CHAPTER 16

Eco-Industrial Parks and their Potential Contribution to Sustainable Industrialization

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16.1 Introduction

Small and Medium Enterprises (SMEs) dominate and play a key role in social and economic development of Africa. They are also responsible for between 5 and 25% of the GDPs of the countries. This contribution to GDP is growing steadily in most countries at rates in the range 1 – 8%. Above all, these SMEs employ 5-15% of the economically active population outside agriculture in Africa (UNEP 2004). However, this favourable development picture, that is responsible for the rapid urbanization being witnessed in many African countries today, is not sustainable since it has been achieved at a great cost to the environment and society. Natural resources continue to be depleted and pollution of terrestrial, atmospheric and aquatic systems increasingly rising to serious levels in most African countries. Industrial pollution around capital cities and other economically important towns now presents new challenges to local authorities.

A number of barriers stand in the way of sustainable industrialization in Africa. These may be classified broadly into five as: policy, technical, financial, structural and institutional. On Policy, no deliberate national industrialization strategies exist in some countries. Furthermore, there are weak laws and regulations (such as in licensing, land and physical planning), poor implementation of policies and enforcement of laws. There is also minimal government support and incentives (poor roads, insecure power and water supply, high taxes, and corruption). Finally, the conflicting mandates among public institutions in promoting industrialization has not been helpful.

Technical barriers include the lack of information on technologies, the high international quality standards, and prevalent obsolete technologies in most manufacturing concerns that are inefficient. These lead to low quality products, inferior to imported goods affected further by the characteristic weak capacity to respond to frequently changing export market conditions. Financial barriers include the high cost of technological options and services (such as foreign quality certification experts), high cost of borrowing from commercial banks, and lack of access to credit by micro enterprises from traditional commercial banks. A number

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of structural barriers also exist and include weak linkage to the academia and research and development (R&D) institutions and to other industries.

Institutional barriers are perhaps the most numerous and include inexistent measurement culture in most small enterprises—such that a lot of energy, water and materials goes to waste unaccounted; poor record keeping, little or no benchmarking against successful cases; mindsets that resist change; limited training among workers; lack of technology development strategy or technology forecasting, poor teamwork and excluding employees from decision-making processes.

A wide of interventions have been pursued aimed at integrating sustainability thinking in industrial development. Some SMEs have successfully applied tools of sustainable production and consumption and achieved significant financial, social and environmental benefits. Case studies exist of successful application of tools such as Cleaner Production (CP), Environmental Management Systems (EMS), and Private Codes (voluntary) in African countries. Some African universities have integrated sustainability considerations into their engineering and business training programmes. A concern by sustainable development experts is that some of these initiatives have largely been driven by external forces including UNEP, UNDP and UNIDO and its not clear whether they will continue long after these institutions leave. The agricultural industry—mainly export oriented is gradually adopting to global market pressure, which puts demand for high quality standards. A generic analysis of these interventions reveals that most have been piecemeal hence incompetent to tackle complexities inherent in environmental systems.

Experience from the implementation of CP projects in African countries (UNEP 2004) shows that SMEs may overcome most of the aforementioned barriers and adopt clean technologies by a range of innovative options including first, accessing low-interest credit such as through micro-finance facilities; secondly, developing intelligent partnerships among firms based on the industrial symbiosis concept and, finally, promoting pilot demonstration projects to increase awareness on the application and benefits of environmentally sound technologies (ESTs).

Industrial symbiosis—as exemplified in eco-industrial parks—is a fairly new concept to the African region. There are hence no deliberate case studies to demonstrate to interested investors. Using case studies from other regions, the following sections clarify what eco-industrial parks are, how they are designed and operated, and finally how they contribute to environmental, social and economic sustainability. Finally, using examples of industrial establishments in Kenya, the chapter presents key prerequisites for successful eco-industrial park establishment and operation in Africa.

16.2 Industrial Ecology

Globally development and hence high living standards are associated with increased industrial activity, which has increased many folds since the industrial revolution, but with it serious environmental impacts. Further industry takes in a lot of input from material flow of nature, often exceeding the reproduction rate, hence risk of depletion. In addition, material derived from nature are not used as efficiently as would be possible in industrial processes, hence the idea of "efficiency gap" This translates into wastage, losses, pollution, degradation and increased environmental costs. Since there are physical limits that nature poses upon industrial development, ecosystem material flows can be used for the prescription of the overall goal and vision for industrial ecosystems towards sustainability. Industrial ecology (IE) is aimed at providing the technological and scientific basis for this purpose and also a considered path towards global sustainability.

In this chapter IE is defined as the study of the flows of materials and energy in industrial and consumer activities, of the effect of these flows on the environment, and of the influences of economic, political, regulatory and social factors on the flow, use and transformation of resources. The vision of industrial ecology is to shift from mere industrial systems to industrial ecosystems and also towards complete cyclicity in material and energy flow.

Industrial ecology introduces the possibility to learn from natural ecosystems to design and engineer industrial systems to reduce the ecological impact of human activity to levels natural systems can sustain. In ecological systems the flow of materials is cyclic, the wastes are recycled and energy is cascading. On the contrary, industrial ecosystems often emphasize the throughput of materials. Ecological systems put emphasis on interaction and interdependence related to the stability of the systems. Industrial systems emphasize independence and competition. Biological analogy is useful in framing industrial ecology. As such some key prescription for industrial ecosystems are (i) industrial activity should reduce the amount of important nutrients (Raw Materials) that industry takes in from nature and (ii) the amount of non-harmful flows of nutrients that are returned to nature should be increased. However, the ultimate differences between ecological systems and human systems should be considered. For instance, biological systems evolve through biology and culture, human systems also through technology. Moreover, industrial systems are dependent on the resources and services provided by the biosphere (Jelinski et al. 1992).

Industrial ecology takes a material and energy flow approach to human society it does not regard society merely from the point of view of organizational and social monetary and production processes. Subsequently, materials, energy and information are flowing in ideal industrial systems the way they do in ecosystems. The use of energy and material is optimized and the generation of waste minimized

Wastes from one process can be used as raw materials in another (Frosch & Gallopoulos 1989). Industrial ecology seeks strategies to increase efficiency and reduce the impact of these flows on the total environment.

Industrial ecology takes a systems approach to flows. This is convenient, as material and energy flows do not respect the general boundaries of regions and countries. The flows can even be global. The contribution of industrial ecology to regular environmental management is that the analysis crosses boarders of countries and goes beyond individual products. Industrial ecology can have a few approaches: it can concentrate on products and materials or it can have a regional industrial ecosystem approach (Korhonen 2002). The first approach uses tools like material flow analysis including substance flow analysis, life cycle analysis and design for environment. A local approach is taken in studying eco-industrial parks.

16.3 Eco-Industrial Parks (EIPs)

i Defining EIPs

Eco-industrial parks pay attention to material and energy exchanges between companies in local and regional economies. It concentrates on closing the loop of materials and enhancing energy cascading in industrial areas. Close synonyms for eco-industrial park include among others: industrial ecosystem, industrial symbiosis, eco-industrial estate, eco-industrial network and eco-industrial development. Different concepts imply different objectives, operational characteristics and system boundaries. For example, 'industrial ecosystems' enhance the analogy to natural ecosystems, 'industrial symbiosis' gives attention to symbiotic and synergistic linkages between companies whereas 'eco-industrial networking' emphasizes cooperation and can sometimes be used as an umbrella term for a number of concepts. 'Eco-industrial parks' can also be seen as a form of symbiotic industrial relationships. Rooted in the emerging discipline of industrial ecology, an EIP mirrors natural systems. Just as single organism can be viewed alone or in a larger ecology, single enterprises can organise themselves in more complex business ecologies.

Eco-industrial parks can be best defined as a community in cooperation and interaction, efficiency in the use of natural resources and through its system view (Cote and Cohen-Rosenthal 1998). The environmental impact is reduced at a regional level, not only separately in individual companies. Industrial symbiosis engages traditionally separate industries in a collective approach to a competitive advantage involving a physical exchange of materials, energy, water, and by-products (Chertow 2000). New unexpected connections between diverse types of industries or even outside industrial production can occur in eco-industrial parks thanks to the physical proximity of the actors (Heeres et al. 2004). As such eco-industrial parks can be defined as follows:

"A community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realize by only optimising its individual performance. An eco-industrial park also looks for benefits for neighbouring communities to assure that the net impact of its development is positive." (Lowe 2001.)

ii Physical Features of an EIP

Some developers and communities have used the term eco-industrial park in a relatively loose fashion. In order for an industrial area to be a real eco-industrial park real waste or energy exchanges must occur between organizations. However, physical features of EIPs are highly variable. Some are not places but "virtual" EIPs with materials exchanged on a regional network basis. The actual parks range in size from 3.5-7000 acres. The physical settings also vary; some are reclaiming brownfields; others developing greenfields. While most EIPs are based on manufacturing, some focus on agricultural and fisheries products, while others are forestry development-based. Yet other parks plan to provide scenic landscape or other recreational use in addition to economic use. Various models of EIP development exist including, inter alia:

- a zero-emissions eco-industrial park, where businesses locate at the same site,
- a virtual eco-industrial park, where businesses form a loose affiliation or network of related regional companies, and
- eco-development, where non-industrial establishments apply industrial ecology principles.

A study of these models shows that eco-industrial development may be driven by a community, a local government, a non-profit organization or by business. Whatever the model or driver, participants generally agreed that eco-industrial development requires broad support and will benefit from collaborative strategies. Chertow (2000) offers a broader typology of EIPs according to their geographical area and quality of exchanges (Box 1).

iii Components of EIP Design

EIPs have a rich menu of design options, including site design, park infrastructure, individual facilities, and shared support services. The following highlights some major strategies an EIP design team can draw upon in planning a park.

Box 1: The five types of eco-industrial parks according to their geographic area and quality of exchanges.

Type 1 EIP:
Through waste exchanges.
Recovered materials are sold or given away by third party dealers to other firms or organizations

Type 2 EIP:
Within a facility, firm or organization.
Usually one-way exchange. This type includes material or product exchange within a single organization but different units.

Type 3 EIP:
Among co-located firms in a defined industrial area.
This type includes materials, waste or energy exchange between organizations in close proximity. Exchanges oc¬cur primarily in a defined industrial area (e.g. Londonder¬ry, Riverside, Burnside).

Type 4 EIP:
Among near-by firms not co-located •
Linking together existing businesses with an opportunity to fill in some new ones (e. g. Kalundborg- Box 2).

Type 5 EIP:
Among firms organized across a broader region.
This type includes exchanges in a broad spatial region and a larger number of firms. These types of eco-indust¬rial parks had not been yet realized, although some vir¬tual exchanges has been studied.

In Kenya the various "Industrial Areas" and Export Processing Zones (EPZ) in major urban centres present opportunities for designing EIPs. These areas have a wide variety of businesses such as manufacturing plants, service industries, and transportation/cargo.

a.) Natural Systems

An industrial park can fit into its natural setting in a way that minimizes environmental impacts while cutting operating costs. The Herman Miller design plant in Phoenix illustrates the use of native plant reforestation and the creation of wetlands to minimize landscape maintenance, purify storm water run-off, and provide climate protection for the building. At another level, plant design, landscaping, and design choices in materials, infrastructure, and building equipment, can reduce a park's contributions to global climate change and its consumption of non-renewable resources.

b.) Energy

More efficient use of energy is a major strategy for cutting costs and reducing burdens on the environment. In EIPs, companies seek greater efficiency in individual building, lighting, and equipment design. Examples include flows of steam or heated water from one plant to another (energy cascading), or steam connections from firms to provide heating for homes in the area. Finally, in many regions, the park infrastructure can use renewable energy sources such as wind and solar energy.

c.) Material Flows

In an eco-park, companies perceive wastes as lost opportunities that ideally are potential products to be re-used internally or marketed to someone else. Individually, and as a community, they work to optimise use of all materials and to minimize the use of toxic materials. The park infrastructure may include the means for moving by-products from one plant to another, warehousing by-products for shipment to external customers, and common toxic waste processing facilities.

One emerging strategy for EIP planning involves anchoring the park around resource recovery companies that are recruited to the location or started from scratch. The park could then support the establishment of aggressive waste reduction goals for all sectors of a community. A cluster of recycling, reuse, remanufacturing, and composting firms could process by-products and supply recycled inputs to manufacturers at the EIP, as well as to other firms in the region.

d.) Water Flows

In individual plants, designers specify high efficiency building and process equipment. Processed water from one plant may be re-used by another (water cascading), passing through a pre-treatment plant as needed. The park infrastructure may include mains for several grades of water (depending on the needs of the companies) and provisions for collecting and using storm water run off.

e.) Park Management and Support Services

As a community of companies, an EIP needs a more sophisticated management and support system than a traditional industrial park. Management supports the exchange of by-products among companies and helps them adapt to changes in the mix of companies (such as a supplier or customer moving out) through its recruitment responsibility. It may maintain links into regional by-product exchanges and a site-wide telecommunications system. The park may also include shared support services such as a training centre, cafeteria, day care centre, office for purchasing common supplies, or a transportation logistics office. Companies can add to their savings by sharing the costs of these services.

f.) Sustainable Design and Construction

EIP planners design buildings and infrastructure to optimise the efficient use of resources and to minimize pollution generation. They seek to reduce the impacts on the ecosystem by careful site preparation and ecologically appropriate buildings and park systems. The whole park is designed to be durable, maintainable, and readily reconfigured to adapt to change. At the end of its life, materials and systems can be easily re-used or recycled.

16.4 Key Steps Towards an Eco-industrial Park

a.) Forming an Industrial Ecosystem

An EIP must develop, at a minimum, an industrial ecosystem that reflects the linkage among the community's natural resources, existing & potential businesses, the transportation infrastructure, and material flows through the local and regional economy.

b.) Attracting Tenants

An EIP needs to attract businesses that are compatible with the goals of the EIP and community, as well as create incentives for existing businesses to remain. EIPs need to attract a variety of tenants. It is widely recognized that EIPs will need to attract and nurture small businesses, incubator companies, local enterprises and environmental technology firms, in addition to any large corporate tenants they can attract.

c.) Management Structure

Managing a site involves many steps and can be approached in a variety of ways.

d.) Financing

Private financing is critical to move projects beyond start up and for EIPs to become a common approach for economic development. Private financing has been difficult to obtain because financial institutions are not familiar with the potential for EIPs to lower risk and increase rates of return. Institutionalising EIPs as a new paradigm for economic development will require:

- Financing that can be provided by private sector financial markets,
- Development that can be done by firms now viewed as conventional developers, and
- Business profits that are comparable to, if not greater than, traditional business investments.

Since this will take some time to accomplish, in the short term, governments, communities, and progressive businesses have an important role in helping launch, pilot and nurture eco-industrial development so it can eventually be financed and managed through market mechanisms.

e.) Performance Standards

Performance standards need to be developed and agreed upon during the design of the park. Some environmental regulations discourage businesses from co-locating or partnering. Removing barriers to waste exchanges and allowing air emissions bubbling and trading at a particular site or within a region were two issues specifically identified by participants.

Although not yet proven in practice, it is strongly believed that business can improve performance and save money (i.e., eco-efficiency) by participating in eco-industrial parks. The belief is based on the promise of synergies, economies of scale, and potential reductions in risk and liability offered by EIPs. Communication among practitioners should occur regularly and the exchange of information made easy. Participants agreed that sharing challenges, strategies and successes is critical to further progress.

16.5 Factors Affecting the Success of an Eco-Industrial Park

When establishing symbiotic relationships, five main barriers can be encountered (Heeres et al, 2004):

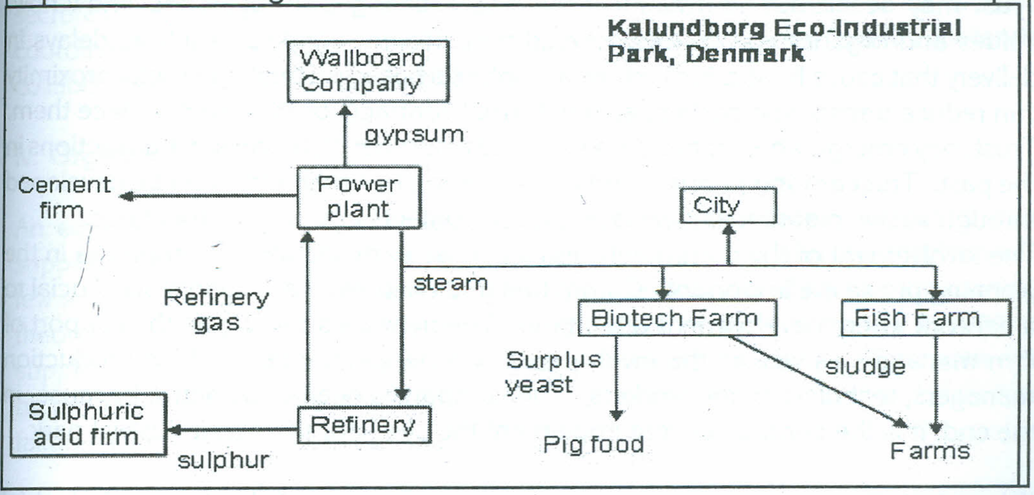
a.) technical barriers occur when exchanges are not viable;
b.) economic barriers include economically unsound or risky exchanges;
c.) informational barriers arise when the right people and the right information do not meet;

Box 2: Example of Eco-Industrial Park: Kalundborg, Denmark

Probably the best example of an eco-industrial park lies along the coast of Denmark, in an industrial region called Kalundborg. There, a complex web of waste and energy exchanges has developed among the city, a power plant, a refinery, a fish farm, a pharmaceutical plant, a chemical manufacturer, and a wallboard maker.

The exchange works something like this: (i) the power company pipes residual steam to the refinery and, (ii) in exchange, receives refinery gas (which used to be flared as waste). (iii) The power plant burns the refinery gas to generate electricity and steam. (iv) It also sends excess steam to a fish farm, the city, and a biotechnology plant that makes pharmaceuticals. (v) Sludge from the fish farm and pharmaceutical processes becomes fertilizer for nearby farms. (vi) Surplus yeast from the biotechnology plant's production of insulin is shipped to farmers for pig food. (vii) Further, a cement company uses fly ash from the power plant, while (viii) gypsum produced by the power plant's desulfurization process goes to a company that produces gypsum wallboard. (ix) Finally, sulfur generated by the refinery's desulphurization process is used by a sulfuric acid manufacturer.

The network of exchanges at Kalundborg developed over a decade or so as companies voluntarily sought to reduce waste treatment and disposal costs. Later, however, companies recognized the efficiencies of organized, planned material and energy exchanges. And Kalundborg happened on its own. It was not planned or financed by the government, and no consultants were hired to design it.



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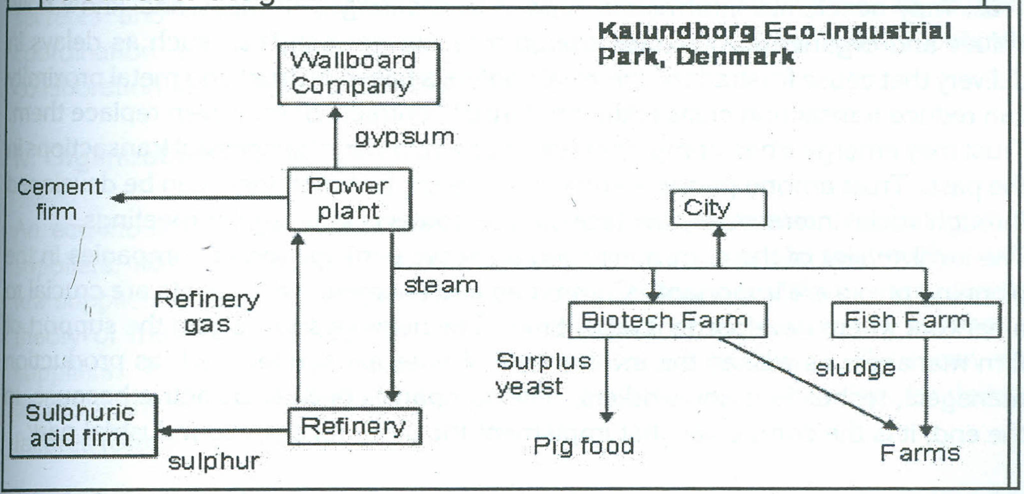

d.) organizational barriers occur when the exchanges intended do not fit the current corporate organizational structure; and
e.) regulatory or legal barriers.

In addition to the above, the key factors for successful eco-industrial park development are:

i. Companies that fit the eco-industrial park concept and how to attract them

Physical business-specific and location-specific features are central factors in successful eco-industrial park design (Eilering and Vermeulen, 2004). Gibbs and Deutz (2004) found external drivers such as geographical setting and broader economic realities of the locality to play a major role in influencing the degree of success of an attempted eco-industrial park. It is essential that the exchanges and flows between companies are matching.

Process waste streams and the flows of materials have to be continuous and sufficient. Regulatory control can sometimes hinder waste exchanges (Gibbs and Deutz, 2004). For example, defining a side-product like molasses as waste instead of material can hinder the exchanges. Different investment cycles of companies can also hold back the flow exchanges. Flexibility potentials should therefore be integrated to the technical solutions related to the flow exchanged and the investment cycles of partners should be brought in line. Back up units could also be developed.

ii Trust, participation and commitment

Trust and mental proximity are important in a successful eco-industrial network. Trust may accelerate information flows and exchanges of ideas and know-how. Values and organization cultures shared may prevent conflicts, such as delays in delivery that cause frustration. Informal contrasts based on trust and metal proximity can reduce transaction costs related to formal contracts or may even replace them. Trust may emerge when companies have had a number of successful transactions in the past. Trust among partners and ties between plant managers can be developed through social interactions, like face-to-face contacts and regular meetings.
The involvement of the community and an active participation of companies in the planning phase are important. Committed and energetic participants are crucial to a network where development takes time. The network should gain the support of firm managers as well as the involvement of other personnel, such as production managers, technicians and workers. The companies need to be active because, in the end, it is the companies that implement the plans for the eco-industrial park.

If the private firms are not committed enough there is a danger that the eco-industrial park network will fade away because of decreasing interest. Commitment could be secured in the initial phase by focusing primarily on the partnerships that provide concrete and short-term benefits. Later, more company specific and economically challenging projects should be implemented (Heeres et al 2004). Commitment might be enhanced also by the financial participation of companies. For example, an entrance fee of a feasible amount might be introduced. Relationships to the surrounding community of an eco-industrial park are important and successful development needs an active participation from many stakeholders (Heeres et al. 2004). Local residents and the community should be encouraged to carry their part of the environment responsibility at home. As a form of corporate social responsibility (CSR), eco-industrial parks should also endeavour to provide jobs in the area, contribute to education, engage the community in emergency preparedness and integrate services like recreation, well-being, transport and day-care with the community.

iii Information and know-how

Lots of information and knowledge are needed to implement a successful eco-industrial park. Companies may lack the skills for networking if they are not accustomed to it (Starlander 2003). They might also be lacking in knowledge about the concept of inter-company cooperation and potential strategies. Moreover, there might be an unclear understanding of the causal relationships between cooperation and sustainability. Communication within a firm can be a barrier if the hierarchical structure of the company includes separated responsibilities or if sustainability and cooperation information systems are deficient. Continuous training should be enhanced to increase knowledge within organizations. Information flows and their efficiency can be improved by institutionalising cooperation (Fichtner et al., 2005).

Sharing information can also pose a barrier if there is a risk of giving away trade secretes and a need to disclose confidential information. Here an external coordination agent could gather the information and help identify potential collaboration areas (Starlander, 2003).

iv. Organizational factors

An eco-industrial park often means cooperation with a smaller number of local suppliers. Although there appear to be benefits in close links and relationships with few suppliers only, many companies are eager to follow a traditional management theory of maximizing bargaining power and profits by increasing the number of suppliers. It can also be difficult for firms to change suppliers. There can also be problems with contracting if there is no compensation mechanism for delivery failures (Starlander, 2003).

There is a risk of a potential power imbalance in eco-industrial parks when companies in the network are very different in size, especially if there is one larger anchor tenant and the others are much smaller companies. That is why the contracts are an important control mechanism for companies to protect themselves form partners' opportunism. Networking may require contracts for all relationships and flows, e.g. duties, volumes, timetables, and quality. An imbalance of power might pose the threat of a monopoly phenomenon if one company within a network becomes the exclusive provider of a service or product. Here the others might, for instance, threaten to change suppliers (Starlander, 2003).

Moreover, global markets and company structures can raise barriers. If the firms are subsidiaries of a global organization their decision-making power might be reduced. In addition, there might be unified global standards for a certain product quality that does not fit the eco-industrial park concept and would hold back by-product use (Starlander, 2003).

v. Champions and coordination agents

Champions, or anchor tenants, are often important actors in the network. The anchors are usually the largest firms in the network. They can have a role in motivating other actors like politicians, citizens, and businesses. They secure motivation partly by securing the output of their own by-product streams. Anchors also often secure sufficient financial resources. Champions should also gain the trust of the other actors in the network.

Besides anchor tenants, a coordination agent is a common feature shared by eco-industrial parks. A coordinator facilitates communication between the actors in the network. A coordination agent can be one of the companies or, more often, an academic institution, consultancy company together with public bodies, or trade, entrepreneurs or employers associations. Private companies may be the most motivated and their management might be the most efficient.

On the other hand, a firm might focus too much on areas where it has a direct interest. A firm also requires significant resources for coordination. A coordinator can gather information and identify potential synergies and collaboration areas. It is important that the coordinator follows up meetings and discussions to keep up the companies' interests. A coordination agent can also have a role in informing and motivating the companies about potential benefits to be achieved. A coordination agent should be fully committed to the network and gain credibility from the other actors (Starlander, 2003, Heeres et al., 2004).

16.6 Management of an Eco-Industrial Park

Management as used in the context of EIP means decision-making processes towards enhanced mutual or collective benefits of stakeholders within the park, including the biophysical environment. Some key functions include among others:

i Administrative Functions

Eco-industrial parks are communities of companies with challenging management and support systems. Administrative duties include standard park service, recruitment, and maintenance functions. In the planning phase the park management should find new connections between companies and look for value-adding functions. The management should cooperate actively with the community and encourage dialogue between interest groups. The management also needs to decide which services the park management provides and which are brought from public utilities or external contractor. Park covenants should also be developed.

ii. Supporting Material and Energy Exchanges

Supporting and maintaining the exchanges of materials and energy among companies are important tasks in an eco-industrial park. The management, or sometimes a third party, like a coordinator, enhances the flow exchanges between the companies in the park. The management maintains the diversity of the companies and the compatibility of by-products as companies change over time, for instance through its recruitment responsibilities, when a supplier or customer moves out from the network.

One of the administrative duties of an eco-industrial park is to support improvement in the environmental performance of individual companies and the park as a whole. The management supports an information system to enhance inter-company communications, to inform members of the state of their local environment and to provide feedback on the eco-industrial park's performance. In addition, the management should develop efficient marketing strategies and techniques and keep up-to-date on legislation and regulations and communicate with regulatory bodies. The park can also maintain shared support services such as a training centre, cafeteria, day-care centre, offices for purchasing supplies or transportation logistics office. Companies can add to their savings by sharing the cost of these services (Lowe 2001).

Lowe (2001) divides eco-industrial park management in two: management of property and management of community (Table 1). The management of industrial park property includes mainly maintaining the property and its infrastructures and providing utilities and support services. The Property Management Company also recruits new firms for the area. Some other property management tasks are:

negotiating rents and service contracts with companies, financial management, negotiating contracts with external service suppliers, communication with stakeholders and monitoring.

The main priority of the Community Self-Management System is to sustain the vitality of the community itself and maintain the synergies between the actors. The management of a community company includes collecting data, enhancing cooperation and arranging meetings between managers and inter-company working groups. External communication can be enhanced through a local paper or appropriate media infrastructure.

The goals of property management and community self-management are interconnected and there must a clear understanding between the two. Probably the most important responsibilities shared will be the management of by-product exchanges and the enforcement of standards. A member from the property management company could help to link the two systems. Sub-committees might be organized for the main functions.

16.7 Benefits of Eco-Industrial Parks

Communities embracing the EIP concept are seeking benefits for all public and private stakeholders.

- Business derives cost savings and new revenues; shared services; reduced regulatory burden; and increased competitiveness.
- The community enjoys a cleaner, healthier environment; business development and job creation; an attraction for recruitment; and an end to conflict between the economy and the environment.
- Government receives increased tax revenues; reduced enforcement burden; reduced costs of environmental and health damage; and reduced demand on municipal infrastructure.
- For the environment there is reduced demand on finite resources; decreased local and global pollution; enhanced environmental health; increased use of renewable energy and materials; and an overall renewal of natural systems.

Table 1. General management functions at an eco-industrial park and management functions in case management has two entities

<table>
<tr><th colspan="2">General Management of an Eco-industrial Park</th></tr>
<tr><td colspan="2">o Finding new connections for cooperation
o Enhancing the dialogue between shareholders
o Maintaining and managing services
o Supporting material and energy flows
o Recruiting new companies
o Improving the environmental performance of the park and individual companies
o Maintaining an information system
o Informing companies in the park
o Linking companies and public organizations
o Developing marketing</td></tr>
<tr><th colspan="2">Management in case of two Management entities</th></tr>
<tr><th>Management of industrial park property</th><th>Community Self-management</th></tr>
<tr><td>o maintaining the property and infrastructure
o recruiting firms
o providing utilities and support services
o negotiating leases and service contracts with tenants
o financial management
o negotiating contracts with external service providers
o communication with stakeholders monitoring</td><td>o sustaining the community
o enhancing communication</td></tr>
<tr><th colspan="2">Management of industrial park property + Community self-management</th></tr>
<tr><td colspan="2">o management of materials and energy exchanges enforcement of standards</td></tr>
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(Source: Lowe 2001).

16.8 Conclusions

The concept of eco-industrial parks is based on industrial symbiosis, which on the other hand is a tool within industrial ecology. With growing and expanding urban centres, including the policy of creating industrial centres and export processing zones in Kenya, the opportunities for EIP development are high. The challenges in research and development in this regard would include survey and documentation of existing industrial and service systems, assessment of possible convergence areas, awareness creation on the benefits of EIPs and lobbying for political support in appropriate policy changes. Already, the modus operandi of the Jua Kali sector in a way represents some form of industrial symbiosis. Lessons can be derived from this sector to promote the eco-industrial park concept.

16.9 Review Questions

i. Using practical examples explain how a milk plant, a fertiliser industry and a manufacturing industry can relate along symbiotic relationships
ii. Critically examine the factors that limit development of eco-industrial parks in developing countries.
iii. In which ways can institutions of higher learning promote development of eco-industrial parks in Kenya?

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