised in loops, open to new ideas, innovation and modification. It needs flexibility both from the administrative and technical side to adjust to the markets and needs of enterprises and stakeholders as the industrial community evolves. In a global economy with competing markets, production facilities have a limited lifespan. Companies merge, are outsourced, move to other locations or close down. An eco-industrial park with industrial symbiosis systems needs the flexibility to adapt to these changes.

Many EIP projects have failed before they could prove that this approach is both environmentally sound and makes business sense, mainly due to project-specific causes: the budget was exhausted, champions moved to other positions, project staff got caught up in daily routines. Managers at the site returned to short-term options rather than long-term benefits. And many waited for new project funds rather than utilize the resources at hand.

Aims of this Guide

This guide aims to provide an orientation for government officials and managers planning or running industrial parks who are thinking of adapting eco-industrial development strategies to their property and region. It is a guide to the process of EIP development, outlining the elements and resources needed to start a successful modification towards sustainable industrial development.

The guide describes the steps in the process but does not cover details for implementation since this depends very much on the individual site. Implementation of industrial symbiosis within an industrial system is usually defined by site-specific feasibility studies and projects for synergies between involved companies and stakeholders. For further investigation the guide points to more detailed resources available through institutions and EIP projects in print or on the internet.

The guide has been developed based on western experience in developing eco-industrial parks and has been adapted for application in the Chinese setting. It incorporates Chinese experience and examples of case studies, in particular from the pilot industrial parks of EMCP.

HOW TO USE THIS GUIDE

The guideline is divided into four main parts:

Part 1: Eco-Industrial Park Concept provides an overview of EIP principles and the necessary preconditions.
Part 2: The EIP Process describes the different stages in EIP development, with necessary information and allocation of resources.
Part 3: EIP Planning provides an overview of the elements to be included in an EIP plan.
Part 4: Implementing EIP Projects deals with the tools that local administration and industrial park management can use to turn plans into synergies.

A great number of handbooks, materials, project reports and research studies have been published, both in print and on the internet. Throughout the guide there are references and links to other resources, websites, documents in the Appendices. This guide is intended to be used together with the **Chinese Handbook on Industrial Ecology and Eco-Industrial Parks,** by Ernest Lowe and Geng Yong, which provides more background to the principles and strategies of eco-industrial development, including detailed case studies:

- Lowe, Ernest A. and Geng Yong. 2003. Industrial Ecology and Eco-Industrial Parks Handbook. Chinese edition: Chemical Industries Press, Beijing. The (modified) English version is available at the Indigo Website: www.indigodev.com/Handbook.html
- Lowe, Ernest A. 2001. Eco-Industrial Handbook for Asian Developing Countries. Prepared for the Environment Department, Asian Development Bank (ADB)

A comprehensive overview of Eco-Industrial Development is available in the book **Eco-Industrial Strategies** edited by Edward Cohen Rosenthal with Judy Musnikow, Greenleaf Publishing (see 'Resources' section). The book provides in-depth coverage by leading experts in the field on:

- Background to Industrial Ecology
- The role of stakeholders
- Key issues in eco-industrial development
- Detailed case studies

TERMINOLOGY

Brownfields are industrial or otherwise developed areas that have been affected by former users or surrounding activities and so are underused or unusable and require remediation before being further developed. The US-EPA defines a Brownfield as "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant".

Circular Economy, a holistic economic concept which seeks efficiency in resource use through the integration of cleaner production and industrial ecology into a broader system encompassing industrial firms, networks or chains of firms, eco-industrial parks, and regional infrastructure to support resource optimization. State owned and private enterprises, government and private infrastructure, and consumers all have a role in achieving the Circular Economy.

Cleaner Production is a holistic preventive and integrated strategy for the entire production cycle, that:

- increases productivity by ensuring a more efficient use of raw materials, energy and water
- promotes better environmental performance through reduction at source of waste and emissions
- reduces the environmental impact of products throughout their life cycle by the design of environmentally friendly but cost-effective products.

(United Nations Industrial Development Organization - UNIDO)

Community is the local village, the town or district where the industrial park is situated. Stakeholders are based in the local economic, cultural, political, or institutional framework of the region; this may include, for example, a clustering of small businesses, inner city low-income residential neighborhood, or neighborhood associations.

Community Participation is the engagement, at varying levels of influence and decision-making authority, of the relevant community stakeholders in the design and implementation of an eco-industrial development project.

Eco-Industrial Park is a community of manufacturing and service businesses located together on a common property. Members seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues.

Eco-Industrial Development is an integrated system of shared resources (material, knowledge-based, social, etc,) among industries, businesses, and the local community that lead to economic gains, enhanced environmental quality, and improved human resources for the business and local community. (President's Council on Sustainable Development).

Eco-Industrial Network is a set of companies in a region seeking to improve their environmental, social, and economic performance through collaboration. An EIN may include industrial parks and their companies and be supported by public sector organizations. An Eco-Industrial Network provides the context in which industrial parks and stand-alone factories can practice Eco-Industrial Development. It allows them to achieve the necessary scale of operation often required to optimize use of resources and create synergies between its members.

Environmental Management Systems (EMS) are management approaches that identify the environmental aspects of a company's operations and legal requirements, establish environmental objectives and targets, create management programs to meet these objectives and targets, establish internal and external reporting systems, regular audits, reports to management, and provide follow-up on the audit findings and reviews to ensure continual improvement.

Green Building Design / Green Architecture is designing buildings to minimize energy consumption, use renewable or recyclable resources, protect the natural environment, and create healthy non-toxic work environments.

Greenfield is a property allocated for new industrial development on agricultural or previously unused land.

Industrial Ecology is the science that examines the impact of industry and technology and associated changes in society and the economy on the biophysical environment. It examines local, regional and global uses and flows of materials and energy in products, processes, industrial sectors and economies and focuses on the potential role of industry in reducing environmental burdens throughout the product life cycle. The field encompasses a variety of related areas of research and practice, including:

- material and energy flow studies ("industrial metabolism")
- dematerialization and decarbonization
- technological change and the environment
- life-cycle planning, design and assessment
- design for the environment ("eco-design")
- extended producer responsibility ("product stewardship")
- eco-industrial parks ("industrial symbiosis")

- product-oriented environmental policy
- eco-efficiency.

Additional resources on Industrial Ecology can be found at the International Society for Industrial Ecology (ISIE) website: http://www.is4ie.org

Industrial Symbiosis describes the co-existence between diverse organisms in which each may benefit from the other. Industrial Symbiosis was first applied for the industrial co-operation that has evolved between companies and the municipality of Kalundborg in Denmark, all of which exploit each other's residual or by-products. Also See 'Kalundborg' in Section 1.1.

Pollution Prevention is synonymous with Cleaner Production (CP) and mainly used in the US. It stands for "source reduction," as defined under the United States Pollution Prevention Act, and other practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water, or other resources, or protection of natural resources by conservation. The Pollution Prevention Act defines "source reduction" to mean any practice which:

- reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and
- reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

The term includes: equipment or technology modifications, process or procedure modifications, reformulation or redesign or products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control. See http://www.epa.gov/p2/ for more information.

Stakeholders are all individuals and groups affecting, and/or affected by the policies, decisions, and actions of the system at any level of society and at any level of organization.

Sustainable Development (as defined by the Brundtland Report of the World Commission on Environment and Development) is "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

1 ECO-INDUSTRIAL PARK CONCEPT

1.1 History of Eco-Industrial Parks

With the fast pace of change in the industrial sector, restructuring and redevelopment of traditional industrial areas and development of new industrial sites is a common phenomenon in many economies. Traditional industrial zones in urban areas are redesigned for commercial use and nonpolluting industries, heavy industry is transferred to rural areas, and brownfields, decommissioned and polluted industrial sites, abandoned inner-city lots and former military bases, need to be redeveloped. Since the middle of the 1990s industrial environmental protection has undergone a new development aiming at integrating sector approaches in reducing environmental effects with modern management and production methods. Eco-Industrial Development (EID) is the result of development that covers pollution prevention, industrial environmental management, cleaner production technologies and the (eco-) efficient use of natural resources.

The concept of Eco-Industrial Parks is very attractive to a large number of established industrial parks as well as new development schemes both in industrialized and developing countries. However, up to now only a few initiatives in the USA, Europe and Asia have reached the point of turning ideas and master plans into action. If successful in the initial stage, EIP initiatives are mostly limited to a few companies forming a symbiosis. Only few projects have so far achieved implementation of resource efficiency at a larger scale, mostly within the chemical and agro-based industries with large quantities of resources moving through industrial systems.

Kalundborg http://www.symbiosis.dk/

The oldest successful and most publicized example of applied industrial ecology is the Industrial Symbiosis at Kalundborg, Denmark, a group of companies and the City of Kalundborg. Kalundborg's industrial symbiosis developed over a period of 25 years, evolving and now has partnerships in 19 projects (see chart below). Today, these 19 different projects concern recycling of water, transfer of energy and recycling of waste products between the six independent symbiosis partners.

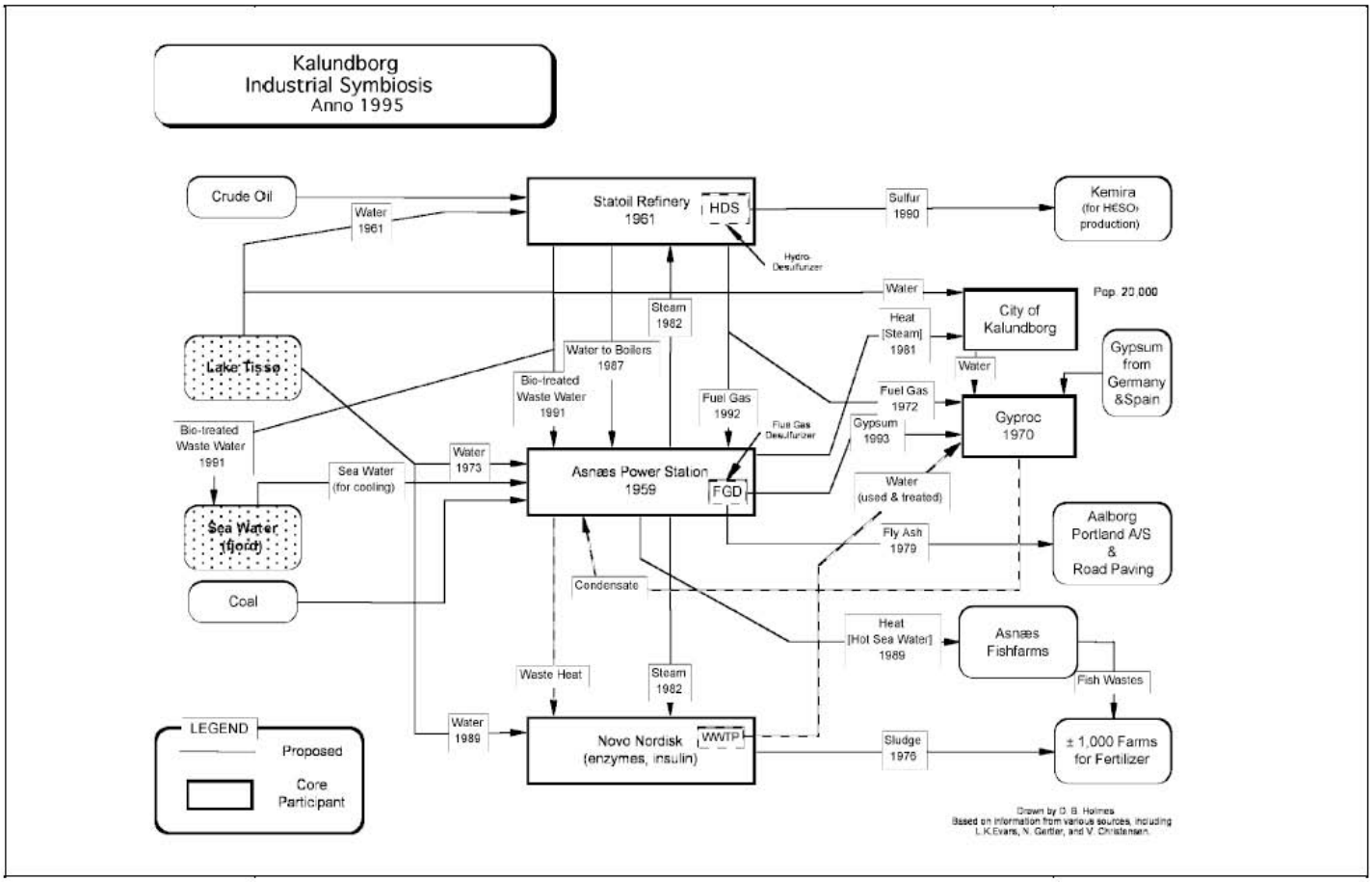
The original incentive for the industrial symbiosis was the improvement of performance from economic investments. All exchange projects were negotiated commercially between partners, often between two partners at a time. The industrial symbiosis did not develop as a well-planned network but as a number of single projects among a limited number of partners. Over the years it evolved into a network of synergy projects, an Eco-Industrial Network, since the site is not an industrial park and has no management. *For full details on Kalundborg see: Jacobsen: The Industrial Symbiosis in Kalundborg, Denmark, in: Cohen-Rosenthal (ed.), 2003. Eco-Industrial Strategies*

The Industrial Symbiosis at Kalundborg is a popular example for industrial synergies since it demonstrates some of the key elements necessary for successful eco-industrial development:

- it is based on a close social relationship between the key actors, the chief executives of the companies involved; the Rotary Club in the small town of Kalundborg provided the platform for networking.
- The companies are close to each other, making physical connections (pipelines, trucking) economical.
- Based on commercial agreements and market prices, the symbiosis did not receive any incentives or subsidies.
- Many promising synergy projects were never implemented due to lack of financing or commercial feasibility.
- Aside from the 19 projects between companies, many more projects have been implemented within the companies.
- With over 25 years of development, the system at Kalundborg is a continuing improvement process as the companies and production technologies are evolving.

Since the implementation of the first symbiosis projects most of the originalmanagers of the involved companies, the 'champions' of the system, have retired. With the new managers a generation change has taken place, both in age and management style. The new managers needed to be introduced to the principles of industrial ecology and the mechanisms of symbiosis system. Last but not least, they needed to establish the new social network necessary for continuing improvements .

Due to its popularity and numerous visitors from around the world, the partners at Kalundborg have set up the Symbiosis Institute to monitor and publicize the evolution of the symbiosis system.



Source: Lowe, E. 2001. Eco-Industrial Handbook for Asian Developing Countries.

The Kalundborg example shows clearly that **it is a misconception that eco-industrial development is an environmental affair.** If EID is defined as Sustainable Industrial Development, development needs to be driven by the companies in an industrial community, with government playing a supportive and regulatory role.

1.2 Application of the Concept

Work in Progress

Industrial Ecology and Eco-Industrial Development are fast growing and popular fields of research and application. The development of EIP concepts and their practical application is a **'work in progress'**. At present there is no distinction between an EIP creating synergies and an EIP being a project under discussion or in a planning stage. Many industrial parks named or associated as eco-industrial parks are projects under research, planning or construction.

Types of EIP

Eco-Industrial Parks are developed in three basic forms:

1. **Transformation** of an existing industrial park,
2. **Revitalization** of previously used sites (brownfields development).
3. **New industrial site** development.

Often these appear in combination. When existing industrial parks undergo expansion, this can be developed as an eco-industrial park. Often such expansion concepts focus on by-product exchange and recycling operations to serve existing industries. Revitalization can both include industrial sites and inner-city urban brownfields. Eco-industrial development concepts are also adapted to the redevelopment of military facilities into both industrial and mixed urban-commercial complexes.

The form of EIP development brings certain preconditions that affect the whole planning process:

- Existing industrial parks have the companies for potential synergies but often the interaction (community) between the companies is not developed, making it difficult to get to know companies and their potential in detail. Park management and local authorities have to invest time in ***community development*** among the companies.

- The nature of brownfield redevelopment often focuses on turning an unpleasent (brown) site into a literally green site, with focus on plenty of open space and a high proportion of social functions. At the same time new developments turn green space into industrial land. This especially applies to inner-city developments.
- New developments have many theoretical opportunities for industrial symbiosis, since companies can be matched according to theory, but to identify these companies and turn them into potential investors is a major task. New developments obviously also lack the community of companies, which will grow as new investors join the project.

EIP Strategies

As in developing traditional industrial parks, similar strategies can be used to establish eco-industrial parks. The most commonly practiced or researched strategies are:

Anchor tenant. This involves having a large industrial user, often a power plant, sugar refinery or other types of operation with large-scale material flows, that the industrial park will be developed around.

Materials or By-product exchange. This can occur either in an eco-industrial park or in a regional network of businesses, including industrial parks. This involves using one industry's waste or "byproducts" as another industry's raw materials.

Resource Recovery System is an expanded concept of the byproduct exchange and includes all forms of material and product recovery in an industrial complex (waste management, by-product exchange, recycling and remanufacturing).

Energy connections. Involves maximizing energy efficiency through design or rehabilitation, co-generation, and energy cascading. It can also include the utilization of renewable energy.

Thematic Park. A number of EIPs focus on co-locating a specific type of industry. Selecting an industry does not provide additional opportunities for synergies as often as mixed sector industrial parks. Industries closely related by sector, however, often have existing networks and business relationships or common interests that foster community development. Examples of such thematic parks are:

Agriculture-based EIP: or Agro-EIP provides support for sustainable farming and food processing and includes several basic types of firms and agencies which may be recruited as tenants:

- Suppliers of equipment, energy, materials, and services to farmers;
- Food processing and distribution firms;
- Firms utilizing by-products from any part of the system.
- Intensive food production located in or near an agro-estate, particularly as landscaping, greenhouses and aquaculture ponds.

Farms and food processing industries have a high flow of organic material that can easily be further processed and maximized in its resource value.

Chemical EIP: The chemical industry uses co-location of production units and upstream–downstream synergies as their core business. Improvements in individual facilities and inter-facility synergies can be achieved through 'green chemistry' innovations in product and process design and co-locating more companies. Modern chemical development usually happens in Chemical Parks. The links between the companies are not EIP structures as such.

Sector-specific EIP (Textile, Electronics etc.): in Asia a number of regions have historical industrial areas with an agglomeration of sector industries, often as industrial clusters, but also as industrial parks. Companies located there usually have similar problems and less potential for synergies, but strong links between companies (associations) can stimulate joint problem solving and innovation concepts.

Resource Recovery EIP: Companies in recycling, reuse, remanufacturing, niche collection of materials, and manufacturing from recovered materials form a cluster with good synergies among them.

Environmental Technology Parks / EIP: The concept focuses on the promotion of environmental technology industries. Aside from possible innovation synergies, their co-location does not necessarily provide any benefit in industrial symbiosis. Many environmental technology companies produce like ordinary manufacturing businesses.

For more details see: Lowe 2001, Chapter 6, Lowe and Geng 2004, Chapter 7 http://www.indigodev.com/AEIP_HB.html and http://www.indigodev.com/AEIPwhitepaper.html

1.3 EIP Definition by SEPA

In response to growing interest in EIP development in China and the development of Circular Economy policy, the State Environmental Protection Administration (SEPA) published "(Tentative) Guidelines on the Planning of Ecological Industry Demonstration Parks" in December 2003, providing initial definitions and procedures for eco-industrial parks and their development for the Chinese administration and industry. This guide refers to the SEPA Guidelines where appropriate.

SEPA definition

"Ecological industry demonstration parks hereafter referred to as "park" are a new type of industrial park designed according to the requirements of cleaner production, the concept of circular economy and ecological industry principles. By means of material and energy recycling, it connects different types of plants and enterprises into a symbiotic association in which resources are

shared and by-products are interchanged. The waste or byproducts of one plant may become raw materials or energy resource of another. Trying to simulate the natural ecological system and establish the circulation mechanism of "producer–consumer—decomposer" this system seeks to obtain closed material circulation, multilevel utilization and the minimum output of waste." *See: State Environmental Protection Administration (SEPA). 2003. Guideline for eco-industry park planning. SEPA formulated these guidelines for guidance and evaluation of EIP projects. The document is available in Chinese at http://www.sepa.gov.cn/eic/650217096101232640/20040419/1048824.shtml*

Circular Economy
The SEPA definition makes a clear link between EIP and the circular economy. As stated by the National Reform and Development Commission (NRDC), eco-industrial parks are a central strategy for implementing a circular economy in China. EIP is therefore not a stand-alone development strategy, but needs to be integrated into the local and regional economy and ecology.

1.4 International Development

America and Europe
The concept of Eco-Industrial Parks has developed in Europe and North America since the middle of the 1990s. The Industrial Symbiosis at Kalundborg has evolved since the 1970s, as have other clusters and industrial networks that exchange energy and by-products. Industrial symbiosis has been practiced for more than 100 years, only not on a systematic level nor under the banner of sustainable development. The term Eco-Industrial Park was coined in the USA with the President's Council for Sustainable Development funding four initial EIP projects. Among the first projects that joined the series of studies and workshops were:

- Baltimore, Maryland,
- Brownsville, Texas
- Burlington, Vermont
- Burnside EIP, Nova Scotia (Canada)
- Civano EIP, Tucson, Arizona
- East Shore EIP, San Francisco Bay, California
- Chattanooga, Tennessee

Many of these early EIPs have vanished as projects. Other successful projects have emerged since then, among them:

- Devens Eco-Efficiency Center and Eco-Industrial Park http://www.devensec.com and http://ecostardevens.com
- Cape Charles Sustainable Technology Park
- Londonderry Eco-Industrial Park.
- Burnside Eco-Efficiency Center http://www.mgmt.dal.ca/sres/ecoburnside/homepage.html
- Cape Charles Sustainable Technology Park http://www.sustainablepark.com/index.html

Initially the Work and Environment Initiative at Cornell University facilitated a number of projects and formed a networking platform. Since then the Eco-Industrial Development Council (EIDC) http://www.ecoindustry.org/index.html and the Canadian Eco-Industrial Network (CEIN) http://www.cardinalgroup.ca/cein/index.htm l have formed as a networking platform for projects, government agencies and consultants. The US Environmental Protection Agency, the US Economic Development Administration and a number of state governments (e.g. New Hampshire, Minnesota) have been supportive of eco-industrial development projects.

In Europe a number of networks and EIP projects have been started, mainly driven by universities and research institutions from the EU. In France, Germany, Italy, Norway and the United Kingdom, projects initiated by industries or industrial networks have emerged. Recently a number of local governments are embracing eco-industrial development, among them Geneva, Rotterdam, and Nordrhine-Westphalia. So far, no projects have emerged as fully developed Eco-Industrial Parks. In France the OREE industrial network has been active for several years in promoting networking and environmental management in industrial parks. In the United Kingdom, the National Industrial Symbiosis Programme (NISP) http://www.nisp.org.uk/ is supporting regional networks and industrial parks in adapting sustainable development tools.

Asia and Pacific
Due to rapid industrial development in Asia and the focus on industrial parks as the main planning policy for new developments, the EIP concept has been received with great interest in most countries. A number of projects have emerged in recent years, with China and Thailand leading the development with several pilot EIP projects. Further EIP developments are located in India, Indonesia and the Philippines. Most of these projects are donor-supported or initiated through US, EU and Canadian projects. In Australia and Japan industrial symbiosis has been implemented in a number of projects by industrial networks and local government. Among them are Perth in Western Australia and Kitakyushu Eco-Town in Japan. In South Korea, a national EIP policy is under development by the national Cleaner Production Center.

1.5 EIP Development in China

By mid-2005 SEPA had approved 12 EIP demonstration projects. A number of other industrial parks, among them EMCP pilot projects, have also adapted the development of EIP concepts. Given the rapid industrial development in China and the increasing number of industrial park and economic zone developments in all provinces, the parks listed below will most likely have new demonstration projects in the near future.

SEPA Approved Projects:

1. Baotou Aluminum Industrial Park, Inner Mongolia
http://www.baotou-al.com.cn/
2. Dalian Eco-Industrial Park, Liaoning Province
http://www.ddz.gov.cn/
3. Fushun Industrial Park, Liaoning Province
http://www.fkjt.com.cn/
4. Guigang Sugar Industrial Complex, Guangxi Province
5. Guiyang Industrial Park, Guizhou Province
http://www.gyce.cn/ReadNews.asp?NewsID=1680
6. Huangxing Industrial Park, Changsha, Hunan Province
http://www.ecoah.gov.cn/newsshow.asp?w_id=10002978
7. Lubei Chemical Industrial Park, Shandong Province
http://www.nbepb.cnnb.net/record-lin.asp?id=343
8. Nanhai Park, Guangdong Province
http://www.nhfet.gov.cn/zsxx/hnhbgyy.htm
9. Suzhou Industrial Park 1, Jiangsu Province
http://www.snd.gov.cn/CN/index.jsp
10. Suzhou Industrial Park 2, Jiangsu Province
http://www.sipac.gov.cn
11. Tianjin Economic Development Area (TEDA), Tianjin
http://www.teda.gov.cn/indexa.html
12. Yantai Industrial Park, Shandong Province
http://www.yantaiinvest.gov.cn/home.htm

The following projects are not currently included in the SEPA list:

13. Wuhan International Eco-Industrial Park, Hubei Province
14. Shihezi Industrial Park, Xinjiang Autonomous Region

Other EIP projects

A number of industrial parks are under review by SEPA to be accepted as national EIP demonstration projects. EMCP has supported four pilot projects in developing elements of ecoindustrial park concepts, one of them, TEDA, an approved SEPA demonstration project:

1. Gao Ba Ecological Industrial Park, Luzhou, Sichuan Province
2. Rizhao Economic Development Area (REDA), Shandong Province
3. Shanghai Chemical Industrial Park (SCIP), Shanghai
4. Tianjin Economic Development Area (TEDA), Tianjin

1.6 EMCP Pilot Projects

Longmatan Industrial Park, Luzhou

The Longmatan Industrial Park project is located in Luzhou, Sichuan Province. The West Chemical Industrial City Construction Office (WCICCO) and Longmatan District government have joined to plan and develop the area based on the eco-industrial park principles. The Longmatan Industrial Park is located near the Yangzi river and has the biggest inland harbor in Sichuan province with a capacity of 50,000 containers per year. The park is also directly connected to the railway and highway system. The region is dominated by chemical industry with over 50% of industrial output from around 1,400 major companies (output over 5 million RMB p.a.). The EIP development is based on two key companies, North Chemical Corporation, an established but old company, and China Offshore Bitumen Company, a new development in operation. The EIP initiative was started in 2002 by the municipal government with two industrial parks (Gao Ba and Longmatan) that were integrated into one development strategy in 2003. The EIP initiative is part of a greater project to develop a Chemical City in Longmatan district as a redevelopment of extensive brownfields in the existing park. A number of old companies are operating based on outdated production technologies, while many companies of the original development have been closed down. The EIP concept approved by the central government includes the following features:

- Inter-municipal cooperation
- Integrated management system

- Integrated facilities
- Integrated service system
- Technology transfer for Cleaner Production

During the first phase of the project (2003-2005) the municipal government formed a management office that is now responsible for the coordination of the industrial park development. Investments were made to improve the transportation inside and around the area and to install basic facilities like water and energy supply, waste management and wastewater treatment. One of the main activities for the first phase was to establish good communication between the related local government units to achieve an agreement about the EIP work and to coordinate development policies, and with the existing enterprises on product chain and waste material issues. The project is facing a number of challenges typical to the western provinces of China, outdated production facilities and random industrial development in the past. At present Longmatan Industrial Park lacks a critical mass of companies to establish symbiotic exchanges within the park. The management office is therefore looking into the possibility of establishing a network with companies in the region. A key element in developing an Eco-Industrial Park in Longmatan is the development and upgrading of the Northern Chemical Corporation until 2010. The challenge is to attract additional companies into a chemical product chain with Northern Chemical Corporation as an anchor tenant.

A number of courses on cleaner production and a pilot project on technology transfer have been carried out at the Liu Tian Hua Chemical Fertilizer company as a demonstration to improve the performance of existing companies. The next step will be the dissemination of training and awareness building to companies outside the industrial park and the establishment of an eco-industrial network.

Rizhao Economic Development Area (REDA)
REDA is a provincial economic development zone that is being expanded by the Rizao Municipal Government. The objective of the REDA development is to establish an Eco-Industrial Park by developing an overall EIP Plan. The EMCP project has assisted REDA in developing the plan through an EIP guideline and the promotion of cleaner production through the establishment of a Waste Minimization Club (WMC). REDA is a provincial level economic development zone located in Rizhao City in the coastal area of Shandong Province. It was launched in 1991 with an area of 10km^2. In April of 2003, The Rizhao municipal government decided to expand REDA to 115.6 km^2 with a population of 110,000 and to adopt EIP principles for its planning.

To date, there are a total of 420 enterprises in REDA, with over 100 joint ventures companies, mainly Korean and Japanese. The total foreign investment is US$640 million. Some large-scale projects have been put into operation like the Rizhao Power Plant and SSYMB Pulp & Paper Co. The main industrial sectors are information technology, biotechnology, advanced materials as well as manufacturing and trading industries. With an expanding international port, Rizhao is a major development center in the Northern China coastal area.

The main objective for EIP development at REDA is the development of an Eco-Industrial Park Plan. In order to integrate this task into regular development planning, an administrative office was set up under the Rizhao Municipal governmental and REDA. The administrative office set up two management teams, one for the existing industrial park, managing the WMC and cleaner production activities, and one for the Greenfield development in charge of the EIP planning.

Through establishment of a Waste Minimization Club, which is called the Eco-Industrial Association, with 16 initial member companies, cleaner production audits and other waste minimization measures were demonstrated in 5 companies. A total of 137 cleaner production options were identified, and mostly implemented, resulting in substantial savings per company of up to RMB 4 million p.a. in the Pulp and Paper company (See Appendix 5: Outline of Ecological Industrial Park Plan of REDA)

REDA Management Teams

Planning Team

	Institute/Company	Position
	REDA Planning Office	Director (Team Leader)
	Municipal Sustainable Development Pilot Region Management Office	Registered Planner(Vice team leader)
	Municipal EPB	Senior Engineer
	Municipal Planning Bureau	Registered Planner
	REDA EPB	Manager
	REDA Economics Development Bureau	Vice Manager
	REDA Planning and Construction Management Office	
	REDA Planning Academy	
	Professional Technology School	Vice Dean
	Rizhao SSYBO Pulp and Pager Co.,Ltd	
	Hua Neng Rizhao Power Plant	Vice general engineer

Management Team

	Institute/Company	Position
	REDA Economics Development Bureau	Manager (Team Leader)
	REDA EPB	Manager (Vice Team Leader)
	Municipal Sustainable Development Pilot Region Management Office	
	Municipal EPB	
	REDA Management Office	Vice Director
	REDA Economics Development Bureau	Vice Manager
	REDA Construction Bureau	Vice Manager
	REDA Planning and Construction Management Office	Engineer

The planning process included a planning meeting with participation of all major government stakeholders and representatives from companies and the concerned public. A company survey was organized by facilitators to collect more accurate data about the existing situation in REDA. The REDA planning includes both new development and the existing industrial park. Upon completion of the EIP plan, the Rizhao Municipal Government will endorse the plan, providing the legal basis for the official implementation of the plan. At the same time, REDA will use the plan to promote itself in order to attract the desired industries to the industrial park.

The EIP plan identifies specific indicators and benchmarks to be accomplished during the planning period. This will be used to measure the performance of EIP implementation. REDA also plans to expand the practice of cleaner production audits to other companies under the WMC based on the successful implementation in the pilot companies.

Shanghai Chemical Industrial Park (SCIP)

SCIP is the largest petrochemical complex under development in Asia with a number of leading global chemical companies located in the industrial park. As part of the EMCP pilot projects SCIP has developed an Emergency Response System with an Emergency Response Center (ERC) and health clinic with services for all companies on site. SCIP is located north of the Shanghai-Hangzhou highway in Pudong, Shanghai. The chemical park has a total area of 29,4 km^2. The area is divided into two development zones by a river, but is designed as an integrated petrochemical production complex with upstream and downstream chemical production chains. The total investment for the chemical park is going to be 90 billion USD. A number of production facilities are under operation or under construction.

With an integrated industrial complex of this scale, the need for an integrated emergency response system with international standards is crucial. Therefore the government decided in 2003 to designate SCIP as a pilot project of EMCP to develop the first emergency response system for industrial parks in China. The SCIP management is the key initiator for establishing an advanced emergency response system. The main reasons for setting up the system are protection of the population in the area and pressure from investors such as BASF, Bayer, SECCO, Huntsman etc. to provide international safety measures in the chemical park. The objectives of the pilot project were to:

- Assist SCIP and SCIP-ERC operational management in designing the operational control center and develop a Management Information System.
- Provide advice on the design and operation of an ERC according to international standards defined by the European EU Directive 96/82/EU (so-called Seveso 2 Directive)

- Demonstrate the application and strength of credible worse case scenarios
- Demonstration training of the crew of SCIP-ERC to handle hazardous material accidents
- Develop material that can be used to disseminate the lessons learnt at SCIP to Chinese enterprises and chemical parks in the field of emergency response.

The integrated SCIP-ERC will be set up for the first 10 km^2 with the extension option for the whole chemical park. SCIP invested US$1 million for construction of the ERC and about US$20 million for fire fighting equipment, a first aid system and health clinic. The SCIP ERC was put into initial operation in March of 2004 with further ongoing development of management structures.

Aside from the standards and investment in hardware and software, the development of the emergency response system placed special emphasis on management and command structures within the different government units. In order to integrate the public system with the individual company systems, the project facilitated communication structures between the different stakeholders. By March 2005 the system was fully developed and equipped. The lessons in developing communication and management structures within the chemical park can serve as a model for other industrial parks, especially those taking an EIP approach. A large number of visitors from other industrial parks throughout China have already visited SCIP ERC.

Aside from the Emergency Response System, SCIP is seeking to optimize production and minimize pollution by encouraging innovative company-to-company exchanges as part of an overall development strategy. In 2004 SCIP hosted an International Green Chemistry conference and has recruited specialty chemical companies working in this field. SCIP is presently building a constructed wetland for tertiary water treatment and water recycling.

Tianjin Economic Development Area (TEDA) http://www.teda.gov.cn/indexa.html
Tianjin Economic and Technological Development Area (TEDA), one of the first develop areas established in China, is an Eco-Industrial Park Demonstration Project approved by SEPA and an EMCP pilot project. The main objective of this pilot project was to establish an industrial solid waste management system for the industrial park and to increase the comprehensive ability of government to manage the environment and develop TEDA into an Eco-Industrial Park.

TEDA was founded in 1984. It is located in the southeast of Tianjin, about 45 km away from the city, and near Tianjin harbor. Its total planning area is about 33 Km^2. TEDA is developed and governed as a separate city with a population of 400,000. TEDA has a mix of industries with four development zones: Yixian science industrial park, microelectronic industrial area, chemical industrial area and the West Area. Some 300 companies are located within TEDA, with about 200 engaged in manufacturing. 100 of these are larger plants and generate more than 80-90% of all emissions, among them Motorola, Samsung, Toyota, GSK.

In recent years TEDA participated in a series of projects and studies to develop an eco-industrial park strategy. In 2003 TEDA was acknowledged as a national eco-industrial demonstration project. A key issue in TEDA was the lack of management of materials and solid waste due to lack of information and experience in handling industrial solid waste and appropriate recycling and minimization strategies. The overall objectives of the EMCP pilot project were to demonstrate business benefits of environmental management and to assist TEDA in developing a waste management system as part of an Eco-industrial Park strategy. The activities included the development of six distinct systems:

- Waste Management Strategy
- Solid Waste Management Information System (SWIMS)
- Waste Exchange
- Waste Minimization Club
- Logo System for Waste Transporters
- Training & Dissemination.
- The Environmental Protection Bureau (EPB) of TEDA heads the EIP development.

In order to develop an overall waste management strategy for TEDA, it was important to secure reliable and accurate information on material and waste streams generated in the industrial park. Existing information was not detailed enough for management purposes. A web based solid waste information management system was developed using an on-line questionnaire that feeds directly into a database. This enables easy access to information and analysis of the wastes generated. The development of the system was finished in February 2004, with a subsequent training on the on-line questionnaire for representatives from nearly 70 enterprises. A web-based waste exchange system and a Waste Minimization Club were developed in order to provide management tools to reduce waste streams and utilize valuable materials. Some trades already existed at the park (Novozymes sludge used for fertilizer, Power Station slag used for construction materials) and others that directly resulted from the project (BBA bulk bags re-used by Lafarge). However, it is presently not possible to evaluate the impact of the system on the waste and material streams due to a short implementation period (See: Waste Minimization Club under EID Tools).

A voluntary logo system for waste contractors and waste generating companies was developed in order to regulate the hauling and disposal of industrial waste. The logo system was developed through a design competition with local schools which brought

an additional benefit by involving the community and raising awareness of the project and sustainable development. The logo is awarded to contractors prepared to operate in a best practice manner and provide information on wastes transported.

Companies at the TEDA site are encouraged only to use contractors who have been awarded the logo. At the end of the project 33 companies were awarded logos including waste generators, contractors and final disposal companies. The Waste Exchange and Solid Waste Information Management System were combined into a web-based portal for solid waste as the 'eWASTE' system. Apart from these two features the site includes information on legislation, news, links, feedback from TEDA enterprises and case studies. TEDA will establish a Center for Sustainable Industrial Development (CSID) in cooperation with Nankai University in order to facilitate further development and services for Eco-Industrial Park development. The center will provide facilitation for Waste Minimization Clubs, Cleaner Production Audits, operate the eWASTE system, promote the logo and developadditional services for eco-industrial development.

So far the EIP development has had a positive impact on local government units and companies alike in providing services for waste management and waste minimization and raising general awareness. It has also identified the need for detailed regulation and technical guidance by local and central government on the management of industrial waste and provided first-hand experience for a voluntary system approach. The results from TEDA in waste management at the industrial park level can be regarded as best practice in China.

2 THE EIP PROCESS

2.1 Linking EID to Local Development

Eco-Industrial Parks do not exist in isolation but within the local and regional development context. For China they are now even part of the Circular Economy policy, securing sustainable growth for the national economy.

The Local Agenda 21 / Community Development Goals
EIPs need to fit into the local or regional development setting. If the local development policy is already in line with sustainable development goals, it has some sort of Agenda 21 character, including economic, environmental and social goals. Any industrial development should be undertaken according to these goals.

Development Plans
EIPs should also be in line with the 5-year development plans (provincial, local and sector), both to secure support from higher administrative levels and ensure cooperation from all departments involved.

Other Development Projects
In many localities a number of development projects are being planned or implemented at the same time, often focusing on the same sector or overlapping in area. For industry-related projects industrial parks are often the target of agencies and donors alike. Cleaner production and energy efficiency projects are often implemented in the same industrial park and even with the same companies. Local authorities need to ensure that ongoing or planned projects are linked to the EIP concept and create synergies rather than overlapping confusion.

Benefits of an EIP
The benefits of applying the EIP approach are manifold and go way beyond the much publicized material exchange. Since industrial parks are a complex form of industrial system, all aspects of these systems should be used to create synergies between companies. Examples of benefits:

Potential Benefits of Eco-Industrial Development

Communities	Environment	Business
Expanded local business opportunities	Continuous environmental improvement	Higher profitability
Improved tax base	Reduced pollution	Enhanced market image
Community pride	Innovative environmental solutions	High performance workplaces
Reduced waste disposal costs	Increased protection of natural ecosystems	Improved efficiency
Improved environment and habitat	More efficient use of natural resources	Access to financing
Recruitment of higher quality companies	Protection and preservation of natural habitat	Regulatory flexibility
Improved health for employees and community		Higher value for developers
Partnership with business		Reduction of operating costs (i.e. energy, materials)
Minimized impact on infrastructure		Reduction in disposal costs
Enhanced quality of life near eco-industrial development		Income from sale of by-products
Improved aesthetics		Reduction of environmental liability
Good jobs		Improved public image
		Increased employee productivity

Source: Maile Deppe and Ed Cohen-Rosenthal, Handbook of Codes, Covenans, Conditions, and Restrictions for Eco- Industrial Development, Work and Environment Initiative. 1999.

2.2 The Roadmap for Eco-Industrial Parks

The development of an EIP usually follows **four phases**:

1. Project Identification
2. Preparation
3. Project Planning
4. EIP Implementation.

This Roadmap for Eco-Industrial Parks can be adapted not only to industrial parks / eco-industrial parks, but in general to any larger development project with a variety of stakeholders and multiple economic, environmental and social effects that involves industrial or commercial development. Even though a number of principles are taken from the experience with western EIP projects, it is recommended that Chinese managers follow the steps in the roadmap to ensure the best ideas for designing an ecoindustrial system and get the broadest support from stakeholders and industrial enterprises.

Phase 1: Identifying the Project

The initial idea for an eco-industrial development project will often emerge as the result of a particular piece of property open for development. This can be brownfields or a denuded urban site. It can also apply to mixed urban-industrial complexes open for restructuring. The EIP strategy should be site specific.

Idea & Champion

A project champion usually starts an initiative or project. A champion best comes from the government, businesses, or the community to get the development process up and running. If possible, champions should be found in each of these arenas. Leadership usually takes the form of an individual or small group of people who are respected for their advocacy of specific business, environmental or community concerns or who simply value the idea.

Mobilization of Support

The champion, who usually has an exposed and recognized position, must promote the EID idea to key stakeholders, including local business and government leaders, other decision makers, interested and affected community members, media, and

potential financiers and sponsors. If the idea gains the interest of some of these stakeholders, the EIP idea can gain momentum and support for further action.

Actors and Stakeholders
Actors and stakeholders can be defined as two sides of the same medal. Actors are those who have the means of changing things in an industrial system while Stakeholders are those who have interest in changing (or not changing) things in an industrial system. In a few cases actor and stakeholder are the same person or institution, e.g. local government departments can be both actor and stakeholder in providing infrastructure; a company manager as actor can also represent an industry association as a stakeholder.

The actors are usually to be found in three groups: companies, service providers and industrial park developers. In China the latter can be private but are mostly government authority or affiliated. Individual actors can be great in number in existing industrial parks, or very few to nil in new developments (nil if the developer has not yet started). Therefore it is difficult to carry out an 'actor survey'. Actors are usually identified during the initial data collection (see below).

Identifying theProject
An Eco-Industrial Development Project can involve the following approaches:

1. Retrofitting in an existing cluster of industries or an industrial park to improve financial, environmental and social performance and reduce necessary inputs in resources.
2. Adapting EID to new industrial facilities, from large individual companies to clusters of industries or new industrial parks, development zones, free trade zones, technology parks etc.
3. Introducing EID into existing operations of administrations and institutions.
4. Applying EID to specific industrial sector activities without a common property through Eco-Industrial Networking.
5. Applying EID to specific goals, e.g. greenhouse gas emission reductions, within a locality or industrial region.

See. Eco-Industrial Park Handbook for Asian Developing Countries (Lowe 2001)

Phase 2: Preparation
Usually there is a particular site (e.g. a brownfield site that the community has) or a dedicated industrial site open for development. The site can also be on a larger scale, a development area of 100 Km or more, or a regional approach with several industrial properties.

Project Site and Project Region
If the development is on a particular site, it needs to be considered whether to think outside the legal boundaries of the project, at the municipal or district level. Preferably an ecosystem or bio-regional approach or a larger watershed should be considered for ecological and resource allocation issues. Watersheds are most suitable, along with political boundaries, to define a project region, since the industrial water supply will come from a nearby watershed. If the water comes through a large canal from some distance, the project region, at least for the water issue, should be expanded to the source of the canal. The project should try and connect with the larger region even if it is limited in size, because the likelihood of addressing environmental issues through eco-industrial development increases as the project accounts for the various connections within and between industries and the community. Rural projects usually require a larger scale to find the maximum number of connections (Case Study: The Luzhouo EIP project has not yet enough potential companies to create synergy networks. The project therefore considers surveying companies outside the industrial park to identify possible cooperation).

Thinking Beyond the Fence
The standard industrial park has a defined boundary and area of jurisdiction. Often the site is surrounded by a fence and controlled by gates. This is a big advantage in managing and securing the site, but leads people to think that the world also ends at the fence. Materials and products move in and out of industrial sites, causing countless implications and effects outside the industrial area. The most affected is usually the immediate neighborhood, where workers live, and suppliers and service businesses set up shop. But in a global economy the effects of an industrial park are also truly global.

Identifying the Project Scale and Interests
Within the project site and project region a number of interests, often conflicting, from different stakeholders are present, concerning economic development, environment and social issues. The project will also address several markets, both regional and beyond, e.g. manufacturers, agriculture, service, government, and the need for resources, natural (e.g. water, wood), cultural, human, financial, etc., product markets (local, regional, national, international), government agencies, political will, community groups, and individuals. All these might affect the design and performance of the industrial project.

Identifying Potential Partners
The most successful EID projects established a broad base of support from the outset. This is not necessarily a distinct step in the project, but it is an important one. There is a variety of stakeholders and potential partners in your municipality who will likely have an interest in the EIP project:

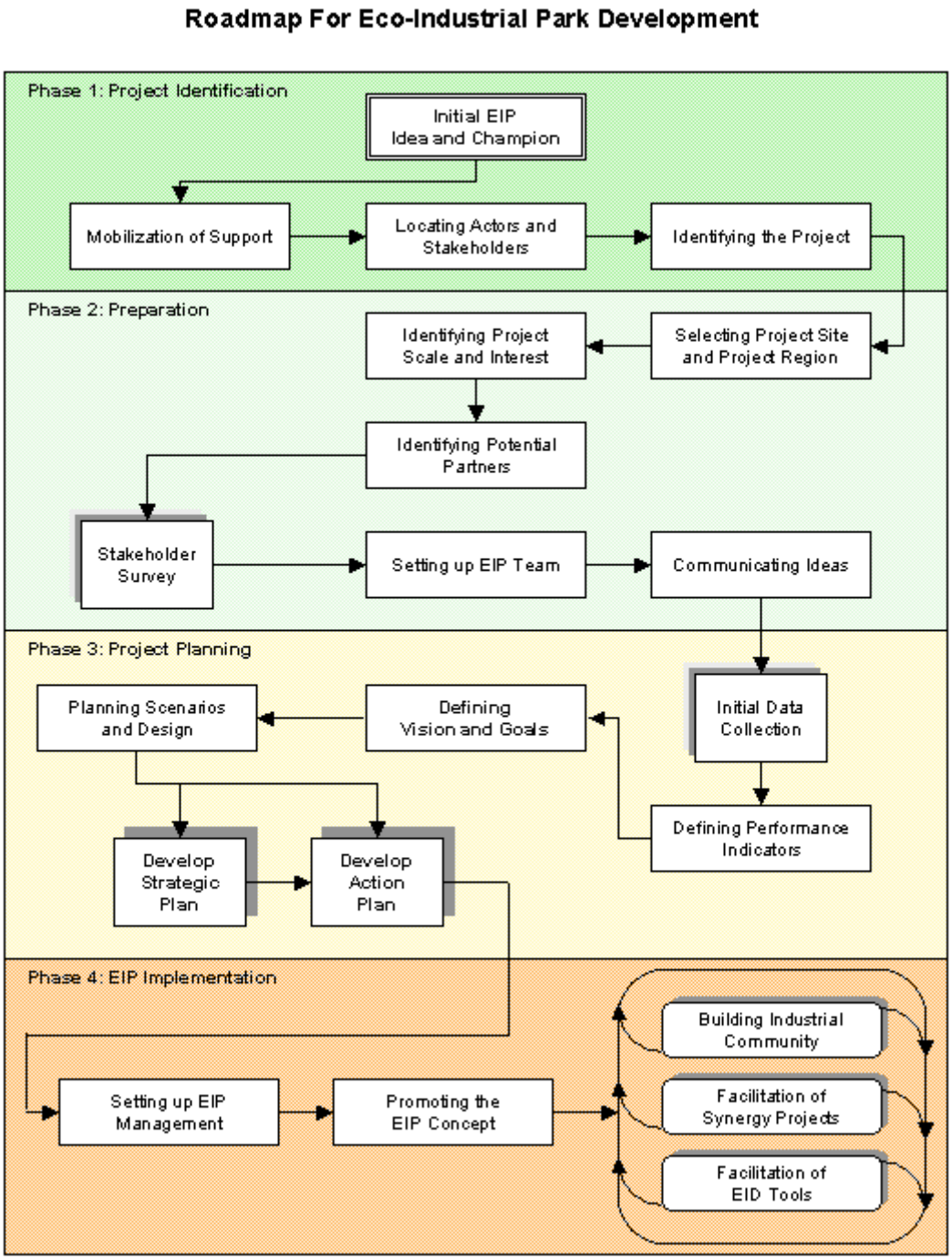
- Municipal government departments
- Neighboring municipalities

- Industry associations, Chamber of Commerce, business clubs
- Industries as potential customers for the EIP site
- Non-profit organizations
- Academic and research institutions
- Consultants
- Resident associations, farmers' groups

The more groups that are engaged in the planning process and are educated about EID, the more likely there will be broad support for the project.

Stakeholder Survey

To find out who has what interests and concerns, a stakeholder survey needs to be made. Based on the issues identified and the regional extent of the project, develop a list of possible organizations and individuals who might want to (or should) be involved. Ensure there is adequate representation from each area (community, government, and business) if possible. If the focus is on a specific location, make sure there are individuals and groups from those neighborhoods involved, as these know best what resources are available locally and are most affected by new development. Also identify the possible interests of each sector to be involved in the proposed project.



Source: EMCP Industry Development and Andreas Koenig, 2005

Setting up an EIDTeam

The local and regional community of industries, administration and institutions has a number of available resources, including planning, design management and research skills that can be utilized, further financial resources and available tools that can be applied in the process. These persons and institutions need to be identified, informed and committed to the planning and implementation process, and a team of appropriately skilled people formed. It is also worth involving local experts who have experience of working with companies on cleaner production and related issues. National or international experts who have experience with EIP development can facilitate the local team and mobilize additional resources from the national level or international organizations.

Understanding the Concept
At a very early stage the concept and opportunities of eco-industrial development have to be clearly communicated to the different groups since everyone will have his own understanding of what an 'Eco-Industrial' park is. If champion, stakeholders and community do not speak the same 'language' the initiative will not go beyond ideas.

Communicating Ideas
As soon as the ideas begin to form into a project, stakeholders and potential actors (government departments, developers, investing companies) to be involved in the project should be informed and consulted through Stakeholder Roundtables and EID workshops. These stakeholders usually include the responsible Vice Mayor of the local government, the EPB, the Planning Department, Development Zone Management, party representatives, and relevant institutions like local Cleaner Production Center, research institutions, University etc. The involvement of these groups from the very beginning is important for their motivation to support the project and contribute with ideas and information.

Phase 3: Project Planning
Many EIP projects see the planning stage as the initial project stage and many never make it beyond the planning stage. Hence the planning stage needs to be well designed and based on a broad consensus between stakeholders and existing / potential actors.

Project or Process Planning
As soon as the planning starts, a project is usually launched. Taking the nature of eco-industrial development as a process, the site development needs to be planned as a process. Most preconditions for the planning process, however, will be for a project (budget, commitment, investment allocation). During the planning process an open approach should be kept in mind and planning for 'after the project' included.

Role of Local Government
The role of Local Government in the planning of a project is central, whether as a planning and supervising body or as the developing administration of the EIP site itself (like TEDA in Tianjin). It needs to ensure that all available ideas, resources and regulations are in place to enable the project.

Initial Data Collection
An initial survey of the area and region is needed to identify resources, features, and development issues and create a benchmark for measuring development against the goals. Most available data are usually either outdated or not sufficient to get an accurate picture of the situation. It is important to base the planning of industrial synergies on information provided by the involved actors. Therefore surveys are necessary to supplement or replace existing data (Case Study: The REDA EIP pilot project has undertaken a survey with questionnaires for existing companies to gain an accurate picture of the issues and material streams in the existing industrial park).

Defining Performance Indicators
Based on the initial data collection or a specialized survey, the benchmark for the future performance of the EIP needs to be defined. This should be based on a set of performance indicators that both reflect the improvement of individual companies and the industrial park as a whole. A number of such indicator systems are under development, but none has been publicized or implemented yet. A useful benchmark system can be based on emission indicators (e.g. wastewater discharge, solid waste generation, CO2 or SO2 emissions) for emissions that are measured on a regular basis by EPB or companies. Energy and water consumption per capita or product output are also suitable indicators. The EIP team should develop their own set of performance indicators under the guidance of experienced experts and test it with the available data. It is not recommended to use international performance indicators which require an expensive monitoring system that is not locally available.

Participatory Planning for Vision and Goals
If all interests of stakeholders and actors, including the potential investors, are included in the planning process, strong ownership will be created and the project design is more likely to meet expectations and create the most synergies. The participation of different interest groups from local and regional government, from existing industries and the communities in the area will produce a variety of ideas for the design process and ensure the best solutions.

Scenarios and Design
Based on the available data, issues and interests, different scenarios and initial designs for the industrial system can be made using tools such as design workshops.

Strategic Plan and Action Plan
The results of the planning process and decisions for further action are summarized in the Strategic Plan and Action Plan.

Phase 4: EIP Implementation
Implementation of an EIP project can start depending on how the project or process is defined by the local team. An EIP project will always start if all parties are committed to implement a plan and the first synergies are created. (Many 'projects' have not gone beyond the planning process. They have created a high awareness among stakeholders, but no actual improvements have been made.)

Industrial Park Management – EIP Management
At some stage, preferably very early, the regular industrial park management and the EIP management (or development team) have to be merged. Some projects, especially expansions of existing parks, are operated separately from the original industrial park with parallel management structures. This prevents synergies between the existing and new EIP development and prevents a smooth integration of EIP management into local government structure after the project is finished. In China an EIP project is often attached to the local Environmental Protection Bureau (EPB) due to the responsibility for environmental management and emission control. The EPB can also be assigned with the task of integrating the EIP development with other government departments under the guidance of the responsible vice mayor or mayor in order to ensure integration with all development aspects of the industrial site.

Promoting the EIP
Once concept and plans are available, potential investors and collaborators need to be informed and committed to the project since they will be the ones using the ideas and designs. Special PR and promotion tools need to be developed for the property market.

Building an Industrial Community
Whether the EIP project builds upon an existing industrial park or develops a Greenfield site or phase, existing and potential investing companies need to be formed into an industrial community. Synergies can only created if the companies know each other and have the trust to work together without giving up their market independence. Project management needs to use specific tools and work with individual companies.

Facilitating Synergy Projects – EID Tools
A major part of an EIP project is to facilitate the implementation of individual projects to create synergies between the companies and provide added-benefit services through the management or joint-venture partners. EIP project and industrial park management can use and provide specific tools to foster this process: develop specific business services, provide a platform for interaction and provide technical facilitation and information to companies and stakeholders. Tools include setting up an Eco-Forum and concentrating services in an Eco-Center.

3 STARTING AN ECO-INDUSTRIAL PARK PROJECT

3.1 Standard Site Planning vs. EIP Planning

Planning Culture
The development of a new industrial area is a major change of land use patterns with several long-term impacts on the local environment and economy. Industrial areas are usually planned for periods of use of more than 20 years. Therefore the regular planning process is lengthy and complex. Even though many industrial developments are at least partly focused towards international investors, the planning procedure depends on local planning tradition and planning regulations.

Planning Regulations
The standard planning procedure has to take into account a multitude of laws, regulations and permit procedures that are specific to country, province and local building regulations. They usually include (list not complete):

- Provincial and Municipal 5-Year Development Plan
- City or District Zoning Regulation
- Transportation Plan (for access roads, train links etc.)
- Site Planning and Permits
- Building Plans and Permits
- Building Codes
- Water Resource Planning and Permits (for water supply and wastewater discharge)
- Environmental Impact Statement
- Emission Discharge Permitting (including waste disposal).

For larger projects some of the regulations and processes can be combined or streamlined in order to shorten the planning and permits process. But the development of new industrial sites is in any case in conflict with existing land use (often agriculture, urban settlement in close proximity, or natural land) and will be decided politically.

EIP Planning Intervention
The EIP process should seek to identify and recognize the present or potential conflicts in the planning or pre-planning stage and involve all stakeholders in the decision process, thus gaining optimal designs and solutions. In order to achieve this, the EIP planning process intervenes in the regular planning process in order to include concerns by stakeholders, design options and modified codes (e.g. building code) at an early stage. The EIP process also enables the planner to identify conflicting regulation and permit procedures that often prevent sustainable solutions.

Adapting Regulatory Framework
An EIP design might include a network for steam energy linked to a cogeneration plant as the most economic and environmental energy solution for a group of companies. This energy solution might fall under a national programme for alternative energy, enabling the companies to apply for grants or low-interest loans. However, regulations for grants and loans are usually designed for ***one*** company, not a group who share the benefits. Other existing regulations can prevent companies from investing in co-operation projects if they will have no benefits or even have to pay more taxes. Waste management regulations often prevent the use of hazardous substances if they are declared as hazardous waste. Local Government will have to address such issues and review and analyze if existing laws and regulations prevent EID solutions or make them uneconomic by protecting traditional production or service structures (See: TEDA case study).

3.2 The Role of Local Government

EID is about synergies and networking. The first and most important place to start collaborating is within the local administration. Local government plays a central role in development planning, obviously not only for industrial projects. But this role is even more important since many industrial development projects in China are large in size and have features and structures like towns, with extensive housing, municipal services and infrastructure. TEDA in Tianjin is an example of what is called an urban-industrial complex.

Variety of Roles
Regarding the development of industrial sites, local government in China often takes a dual role, unlike authorities in western countries. Local government units are both developer of a site and regulating authority. This can ease decision-making regarding a project but can also lead to conflicts between the different roles. In an EIP project local government tends to also take the role of the service provider and facilitator of a project. However, it can be more economic and easier to regulate if services are provided by private service providers. Facilitation can also be assigned to third parties like universities or consulting groups (e.g. Cleaner Production centers).

Role of EPB
In many EIP projects the environmental management unit of the leading organization heads the initiative. In China it is usually the Environmental Protection Bureau, in a private development company it would be the environmental management unit or the pollution control office. In rare cases it is the unit or department responsible for industrial development. This is based on the misconception that eco-industrial development is an environmental affair. If EID is defined as Sustainable Industrial Development, it should be the Mayor or Vice-Mayor who takes the lead in the EID process. An eco-industrial park project needs to be supported by all departments relevant to development.

Even though in theory EPB's are probably the best promoters of environmental causes, they are one of the weaker parts of local government in terms of political weight and budget. EPBs are, however, in a perfect role as a coordinator and moderator between other interests. In the ideal situation, the EPB will team with the Economic and Trade Commission (ETC) and Planning Department under the guidance of the Mayor (Case Study: In most Chinese EIP projects the EPB has taken the leading role for design and implementation of a project. Often the overall development is guided by the Vice Mayor).

Allocation of Available Resources
The initial stage is always very critical in terms of securing resources for the project. Even the planning process with free input from stakeholders and government departments might need additional funding if national or international experts are going to be involved, from an estimated RMB 1-5 million without extensive surveys and feasibility studies. Once the EIP project is fully integrated into the regular planning and budget procedures, funding for EID investment projects is allocated in the local budget. For local government decision makers it is a key issue how much a project will cost and how it is funded. By looking for partners in the process it might be easier to secure funding for the initial steps of the project and share the cost between a number of interested parties.

The new approach to preparing an EIP and the open-ended scenario takes more time and therefore more funding at the Planning stage. Developing different scenarios also will add cost compared with a standard procedure. The total cost for an EIP project can vary widely, depending on the size of the area, available infrastructure and the number of existing investors. The key questions to be answered for municipal decision makers are:

- Which tasks are we prepared to do in-house, and which should be commissioned to other institutions or consultants? The rule of thumb is: If no budget is available, do it in-house.

- For which of these tasks do we need external expertise (EIP experts, architects, systems engineers)?
- Do we need to reallocate staff internally or hire additional staff to be able to cope with the EIP work?

Typical EIP Cost

Cost for EIP projects usually include:

- Internal project management (in addition to regular positions)
- Meeting, workshops, information visits to other projects
- Internal and external data collection, surveys, studies
- Promotional Material, awareness raising (brochure, video, web page etc.)
- Assigning a facilitator to the management team
- Hiring local, national and international experts for review and coaching of the project
- Industrial Ecology synergy studies, feasibility studies for individual groups of companies, detailed research on material streams, water and energy usage
- Developing and setting up management information systems
- Hiring professional marketing specialists
- National and international promotion (advertisement, trade shows etc.)
- Participation in national and international EIP networking events and conferences.

EIP projects can usually draw on a wealth of local resources. Different local government departments integrate their knowledge of the local situation and specific technical skills. Local and provincial government has skilled personnel in planning, engineering, environment, finance, business regulation and licensing, parks & recreation, utilities and construction, among others. EIP projects need to draw on all these skills. Working groups and EID teams should include all functions in order to have easy communication with government decision makers in case of needed resources or conflict.

Adjustment of the Policy Framework

Local government is also in a position to adjust policies that might contradict or obstruct an integrated EID approach. As in every administration, government departments have overlapping functions and sometimes are in competition with each other. Unclear jurisdiction often prevents the implementation of innovative ideas and technologies. Policy, laws and regulations need to be adjusted and fine-tuned according to the principles of eco-industrial development for sustainable industrial development, including economic incentives and subsidies for introducing efficient and environment-friendly technologies. Local government is in a position to provide such changes or initiate them at the provincial or national level (Case Study: In export processing zones material declared as waste can be exported from the zone and disposed of based on regular waste fees. If the material is intended for use as by-product, it will be declared by customs as raw material and thus taxed when exported out of the zone. This increased cost often prevents the use of by-product materials. Customs and waste regulations need to be adjusted to enable by-product exchange).

Institutional Capacity Building for Eco-Industrial Development

All government levels that need to be involved will need extensive awareness raising and training in principles of industrial ecology, circular economy and eco-industrial development. The leading body of the EIP project needs to ensure the availability of training courses and promotional material for individual departments and government institutions. Only an understanding of EID will ensure cooperation and generate ideas from each specific department.

In a similar way, industrial park developers and operators (managers and engineers) need to be introduced to the subject. The same goes for companies on the site or potential investors, but they will not be able to invest much time in capacity building and will need a different set of materials. Introductory workshops for each group should be organized by the project according to needs, with first priority given to the decision makers. Capacities to be developed at the local level should include:

- information management and exchange for technical and organizational issues, development of technology databases for EIP projects
- know-how of 'best practices' based on international experience and Chinese pilot projects, and promotion of eco-industrial development principles,
- development of new services for assisting individual companies in eco-efficient production and environmental management practices, e.g. cleaner production, energy efficiency, waste management, social services.

Support of Pilot Initiatives

Local government is also in a position to support the implementation of individual synergy projects by the private sector, such as alternative energy generation through co-generation. These projects should be driven by private companies and not necessarily be implemented by the government itself. In this way the market will guarantee that the projects not only create environmental benefits, but are also profitable. Projects regarding social services or with a greater benefit to the public, such as public transport in industrial parks, should be carried out by the government if no private investor is available.

Local government or the private developer can also promote business opportunities for closing material loops ('missing link'), actively search for respective companies that can fit the EIP concept (such as a co-generation service provider and companies that need large amounts of steam). Local Government can also provide selected services that do not have a profitable market, e.g. coordination of a waste minimization club, a byproduct exchange, or information services websites).

3.3 Communicating EID

Working Group and Stakeholder Roundtable
Before the planning process starts, an advisory committee or working group should be formed. Once a list of stakeholders is available, it is a good idea to have a core advisory group or working group to assist in the planning process that is well integrated into the community as well as local and regional governments. Often this group will come from the stakeholders. One option is to have a workshop that allows potential members of an advisory board to learn about and discuss eco-industrial development and the project itself and then decide whether they want to participate. Other times, it is more effective to begin with a series of one-on-one interviews and discussions with individual representatives, especially the 'real' decision makers. It can be very helpful to conduct a series of interviews with the stakeholders identified in the survey. These interviews have a threefold purpose: first as an opportunity to present the ideas of eco-industrial development; second, to elicit ideas about the potential for this type of development; and third to generate interest in participating in a working group.

3.4 Participatory Planning

Goals of Government
The goals of the main stakeholder groups for developing industrial park sites usually differ to some extent. Government is interested in achieving economic development to provide jobs for citizens and tax revenue. In low-income regions many industrial developments are designed to attract international investors. An EIP concept might be oriented towards preventing excessive damage to the environment and protecting locally scarce resources such as water.

Goals of Industry
For industry an industrial park usually offers a more or less complete package of administrative and infrastructure services that cannot be found outside. These services need to be competitive in the market and secure, e.g. uninterrupted supply of energy and water. Industry also likes to avoid labor unrest (strikes) and security risks. An EIP concept could be of interest if it provides better services at the same or lower prices and guarantees improved long-term security in supply. Industry also sees EIP as a problem-solving tool for issues like waste and hazardous waste management, improved administrative services such as compliance with government regulations and shorter permit periods, which both reduce operating cost.

Goals of the Industrial Park Administration
A administration of an industrial park is usually interested to develop the land at low cost and sell or lease it at high cost. Through management of the site, the administration will provide adequate services to make it attractive for investors and collect fees for its services. An industrial park administration is therefore interested to provide prime services for increasing the site value, its attractiveness and be able to justify higher fees. The EIP concept is basically attractive to developers as it implies industrial development without negative effects. In practice developers understand the concept as 'Green and Clean', a site development as an industrial 'Park', with focus on landscaping and design of buildings and scenery in a park-like setting.

Goals of the Community
The community is usually interested in secure, well-paid jobs that don't have to be traded against environmental degradation. Since negative effects of industrial developments are manifold and often reach far-distant areas through water and air pollution or the export of waste, communities like to see industrial developments set apart from housing and recreation areas but still easily accessible for commuting. An Eco-Industrial Park could be the 'ideal' industrial development for the community, since they are involved in the design process and are able to build community benefits into the system.

Involvement of Stakeholders
There are many ways to bring about "agreement" among stakeholders for an eco-industrial project. Simply getting official consent from representatives of a community or group often does not constitute true consent, understanding, or commitment from the greater community and relevant stakeholders. Implementing a comprehensive participation process ensures much more than superficial acceptance or rejection of the plan. Involvement of stakeholders achieves far more than simply providing stakeholders a forum to express their own interests and concerns. The process urges discussion among diverse groups to collaboratively brainstorm new interests and concerns, improve understanding of the pertinent issues, and create effective and appropriate solutions. This process usually generates new ideas, enabling the EIP team to build their plan with more options. The views and opinions of participants perpetually evolve, and often the process can achieve increasing support and acceptance for a mutually devised eco-industrial development plan. Furthermore, the resulting plan will be a better fit for the community than a plan not subject to the participatory model.

Trust among stakeholders enables them to remove defensive barriers, making them more receptive to alternatives, tolerant of ideas outside their own position, and creative in their thinking. People's preconceived notions of industrial zones as towering monoliths belching clouds of black smoke from their peaks are difficult to overcome. Open-mindedness is often necessary to combat this stigma associated with industrialism.

Involvement of Community
Community participation in the eco-industrial development process can span a broad range of decision-making approaches depending on the specific circumstances. If a project includes social services (e.g. a daycare center in the industrial park) women's groups and worker representatives will have a strong interest in participating in the design.

Capacity Building
Building capacity enables communities lacking organization and leadership to turn concerns into responsible action and contribute to the design. The involvement of community leaders is an opportunity to provide education about eco-industrial development to the general public and ordinary workers. Not only the various decision makers in local government will profit from the process, but also the general public. A well-informed public will support projects if it is clear that they are (at least partially) part of the planning process.

3.5 Industrial Park Management – EIP Management

All industrial parks have some form of management for the day-to-day activities of the industrial park. Management structures take many different forms, including professional management companies, tenant-run, and private/public partnerships. Eco-industrial parks have similarly diverse structures. In China most industrial parks and development zones are managed by public authorities with extensive administrative structures for planning, recruitment, construction, environmental management, and maintenance. In becoming an EIP, such a management structure needs to closely integrate all departments in the process.

Role of Management in EIP
Industrial parks traditionally provide a means for input or decision-making in the management of common elements. These include common facilities, signage, maintenance of roads, adjustments for construction obstructions, and sewage use. Since Eco-Industrial Parks seek broader connections and reduction in overhead through shared facilities, materials and/or energy, these areas of overlap will likely be broader. In some places these can be commonly contracted services such as hazardous waste removal or trash collection. An eco-park would also look for ways to recycle waste and reuse by-products by seeking common solutions among its participants. In fact, management may become more crucial in eco-parks, since there is an overall goal of continuous environmental improvement, community connections and business success. Hence identifying the precise management structure is extremely important.

The management of an eco-industrial park becomes one of the most important features of the park. The premise of eco-industrial development is the networking possibilities cross-industry. This needs to happen on several levels, from inter-firm to interpersonal. Jorgen Christensen, Director of the Symbiosis Institute in Kalundborg, Denmark, contends that in the early days of the "Symbiosis" (the name given to the eco-industrial park in Kalundborg), the fact that many of the managers of the industries were in the Rotary Club, a business service organization typically made up of management level people, was critical in being able to identify common interests (*For EIP management functions and structures, see: Lowe 2001, Chapter 10 or Lowe and Geng 2003, Chapter 11).*

Management Functions
An eco-industrial park is not just comprised of the physical structure of the park; it is an on-going commitment to continual environmental improvement and a commitment to networking with the business within the park, the region and the community. To meet these goals, the eco-industrial park management is most often concerned with one or more of the following functions (UNEP, 1997):

Planning
- identifying possible sites
- conducting environmental impact assessment
- selecting sites
- undertaking pre-planning
- transport of goods, materials, and people
- designing layout
- developing an environmental policy and setting environmental performance objectives
- establishing a regulatory framework (i.e., codes, covenants, and restrictions)
- locating sources of funding to finance the project

Operating
- constructing infrastructure and services
- operating infrastructure and services designing individual facility sites
- constructing facilities

- landscaping sites
- marketing environmental quality
- attracting industry
- facilitating networks

Control
- monitoring emissions and media quality
- motivating for environmental achievement
- enforcing regulations or covenants
- auditing environment
- reporting on environmental performance of companies and park
- common safety issues

The degree of community representation on an EIP management group is also an area with a variety of solutions. In Cape Charles, one of the first EIPs in the US, there is an oversight group through the Industrial Development Authority, while there is an internal group equivalent to a tenants association of businesses in the Park. To some degree, community participation is shaped by who originates the idea. If it emerges from a locality there is usually one degree of accountability compared to those that emerge from private developers. In either instance developers would be wise to provide significant community input in an ongoing way and communities should be careful not to smother the businesses with elaborate regulations.

3.6 Initial Data Collection

An industrial park is a complex system of land, environment, infrastructure, buildings, materials, and last but not least, the people working there. It is connected well beyond its legal and physical boundaries through supply of raw material, water and energy, customer and supplier relations, and through the workforce. All these aspects have to be taken into consideration when analyzing and re-designing industrial systems into eco-industrial systems.

Available Data
The first priority in data collection is the evaluation and use of readily available data sets. Any industrial area has some kind of data sets available, either with the industrial park management, with local authorities or research institutions. Commonly available data sets include:

- Building Permits
- Operation Permits
- Environmental Impact Statements
- Emission Discharge Permits / Waste Transportation Permits
- Import / Export Permits
- Investments by public and private sectors
- Taxes and fees collected
- Annual Emission Discharge Reports to EPBs
- Safety Reports by companies Also available are usually
- Topographic and geologic maps
- Hydrologic data for the watershed
- Environmental data from Environmental Impact Assessments or environmental studies

A list of all readily available data sets should be compiled, indicating the date of recorded data and their presumed accuracy. All available data should be checked and verified in order to gain a picture of the real situation. In case some data, especially on material, water, energy and waste usage seems to be outdated or too general, additional surveys have to be undertaken.

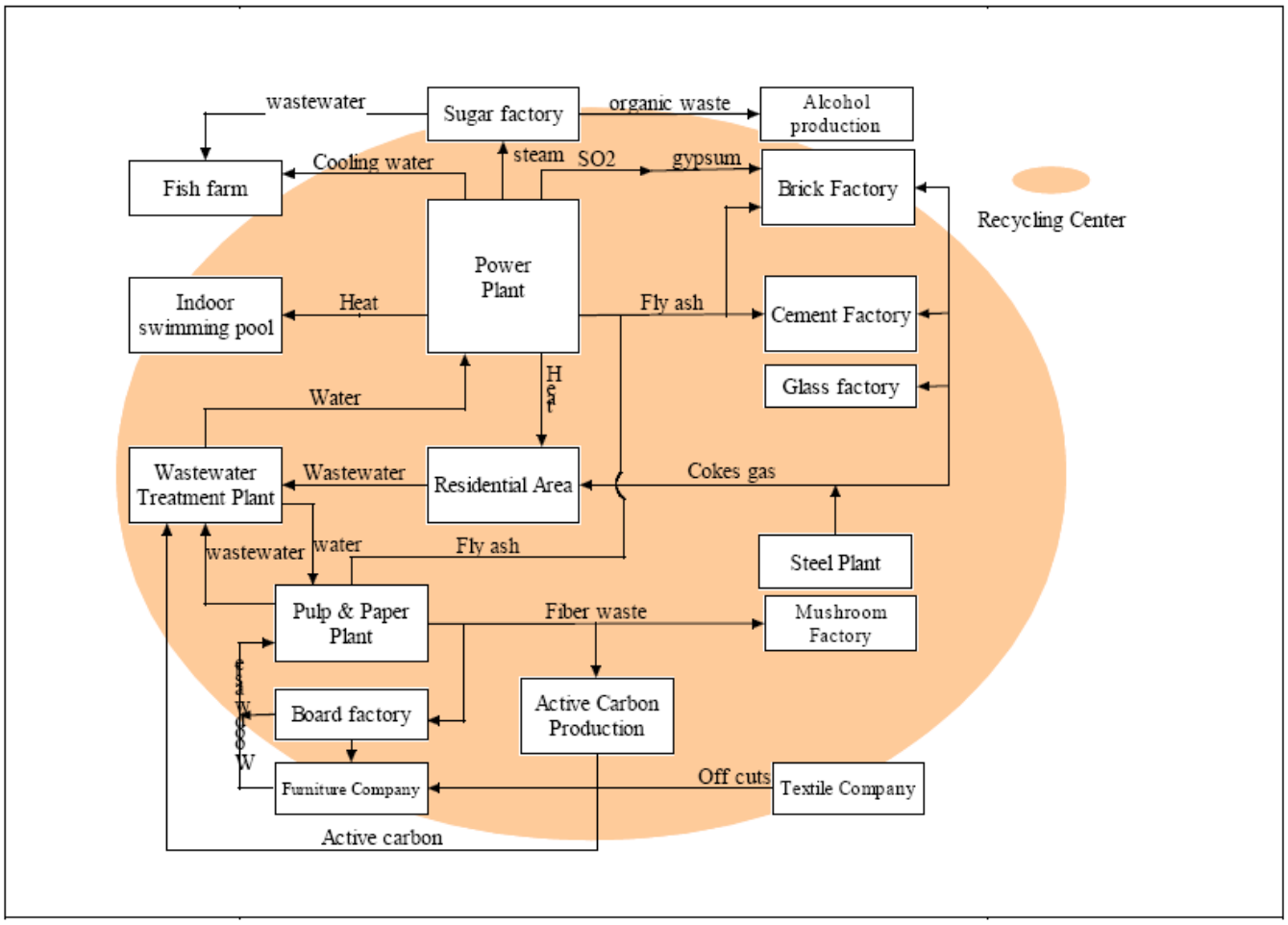
Traditional Baseline Analysis
- Assess land availability and consistency with the comprehensive plan
- Evaluate infrastructural capacity - sewer, water, transportation, electric, storm water
- Analyze access to markets - local markets, regional markets, national markets, obstacles to moving goods and services
- Analyze access to capital - public sources, private and venture capital, local sources of capital
- Analyze labor force - size and training level of local workforce, market wages, availability of housing, and access to transportation routes or transit

Additional EID Baseline Analysis
- Analyze regional industrial resource flows - gather information on material, energy and water flows (inputs and outputs) within a geographic region targeted for EID. Match with projected industrial loads based on profiles of preferred candidate tenants.

- Inventory regional and site-specific amenities and infrastructure. Identify existing and proposed industrial infrastructure, utilities and facilities in the region. This would include an analysis of water supplies, existing and potential renewable energy options (thermal and electric). Qualify access to transportation networks and appropriate scale for new industrial ventures.
- Collect and analyze data on existing businesses and production activities. What kinds of manufacturing processes and technologies does the existing industrial development use? What technologies could allow both retooling of existing industry for greater resource and economic efficiency, while allowing new industrial development?
- Collect and analyze data on material flows- inputs, by-products and wastes, product output. What are the existing household, industrial, commercial, and agricultural waste streams that could be a feedstock for new industrial development, or that could be co-managed more effectively with new industrial infrastructure?
- Develop site evaluation and profiles. Conduct assessments of potential industrial sites in the region to determine options for EID. Determine the feasibility of each site or combination of sites for locating processing and conversion facilities along with manufacturing ventures. Site profiles will include materials handling and storage options, infrastructure assessments, existing assets, community development capabilities, alignment with local policies, and compatibility with regional suppliers. Determine preferred eco-industrial site characteristics.
- Identify end-users of by-products and wastes produced within the community.
- Create an energy profile for the community - production, demand, prices, environmental aspects. What kinds and capacity of distribution, generation, and transmission system infrastructure currently exist in the community? How could existing infrastructure facilitate use of waste heat, co-generation systems, distributed generation, or aggregation of energy use?
- Natural resources available for development. What underutilized resources can be sustainably harvested, including forest resources, agricultural resources, minerals, and water resources?
- Inventory of local suppliers and services. What kinds of locally produced goods and services can be used in new businesses, locally capturing the added value of existing businesses?
- Review and characterize previous related planning work.

Potential Eco-Industrial Park Links at REDA

The chart below is an example of potential material exchanges identified at REDA through an initial survey with available data at an early stage of the project. The diagram was used to demonstrate the potential and was powerful in encouraging buy-in and discussion among participating companies. Feasibility analysis and commercial analysis are underway at the time of writing (See also: EMCP REDA Pilot Project Final Report. Kothuis, B.)



Economic and Environmental Performance Evaluation

- Determine economic and environmental performance of the existing park or the industrial sector in the region
- Model economic impacts. Conduct economic impact modeling of the proposed eco-industrial supply chain. Create projections of the localized economic impacts of an eco-industrial park with regard to job creation, overall output and reduction of environmental cost.
- Evaluate economics of environmental benefits for proposed or existing companies based on CP models (no cost, low cost, high cost model) and for the EIP as a whole (reduction of waste management cost, waste water treatment operation etc.).

Technology and Market Analysis

- Assess technology and financial status. Conduct appropriate technical and financial assessments to determine the commercial scale viability of the materials handling, processing, wastewater treatment, manufacturing and renewable energy technology components of a eco-industrial cluster. Include independent technology validation, materials and product performance testing, cost-benefit analysis, and a systems mass balance.
- Profile candidate tenants. Parallel with site profiles, conduct profiles of candidate manufacturing, commercial, and/or service businesses that could locate within select sites or become part of an eco-industrial cluster. Candidate profiles will include a business prospectus, assessments of material and energy needs, facility requirements, product specifications, market assessments, and identification of supply chain production and networking synergies. Determine the necessary conditions for core and ancillary tenants.

'Rapid' Surveys

Local authorities are faced with the task of building a comprehensive picture of a complex system for their decision-making and design, often without the ability to undertake extensive studies. An initial survey of the proposed development area and adjacent region needs to be conducted to gain a comprehensive overview within limited time and resources. In existing industrial regions

comprehensive surveys might take several months. A rapid survey is based on available and accessible data and information that can be collected from companies, agencies and other sources with little effort and time.

Setting the Time Frame
A **rapid** assessment should be accomplished within 2 – 4 weeks, processing and documentation within another 2-4 weeks. If the whole process last 6 to 8 weeks, the data can be utilized in the initial stakeholder information. Thus the survey is linked directly to the planning process.

3.7 The Design Process

Design Concepts
The EIP project team can create EID design concepts based on the priorities of stakeholders and commonly agreed goals for the region and the site. Design concepts are based on the issues and data identified during the survey(s). They take the existing material flows of the local economy into consideration. As with the overall EIP process, the designs will not be static, they will be iterative, reflecting the changing conditions as more investors are interested and more data is available.

It needs to be stressed that there is no single, ready-made design formula that can be applied to an industrial site once it has been identified. Designs rather have to be fine-tuned to the industrial system as it develops. Plan and Scenario design concepts include:

Conceptual EID site or modification scenarios. Based on results of site and tenant profiles, conceptual site plans can be developed and will include scenarios that provide facility design/layout options, infrastructure connections, opportunities for shared facilities/amenities and sustainable design. Waste exchange options as discussed in Waste Minimization Clubs can also be based on different scenarios, assuming that there are always more than one technical and economic solutions.

Site master plans. Development of site plans for industrial facilities complementary to community plans for urban and infrastructure development. This is especially relevant for bigger companies occupying large single sites. Determine principle uses of site/s: how to zone, conditions, restrictions, development guidelines, and necessary infrastructure on site.

Schematic design and engineering. Based on previous work, develop schematic design and engineering plans for commercial scale operations. These plans should include facility design/layout, material handling/storage/processing flow, transportation interfaces, engineering specifications for integrating the modular renewable energy component, waste and wastewater recovery system design, and sustainable design guidelines for buildings and site (See REDA Case Study and Appendix 5).

Eco-Industrial Design Principles
Design issues are a key feature in the ability of any eco-industrial development project with their impact on the environment and work force. Design refers largely to the physical layout of the industrial park and the buildings including both interior and exterior elements. Incorporating sustainable design principles such as energy efficiency and indoor workspace quality has been shown to increase productivity, which can offset higher rent or installation costs. For an extensive summary of design options, see: Lowe 2001, Chapter 8, Lowe and Geng, 2003, Chapter 9 (in Chinese)

Designing eco-industrial development begins during the initial stage of developing vision and goals. In traditional industrial parks, designing the park involves the extension of infrastructure to the site and permit approvals for industrial buildings and uses. More advanced design processes include site planning for building footprints and possibly creating a planned industrial development zone. One reason for this design approach for traditional industrial parks is that many industrial users have very particular specifications for their operations.

Designing Synergies
The unique design approach of an eco-industrial park is that it also considers environmental and social issues up front in the design process. Up-front planning for businesses can help to ensure that eco-industrial development buildings and spaces are "better" than traditional industrial development while taking into consideration the unique needs of various industrial users. They are better because they are more productive and healthier, they aim at overall cost savings for tenants and developers, and they can compete in local markets because of their advantages.

Eco-industrial development is keenly aware of the need for functional space, but also acknowledges that development is connected with the community and the environment. In some cases, people have begun to take this approach because of increasing environmental regulations, such as air quality, wetlands, transportation impacts, and water quality legislation, which are all connected with fairly onerous permit requirements. Most design considerations that avoid triggering permit requirements are advantageous (i.e. avoiding wetlands on a site). No ready-made design guide exists for eco-industrial development. In fact, the primary difference between eco-industrial development and traditional industrial development is that much consideration be

given to the specifics of the site and community to establish a design. Another factor is the potential for interconnectedness between industry and fostering the potential for networking.

Building Design

Important elements of eco-industrial parks are buildings for production facilities, offices and utilities. In China many industrial parks and development zones are designed like industrial cities, adding the whole range of urban buildings to the EIP concept. Many planners are not aware of the fact that buildings, once not used anymore, are the largest waste stream we produce. If hazardous materials contaminate building material, it needs to be disposed of as hazardous waste, adding tremendous costs to the life cycle of a building. In Europe and in the US many public buildings were constructed in the 1960s and 70s by using asbestos and PCBs for fire retention. These materials are not only problematic in their disposal but also toxic while the building is still being used, polluting the indoor air and causing long-term health problems if inhaled. Paints and adhesives that are being applied to indoor surfaces usually emit their solvents over time. If these solvents or other components are toxic they also are emitted into the ambient indoor air.

International Building Standards

To avoid these health threats, ensure the sustainable use of building materials and reduce the energy and water consumption of buildings, sustainable building standards have been developed by a number of countries at different levels. Often the design and respective standards only focus on energy consumption of a building, but more advanced standards include all aspects of buildings design and operation, including management and landscaping issues (*For detailed building design principles see: Appendix 4*: The Basics of Sustainable Building Design). The most prominent standards are:

Energy Efficient Building Codes and Equipment Standards http://www.chinacleanenergy.org/gbproject1.asp
Under the China Clean Energy Program, the National Reform and Development Commission (NRDC) has put together a dynamic program to help China develop and improve its mandatory standards for energy efficient buildings and equipment. Currently, NRDC is working on a set of energy standards for public buildings that will include offices, commercial buildings, hotels, and hospitals. NRDC also was a consultant to the Global Environment Facility to develop technical standards for energy efficient lighting in buildings, which are being integrated with the public buildings standard. In addition to the regulatory push of mandatory standards and regulations, NRDC is working to help China promote voluntary market-pull programs in green buildings that go beyond minimum standards. In the United States, NRDC chairs the green building rating system LEED (see below), developed by the U.S. Green Building Council. Together with the Ministry of Construction and the Ministry of Science and Technology NDRC is working to adapt and translate LEED for the Chinese market.

Leadership in Energy and Environmental Design (LEED) http://www.usgbc.org
The LEED Green Building Assessment tool is technically an assessment tool, but many professionals also use it as a design tool. LEED, which stands for Leadership in Energy and Environmental Design, is an increasingly popular building assessment and design tool developed by the US Green Building Council (USGBC) and the most widely applied within the US. LEED is designed for rating new and existing commercial, institutional, and high-rise residential buildings.

Building Research Establishment Environmental Assessment Method (BREEAM) http://www.breeam.org/
BRE's Environmental Assessment Method (BREEAM) has been used to assess the environmental performance of both new and existing buildings. It is regarded by the UK's construction and property sectors as the measure of best practice in environmental design and management BREEAM assesses the performance of buildings in the following areas:

- management: overall management policy, commissioning site management and procedural issues
- energy use: operational energy and carbon dioxide (CO_2) issues
- health and well-being: indoor and external issues affecting health and wellbeing
- pollution: air and water pollution issues
- transport: transport-related CO_2 and location-related factors
- land use: greenfield and brownfield sites
- ecology: ecological value conservation and enhancement of the site
- materials: environmental implication of building materials, including lifecycle impacts
- water: consumption and water efficiency

ENERGY STAR® http://www.energystar.gov/index.cfm?c=about.ab_index
ENERGY STAR is a US government-backed program helping businesses and individuals protect the environment through superior energy efficiency. It includes a building energy performance rating developed by the U.S. Environmental Protection Agency. Because a strategic approach to energy management can produce twice the savings – both economical and for the environment - as typical approaches, EPA's ENERGY STAR partnership offers a proven energy management strategy that helps in measuring current energy performance, setting goals, tracking savings, and rewarding improvements. EPA provides an innovative energy performance rating system which businesses have already used for more than 21,000 buildings across the country. EPA also recognizes top performing buildings with the ENERGY STAR.

3.8 Promoting the Eco-Industrial Park

Marketing of the Site

Marketing of the eco-industrial park is crucial to the success of eco-industrial development. Marketing serves several purposes; it attracts potential tenants to the industrial park or to participate in the network, and, it also provides information to the community encouraging them to support the development and the businesses within it. For businesses, the two essentials for success are responsive markets and access to cost-effective, quality resources for producing products or delivering services. From a marketing standpoint, presenting the strengths in the primary areas – market and resources — can move a location higher up the decision-making chain before having to compete with tax giveaways. However, that is important only after competing sites are judged to be superior with respect to market and resource access issues. Once those two factors are met, however, elements connected to quality of life have become increasingly important to employers and to employees, including, the environment (clean air, water, open space), recreational opportunities, and cultural amenities. Companies will move to communities with high quality resources, including labor and materials, and good access to markets, including transportation connections.

Marketing Strategies

Marketing is an on-going activity for an industrial park and can take a number of approaches. The types of marketing strategies that could be used once target industries have been identified are:

- Direct mail campaigns: databases on industry sectors, trade associations, conference and trade shows can turn up contact names and product information.
- Web-based marketing: identify potential companies through web site searches and through having a website where video clips, contact information and relevant information about the site can be easily updated and reviewed.
- Workshops, seminars and trade shows. These can be used to introduce companies to the area. They can be designed around particular topics related to eco-industrial development or their industry.
- Direct marketing of services in high demand: One example is overseeing certification and compliance with environmental management systems such as ISO 14000. In some places, large manufacturers have committed to requiring all of their suppliers be ISO 14000 certified to continue working with them. Certification of an eco-park provides a valuable service and makes it easier for suppliers to meet new requirements.
- Other incentives for location: focus on the direct benefits of locating in an eco-industrial park, such as, reduced energy costs due to energy cascading, or green building efficiencies, and a healthier work environment.

Marketing to the Community

It is also important to maintain the ties with the community that you have worked on developing through the planning and design process. The community connections can prove to be an attractive location factor for businesses too, because it gives them some “free” marketing and publicity benefits. Communities are looking for ways to attract clean companies, good jobs and organizations that will contribute to local sustainable growth. Ways to connect with the community are:

- Market amenities of the park available to the public. Some eco-industrial parks have incorporated design features of the park that are accessible to the community (i.e. meeting space, pathways, boardwalks, recreational facilities, etc.).
- Community celebrations and open houses. Opening the park to the neighbors of the eco-industrial park can also encourage good will and connections to the community.
- Community Right-to-Know Information. Making the environmental management records available to the public can also ease their mind on how the businesses are operating safely in their community.
- Board of Directors access. You can consider guaranteeing the community a voice in any changes in the approved Codes, Covenants, and Restrictions of the Park. This allows guaranteed community input on any major changes and develops trust between the community and the eco-industrial park.
- Involve the community in a positive way in recruiting new businesses. When the community is on your side, it eases the recruitment process and gains community confidence in a proactive approach.

Marketing in the Region

Marketing to both the businesses and the larger community is critical to the success of an eco-industrial development. Each community responds to different things. Marketing should always address the basic “drivers” of businesses and community members. For example, for companies critical drivers may be:

- An environmental image in the marketplace is important and location in an eco-park sends that message.
- Connection between suppliers and subsequent customers/users may be the key to business success and an eco-park can house that.
- Ability to bid on new kinds of jobs due to coalitions built in the eco-park.

For communities critical drivers may be:

- Well-paid jobs near where people live.
- Increased access to training due to offerings in the park and relationships with local schools.
- Enhanced recreational setting shared with the community and companies.

3.9 Developing EID Services

EID Services
As mentioned at the beginning of this guide, eco-industrial development is not (only) about environmental issues but about innovative, lean, responsible and forward-looking business opportunities. By optimizing the use of resources through synergies between companies and with the community, enterprises save operating expenses and investment, and at the same time reduce or eliminate environmental pollution.

For most companies this is a new way of doing business, from product design to organizing production and managing their supply chain and customer relations. With the exception of a few multinational corporations, enterprises usually don't have the technical and management skills to tackle the new tasks, however profitable they might be in the end.

New Type of Service
The industrial park administration or a cooperation partner can develop and provide services that support enterprises on the road to eco-industrial development. This can include traditional, but premium quality services such as providing power, water supply, telecommunications and transportation infrastructure, but generally it should facilitate the companies within an Eco-Industrial Park with all resources to improve their business. This includes the whole palette of activities and needs linked to an industrial park (see table below). These services are presently provided by world-class industrial parks like Infraserv Hoechst in Frankfurt, Germany (http://www.infraserv.com/en). However, in an EIP companies cooperate through networking to share these services and optimize the use of resources.

EIP Management as Facilitator and Service Provider
The EIP management is in a position to facilitate the networking of enterprises by providing a platform and hosting meetings and providing technical expertise and tools for individual networking issues as listed below. This in itself is a service to companies (in Kalundborg no such service was provided). The EIP management can also link groups of companies to external consultants or other resources needed to create eco-industrial systems. The Burnside industrial park, in Nova Scotia, Canada, with some 1500 companies has no management unit, but provides eco-efficiency services through collaboration between the City of Halifax, Dalhousie University and Environment Canada (http://www.mgmt.dal.ca/sres/eco-burnside/homepage.html). The best possible form is, however, to provide services needed for better Eco-Industrial networking: provide technical and communication experts trained in industrial ecology, networking and community development skills, provide training facilities, data bases and management service to enable eco-industrial symbiosis projects. These services can be provided through the regular industrial park outlets or through an integrated EID / Eco-Center.

Potential Areas of Eco-Industrial Networking

Quality of Life/Community Connections
Integrating Work and Recreation
Cooperative Education Opportunities
Volunteer and Community Programs
Involvement in Regional Planning

Materials
Common Buying
Customer/Supplier Relations
By-product Connections
Creating New Material Markets

Transportation
Shared Commuting
Shared Shipping
Common Vehicle Maintenance
Alternative Packaging
Intra-park Transportation
Integrated Logistics

Environment, Health & Safety
Accident Prevention
Emergency Response
Waste Minimization
Multi-media Planning
Design for Environment
Shared Environmental Information Systems
Joint Regulatory Permitting

Energy
Green Buildings
Energy Auditing
Cogeneration
Spin-off Energy Firms
Alternative Fuels

Information/Communication Systems
Internal Communications
External Information Exchange
Monitoring Systems
Computer Compatibility
Joint Management Information System for Park Management

Marketing
Green Labeling
Accessing Green Markets
Joint Promotions (e.g. advertising, trade shows)
Joint Ventures
Recruiting New Value-Added Companies

Production Processes
Pollution Prevention
Scrap Reduction and Reuse
Production Design
Common Subcontractors
Common Equipment
Technology Sharing and Integration

Human Resources
Human Resources Recruiting
Joint Benefits Packages
Wellness Programs
Common Needs (payroll, maintenance, security)
Training
Flexible Employee Assignments

Source: Ed Cohen-Rosenthal and Thomas N. McGalliard. “Designing Eco-Industrial Parks: The United States Experience”. United Nations Environment Programme, Industry and Environment, Vol. 19, No. 4, 1996 Quarterly.

4 TOOLS FOR ECO-INDUSTRIAL DEVELOPMENT

Eco-Industrial Development needs only few specialized tools that have not yet been developed. Most technologies and skills are out in the market, although developed for individual companies rather than company networks, and mostly not perfectly suited for a combined use. Aside from dozens of well proven management tools, which are not covered in this guide, a large number of concurrent and overlapping tools for cleaner production / eco-efficiency / environmental management have been developed and promoted based on different legal and cultural background.

Companies are often confused about which tools to use for what stage of company and production development. Complex management tasks as required by the ISO 14000 series are often impossible to handle by small and midsize companies. An industrial park administration or EIP management team with the respective skills can provide guidance for companies which tools are suitable for what type of companies.

A number of tools are also designed specifically for use within groups of companies (e.g. PREMA, Waste Minimization Club), and several EIP networks share experience and training resources on individual tools like ISO 14000.

Selection of Tools
The following is a selection of tools for: a) use at the industrial park level, in industrial networks, by EIP management and facilitators, to stimulate, facilitate and support eco-industrial synergy projects **between** companies, and b) tools to improve the performance of **individual** companies. For each category there are many more tools available. The tools presented here have been used within the EIP context or have been developed or modified for EID application. All tools are available in English and have resources or examples available on the internet. Most tools are meant for use by facilitators or consultants, need some form of training through courses or workshops, and should be supported by experience in the field before being applied in a new EIP development. A number of tools are highly specialized systems (e.g. Cleaner Production, ISO14000, PREMA) that need to be implemented by specialists with extensive training and application background. Most tools have been applied in China or Asia in some form, and Chinese case studies and application experience in EID related projects are partly available through the internet or from consultants.

4.1 Facilitating Synergy Projects –Tools for Industrial Parks and Networks

Eco-Industrial Handbook for Asian Developing Countries
The Eco-Industrial Handbook for Asian Developing Countries Handbook presents a comprehensive means of applying Cleaner Production and Industrial Ecology in Asian developing countries(http://www.indigodev.com/AEIP_HB.html). The Eco-Industrial Park (EIP) concept and methods enable real estate developers, industrialists, policy makers, regulators, investors, and communities to collaborate in the vital search for sustainable development. The purpose of this publication is to support the many stakeholders in industrial development who seek a sustainable path for industry in this major region: real estate developers, industrial leaders, economic and environmental policy-makers, financiers, leaders of non-governmental organizations, and leaders of communities that host industrial parks and facilities. To serve the purpose of EIP, the Handbook includes an overview of each facet of industrial park development. It ranges from engineering to considerations in industrial park design, as mentioned in the overall information. It includes many Asian examples as well as some from elsewhere. In each chapter there are sources of print and electronic information to find more information.

The Handbook offers a rich menu of design options, including ideas for site design, park infrastructure, individual facilities, and shared support services. It also covers recruitment strategies and EIP management. Several basic strategies are fundamental to developing an EIP. Individually, each adds value; together they form a whole greater than the sum of its parts.

- Integration into Natural Systems
- Energy Systems
- Materials Flows and ‘Waste’ Management for the Whole Site
- Water
- Effective EIP Management
- Construction/Rehabilitation
- Integration into the Host Community

Eco-Forum /EID Forum
An Eco-Forum /EID Forum is a regular meeting venue for companies within an industrial park or a local industrial network. The meetings are held to share information on development issues relevant to the group's interest and organize joint activities. An Eco-Forum also serves for the dissemination of information on best practices in management and eco-efficiency, for updates on laws and regulations, and as a link to stakeholders, e.g. government bodies, service providers etc. An Eco-Forum can also be the platform for other more specific activities, e.g. working groups, employee and manager clubs, etc. To establish an Eco-Forum in an industrial park with little or no common activities between companies and with the park management, the following steps should be taken:

Step 1: Getting to know the Industries
Step 2: Creating a Platform for Dialogue
Step 3: Developing Partnerships
Step 4: Establishing a Forum for Champions
Step 5: Initiating Cluster Activities
Step 6: Sharing the Results

A well-managed industrial park administration usually knows the companies within its jurisdiction and their managers. But it might be possible that the contacts are not up-to-date or detailed enough for starting a dialogue. After getting to know who’s who inside the industrial park (contact persons, details on production processes, flow of material and outputs, etc.) management can take the initiative in establishing the Eco-Forum as an opportunity for open dialogue among members. Usually an industrial park has some urgent issues concerning all companies to justify such an initiative.

The industrial park administration or EIP management can be the host, but key companies with a dominant role in a local supply chain or service orientation can also take over this role. The initiative can also come out of an existing association or business club. Initially active and regular participation will be limited to few companies. Based on the activities initiated by the Eco-Forum, e.g. Waste Minimization Circles, Cleaner Production roundtables, and their relevance to all companies, participation will

increase over time. Areas of common interest to a larger number of companies are: Material and Waste Management, Transportation, Human Resource, Information Communication, Quality of Life/ Community Connection, Energy, Marketing, Environmental Health & Safety, and Production Technologies. During each meeting, a different subject of interest can be addressed, based on the issues relevant to the estate. Each member can contribute with his or her best practices in the above-mentioned fields or with examples on solving problems. Question and answer allow a sharing of ideas and experiences.

The EIP management can promote the EIP concept in various events such as factory visit programs, charity events, and diverse meetings to convince the top management of factories to send in more representatives to the Eco-Forum to brainstorm and achieve win-win solution that meet factory requirements. As a result, companies have realized the beneficial nature of the Eco-Forum and are actively engaging in maintaining a fruitful and effective network.

The participatory approach can also result in the creation of an open dialogue between industries and the local community. Local community leaders can be invited to share their comments and ideas on the development of infrastructure and recreational space.

The triple bottom-line benefits of an Eco-Forum /EID Forum include, but are not limited to:

Economic Benefit:
The Eco-Forum can create an effective network among its members and can thus resulted in common activities that reduce costs and increase operation efficiency in various areas of eco-industrial networking. The forum provides the social platform for the industrial community.

Environmental Benefit:
Environmental awareness and activities for an eco-industrial park and better quality of life for both workers and the surrounding communities are targets for discussion and activities of an Eco-Forum. All industry operations not only meet the government standard, but aim to go beyond the standards required for emission, waste water discharge, waste management etc. Promotion of ISO 14000 and 18000 series is encouraged among forum members.

Social Benefit:
Two-way communication between EIP management, companies, government and community stakeholders allows transparency for all development issues. The participatory approach can improve communication between industry, government and communities. As a result, industries can effectively contributed to the local communities and coordinate their social activities.

Senior Executive Seminars
EMCP Industry Development piloted a series of Senior Executive Seminars on Sustainable Business, aimed at non-technical and non-environmental senior management functions such as Finance, Sales and Marketing or Production Directors (or similar). Aimed at key decision-makers within companies, this one-day seminar brings to life the business potential of sustainability, encompassing innovative approaches to product design, process improvement, management and new business models. It draws on concepts and methods used by leading companies to become more competitive and sustainable.

The seminar is divided into four sessions covering such core business elements as:
1. strategy – making the link between sustainability and competitiveness
2. productivity – improving the performance of products and processes, reducing cost and waste, increasing energy efficiency, materials and labour productivity, and quality control
3. management – using superb management to make the most of your resources; company culture and organization, incentives, monitoring and maintenance, risk management
4. markets – delighting the customer, creating new markets or expanding market share, using new business models, marketing

The seminar is highly interactive and participants are encouraged to use discussions and mapping exercises to explore potential opportunities within their own firm – by the end of the day participants have developed a preliminary action plan to take back to their company. They are also provided with notes with key principles and guidelines, as well as recommending the best tools and resources. Materials relating to the Senior Executive Seminars can be found at EMCP Industry Development's partner website: www.cestt.org.cn . The key to making such a seminar work is to convey the competitive advantage that sustainable business can confer. By doing this, you are likely to build receptivity to EIP and similar activities.

Sustainable Business Network
EMCP Industry Development piloted a Sustainable Business Network for CEOs in four Chinese cities. This involves a regular meeting every 2-3 months, short and informal, bringing CEOs together to hear one of their peers explain how a more sustainable approach to business made his company more competitive. Thus, CEOs have the chance to network for business purposes, while hearing a variety of real success stories illustrating different aspects of sustainable business, whether leading to more efficient production processes, product innovation, cost reductions, access to new markets or greater market share,

reduced liabilities, new business models, greater employee well-being and productivity, or enhanced reputation. Such a network will also be a good medium through which to channel information and win support for EID activities. See the EMCP Industry Development partner website for more information and guidelines on how to run such a network: www.cestt.org.cn .

Eco-Center

An Eco-Center can have many names: EID Center, Cleaner Production Center, Eco-Efficiency Center, Sustainable Development Center, Regional Resource Center etc. The main characteristics of an Eco-Center will be formed by the services provided and by its users. The Eco-Center is ideally located in an industrial park with an EIP project. The best location is within the main administrative building or in close proximity if it is a dedicated building. If the Eco-Center has its own building, the building should be a showcase for green building design and sustainable technologies. Eco-Centers can also serve as technology transfer centers.

An Eco-Center is mainly an information and service center providing resources for eco-industrial development. It can host the EIP web-page, materials on tools and technologies, information brochures, a library, technology showcases, etc. Most important, it should be staffed with service-oriented engineers or consultants. It can be the main office of the EIP management or planning team and the facilitator, whether part- or fulltime. Such centers can also provide meeting and workshop facilities, offer seminars or full-fledged training courcses, and can host offices of the local industrial associations.

Eco-Centers are meant to become the focal point and platform for all EIP activities. At the same time, they institutionalize the EIP development process and make it more sustainable, more independent from individual champions and supporters. Eco-Centers can be an added-benefit institution financed by the industrial park administration or operated as profit centers, charging market fees for certain services while providing free information to stimulate EID projects. The Eco-Center can also be the outlet for government services, where officials can hold office at regular intervals. In India, CP Centers have mobile CP-Clinics where consultants visit industrial parks once a month for information and promotion of their services. The Northern Industrial Estate, Lamphun, Thailand and Jababeka Industrial Estate, Jakarta, Indonesia, have located their Eco-Centers in the main management building, making the Center visible to all visitors.

Eco-Centers should and often do have a strong regional effect beyond the boundaries of the industrial park or EIP project. They often become regional hubs for sustainable development, with interest and support from government, industry, the general public and the research community.

Case Study: The Eco-Efficiency Center at Burnside, Halifax, Canada

The Eco-Efficiency Centre is a not for profit agency that provides services to small and medium sized businesses (SMEs to improve the efficiency of individual companies on the one hand, while encouraging an eco-systemic perspective, by supporting cooperation between businesses. The Centre focuses on providing information in an integrated fashion on eco-efficiency/pollution prevention, resource conservation and economic efficiency. Services include

- *Assistance to companies, primarily small and medium sized businesses, to achieve better environmental and economic performance through resource conservation, recycling, reuse, and general good environmental practices;*
- *Encouraging companies to join the Eco-Business Program, the umbrella program, in which businesses adopt an environmental code and commit to reduction and conservation goals;*
- *Conduct preliminary environmental reviews of company facilities with the objective of identifying source control, energy and water conservation opportunities;*
- *Organizing an annual "Environmental Excellence in Business" breakfast to celebrate local companies making progress on improving their environmental performance and to encourage networking between business, government and the academic community;*
- *Responding to requests for information, and provide relevant information on eco-efficiency/pollution prevention and resource conservation opportunities to businesses;*
- *Producing and distribute materials (fact sheets, primers, newsletters, presentations, information on relevant training opportunities, regulation changes, upcoming events) to small and medium-sized companies;*
- *Organizing, and cooperate in offering, training sessions and workshops;*
- *Promoting business success stories;*
- *Encourage networking and co-operative efforts among businesses within and between sectors. As companies identify successful ways to reduce and conserve, the Centre encourages the cooperation of businesses in exchanging and promoting these ideas, both within the Park and to a wider business community;*
- *Contribute to the education of students through coop placements, summer employment and research projects.*

The Center provides services in Burnside and other industrial and business parks in the Halifax Regional Municipality, and assists other companies from the broader Nova Scotia business community For more information about the Burnside Eco-Efficiency Center and tools for download and training opportunities, visit: http://ecoefficiency.management.dal.ca/homepage.html

Participatory Planning Design Charrette
Building owners, architects, and engineers can use the Participatory Planning Design Charrette process to save time and money by identifying and solving design problems before design and construction begin. A charrette is an intensive workshop in which various stakeholders and experts are brought together to address a particular design project. It is the mechanism that starts the communication process among the project team members, building users, and project management staff. A facilitated discussion allows the team to brainstorm solutions to meeting the building user's requests and the sustainability vision for the building design. "Charrette" is derived from the French word for the cart used to collect the drawings of 19th-Century students at the Ecole de Beaux Arts in Paris. In the 21st Century, a charrette is a workshop for generating and discussing ideas in the planning and design process. Holding a design charrette is a good idea when people need to cut across boundaries and work on a large, collaborative project.

Whole-Building Design Strategies
Greening a federal facility or building often means making use of whole-building design strategies. These strategies take into account the complex ways that a building's occupants, components, and materials connect and interact. High-performance, energy-efficient, environmentally sound buildings (often called "sustainable" or "green" buildings) help to meet at least five key national objectives; they:

1. Provide housing, office buildings, and commercial structures that are safe and affordable.
2. Enhance the health, comfort, and productivity of occupants.
3. Reduce pollution and the greenhouse-gas emissions associated with burning fossil fuels.
4. Alleviate the strain on our nation's gas and electric utilities.
5. Conserve conventional fossil fuels, like oil and natural gas.

An integrated, whole-building design approach can also help to reduce both construction costs and long-term building operating costs. Designing such a building usually requires a collaborative, interactive approach to successfully integrate its many energy- and water-efficient components, such as high-performance insulation and water-conserving fixtures. Those who specify and configure the components—architects, designers, consultants, engineers, managers, and contractors—must work together closely throughout the design process. Often, they start by participating in a kind of peer review workshop or "design charrette" early in the process.

4.2 Facilitating Production Process Improvements – Tools for Industry

Performance Measurement, Improvement and Financing (PMIF)
The promotion of sustainable business practices in China is facing two main problems:

1. Measuring environmental and process performance properly to indicate the actual situation;
2. Obtaining finance for projects where environmental and process changes – revealed by performance data and justified with the relevant information – can be achieved to the benefit of the company.

For detailed guideline see: Barry Tunnah, PMIF Final Report, EMCP Industry Development 2005, and his PMIF Manual, also EMCP Industry Development 2005

PMIF includes a set of tools and techniques to measure performance. PMIF looks at how performance data can be translated into business information and how that information can be used to drive improvements in performance in industrial enterprises. It also provides guidance to industrial enterprises to put together a business proposal to secure finance – internal or external – for technical improvements, highlighted by performance measurements. As such, PMIF aims to integrate environmental management into core business processes. The PMIF process enables companies to:

1. Measure environmental and process performance, and quantifying potential improvements in financial terms;
2. Identify and prioritise areas for improvement;
3. Choose the means to carry out the improvement, and justifying the costs involved;
4. Use data to create a business case for the necessary investment to implement the improvement;
5. Measure the degree of improvement achieved.

The analysis of plant performance is itself divided into three approaches – material balances, routine data monitoring, and physical inspection within the plant. Each of these approaches is discussed in detail in the training course and manual. The main difference between the PMIF approach and other – more traditional – approaches is the collection and analysis of routine data, the use of which allows the managers to monitor plant performance regularly and to check the real cost of lower performance (or profitability of potential gains).

Profitable Environmental Management
Through systematic integration of the Non Product Output (NPO) perspective and of environmental aspects in the company's management, the PREMA® concept and its instruments aim at achieving a triple win: improvement of economic competitiveness through cost savings, reduction of environmental impact through more effective use of raw materials, as well as

sustainable implementation of improvements through organizational learning, including improvement of workplace safety. (http://www2.gtz.de/p3u/english/indexeng.htm (see webpage for downloadable tools and consultant resources in China).)

Profitable Environmental Management (PREMA®) is an integrated concept for the promotion of profitable, effective, and environmentally sound management practices designed for micro, small- and medium-sized enterprises (SME) in developing countries, but also applicable in bigger companies. Its application in about 30 countries has triggered a more systematic management of resources through check of raw materials, reduction of losses in storage, handling and transport, optimization of production processes and plant organization, especially in order to reduce NPO, reprocessing, waste; waste water and emissions, training and participation of personnel, change in client relations, and improvement in product design.

The training and consultancy concept is built around 3 key issues: (1) It starts from the economic self-interest of the SME, integrating a variety of quality, environmental and workplace safety management issues. (2) It uses a group approach in order to enhance mutual learning and networking between SMEs and to decrease training and consultancy costs. (3) The training design is based on a modular approach, which uses experiential learning and systematic support to implementation through coaching (and a specific counseling technique).

PREMA® pursues a triple win approach (reducing production costs, improving the company's environmental performance and promoting organizational learning) by applying the Non-Product Output (NPO) concept, i.e. by identifying and assessing the flows (1), costs and environmental impact (2), as well as causes (3) of all those materials, water, and energy, which are used in production process, but which do not end up in the final product. By following 3 more steps of the PREMA® "cycle of change", i.e. development of measures (4), implementation (5), and evaluation and integration into the company's everyday practice, companies are enabled to practically implement and document effective changes.

A continuous process of improvement is aimed at through a modular combination of Resource Management Module (RMM®) (for micro and small companies), Good Housekeeping (GHK®), Environment oriented Cost Management (EoCM®) and PREMAplus, which analyses the gap which still exists to certification according to ISO 9001, 14001, and OHSAS.

Waste MinimizationClub
A single region, multi-sector, consultant mediated, waste minimization club was successfully operated at TEDA for seven companies situated on the park. The companies appointed Project Champions at each site and made a commitment to support the work of the club at each location and to implement any savings identified where possible. The objective of the club was to minimise waste resources, energy, labour, materials, water, fuel, and waste using a systematic approach (sometimes called “Cleaner Production” in the US) assisted by a team of club experts. The “club” approach provides the additional benefits of shared knowledge and experiences as each project champion and other company staff meet the experts on a regular basis.

The Club was well administered and training sessions held for enterprise members, experts and local staff. Visits to each site were undertaken and savings identified in a range of areas (energy, water, solid waste etc.). A total of RMB8.8m (€ 0.88m) savings were identified, some of which were already implemented before the project was completed. The club stimulated a great deal of interest across the park and it is understood that the programme will continue and/or expand. This is an excellent technique to address obligations under the Cleaner Production Promotion Law as well as to improve industrial energy efficiency at a time when energy issues are high on the agenda.

TEDA Waste Minimization Club
The TEDA Waste Minimization Club (WMC) is a significant element in EMCP Industry Development's TEDA Pilot Project. It aims to encourage companies to reduce waste at source and improve resource efficiency through waste minimization activities, thus avoiding or largely reducing the generation of waste, preventing pollution and cutting costs. The TEDA WMC was founded in 2004, supported by EMCP and the TEDA EPB, with nine key enterprises signing up. A representative from each firm signed the 'TEDA Waste Minimization Club Declaration of Commitment', and a team within each plant was organized to carry out waste minimization activities, including engineers from different departments, such as production management, facilities, engine maintenance, and environmental protection and safety.

Sponsored by EMCP and with advice from a European expert, Dr. Stephen Etheridge, the TEDA pilot project organized a waste minimization expert group, consisting of experts from different fields. The experts visited the sites of companies taking part to help them identify existing problems and opportunities for waste minimization, and saving water and energy, and put forward improvement plans. They have so far proposed 52 technical improvements resulting in waste minimization and savings in energy, electricity and water use, as well as solid and liquid waste treatment. If all these were implemented, about 1,034.4 tons of materials, 108 tons of fuel, 2,340 m3 natural gas, 1,191.6 tons of steam, 5.938 million kW/h electricity and 0.244 million m3 water could be saved annually, thus saving about RMB 8.8 million in total, mostly with a payback of under a year, with some being two to three years.

At present, three projects have been implemented in three plants, and are running well; there are five under construction and about ten projects will be implemented soon. The waste minimization activities of the TEDA pilot project benefit companies.

Their representatives all think this kind of activity can drive enterprises to inspect every part of their production process carefully, thus, helping to prevent waste and find potential savings in water, energy and materials use, cutting costs and increasing profits. They all hope the waste minimization club can continue and keep on promoting sustainable development.

Leadership in Energy and Environmental Design (LEED)

The LEED Green Building Assessment tool is technically an assessment tool, but many professionals also use it as a design tool. LEED, which stands for Leadership in Energy and Environmental Design, is an increasingly popular building assessment and design tool developed by the US Green Building Council (USGBC) and the most widely applied within the US. The U.S. Green Building Council is a building industry coalition promoting the "understanding, development and accelerated implementation of 'Green Building' policies, programs, technologies, standards and design practices." LEED is designed for rating new and existing commercial, institutional, and high-rise residential buildings. Credits are earned for satisfying each criteria specified by the Rating System. Different levels of green building certification are awarded based on the total credits earned. The LEED™ Scorecard identifies the areas that are evaluated in the design. It provides some ideas about what to consider when designing the eco-industrial space http://www.usgbc.org .

LEED measures and ranks a building's environmental performance in terms of 6 general categories:

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality, and
- Innovation & Design.

Points are awarded for achieving specific goals clearly outlined in each category. The total number of points possible is 69. A score of 26-32 points achieves basic certification; 33-38 achieves Silver; 39 – 51 Gold; and 52+ achieves Platinum certification. The USGBC LEED website provides a summary of the three steps to certification http://www.usgbc.org/LEED/LEED_main.asp .

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Appendix 1: Principles of Industrial Ecology
Source: (Lowe et al 1998, Lowe 2001)

Some Principles of Industrial Ecology

The word 'industrial' is used here to also denote service and construction, not just manufacturing industries.

Connect individual firms into industrial ecosystems

- Close loops through reuse and recycling.
- Maximize efficiency of materials and energy use.
- Minimize waste generation.
- Define all wastes as potential products and seek markets for them.

Balance inputs and outputs to natural ecosystem capacities

- Reduce the environmental burden created by releases of energy and material into the natural environment.
- Design the industrial interface with the natural world in terms of the characteristics and sensitivity of the natural receiving environment.
- Avoid or minimize creating and transporting toxic and hazardous materials (when needed; synthesize locally).

Re-engineer industrial use of energy and materials.

- Redesign processes to reduce energy usage.
- Substitute technologies and product design to reduce use of materials that disperses them beyond possibility of recapture.
- Do more with less (technically called dematerialization).

Align policy with a long-term perspective of industrial system evolution.
(The above principles were adapted from Tibbs 1992). We add the following:

- Design industrial systems with awareness of the social and economic needs of local communities.
- Optimize local business and job development opportunities.
- Offset impacts of industrial development on regional systems through investments in community programs, as needed.

Appendix 2: Principles of Sustainable Design and Construction
Source: (Lowe et al 1998, Lowe 2001)

Some Principles of Sustainable Design and Construction

Apply these principles across time to each stage of a project: development, planning, design, construction, operation, and deconstruction. The bullets suggest *a few* ways to apply these principles to energy, water, materials, and land resources.

Minimize resource consumption. (Conserve)
- Design for energy efficiency in building design, HVAC systems, and lighting.
- Use passive solar and daylighting features.

Select materials and design for durability. Maximize resource reuse. (Reuse)
- Redevelop existing sites rather than breaking new ground.
- Reuse construction materials, assemblies, and products.
- Include greywater systems to reuse water.

Use renewable or recyclable resources. (Renew/Recycle)
- Use building materials with recycled content, i.e. tiles with recycled glass.
- Specify woods from sustainable forests.

Protect the natural environment (Protect Nature)
- Minimize disruption of the natural environment in site preparation and construction.
- Select materials for low impact in their extraction and processing.

Create a healthy, non-toxic environment. (Non-Toxics)
- Select non-toxic materials and equipment.
- Provide fresh air for all occupants.

Integrate building and infrastructure design into the natural and human environments.
- Landscape the site using native plants of the region and ponds or wetlands to capture stormwater runoff.
- Incorporate features to reduce impact of development on community transportation systems.

Integrate design teams across professional, business, and agency boundaries In applying these principles.

(Architects, engineers, and other designers have created many strategies, technologies, and tools for realizing these principles in buildings and infrastructure. See Chapter 8 for more detail on design options.) The first five principles are based on Kibert 1994a.

Appendix 3: Feasibility Study - Sample Structure

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3 BENCHMARKING ECO-INDUSTRIAL DEVELOPMENT
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3.3 CRITICAL SUCCESS FACTORS
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4 ECO-INDUSTRIAL DEVELOPMENT CONCEPTS
(Examples for Material-Based or Sector Specific Concepts – Concepts are defined by Project Objectives)
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6 CONCLUSION

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A. LAND USES IN AND AROUND ECO-INDUSTRIAL PLANNING AREA
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C. PHOTOGRAPHS OF MARKET AREA INDUSTRIAL PROPERTIES
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BIBLIOGRAPHY

Annex 4: Sustainable Building Design Basics

The Basics of Sustainable Building Design
(from Sustainable Building Primer, Association of Professional Engineers and Geo Scientists of British Columbia - APEGBC)

The Components of Integrated Design
In general, integrated design of new buildings must address five key elements:

1. Site
2. Water Efficiency
3. Energy Efficiency
4. Materials and Resources
5. Indoor Environmental Quality

Below are some sample design considerations in each of the five key areas:

1. Site
- Orientation to the sun to maximize natural daylight and heating
- Choice of brownfield site over greenfield
- Utilization of previous building footprint
- Layout to minimize footprint
- Location of site to utilize existing infrastructure (utilities and transportation)
- Provision of alternative transportation services such as bicycle storage, alternative fuel refueling stations, showers and changing rooms
- Minimization of impervious areas on-site to reduce run-off
- Landscaping to reduce heat island effect

2. Water Efficiency
- Use of low flow, water efficient fixtures, waterless urinals, dual flush toilets etc
- Use of native plants to eliminate/reduce irrigation needs
- Grey-water reuse, on-site treatment

3. Energy Efficiency
- Use of renewable energy
- Use of energy efficient fixtures
- Effective use of insulating materials, glazing, etc
- On-site energy generation
- Use of energy modeling to optimize heating/cooling systems

4. Materials and Resources
- Use of local/regional materials
- Use of recycled materials
- Construction waste reduction/reuse/diversion
- Storage and collection of recyclables
- Use of durable materials
- Reuse of existing building shell

5. Indoor Environmental Quality
- Use of low-emitting materials (adhesives, sealants, paints, carpets, composite wood products)
- Maximized percent of daylight spaces
- Maximized ventilation performance
- Management of Indoor Air Quality during construction
- Monitoring of CO2
- Design for controllability of systems

As these examples show, it is difficult to consider these components in isolation. Indeed, improvements in one area typically result in spin-off improvements in another. Some benefits realized by high-performance buildings include:
- Lower operating costs
- Lower lifecycle costs
- Longer lasting building
- Reduced impact on the environment
- Increased occupant comfort, health

- Increased occupant productivity / satisfaction
- Higher building value
- Lower vacancy rate
- Enhanced corporate image