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Eco-industrial clusters: Enhancing regional economic development through environmental linkages

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Developing countries in Asia are struggling to cope with the negative impacts of concentrated industrial activities. Inspired by the theory of industrial ecology, eco-towns or eco-industrial parks are frequently promoted in many localities as a strategy for reducing the environmental burden of industry in a way that is consistent with economic development. Yet the reach of those eco-approaches are limited to traditional manufacturing industries concentrated in urban areas. For countries still focusing on manufacturing they are good models to follow.

However, for countries looking beyond simple manufacturing and which are turning to the adoption of new kinds of industries, it is the inner regions, the zones of transitions which begins with the edge of residual green space and the fringe areas making up the hinterlands between urban and rural areas that offer an opportunity for equitable growth. These areas are already used as sites for clusters of new industries that want equal access to raw materials as well as to urban markets. However, rather than just co-existing, these companies could become interconnected, sharing resources and achieving economic, social and environmental success. The solution is to create an Eco-Industrial Cluster (EIC). Essentially an EIC aims at efficiently using local resources, discarded materials and byproducts which are otherwise termed as waste, while achieving equitable development targets. Successful EICs, are made up of enterprises that constantly seek inter-firm networks, not only to conserve resources but also look for all types of innovations that bring wealth to the community. The key foundations of EICs, as can be learned from these four prototype cases in India, Japan, Thailand and Viet Nam are: inter-firm networks, enabling technologies, social capital and public policy support. It is important that these infrastructures should be created simultaneously with new industries, and not after environmental problems have already developed, as has been done in the past.

Changes in policy orientation are essential to promote the EIC as a new model for sustainable regional development. Joint efforts that cut across three main policy streams of industrial policy, environmental policy and regional development policy that favour co-operative, multi-stakeholder and often location specific approaches are needed to unleash the sustainability potentials of EICs.

Industrial development, eco-restructuring and sustainable development issues in Asia

Economically, Asia is the fastest growing region in the world, but it is currently facing the consequences of rapid industrialisation and urbanisation, resulting in scarcity of resources due to ever-rising consumption. Changes in industrial production processes and consumption patterns have also meant a considerable increase in waste generation. Ample evidence exists to argue that industrialised urban areas of Asia are the location of concentrated industrial

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activities and thus a source of pollution and emissions. The public and private sector response to alleviate this environmental burden is to formulate eco-town or eco-industrial park development projects. Based largely upon the concepts of industrial ecology and/or cleaner production, those eco-approaches seek to increase business competitiveness, reduce waste and pollution, as well as create improved living and working conditions for local community (GEC, 2005). There are many different type of eco-town concepts being formulated and implemented in countries like Japan, China, Republic of Korea and Thailand. The motive of the Japanese Eco-town concept, which was developed during a period when government subsidies were available, is to promote the use of the recycling industry as a basis for establishing a sound material cycle society. On the other hand, eco-industrial park concepts that have evolved in countries like China, Republic of Korea and Thailand are founded largely on adaptation of industrial symbiosis approaches for resources recovery. Nevertheless, eco-town concepts are still dominated by large industries in traditional manufacturing sectors such as automobile, ceramics, steel, ship building, chemicals, semi-conductor and electronics.

Pushing such eco-approaches is a crucial element for resource recovery in those sectors and can become a good model for the countries that are still focusing on manufacturing. However, new transformation techniques are needed for countries that are looking to adopt new industries, and for regions that are still dominated by small-scale industries and lagging behind modern industrial frontiers. Moreover, the challenge for many Asian countries is that the industrial development and environmental protection efforts must work interchangeably, in light of disproportionate wealth creating opportunities available to inner regions. One of the vehicles commonly used to achieve the goals of local wealth creation, innovation and regional competitiveness is to support ‘industrial cluster’ formation in inner regions, which could optimise use of local resources to activities with higher levels of productivity (Porter, 1998). This new approach is visible across a number of countries in Asia. There is quantitative evidence to prove that many industries remain relatively concentrated in specific regions (Kuchiki and Tsuji, 2005). Additionally, in some countries in Asia, they outnumber their counterparts located in urban centres (IGES, 2006).

Conventionally, physical resources like bios and human capital are sourced from inner regions, while adding value to the raw material and converting them into directly usable products, which takes place in the urban centres. The intensity of environmental issues in urban centres can be reduced by clustering the new bio-resource based industries and relocating appropriate process industries to fringe areas providing equal access to both rural and urban areas. Central to this is the conservation of environmental quality in urban areas while providing equal employment and social opportunities to rural communities. This aspect of the environmental and economic gains of eco-industrial clustering has often been ignored by development planners. Addressing these issues will accelerate the development of new eco-industries and make sure that new industries develop in a more eco-friendly way compared to the past.

What are eco-industrial clusters and how do they benefit regional economies?

Eco-Industrial Clusters (EICs) are defined in this policy brief as:

“a community of business; geographic concentration of interconnected companies in a specialized field that cooperate with each other and with the local community to efficiently share resources (information, materials, energy, water, infrastructure, finance, etc), leading to improved environmental quality, economic gains, and equitable enhancement of human resources for both the business and local community”

While the terminologies and operational scales of eco-approaches differ (Figure 1), the purpose of an Eco-Industrial Cluster (EIC) is essentially to use local resources

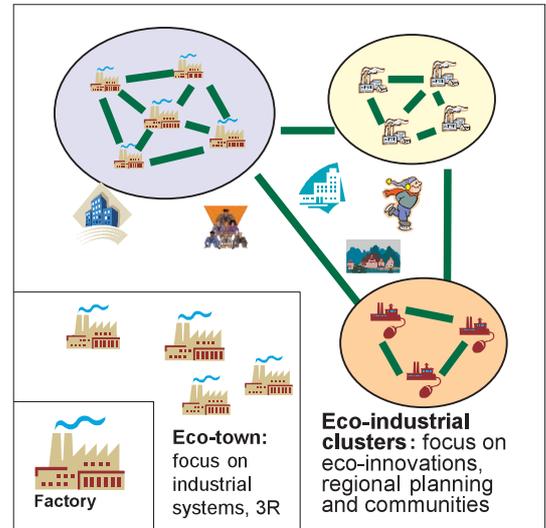
efficiently while achieving economic development targets and meeting the social demands of the community. In accordance with the applications of industrial ecology principles and business competition theories, EICs can become an emergent venture of integrated environmental and economic planning.

The theory behind the benefits of eco-industrial clusters is based on the economies of scale, sound resource use and the availability of human capital. As firms physically congregate into one region, there are overflows of knowledge, technology and people. These overflows lead to the creation of inter-firm networks for increased material productivity and reduced operating cost for all firms within an industrial cluster. There are four major sources of productivity gains and cost benefits that can be linked to eco-industrial clusters. These are (i) the effective use of raw and waste materials, (ii) access to knowledge and technology, (iii) employment generation, and (iv) complementary eco-product development. These benefits occur both directly and indirectly for firms within an eco-industrial cluster.

“The first benefit of EIC arises from effective use of local resources by converting waste into material and energy forms, thus reducing demand and environmental impacts.”

“Another benefit of EICs is that they enhance social capital and employment opportunities. By setting high norms for sustainability, firms and communities in a cluster can seek joint actions for environmental sustainability and economic development.”

Figure 1 : Eco-industrial clusters and similar concepts



The first benefit of an EIC arises from effective use of local resources by converting waste into material and energy forms, thus reducing demand and environmental impacts. This benefit can also enable an EIC to reduce the cost of meeting regulatory requirements. For example, an EIC may eliminate the need for transporting waste material, which might occur by virtue of inter-firm networks, where waste output of one firm becomes raw material input for another firm located within the cluster. The firms within a cluster can sell the waste resources to another firm as a substitute for virgin material, and they find that this is more profitable than paying for treatment and disposal. Other regulatory arrangements might provide opportunities for reducing the cost of complying with environmental regulations. For example, the notion of an EIC-wide umbrella permit, covering all firms within a cluster, would reduce the administrative costs of compliance and allow the EIC members to determine among themselves the most efficient self-regulating method for meeting the terms of the cluster permit.

Access to knowledge and technology is intangible, but it remains an important benefit for an eco-industrial cluster. Closely networked firms can monitor and self-evaluate the knowledge and technology needs that match the availability elsewhere, with fewer transaction costs. In fact, cost savings would increase if specialised service infrastructure such as universities and environmental information centres already existed in an EIC. Since these specialised services are subject to the economics of scale, a group of firms demanding similar services could increase the carrying capacity for upfront costs. In turn, this would eventually lead to improvements in long term competitiveness and to the sustainability of businesses operating within the cluster.

Another benefit of EICs is that they enhance social capital and employment opportunities. By setting high norms for sustainability, firms and communities in a cluster can seek joint actions for environmental sustainability and economic development. Joint actions for integrated environmental and economic planning can be facilitated via community meetings and knowledge transfer seminars that can result in the creation of new businesses. As a result more employment opportunities would be created at the local level. As more workers are drawn into the cluster, firms benefit by having access to a large pool of skilled labourers.

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Inter-firm networks could also lead to innovation, new eco-product development and new markets capturing opportunities for a cluster. For example, the eco-product of one firm within an industrial cluster may have an important influence on the marketing activities of other firms within the cluster. Furthermore, retailers or traders may wish to make joint purchases in order to meet their overall market demands. Clusters of these types of businesses could also spread the fixed cost of market capture over more firms within the clusters.

The fact is that these environmental and economic benefits can only be achieved due to the existence of industrial clusters. Similar benefits cannot be replicated throughout the existence of an individual firm or firms not located in close physical proximity. Helping business to be a part of a dynamic EIC that fosters resource conservation, collaboration and competition could also be used as a vehicle for improving the overall environmental performance of small and medium-scale enterprises in the long run. These benefits demonstrate a clear rationale and motivation for extending policy support for development of EICs.

What are the challenges in establishing eco-industrial clusters?

Clustering of micro, small and medium-sized industries appears to be a viable solution as it can lead to environmental and economic competitiveness. In fact there are some successful EIC initiatives (Box 1) that also promote horizontal and vertical networks as a strategy for sustainable regional development. However, communities and companies in many developing countries of Asia still face several challenges in seeking the benefits of eco-industrial cluster development. The four prototype eco-industrial clusters in key economic sub-sectors of India, Japan, Thailand and Viet Nam demonstrate the variety of drivers as well as barriers.

Box 1 : Example of a Wood Industrial Cluster in Japan

Processing of wood logs and production of wooden boxes for packing is the mainstay of the wood industries in Maniwa, Okayama Prefecture. This region has a population of 52,000 and is home to about 75 wood based small businesses. The production process generates waste such as wood trimmings and shavings. An inter-firm network of various businesses in the supply chain realised the commercial value in such waste products and explored options of wood as a biomass fuel, extraction of ethanol and wood-based concrete. Technologies such as boilers enabled the process to be carried out, and knowledge/information was brought in by the University of Tokyo and Okayama University. Taking leadership and participation by business in community based social capital networks increased the availability of market information and lowered its transaction costs. This also led them to reach collective decisions and implement actions together. Maniwa City promoted a “biomass town” initiative encouraging businesses with several kinds of funds and subsidiaries. (Anbumozhi, 2007)

In each case-study cluster, it appears that for small businesses to develop into competitive forces, links with large firms, ties with external market agents, and the presence of local support institutions have been of great significance (Table 1). Industrial, environmental and regional development policies were also found to have a strong impact. Successful EICs are made up of enterprises that constantly seek inter-firm networks, not only to minimise waste and reduce pollution, but also to look for all types of innovation to improve zero emission processes and develop new eco-products. Agreements based on mutual trust within a network aim at sharing by-products, wastes and resources are found to generate new markets, logistics and cluster management.

However the studied prototype clusters were also found to have certain deficits that hamper the functional characteristics of EIC.

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Enabling technologies

For individual companies to form inter-firm networks in order to become environmentally-friendly, eco-industrial clusters require a range of different technologies available within their reach to do so. New industrial clusters in Asia use intermediate or primitive technologies for their production process. Environmental technologies for conversion of waste to energy, wastewater treatment and use of renewable materials have to spread easily among the companies to benefit the cluster as a whole. Both Thailand and Indian cases are found to have deficits and need serious intervention in this field in order to strengthen existing inter-firm networks. Their choice of technology depends on various factors such as affordability, availability and the growing need for transition. Research institutes that focus some of their research within the industrial cluster are helpful in assisting with eco-innovations and the diffusion of appropriate technologies within firms of a cluster.

Table 1: A comparative evaluation of key elements of prototype EICs

Key Factors	Countries and Industrial Clusters			
	Hosur India	Maniwa Japan	Chachoengsao Thailand	An Giang Viet Nam
	Sericulture	Wood	Rice	Fish
Small Business Growth	120	72	60	175
Nature of Market	Supply-led, mainly secondary towns	Demand-led, domestic	Demand-led, regional, passive exports	Demand-led, mainly export, limited domestic
Key Players	Producers & Development assistance policy	Lead firms & Environmental policy	Large firms & Social development policy	Foreign buyers & Industrial policy
Eco-clustering Activity	Resource recovery from disposed waste, installing biomass system for thermal application	Energy, ethanol, pellets and cat sand production from wood waste, carbon offset horticulture	Biomass power generation from rice husk and residues, biogas system for poultry and piggery waste	Biofuel from fish fat, use of scientifically made industrial fish feed and waste water treatment
Evidence of Inter-firm Networks	Extensive bilateral linkages	Extensive multilateral cooperation focussed on supply chain	Effective horizontal linkages	Extensive subcontracting
Key Benefits	Product/market diversification, employment	Zero-emission, eco-product development	Waste management, income generation	Improved water quality, employment generation
Role of Community & Support Institutions	Limited. Disabling labour market pooling	Significant. Positive intermediate input effects	Important. Potential for significant technology spill over	No local but some central institutions; Improved market access
Major Constraint	Social capital	Integrated policy	Enabling technology	Eco-market forces

(Source: IGES, 2007)

Social capital

“While the concept of mutual trust among competitors is not the norm among businesses, the evidence from the Japanese case indicate that similar relationships can be built through progressive action by community-based cluster players ...”

Well-established social networks and binding business relationships between cluster firms can greatly facilitate inter-firm collaboration as well as diffusion of new technologies. The Japanese wood industrial cluster serves as a good example, where high social capital that includes the relationships, attitudes and values governing the interactions among people, businesses and institutions, facilitated the sharing and development of ideas and pertinent market information thus reducing the transaction cost for businesses operating within the cluster. The creation of social capital in the sericulture industry in India would help the industry reach its full sustainability potential. While the concept of mutual trust among competitors is not the norm among businesses, the evidence from the Japanese case indicates that similar

relationships can be built through progressive action by community-based cluster players like local Non-Profit Organisations (NPO) or Self-Help Groups (SHG).

Eco-market forces

Market differentiation for green products is another viable business strategy for eco-industrial clusters, that is being exploited by Japan and Vietnamese clusters. Relying on the need for real innovation that lowers costs and improves output is an important aspect to invest in. In countries like Japan, venture capital is increasingly flowing to green start-ups and green technology based enterprises. But weak distribution systems and small markets are the constraints faced squarely by the proto-type clusters studied. The nature of eco-markets obviously poses a stiff challenge to the economic performance of industrial clusters. Some products coming out of industrial clusters are inferior in quality when compared to conventional ones for which demand can be expected to drop in the long run. Eco-products like bio-ethanol, natural cosmetics, rice bran oil and green energy have different markets in the urban centres, which need varying marketing strategies. The relationship between the production process and acceptable quality is another consideration in the green energy generation which the market always fails to recognise.

“The nature of eco-markets obviously poses a stiff challenge to the economic performance of industrial clusters.”

“... interaction between the local entrepreneurial attitudes and activities, and their characteristics, is an important starting point for the promotion of eco-industrial clusters in any region.”

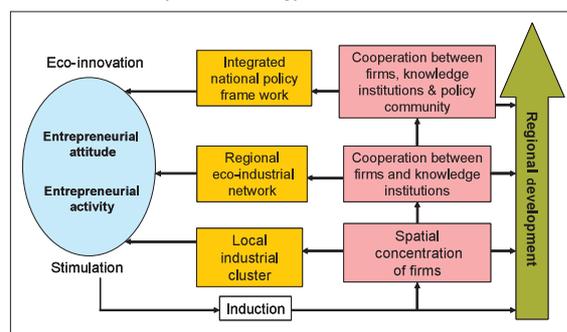
“A local industrial cluster is upgraded or transformed into an EIC through more organised cooperation or informal agreements between companies within clusters, stimulated by mutual trust, norms and community conventions ...”

How to promote eco-industrial clusters

There are many barriers such as search and transaction costs, information and infrastructure that hinder the spontaneous development of industries and hence the market alone cannot create EICs. Governments can address market failures by strengthening the micro-foundations of EICs through a coordinated system of approaches. Comparative evaluation of four prototype clusters demonstrates that this process would take place in three hierarchical steps as shown in Figure 2. The interaction between the local entrepreneurial attitudes and activities, and their characteristics, is an important starting point for the promotion of eco-industrial clusters in any region. These interactions would lead to a spatial concentration of firms that would in turn contribute to regional development. Local industrial clusters can also be classified into existing and emerging clusters. In some cases, existing clusters are easily identified, but in other instances they are less evident. Policy makers may need to work with other stakeholders to properly use cluster identification techniques. If a locality does not have a cluster, but does have resources, an explicit choice must be made regarding support to develop a new cluster. Examples of such programs include bio-technology cluster in U.K, food processing in Indonesia or Japan’s Industrial clusters. In doing so, it is important to target those firms that are isolated due to variations in markets, resources, manpower, technology and products.

Building cooperation among firms and between communities is the second essential step of eco-industrial cluster development. A local industrial cluster is upgraded or transformed into an EIC through more organised cooperation or informal agreements between companies within clusters, stimulated by mutual trust, norms and community conventions as well as through support from knowledge institutes. Thirdly, strong public policy support is needed at the national level to upgrade EICs into specialised eco-friendly economic zones. Integrated policies should aim to attract more businesses into the clusters and make them innovative in terms exploiting environmental linkages for regional economic growth.

Figure 2 : Hierarchical steps in EIC-based regional development strategy



Thirdly, strong public policy support is needed at the national level to upgrade EICs into specialised eco-friendly economic zones. Integrated policies should aim to attract more businesses into the clusters and make them innovative in terms exploiting environmental linkages for regional economic growth.

Policy implications and options for EIC based sustainable regional development

Eco-industrial clusters can become a promising tool to boost the competitiveness of companies. However, in order to be used as a model for sustainable regional development, they require strategic policy choices. In addition the nature of policy intervention very much depends on which type of industrial cluster, either emerging or existing, holds the greatest potential from an integrated environmental and economic stand point. As summarised in Table 2, public policy measures that can support EICs could originate from three main policy streams: industrial policy that inspires innovation and technology development; environmental policy that focuses on resource conservation and emission reduction, or regional development policy that seeks to stimulate necessary infrastructure investment.

Table 2 : Policy trends supporting EICs and regional innovation

Policy Stream	Cluster Focused Intervention	Relevance to Sustainable Development
Industrial Policy	Support for the common infrastructure needs of a group of small and medium companies	✓ Sound material flow across the cluster
	Incentives for insertion of green materials, products and services in local and global value chain	✓ Drives for eco-enterprise development
	Collaborative R&D investments to support commercialisation across sectors	✓ Increased community wealth through brand market creation
Environmental Policy	Umbrella permit for a group of firms operating within a cluster	✓ Improved environmental performance of companies
	Assistance targeted at cluster based firms for innovation by technology & knowledge transfer	✓ Decreased regulatory costs
	Consensus on cluster-wide environmental agenda and economic priorities by promotion of the idea of cooperation by bottom up approaches	✓ Increased responsiveness of local support institution for environmental actions
Regional Development Policy	Clusters targeted as drivers of competitive regions by increased use of untapped local resources	✓ Optimised use of local resources
	Create public-private partnerships to attract investment and employees	✓ Employment generation
	Engage the communities, producers and workers for collective action	✓ Increased social capital

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Private sector involvement in EIC creation during its initial stages also tends to concentrate in regions where adequate infrastructure is available. The permeation of private sector initiatives to inner regions, among new bio-resource sectors and more vulnerable communities tends to be slow unless accelerated by institutional and policy support. Therefore, creating synergies between key policy streams through regulatory and financial tools and avoiding policy conflicts are essential for EIC development.

Current institutional frameworks and policies that favour the development of EICs are fragmented and uncoordinated, not as a result of negligence, but rather due to inconsistent understanding on the presence and importance of industrial clusters. Since there are blurry distinctions among the objectives of sustainable development in different policy domains, a central level coordination is essential for inter-agency working groups that conceptualise, design and implement eco-industrial cluster development programmes. Moreover, the benefits of improved environmental and economic conditions must be weighed against the risks of a further concentration of inter-linked industrial activities that may accelerate the depletion of virgin resources.

In view of the above facts and trends, the following guidelines are drawn to promote eco-industrial clusters as a strategic approach for regional development:

- Countries should adjust their industrial policies to identify existing industrial clusters and strengthen inter-firm networks within them, no matter how nascent they are. Looking beyond urban-centred traditional manufacturing sectors and to have focus on new bio-based industries in urban-rural fringe areas will bring tangible economic benefits to those isolated inner regions.
- Technology providers should consider expanding the use of low cost and easy type technologies that convert waste into material and energy forms. Facilitating inter and intra-cluster relationships and if needed, international technology flow through agreements at different levels, is an important alternative form of cooperation, particularly when there is no business equity participation at cluster level.
- In order to attain full potential, environmental regulatory instruments need to foster a cluster-level entrepreneurial culture that is open to new ideas, that encourages mutual linkages and that raises prospects for cooperative actions in specific product value chains. There should also be equal promotion of eco-products coming out of clusters as with conventional sources which could be achieved by internalising the external costs of conventional products.
- Regional development policies must also adequately estimate the economic and environmental potential of cluster development based on factors such as area-specific advantages, infrastructure needs, and social capital creation. Moreover, such infrastructure should be created simultaneously with development of new industries, and not after environmental problems have built up, as was previously done in the past.

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