

ECO-INDUSTRIAL PARKS AND SUSTAINED INDUSTRIAL DEVELOPMENT: PROSPECTS AND LESSONS

¹P. Noufal (M.A., M. Phil), ²Dr. K.V. Ramachandran (M.A., Ph. D.)

¹Assistant Professor, Department of Economics, Sree Neelakanta Government Sanskrit College, Pattambi, Kerala, India.

²Associate Professor, Department of Economics, University of Calicut, Dr. John Matthai Centre, Trissur, Kerala, India.

INTRODUCTION

Eco-industrial development is currently being spread out in both industrial and developing countries. It is an important way to achieve sustainable development keeping the rules of energy saving, pollution reducing and efficiency increasing. With the advancement of sustainable developmental strategies, the development of eco-industry and eco-industrial parks have been adopted as an important methodology to realise the prospects and coordination of environment and economy. Eco-industrial parks are the industrial parks which are designed and constructed according to the principle of industrial ecology, cleaner production requirement, and the idea of circular economy. They create certain inter-linkages between manufacturing and service enterprises so that the environment and resources are managed sustainably and with minimum ecological impact. Eco-industrial parks aim at achieving proper economic, environmental and social interaction and thus seek to increase business competitiveness.

1.1 The Concept of Eco-Industrial Parks:

Eco-industry is a whole living system, a natural and human-made unity with an economically productive and ecologically efficient industry, systematically responsible and socially harmonious, and physically beautiful and functionally vivid landscape. The strategies of eco-industrial development focus on (i) providing safe and quality living conditions, (ii) conserving the natural eco-system, (iii) effective utilisation of natural resources, (iv) seeking an effective eco-friendly economy, (v) establishing environmental justice, and (vi) initiating global sustainable development.

Eco-industrial parks are a variant of industrial parks that strive for high environmental, economic, and social benefits, as well as business support. The concept of has been first

described at the United Nations Conference on Environment and Development, Rio de Janeiro in 1992. They are based on a principle of industrial development that is more resource efficient and cleaner than traditional industrial parks, while at the same time they share the core principles of all industrial parks of creating business niches, supporting business incubation and competitiveness. Simply, the concept of eco-industrial park affiliates to industrial ecology which draws analogies from the natural ecosystems to human industrial systems.

An industrial park is defined as “a large tract of land, sub-divided and developed for the use of several firms simultaneously, distinguished by its shareable infrastructure and close proximity of firms.” Similarly, “an eco-industrial park is 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 the environmental and key 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 realise by 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.) An eco-industrial park obeys the ‘reduce–reuse–recycle’ principle of industrial ecology. The goal of an eco-industrial park is to improve the economic performance of the participating companies while minimising their environmental impact.

Eco-industrial parks are the production organisation patterns that are constructed under the idea of circular economy on the basis of exchange mechanisms of material, energy and information among enterprises. Communities and enterprises creating eco-industrial parks will have common grounds for industrial development, which is much more competitive, more efficient and much cleaner than traditional industrial parks. Eco-industrial parks are designed in such a way so that they promote the collaboration between companies in order to reuse recyclable materials and green energy sources. It involves a network of firms and other organisations working together to improve their environmental and economic performance. Some planners and researchers of eco-industrial parks have used the term ‘industrial ecosystem’ to describe the type of symbiotic relationships that develop amongst participating firms. The most important viewpoints of eco-industrial parks are closing the material flows and energy cascading.

1.2 Key Elements of Eco-Industrial Parks–Select Literature Review:

Eco-industry is a whole living system, a natural and human-made unity with an economically productive and ecologically efficient industry, systematically responsible. The major elements of eco-industrial parks are the (i) industrial ecology, (ii) biological ecology, and the (iii) landscape ecology. Industrial ecology relates to the industrial and ecological systems that are based on optimal circulation of materials and energy. Regarding biological ecology, the eco-industrial

parks seek to mimic the natural ecosystems where waste products from one process are incorporated into another process, just as carbon dioxide and oxygen in the processes of photosynthesis and respiration. Landscape ecology provides the spatial perspectives and aims to reduce the negative ecological effects of urban and industrial development. The following table summarises the key elements of the most cited eco-industrial parks in international literature:

Key Elements		Tudor et.al, 2007	Gibbs & Deutz, 2007	Chertow et.al, 2008	Boons et.al, 2011
1	By products and energy exchanges	✓	✓	✓	✓
2	Sharing service			✓	✓
3	Landscape ecology	✓			✓
4	Common Infrastructures			✓	✓
5	Networking		✓	✓	
6	Involvement of local stakeholders		✓		✓

Industrial ecology takes a material and energy flow approach to human society; it does not regard the society merely from the point of view of organisational process. The local communities embracing the concept of eco-industrial parks are looking for some additional benefits such as: economic efficiency, higher competitiveness, generation of additional revenues through positive regulations at the community level, creation of jobs, solving the conflict between economy and environment, diminishing the demand on the country infrastructure, decreasing the effects of pollution, and using energy from regenerating sources and replacement materials.

1.3 Designing Eco-Industrial Parks–The Plan and Framework:

Eco-industrial parks may be planned, designed, and built in such a way that it makes it easier for businesses to co-operate with each other and with the local community in an attempt to reduce waste and pollution, efficiently share resources such as information, materials, water, energy, infrastructure, and natural resources, and help achieve sustainable development, with the intention of increasing economic gains and improving environmental quality. They can be best defined as a community in cooperation and interaction and efficiency in the use of natural resources (Cote and Cohen-Rosenthal, 1998). They have made an explicit synthesis based on a

literature review and they propose that an eco-industrial park compared with normal industrial park in general would:

1. Define the community of interests and involve that community in the design of the park.
2. Reduce environmental impact or ecological footprint through substitution of toxic materials, absorption of carbon dioxide, material exchanges and integrated treatment of wastes.
3. Maximise the energy efficiency through facility design and construction, co-generation, and cascading.
4. Conserve materials through facility design and construction, reuse, recovery and recycling.
5. Link or network companies with suppliers and customers in the wider community in which the eco-industrial park is situated.
6. Continuously improve the environmental performance of the individual businesses and the community as a whole.
7. Have a regulatory system that permits some flexibility while encouraging companies to meet performance goals.
8. Use economic instruments that discourage waste and pollution.
9. Employ an information management system that facilitates the flow of energy and materials within a more or less closed loop.
10. Create a mechanism, which seeks to train and educate managers and workers in new strategies, tools and technologies to improve the system.
11. Orient its marketing to attract companies which fill niches and complement other businesses.

Eco-industrial parks are the communities of manufacturing and service businesses located together on a common property with challenging management and explicit and transparent support systems. Members seek enhanced environmental, economic, and social performance through collaboration in managing the environmental and resource issues. The subsequent development of eco-industrial parks have been deeply based on the application of industrial ecology theory, which pays specific attention to metabolic exchanges within the industrial

processes to address a deep reduction of limited resource consumption and a minimisation of waste production in the framework of a sustainable development approach.

1.4 Potential Benefits of Eco-Industrial Development:

Eco-industrial parks are receiving increasing attention in light of the sustainability discourse. They strive for high environmental, economic and social benefits. The parks function according to a shared goal of maintaining the economic viability of industry, trade and commerce while sharing the same core principles of all industrial parks, of creating business niches, supporting business incubation and competitiveness. Eco-industrial parks are a promising strategy to promote sustainable industrial development and to improve the industries' environmental performance in terms of management of materials, energy and waste. They provide substantial benefits for participating companies, for the neighbourhood and for the region. The potential benefits of eco-industrial development may be analysed under three heads, namely: (a) Benefits to the Community, (b) Benefits to the Environment, and (c) Benefits to the Business.

(a) Benefits to the Community:

1. Expanded local business opportunities.
2. Reduces waste disposal costs.
3. Improved environment and habitat.
4. Recruitment of higher quality companies.
5. Improved community partnership with business.
6. Minimised impact on infrastructure.
7. Enhanced quality of life near the eco-industrial development.
8. Improved aesthetics.
9. Good jobs.

(b) Benefits to the Environment:

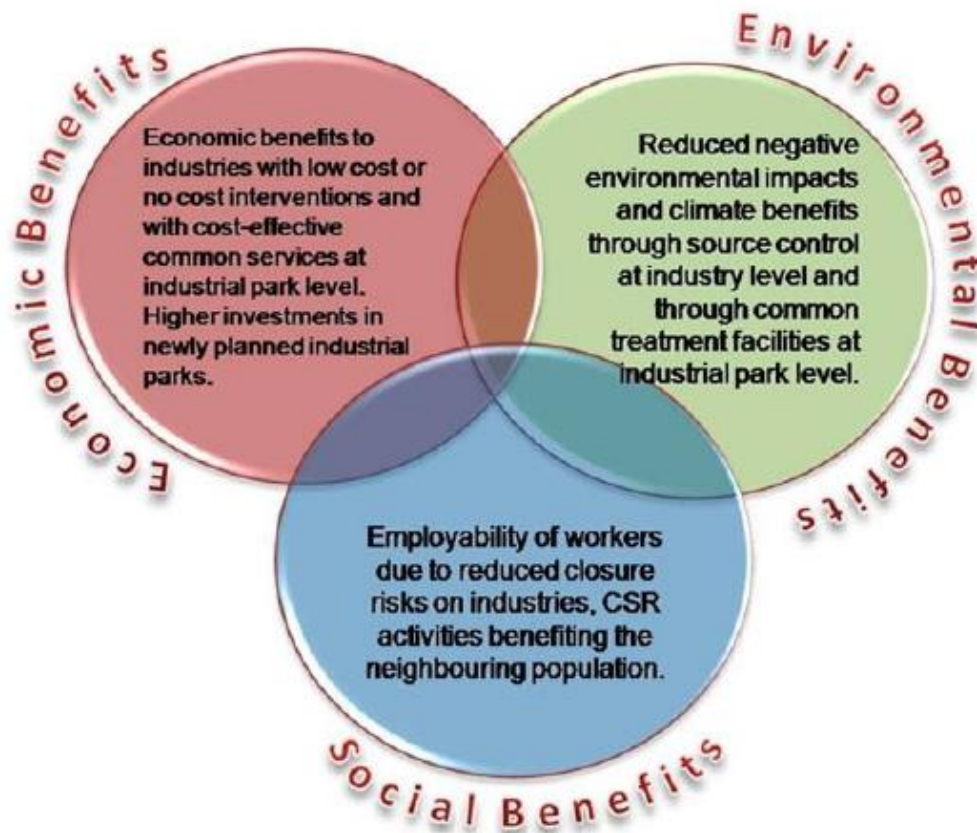
1. Continuous environmental improvement.
2. Reduced pollution.
3. Innovative environmental solutions.

4. Increased protection of natural ecosystems.
5. More efficient use of natural resources.
6. Protection and preservation of natural habitat.

(c) Benefits to the Business:

1. Higher profitability.
2. Enhanced market image.
3. High performance workplaces.
4. Improved efficiency.
5. Access to financing.
6. Regulatory flexibility.
7. Higher value for developers.
8. Reduction of operating costs.
9. Reduction in disposal costs.
10. Income from sale of by-products.
11. Reduction of environmental liability.
12. Improved public image.
13. Increased employee productivity.

Thus, by integrating the economic, social and environmental aspects, the major benefits from a sustainable industrial development approach are presented below:



Eco-industrial parks consider industrial symbiosis and sustainable resources management as opportunities for economic promotion where, industrial symbiosis involves economic activities in a collective way for the reduction of environmental impact and costs. They bring together businesses that cooperate to minimise resource use and reduce waste. The companies are encouraged to operate in an inter-dependency loop whereby waste and by-products can be used more productively wherever possible. Businesses cooperate to minimise the resource use and reduce waste. The eco-industrial parks function according to a shared goal of maintaining the economic viability of industry and play a significant role in spreading the ideas about a sustainable and efficient industrial development.

1.5 Success Factors of an Eco-Industrial Park:

Implementing an eco-industrial park can bring environmental, social and economic benefits. It can be observed that industrial ecology is principally concerned with the flows of materials and energy through systems at different scales, from products to factories and up to national and global levels and industrial symbiosis focuses on these flows through networks of businesses and other organisations in local and regional economies as a means of approaching ecologically

sustainable industrial development (Chertow, 2004). To be a real eco-industrial park, the development must be more than: (i) a single by-product exchange or network of exchanges, (ii) a recycling business cluster, (iii) a collection of environmental technology companies, (iv) a collection of companies making 'green' products, (v) an industrial park designed around a single and competent environmental theme, (vi) a park with environment friendly infrastructure or construction or (vii) a mixed-use development (Lowe 2001).

The major factors influencing the efficient functioning and success of an eco-industrial park are listed below:

1. Close proximity of companies.
2. Matching exchanges of materials and energy.
3. Diversity of actors.
4. Continuity of flows.
5. Economic viability.
6. Low economic risks.
7. Economic gains are shared equally.
8. Direct expenses payable by the firms remain low.
9. Clear economic benefits to all actors.
10. Existing institutional platforms.
11. Environmental awareness in the firms.
12. Balanced interdependence relationships between partners.
13. Balance of power between partners.
14. Similar organisational cultures of firms.
15. Enough information and knowledge.
16. Realistic expectations of firms.
17. Active participation.
18. Commitment.
19. Continuing interest.
20. Trust.
21. Vision towards the future and its goals.
22. Existence of a driver/coordination agent.
23. Existence of an anchor tenant.
24. Prevalence of a contracts/informal control mechanism.
25. Legal and political support.

For the Indian scenario where in there are several old industrial parks that do not have cost effective common environmental infrastructure and services as well as lack synergies among the

industries in the parks, the eco industry park concept has been emerged to address the major aspects of eco-industrial development, namely: (i) Siting and planning of new industrial parks integrating the environment, energy and climate issues, (ii) Transformation process of existing industrial parks to eco industrial parks, (iii) Strengthening of environmental infrastructure and services in the industrial parks, (iv) Resource efficiency and improved environmental management in individual industries, and (v) Capacity building and skill development of individuals and organisations in the area of eco-industrial development.

CONCLUSION

The concept of eco-industrial parks seeks to ensure that industrial development in urban areas brings a range of economic, social and environmental benefits to the local community. They pay attention to the 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. The quality, continuity and quantity of interconnected material and energy flows and the close proximity of firms are the important characteristics in the successful eco-industrial networking and management. The estimation of basic eco-efficiency and sustainable developing ability for an eco-economic system has become a major problem with the foundation and development of ecological industrial parks all over the world. This estimation will further provide a scientific basis for the ecological transformation of traditional industrial parks as well as the establishment of new eco-industrial parks. With the growing environmental concern, there is evidence that increasing symbiotic relationship between plants in the same industrial area highly contributes to a more sustainable development of industrial activities. The overall concept is that eco-industrial park development integrates business success, environmental excellence, and community connections to create economic opportunities and improved ecosystems.

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