Eco-Industrial Clusters

A Prototype Training Manual

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Eco-Industrial Clusters

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Module 1: Overview

1.1 Background

1.1.1 Growing Industrial Clusters in Asia

Industrial clusters (IC), or geographical concentrations of firms and ancillary units engaged in the same sector, can generate a multitude of advantages for small firms—from agglomeration economies to the benefits of joint action with other companies in the cluster. The “industrial cluster development model” emphasizes internal linkages whereby cluster gains are furthered by local firm cooperation, local institutions, and local social capital. The growing evidence of small-firm industrial clusters in Asia competing in local and global markets has driven much of the policy enthusiasm for promoting cluster-based regional development.

Industrial clusters lend themselves to sustainable development—directly through economic development, incomes, and well-being generated for the working people; and indirectly, through their wider impact on the local economy and environmental conservation. Few cluster studies have explicitly addressed environmental concerns. There is substantial evidence that clusters not only generate employment and income for local people, but also contribute to national economic growth. The emergence of rust belts has signaled the end of a cycle of urban development for many mature industrial clusters, triggering the search for innovative business models and policies that can attract new industries and rejuvenate local economies.

1.1.2 The Allure of Eco-Industrial Clusters

Industrial clusters can be used as a fundamental organizing framework for understanding regional economies and for developing sustainable development strategies. In particular, their appeal derives from their attributes that can be grouped under the concepts of agglomeration economies when industrial ecology principles are integrated. In eco-industrial clusters (EIC), small producers advance their business by taking economic steps in coordination with others in the clusters in the pursuit of environmental causes. This allows small firms to survive and grow, thus raising incomes, brand value, and well-being. The gains that the clusters bring about in turn accelerate such positive outcomes. These local agglomeration economies and inter-firm networks are central to new growth, as well as to the environment and income of those engaged in clusters, from rural Japan to the urban informal sector of Thailand and to the export clusters of Viet Nam and Indonesia. Joint action is also important as can be seen for example when local producers were confronted with external market shocks in Sri Lanka and India. There is evidence that social capital, technology, and marketing strategies can augment economic and environmental capacities and the well-being of local people.

For these reasons, the nurturing of industrial clusters has become a focus of regional development, industrial, and environmental policies in the developing and developed economies of Asia. A cluster made up of a sufficient number of small firms and associated support services can be an innovative EIC to stimulate and sustain growth over time. And many local governments are eagerly experimenting with policies that foster the creation of EICs, either as a freestanding group or a cluster of companies that is pegged to an existing production base, resource use, and area of competency.
1.1.3 The Brilliance of Eco-Industrial Clusters

Eco-industrial clusters come in several different forms, and various authors have attempted typologies, but all clusters share several common features: they are composed of a multitude of firms of different sizes belonging to one branch of industry, they are broadly defined, and membership is open and elastic. The most successful existing eco-industrial clusters—and those with the best prospects of success—have distinct locational advantages, and such attributes are likely to be even more important for new clusters. The most promising and durable EICs can be found not in major urban centers or rural areas, but in the urban-rural fringe areas that have gathered strong economic momentum by combining economic legacies and resource endowment with good policies. In many countries, fiscal and administrative decentralization has pushed the focus of decision-making with respect to land use policy, industrial licensing, infrastructure development, and fiscal incentives to regional level decision-makers. These kinds of robust systems also create good opportunities for poorer, less industrialized regions to grow in a sustainable way. However, a joint approach by central, subnational, and private bodies is essential in any case, with national innovation systems providing a framework for the orchestration of a number of policy initiatives, ranging from education to infrastructure. Such an approach minimizes coordination failures and maximizes the objective functions of EICs.

1.2 An Introduction to the Training Manual

1.2.1 Objectives of the Training Course

This Prototype Training Manual is for use in training courses on EICs and is aimed at building the capacity of government officials, academia, and other non-governmental entities responsible for developing and implementing industrial cluster programs or projects. This is attempted by introducing the issues and opportunities for integrating industrial ecology and economic competitiveness into industrial cluster projects. The knowledge shared through this training will help participants better identify which kind of EIC strategy would result in the greatest benefits.

We expect participants in this training to have a basic knowledge of industrial cluster formation that prioritizes economic, environmental, and social aspects. The course also aims to raise the awareness of regional development experts about the role eco-industrial clusters can play in sustainable development, emphasizing the importance of adopting integrated industrial, environmental, and regional planning policies.

This training manual is based on the resource materials used at the Workshop on “Eco-Industrial Clusters: Policies and Challenges,” which was held at the Asian Development Bank Institute, Tokyo, Japan, 8–11 December 2009. The training program deals with the sustainability challenges faced by industrial clusters and the strategies for transforming industrial clusters into eco-friendly economic zones. The objective of the training manual is to provide a framework for discussing key issues of environmental and industrial change that lead to the formation of EICs.
On completion of the training course, it is expected that the participants will be able to
(i) demonstrate the economic and environmental merits of transforming small and medium enterprise (SME) clusters into eco-friendly economic zones;
(ii) identify policy constraints and formulate strategies for boosting cluster-based innovation systems;
(iii) identify successful examples of doing eco-businesses within industrial clusters; and
(iv) acquire leadership skills for inclusive and sustainable development of urban-rural fringe areas.

1.2.2 How This Manual Is Organized

The course is divided into six modules:

Module 1:
Presents the rationale behind the need to move from IC to EIC, summarizing the key terms and concepts related to EIC. The second part of this module presents the objectives of the training manual, its contents, and the proposed training schedule and structure.

Module 2:
Introduces the concept of industrial clusters as eco-friendly economic zones and demonstrates the strategic importance of EICs in national industrial development using case studies.

Module 3:
Summarizes the necessary framework conditions for strategies for EIC development under the following major topics:
- Improving environmental performance of industrial clusters
- Social capital creation
- Technological advancement
- Green financing concepts

Module 4:
Explains the operational aspects of an EIC from the perspectives of key stakeholders, namely:
- Policymakers
- Businesses
- Knowledge institutes

Module 5:
This concluding module presents:
- Need and identification of policies that incorporate EIC into national level development plans
- Identification of concerns arising at the national level and discussion of ways to promote EICs vis-a-vis national policymakers
Module 6:
Provided as an optional module. It is designed to recognize the importance of multiple simultaneous strategies of EIC formation.

1.2.3 Course Schedule

This course can be organized into different modules, as a series of thematic sessions:

(i) Plenary session—introducing the concepts and theories of industrial clustering;
(ii) Learning modules based on case studies, practical examples with worksheets;
(iii) Case studies to learn to understand the necessary and sufficient conditions for EIC formulation; and
(iv) Summary of the group discussions for developing credible EIC development strategies and leadership qualities.

This training program is designed with several thematic sessions distributed over four working days and a field visit to an eco-industrial development area. In each session, the resource person will present a short introductory lecture (maximum of one hour) based on the material presented in this training manual. If necessary, additional relevant case studies shall be introduced by the resource persons to share their knowledge, expertise, and experience. The training program will mainly adopt a problem-solving approach, where the trainees will be divided into groups to solve the case study-oriented problems listed in the work sheets. At the end of a session, each group will make a joint presentation.
### Topics

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<th>Day 1</th>
<th>Session 1: Industrial Clusters—Overview</th>
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<tr>
<td></td>
<td>The meaning of and need for EICs</td>
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<td></td>
<td>• What is the status of EICs and what are their local, regional, and national contributions?</td>
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<td>• If SME clusters exist in Asia, what are their shortfalls in environmental, economic, and social respects?</td>
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<td>• Industrial clusters and urban environmental issues</td>
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<td>• Economics of industrial clustering</td>
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<td>• Entrepreneurial dynamics of EICs</td>
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<td>• EIC formation process</td>
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<th>Day 3</th>
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<td>• Concept of environmental performance</td>
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<td>• Downstream pollution control trajectory/End-of-pipe pollution control—What is missing?</td>
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<td>• Upstream resource efficiency improvement—Cleaner production; industrial ecology; Reduce, Recycle, Reuse (3R) concepts</td>
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<td>• Importance of inter-firm networks and bonding relationships</td>
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<td>• Building sustainable resource recovery systems</td>
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<td>• Physical infrastructure and role of knowledge institutes, skills creation</td>
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<td>• Institutionalizing the informal sector—creating sustainable livelihoods</td>
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<td>• Designing technological management systems at cluster level</td>
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### Module/Duration

| Module 1 | 1 hour |
| Module 2 | 1-hour lecture, 1.5-hour group work |
| Module 3a| 1-hour lecture, 1.5-hour group work |
| Module 3b| 1-hour lecture, 1.5-hour group work |
| Module 3c| 1-hour lecture, 1.5-hour group work |
| Module 6 | 4 hours |
### Topics

#### Module 1

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<th>Topics</th>
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| **Session 7: Strategies That Work: Financing Eco-Initiatives in SME Clusters**  
  • Innovative financing models for industrial clusters  
  • Micro-financing for new businesses in industrial clusters  
  • Non-banking financial institution’s lending for industrial cluster development  
  • Banking sector’s interest in promoting social development through industrial clusters  
  • Project financing for industrial clusters | **Module 3d**  
  1-hour lecture  
  1.5-hour group work |

**Day 4**

| Session 8: Enabling Policy Environment | **Module 4a**  
  1-hour lecture  
  1.5-hour group work |
|----------------------------------------|------------------|
| • Overview of industrial, environmental, and resource conservation policies in Asia  
  • Policy innovation and integration as a driver for EICs  
  • Issues in formulating and reformulating policies  
  • Linkages and integration of socio-economic concerns in policies  
  • Sector and location-specific policies for industrial cluster development | |
| **Session 9: EIC as an Inclusive Business Development Model**  
  • Opportunities for business: Profitability and growth  
  • Opportunities for planners: Resource maximization  
  • Opportunities for the poor: Wealth creation and value addition  
  • Cracking the codes of success: Market orientation, product differentiation, supply chain management. | **Module 4b**  
  1-hour lecture  
  1.5-hour group work |
| **Session 10: Role of Knowledge Institutes in Promotion of EIC**  
  • Knowledge spillovers within EIC  
  • Impact of knowledge institutes on the growth of EICs  
  • Building multi-stakeholder cooperation | **Module 4c**  
  1-hour lecture  
  1.5-hour group work |
| **Closing-Panel Discussion: EIC Initiatives for a New Era**  
  • What are the policy priorities for local and national governments?  
  • How to remove market constraints?  
  • How to leverage the strengths of local resources?  
  • How to combine resources and capabilities with others?  
  • How to engage businesses in cluster initiatives?  
  • How to engage in policy dialogues with governments? | **Module 5**  
  1 hour |

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<th>Course Evolution</th>
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| • Defining next steps  
  • Overall evaluation |
1.2.4 Use of the Training Manual

The manual is aimed at conducting training on eco-industrial cluster formation at a regional level. It is intended to act primarily as a participant’s handbook during the delivery of the training course, as a companion document to the PowerPoint presentation, and a compilation of reading material for each of the training sessions.

In addition, it provides suggested approaches for the delivery of each session covering the key guidelines of the course, thereby functioning as a manual for the training of trainers.

The manual is structured into three main sections:

Section 1: Training Modules
Section 2: Case Studies and Worksheets
Section 3: References and Reading Materials

Section 1: Training Modules: This section forms the main body of the manual. It sets out the objectives, key concepts, and references for each session. The concepts are explained to the extent necessary for the purpose of this training course and this manual does not aim to provide a comprehensive explanation of the subject in question. The contents of the sessions are largely adapted from the regional training course being developed by ADBI and from existing literature and studies, and are to be used solely for training purposes.

Section 2: Case Studies and Worksheets: Wherever applicable, cases are provided to elaborate the key concepts the session aims to convey to participants. Case studies from Asian countries are used wherever possible as participants on the whole are from Asian countries.

Session delivery will consist of PowerPoint presentations and group exercises. The PowerPoint presentations for each of the sessions are not included in the printed version of the manual and can be found on the ADBI website. The worksheets and group exercises are provided in session 2. As both industrial clusters and eco-strategies are subjects involving a wide range of stakeholders and requiring a cross sectorial approach, it is highly recommended that, wherever possible, external resource persons are invited from national stakeholders and partner agencies to deliver the sessions. The session facilitator according to his or her need will adapt the module to the profile of the participants.

Section 3: References and Reading Materials: While the list of key concepts at the end of each session attempts to provide a brief summary of information available on the related subject, this section provides a compilation of several documents relevant to the module which aims to give participants a better understanding of the topic in question. The documents compiled range from theory to research to case studies.
Module 2: Eco-Industrial Clusters as Eco-Friendly Economic Zones

2.1 Introduction

The emerging economies of Asia are experiencing strong growth, accompanied by increased production and consumption. During the past three decades, growth rates in some Asian countries have increased sharply and it is estimated that emerging Asia's gross domestic product (GDP) will grow at an average rate of 5.4% between 2004 and 2030 (ADBI 2011). The region has made tremendous progress in terms of living standards. In pursuit of the Millennium Development Goals (MDGs), the majority of Asian countries have exceed expectations, particularly in terms of social indicators, eradicating extreme poverty, gender inequality and discrimination, improvements in education enrolment, and better access to safe water supplies, sanitation, and health care.

There is ample evidence to suggest that the regional economic development experienced in Asia is associated with the diffusion of industrial clusters in terms of productivity improvements and innovation. But industrial clusters can also be a source of environmental degradation, generating untreated waste discharges, airborne emissions, soil contamination, and depletion of natural resources. Industrial production exploits the environment as an unlimited source of raw materials, energy resources, and as a reservoir for industrial waste. As a consequence, industrial clusters in Asia are highly polluted, which has critical consequences for human health and natural ecosystems.

Policymakers in Asia need to move towards a more sustainable model that includes economic and social development strategies along with environmental protection principles. Adopting competitive and environmentally friendly approaches could be a crucial element of resources recovery and treatment of waste flows for the industrial clusters located in urban centers. Based on the concepts of industrial ecology and business competitiveness, industrial clusters could be transformed into EICs by adopting appropriate working strategies that reduce environmental impacts of current industrial activities within them. Alternatively, new industrial clusters could be formed in green sectors and isolated areas taking into account their economic advantages.

However, a number of difficulties have to be overcome, primarily related to disintegration of sectorial policies, insufficient involvement of key stakeholders, financial limitations, and lack of appropriate technologies and know-how. How can policymakers overcome such obstacles? What is the potential for transforming industrial clusters into eco-friendly economic zones in Asia? Which are the most successful examples found in Asian countries? Which actions and strategies can simultaneously achieve the greatest economic efficiency and sustainability? This session addresses such key questions and aims to provide an overview of resource recovery principles that lead to economic and social development and foment environmental protection. The analysis of case studies of EICs in Asian countries aims to provide an understanding of practical eco-industrial strategies.
2.2 Economics of Industrial Clusters in Context: Economics, Environment, and Local Wealth Creation

Porter (1989: 31) defined an industrial cluster as a “geographically proximate group of interconnected companies and associated institutions in a particular field, linked with commonalities and complementarities.” It is characterized by a social community of people and economic agents, including suppliers, service providers, and associated institutions, located in close proximity to each other in a specific geographic region, consisting mostly of small and medium enterprises (SMEs) that mainly use household labor (Anbumozhi et al. 2009).

The key benefits of industrial clusters can be summarized as follows:

(i) Promotion of national and regional economic development, as industrial clusters strengthen the capacity to generate employment and local wealth;
(ii) Poverty alleviation, as industrial clusters may empower specific oppressed groups in society, leading to a more equitable distribution of income;
(iii) Transition to a market economy by reinforcing the influence of the private sector and promotion of privatization;
(iv) Promotion of good governance, as industrial clusters encourage broad participation from the private sector, knowledge institutes, and local communities in the economic, political, and social activities of a country;
(v) Promotion of a more flexible, innovative, and competitive economic structure, as industrial clusters can easily adapt and adjust to market changes.

Typical cases of the industrial clusters’ influence on national and regional economic development can be found in the Philippines, where SMEs represent 99.6% of all businesses registered, employ 69.9% of the total labor force, and account for 32% of GDP (Leano 2006). Industrial clusters also play a significant role in the economy of the People’s Republic of China (PRC) and are key drivers for employment, economic growth, and development. In 2010, SMEs contributed 39.26% to the PRC’s GDP and 67.09% of its value-added, while employing 30.4% and 14.2% of the population in urban and rural areas, respectively, in the SME sector. Although there have been positive effects, ICs may also have a serious negative impact on the environment, if they are located in unsuitable inhabited areas (Shao et al. 2006).

For decades, concentrated industrial cluster activities have resulted in water and air quality degradation, and discharge of untreated sewage and hazardous wastes, as reported by the World Health Organization (WHO 2008). In the PRC, for instance, nearly 70% of all cities monitored did not meet national environmental air quality standards. Therefore, 75% of urban residents were regularly exposed to air considered to be unacceptably polluted.

Added to these concerns is the acceleration of natural resources consumption. Asian countries extract nearly half (48%) of the world’s resources, either for internal use or for export. This share is likely to rise due to population growth and an increasing rate of industrialization in emerging economies.
This unsustainable paradigm is in urgent need of being replaced with a more sustainable approach, based on a highly efficient use of resources and minimization of waste generation. Rather than following a linear material flow of production accompanied by increased resource use, firms should move towards an integrated system, where energy consumption and waste generation is reduced by reusing and recycling materials within the same firm or by other firms in the cluster, in a quasi-closed or, ideally, in a closed-loop system, as schematically shown in Figure 2.1. This could be made possible by applying industrial symbiosis principles and transforming industrial clusters into EICs.

2.3 Strategic Importance of Eco-Industrial Clusters

EICs are defined 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” (Anbumozhi et al. 2009: 4). Thus, the aim of EICs is to minimize the environmental impacts of industrial clusters and improve the effective share of resources in industrial clusters by facilitating and strengthening the interrelationships between components and elements of industrial and natural systems. It evaluates the merits of energy cascade systems and material close loops, while leading to inclusive and sustainable economic growth (Chiu and Yong 2004). While industrial clusters foster innovation and prioritize economic development and social capital creation, EICs essentially consist of clusters that operate with a higher degree of eco-efficiency making use of better management practices, technologies, and skills. Economic gains are therefore achieved through the reduction of natural resources and energy costs, waste management costs,
and conforming to environmental legislation. The green market potential may also present an opportunity for the industrial actors.

The “triple bottom line approach,” which aims to achieve a balance between environmental, economic, and social objectives, has become a source of direction and support for eco-industrial development (EID). The key to EID is to map the flow of resources (e.g., energy, material, and water) and non-products (e.g., waste and by-product). Two components make up EID according to Chiu (2009)—(i) primary (hardware), which deals with interactions like energy utilization, material flow, system design, and information management; and (ii) supportive (software), which focuses on the inter-relationship between elements in the industrial system such as multi-stakeholder participation.

One of the key concepts underlying EID is the inter-firm network that operates along the principles of optimized use of resources, promoting reduce-reuse-recycle (the 3Rs), and finding alternative utilization for waste materials, while cooperating with the local community. According to Chertow (2004), industrial ecology operates at three levels (Figure 2.2). Firstly, at the intra-firm level, it includes optimization of processes by adopting best available technologies to enhance efficiency of processes and recycling of waste flows. Secondly, at the inter-firm level, it involves the interaction of firms to promote energy cascading and sharing of material flows, in such a way that by-product outputs of one firm will be input for another firm’s processes. Finally, at the regional/global level, it refers to industrial metabolism and integration of actors’ efforts towards de-materialization and de-carbonization of industrial processes.

Geographically, EICs play a particularly relevant role in urban-rural fringe areas. In fact, urban-rural fringe areas are suitable for the implementation of EICs, as there would be benefits both in terms of environmental preservation and industrial competitiveness. On the one hand, urban areas are privileged by their higher consumption demand and the availability of large pools of human resources. But on the other hand, urban areas face limitations in terms of constraints on the availability of natural resources. Rural areas, by contrast, have abundant natural resources but not enough manpower, industries, or consumption demand. Therefore, fringe areas are ideally located to address the shortcomings of both rural and urban areas and take advantage of resources availability to meet consumption demands. An illustrative example of EICs’ new role in urban-rural fringe areas through forward and backward linkages is given in Figure 2.2.
2.4 Eco-Industrial Cluster Formation from the Bottom-Up Process Perspective

EIC formation varies across regions and sectors, depending on economic, social, local, and industry-specific conditions. Despite such heterogeneities, a standard combination of features has shown to catalyze the formation of EICs. Figure 2.3 shows the formation factors of an EIC as a series of three stages. In the early phase, the interaction between local entrepreneurial attitudes and activities and their characteristics are an important starting point for the evolution of SME clusters in any region. This leads to a spatial concentration of firms that maximize the use of local resources. Firms to be targeted include those previously operated in isolation owing to variations in markets, resources, manpower, technology, and products. Inter-firm networks and community collaboration are the second essential part of EIC development. A local SME cluster is upgraded or transformed into an EIC through more organized cooperation or informal agreements between companies and within clusters, stimulated by mutual trust, norms, and community conventions. Besides cooperation within firms, collaborations between clusters and other knowledge institutes, like local universities or research institutions and community-based organizations, help to develop enabling technologies and diffuse environmental market information. Key factors to promote inter-firm networks are trust building and constructive dialogue among industrial actors, transparent exchange of information, identification of common strategic development objectives, and their systematic implementation.

The third stage is dominated by a strong public-private partnership to upgrade EICs into specialized eco-friendly economic zones. Government should aim at public-private
partnerships that stimulate the propensity of the EIC as an innovative incubator space to start new firms and thus to enhance regional development. Affordable technologies and accessible infrastructure should be provided to attract companies to urban-rural fringe areas. For new companies to start in an EIC or for existing companies to relocate to an EIC has business advantages, such as proximity to transportation systems, easy procurement of raw materials, an abundant supply of labor, and easily accessible customers and markets. Through the analysis of case studies of successful examples of EIC in Asia, it appears that for SMEs to develop into eco-friendly economic zones, links with large firms, ties with external market agents, and the presence of local support institutions have been of great significance. National policies can also have a strong impact. The state’s role as a facilitator and an enabler for fully functional EICs cannot be underestimated in light of continuing technological, social, and policy constraints. Regardless of the origin or sector, however, the following characteristics are identified as key foundations of EICs:

(i) Inter-Firm Networks

Successful EICs are made up of enterprises that constantly seek inter-firm networks, not only to minimize waste and reduce pollution, but also to innovate continuously to improve zero emission processes and develop new eco-products.

(ii) Social Capital

Well-established social networks and a trusting relationship between cluster firms, academic institutions, and community-based organizations greatly facilitate inter-firm collaboration as well as diffusion of new technologies. The creation of social
capital through the formation of an eco-industrial cluster would help the industry reach its full potential. While the concept of mutual trust among competitors is not the norm among businesses, evidence suggests that it can be built through progressive action by community-based cluster players like local Non-Profit Organizations (NPO) or Self-Help Groups (SHG).

(iii) Enabling Technologies

It is not sufficient for individual companies to form inter-firm networks in order to become environmentally friendly; EICs also require a range of technologies available within their reach to be able to do so. 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.

(iv) Knowledge Institutes

Knowledge institutes, including universities and research centers, play an important role in supporting EICs through their contribution to innovation processes and local competitiveness. Knowledge institutes foster the capability of local firms to take up new technological and market knowledge and to apply it effectively in their industrial processes.

2.5 Entrepreneurial Dynamics in Eco-Industrial Clusters

Several factors contribute to the successful implementation of EICs. Its role depends upon the specific context industrial clusters are integrated in. Generally, stakeholders may be classified as being directly involved inside the industrial clusters or as outside entities that also contribute to the development of eco-friendly economic zones (Figure 2.4). The main actors relevant to the EIC include:
local and central governmental agencies, local communities, knowledge institutes, EIC members, EIC management organizations, and external businesses.

The above mix of actors reflects the capacities required to catalyze the shift towards EID. Motivated by economic and social interests, firms are key elements in adopting energy efficiency practices and adoption of measures to reduce waste generation. Nonetheless, local and central governmental agencies also play a significant role in initiating actions that promote and facilitate the implementation of EIC programs. For example, in Japan, central and local governments embrace the industrial ecology approach as a key pillar to achieving sustainable development. Furthermore, civil society and community-based organizations play a leading role in developing and initiating actions on several sustainable development issues that foment EICs. Social institutions, such as workers associations, can play a significant role in strengthening links with markets to reinforce trust between firms.

2.6  Case Studies

2.6.1  Case 1: Eco-Industrial Clusters for Resource Recovery: Wood Biomass Eco-Industrial Cluster (Maniwa, Japan)

The Maniwa wood biomass industrial cluster is a typical example of a bottom-up approach that resulted in a successful EIC. Maniwa town is located in Okayama Prefecture, in the western part of Japan. Its economic activities are based primarily on the wood industry. 80% of Maniwa town is forestland and it has a population of 37,000, 34 small and medium-sized timber factories, 16 dry wood factories, and furniture makers. Despite the effective interaction between the SME factories and economic prosperity, two constraints threatened the future of the industrial cluster. Firstly, an exodus of young people who seek employment, education, and training in larger urban centers, has resulted in skilled manpower losses. Secondly, in 2002, the Government of Japan introduced a biomass waste treatment law (“Dioxin Law”) that limited the burning of wood waste in open spaces. It meant that wood waste had to be disposed of in landfills, which involved high transaction costs. Presented with these new circumstances, the challenge for the local community was to create an economically resilient waste disposal and conversion system. Promoted by a strong alliance between local community, wood industries, knowledge institutes, and local government, the wood cluster was reinvented and new inter-linkages between industries were introduced. Four different innovative streams transformed the Maniwa industrial cluster into an EIC:

(i)  Power generation from wood waste;
(ii) Conversion of wood biomass into pellets;
(iii) Second generation ethanol production from wood biomass; and
(iv) Utilization of wood waste for construction (a series of new eco-products were developed from these inter-linkages, including lignin, plaster, polyactic acid, ethanol/fuel, and binder molding).

The crucial component for such cooperation was believed to be social capital, which is to be retained and augmented: local community culture, openness to new
ideas, and flexibility of permitting easy entry of firms, local leadership, deliberate cooperation, and joint actions by cluster members to identify common problems, and find and implement common solutions. This was done under the stewardship of a group called the 21st Century Maniwa, which was concerned about the future of the cluster. It performed the role of a catalyst to network and connect the region to the outside market through symposiums and seeking alliances.

Another catalytic factor is related to the introduction of the Dioxin Law, which forced the cluster to be innovative and to reconsider the past practice of incinerating wood waste. Simultaneously, there was greater coordination and mutual support among the ministries: the Ministry of Industry supported by the Japan Development Bank (JDB) funded SMEs in the agriculture and forestry industries, while New Energy and Industrial Technology Development Organization (NEDO) provided funding for research and development, and the Ministry of Education fostered alliances of universities with businesses for eco-innovations. At the sub-regional level, Okayama Prefecture created a customer niche market to support eco-products from the cluster to be promoted through the Maniwa NPO as part of their Eco-vision 2010.

The case of the Maniwa wood biomass industrial cluster shows that stimulating community-based actions, providing enabling technologies, and creating social

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**Fig.2.5: Present Status of Inter-Firm Networks and Biomass Flow Pattern in Maniwa**

Source: Authors.
capital and policy integration are the pillars for the effective conversion of biomass waste into wealth creation (Anbumozhi et al. 2010). This is illustrated in Figure 2.5.

2.6.2 Case 2: Policy Support for Successful Eco-Industrial Clusters: Biotech Cluster (Bangalore, India)

A biotech cluster was developed following a policy-oriented approach, as public policies provided major contributions to the creation of the agglomerations of biotechnological firms in Bangalore.

The central government established a variety of top-down policies to foster the implementation of industrial clusters in the region, including the State Industrial Policy 2006–2011 and the New Karnataka State Industrial Policy 2009–2014. Apart from national policy, the state government has also been crucial in developing this cluster. The state’s Millennium Biotech Policy set out a vision to be a leader in bio-industries through agglomeration economies and has set up specific infrastructure for the development of biotechnology by developing biotech corridors. These policies proactively targeted facilitating private investment and infrastructure implementation and operation. The government works with industry associations in an effort to ensure policy reflects the combined viewpoints of the private and the public sector in these areas.

The biotech cluster in Bangalore is based on an association of hospitals, agricultural businesses, information technology (IT) and other manufacturing industries, universities, research institutes, and government agencies. It resulted in a diamond of economies of scale and environmental conservation with: context (policy, infrastructure, etc.); factor input conditions (natural resources, human resources, research and development [R&D], etc.); related and supporting industries (information technology [IT], logistics); and demand conditions (market) as the four vertexes (Fig 2.6).
A large number of external factors have contributed to the evolution and growth of the cluster, such as human resources, capital availability, and physical infrastructures. Moreover, external actors—including universities and research centers, government agencies, and suppliers—play an important role in promoting industrial symbiosis in the Biotech Park.
2.7 Epilogue

EICs tend to arise naturally, driven by the market’s competitive pressures. Nevertheless, there is a need for an overall framework to regulate and foment the creation of EICs. Owing to the vast geographic range of SMEs, governments at all levels should be involved, which, in some cases, may lead to conflicting policies and contradictory signals to the industrial sector. Thus, policies need to holistically address stimulus and directions to all stakeholders involved in EICs. At the central level, inter-ministerial committees need to define coordinating strategies and to create a suitable environment to enable the dialogue between actors directly involved in industrial development. At the initial stage of implementation, governments may play a leading role, whereas in the final stages, the government may assume a lower profile. If correctly implemented, a set of policy agendas could reinforce the local advantages of SME clusters, as follows:

1) Look at SME clusters as a new market-based integrated environmental and economic approach to sustainable regional development that spells out new roles for governments, businesses, community-based organizations, and knowledge institutes. In this context, promoting eco-initiatives within SME clusters has greater potential for sustainable development than other, well-intentioned but often isolated environmental approaches with little social impact.

2) Undertake joint efforts that cut across sectorial policies and transcend the boundaries of established departments in different tiers of governments to unleash the sustainability potentials of SME clusters. EICs as a sustainable development model can rise or fall based on the same weakness as other models. Identify existing SME clusters in urban-rural fringe areas and strengthen inter-firm networks within them, however nascent they may be. Look beyond urban centered manufacturing sectors such as metal processing, textiles, chemicals, etc. Private sector involvement in eco-initiatives, during their initial stages, tends to concentrate in urban areas where adequate infrastructure is available. The permeation of private sector initiative to rural regions and among weaker and more vulnerable sections can tend to be slow or lacking unless the process is accelerated or encouraged through promotional and institutional support and financial incentives. In most of developing Asia, unless comprehensive promotional and institutional support is provided, EIC development in urban-rural fringe areas will be very slow.

3) Estimate the potentials of EIC development based on factors such as locational advantages, cultural specificities, infrastructure needs, entrepreneurship skills, intended social benefits, etc. Target new regulatory instruments and incentive mechanisms and loosen bureaucratic procedures to foster an entrepreneurial culture that is open to new ideas; encourage backward and forward economic linkages; and raise prospects for cooperative environmental actions in the value chain.

4) Invest in improving environmental monitoring systems and environmental impact assessment methods at cluster level to unlock the full potentials of industrial clusters and avoid negative impacts. This is especially relevant in the vast, but currently little monitored, SME clusters in Asia.
5) Facilitate eco-technology flows into SME clusters through agreements at different level as an important alternative form of international cooperation, particularly when there is no business equity participation at cluster level. For this purpose, create an effective system of information on alternative technologies at cluster level if necessary, together with information on terms and conditions in various types of contracts.

6) Support local knowledge institutes and community-based organizations to provide a wide range of services that diffuse technologies, dissipate market information, and foster innovation inside clusters. Use local governments to improve social capital through such support interventions.

7) Work with business associations to create a macro-economic framework that provides incentive structures for small business to operate in the cluster on fair terms. Generalist financial support programs to individual companies within a cluster tend to have only limited impact. Aim policy interventions at groups of SMEs around joint projects. Give priority access to limited available finance to innovative clusters based on environmental and economic performance benchmarking.
Annex I:
Eco-Industrial Clusters as Eco-Friendly Economic Zones

Worksheet

Learning Objectives:
After completing this session you should be able to:
• Define key concepts of EICs
• With other participants, establish a common understanding on framework conditions for EIC formation

Workshop Duration:
1.5 hours [Study Time—45 minutes; Group Discussion—45 minutes]

1. Industrial clusters are associated with economic and regional development in Asian countries, as agglomeration economies favor innovation and help firms to compete globally. What are the major advantages of industrial clusters? How can these benefits promote economic growth and wealth creation?

2. Industrial clusters are commonly linked with air pollution, contamination of water streams, generation of waste, and depletion of natural resources, which contribute to the degradation of the environment. In this context, EICs emerge as an attractive alternative to promote the triple benefits of sustainability by balancing economic, social, and environmental priorities. What are the main differences between ICs and EICs? What are the principles behind EICs?
3. The local environment surrounding EICs enhances and facilitates growth at the region-cluster level. Commonly, rural fringe areas have certain advantages in terms of economic and social development. Which are the factors that promote the competitiveness of rural fringe areas?

4. ICs often fail to take sufficient advantage of the synergetic possibilities offered by geographic proximity. Thus, the challenge is to engage traditionally separated industries in a collective bottom-up approach and to promote the exchange of physical materials. What are the three stages for EIC formation? What are the formation factors that foster EIC?

5. The external and internal linkages and interaction between industrial actors and other relevant stakeholders are important factors for EIC. Who are the stakeholders involved in the EIC? What are their roles in terms of fomenting the EIC?

6. Although a bottom-up approach is considered to be the preferred strategy to promote the creation of EICs, government intervention is needed to stimulate industries to be environmentally friendly. How should policy intervention be channeled to guide stakeholders rather than impose normative directives?
7. Referring to the case study of the wood-based EIC in Maniwa, four innovative components—(i) power generation from wood waste, (ii) conversion of woody biomass into pellets, (iii) second generation ethanol production from wood biomass, and (iv) utilization of wood waste for construction—were essential for promoting industrial cluster sustainability by converting biomass waste into potential energy resources. In your opinion, how did these new material flows emerge? How was the knowledge transfer conducted among the firms? What is the contribution of inter-firm networking to materials closed loops promotion?

8. Fragile supply chains and market price fluctuations are the main constraints of the EIC in Maniwa. Which strategies should be implemented to minimize material flow fluctuations? What is the role of social capital in promoting stable input material flows and stable market prices?

9. Green taxes have been widely discussed among policymakers as an effective tool to promote eco-product market competition. The biomass-based EIC in Maniwa would get concrete benefits from the implementation of green taxes, since it would increase the competitiveness of and demand for eco products. Do you believe this strategy is effective in promoting EIC? If so, state your arguments. What is the role of social capital for the success of this type of fiscal incentive?

10. With regard to the Biotech cluster in Bangalore, India, environmental challenges need to be overcome, mainly with regard to air and water pollution, and waste management. While larger companies have already accomplished this in adhering to international environmental protection standards, smaller firms are struggling with solid waste and water effluent
treatment. If you were a local governmental official in the State, what strategies would you like to implement to guarantee all companies in the cluster comply with the environmental quality regulations?

References and Reading Materials


Module 3: Strategies for Eco-Industrial Cluster Development: Necessary Framework Conditions

3.1 Introduction

The goal of EICs—communities of business; geographic concentrations of interconnected companies sharing resources and technologies—is to improve environmental quality, economic gains, and social capital building, benefitting both the business community and the local community. To achieve this, an EIC requires integrated tools and strategies that consider design and production processes, developing products that increase resource efficiency, and lower economic and environmental costs.

Successful EICs are made up of enterprises that constantly seek inter-firm networks. EICs also require a range of innovative technologies to be available within reach to achieve better environmental performance without compromising economic benefits. Well-established social networks with academic institutions and community-based organizations are also required to facilitate inter-firm collaboration as well as diffusion of new technologies in the EICs. Building linkages, not only business-to-business, but also business-to-government, and, more importantly, business-to-community to facilitate the exchange and sharing of materials, resources, information, industrial services-energy, water, pollution control equipment, and engaging the local people and delivering benefits to them, is an integral part of an EIC’s strategic interventions. Social capital building thus becomes an important domain of EICs. Financing is amongst the most important strategies that need to be taken care of when planning EICs.

In short, a successful EIC has an environmental face, an economic doctrine, and a social dimension. Module 3 presents four main strategies for transforming a conglomeration of small and medium-sized industries into an eco-industrial cluster: environmental performances, technology advancement, social capital building, and financing. The module presents key concepts and case study examples to explain each of these strategies. The questions and worksheet at the end of the session provide working exercises for the course participants.
Module 3a: Environmental Performance of Eco-Industrial Clusters

Environmental performance is the relationship between an organization and its impact on its natural environment, including the effects of resource consumption, the process of recovery, the processing of products, and meeting the environmental requirements of the law. In short, environmental performance = upstream resource efficiency + downstream pollution control.

3.a.1 Key Concepts: Why and How to Achieve Environmental Performance?

To gauge the success of an EIC, measuring and improving its environmental performance becomes an important strategy. Environmental performance measurement of an EIC is a two-fold process:

(a) Establish how constituent firms use raw materials and energy resources, and

(b) Measure waste and pollution (air, water, soil) that arise from the production process.

Hence, improving the environmental performance of EICs includes not only treatment of pollution, but also optimization of resource inputs by fine-tuning material flows. For example, instead of heavy reliance on end-of-pipe (EoP) technology for downstream waste or pollution treatment, gaining upstream resource efficiency is the system approach followed by EICs to achieve improved environmental performance. Figure 3a.1 below explains such a macro environmental approach to industrial ecology within an EIC.

Fig. 3a.1: System Approach of an Eco-Industrial Cluster
Source: Authors.
Industrial activities should be continuously monitored and evaluated to improve their environmental performance. National laws and regulations require companies to comply with the pollution standards. EoP treatment is usually chosen by companies to comply with administrative regulations and requirements. Figure 3a.2 explains the EoP strategy. EoP only focuses on meeting the standards; it does not explore possible opportunities for technology improvements and achieving higher environmental performance.

Besides meeting the administrative regulations, businesses and industries have a larger role to play. This understanding is reflected in their shift towards adopting corporate, social, and environmental management strategies, rather than merely meeting the national pollution standards. Small and medium-sized industries are also adopting various means, within their constrained resources, to protect the environment. However, most environmental protection measures have always been directed towards EoP treatment solutions, which handle the waste after it is generated. EoP treatment only allows industries to take a corrective approach, rather than a preventive approach, to eliminating waste being produced. Thus, these types of industrial production practices are unsustainable and unprofitable in the long run.

**What is end–of–pipe treatment?**

Traditional method to control pollution or disposal of waste wherein the quantity of waste disposed to the external system is cut down

- Corrective approach, does not focus on pollution prevention
- No waste utilization

![Fig.3a.2: End-of-Pipe Treatment](image)

Source: Authors.

### 3.a.1.2 Upstream Resource Efficiency

Contrary to downstream pollution control, upstream resource efficiency lowers material inflows into the production system by careful design of production processes and products. Also, instead of disposing of the waste produced, waste
and by-products are used as resources or raw materials for secondary industries. Environmental performance and benchmarking are also adopted to improve industrial competitiveness through efficient use of resources, and reusing waste. Companies tend to be interested in meeting environmental standards by adopting only the cheapest possible means. The social, environmental, and micro-economic benefits of poverty alleviation and job creation have yet to be integrated into their strategic thinking. So far, companies have typically failed to improve upstream resource utilization and mostly focused on downstream pollution control.

Upstream resource efficiency breaks the linear flow of material into the cyclic pattern by recovering and recycling waste. This can be achieved through Reduce, Reuse, Recycle (3R) technologies and cleaner production practices. Using these tools is possible and achievable in EICs through inter-firm networks.

3.a.1.3 Reduce, Reuse, and Recycle

Upstream resource efficiency can be achieved through implementation of the 3Rs—reduce, reuse, and recycle. The definitions of the 3Rs are depicted in Figure 3a.3.

![Figure 3a.3: Principles of the 3Rs (Reduce, Reuse, Recycle)](image)

The first R—reduce—helps to phase out waste before it is created, and hence further resource extraction is reduced and energy is saved in the production processes. Reuse is the second step of the 3Rs. It does not work in equal capacity in every society, but in low-income countries reuse of commodities is a traditional practice. Reuse is preferable to dumping. However, the focus is on the third R—recycling, which means recyclable materials from the waste streams are used, keeping the material resources in a cyclical pattern, thereby avoiding extraction of virgin raw materials.
3.a.1.4 Cleaner Production

Cleaner production (CP) is another approach to achieving successful upstream resource efficiency. Compared with the EoP approach, CP offers a longer-term solution to increasing environmental performance by saving energy and materials as well as producing less waste and emitting lower levels of pollutants into the environment. Hence, CP is a preventive measure, while EoP is a corrective measure. EoP is generally for compliance with national pollution standards, whereas CP involves innovative technologies to realize the benefits of increased environmental performance along with other economic and social benefits.

Implementing cleaner production, on the one hand, can be a straightforward approach of adopting better housekeeping practices to prevent pollution. On the other hand, the cleaner production approach also involves rethinking products, product components, and production processes to achieve sustainable production. Hence, cleaner production is about system re-engineering to achieve resource optimization, but in a linear production system. Cleaner production measures include: process modification, technology modification, modification of end product design, input material, and reusing material on the site through resource recycling.

A Norwegian pulp and paper plant cluster has adopted approaches shown in Table 3a.1 to increase environmental performance:

<table>
<thead>
<tr>
<th>Approach</th>
<th>Measure</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilution</td>
<td>Build a 23 km long pipe, 1.3 m in diameter</td>
<td>NKr 100 million</td>
</tr>
<tr>
<td>Pollution control</td>
<td>Build a waste water treatment plant</td>
<td>NKr 32 million and an operating cost of NKr 8 million/year</td>
</tr>
<tr>
<td>Prevention</td>
<td>Incorporate a series of procedural and technical changes within the facility</td>
<td>NKr 10 million Plus saved: • NKr 5 million/year on chemicals • NKr 10 million/year on energy • NKr 8 million/year due to increased productivity</td>
</tr>
</tbody>
</table>

NKr: Norwegian kroner
The approaches involved both process modification and equipment modification. Equipment modification involved changing from Conventional Jet Dyeing machines to Advanced Jet Dyeing machines (figure 3a.4 below). This equipment modification resulted in an exceptional improvement in performance:

- 33% reduction in greenhouse gas (GHG) emissions or air pollutants;
- 55% reduction in water consumption.

Conventional Jet Dyeing machines used 1,480 kg/batch of steam, 4,191 MJ/batch of energy input, and 67 m³/batch of water for dyeing with 396 t CO₂ per/batch produced, whereas the Advanced Jet dyeing machine used only 980 kg/batch of steam with a total energy input of 2794 MJ/batch and 30.4 m³/batch of water for dyeing and producing only 264 t CO₂ per/batch.

Figure 3a.5 below is the modification of the entire process of rinsing in an electroplating plant. The figure below presents the effect of rinse water consumption by the use of intermediate static rinse baths to achieve an equivalent degree of rinsing.
3.2 Increasing Environmental Performance through Industrial Networking

EICs create an environment for multiple industries to integrate and achieve resource efficiency and resource recycles through inter-firms partnerships and collaboration. Achieving economic efficiency with EICs goes beyond conventional downstream pollution control towards upstream resource efficiency. Pollution issues in an EIC are considered from “cumulative effect” perspectives. Since an EIC is an inter-firm network of similar industrial operations (inter-related field of businesses), it works for pollution control as a collective approach. The cumulative pollution effect works on the basic understanding that the cluster faces common environmental problems. Figure 3a.6 presents the factors favoring better environmental performance in clusters.

Pollution problems need to be solved collectively, with members considering the core values of EICs. This collectiveness is possible only if the interrelated businesses are open to innovative management and technological measures. Inter-firm connectedness works collectively to fight the pollution through waste exchange, technology sharing, or common waste treatment plants, etc. Such collective collaboration to fight pollution is very different from the stand-alone pollution control approach of a scattered industry. In a scattered industrial operation, pollution from a single industry can usually be easily ignored as the quantity of pollutants or waste generated is smaller. But this is not possible in an industrial cluster, where the collective pollutants/waste volume is larger. A cluster approach to pollution control is preferable and more economical as there would be waste exchange (someone’s waste is another’s resources) and resource and technology exchange among industries. Establishing a centralized wastewater treatment plant, for instance, lowers the pollution abatement costs.

![Fig.3a.6: Factors Favoring Better Environmental Performance in Clusters](image)
Table 3a.2 is a comparison of pollution control in a cluster versus scattered industries.

Table 3a.2: Pollution Control in a Cluster Versus Scattered Industries

<table>
<thead>
<tr>
<th>Individual firm approach to pollution control</th>
<th>Industrial cluster approach to pollution control</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pollution volume is less and the tendency of ignorance is higher.</td>
<td>• Larger pollution volume hence ignorance is not possible. Pollution control measures are deployed.</td>
</tr>
<tr>
<td>• Pollution abatement is done to comply with administrative requirements. Minimum pollution standards are met; hence there are no opportunities for innovation and furthering zero waste policies.</td>
<td>• Pollution abatement is practiced beyond the level necessary to meet national pollution standards; innovations are put into practice to achieve zero waste policies.</td>
</tr>
<tr>
<td>• End of Pipe (EoP) is practiced to deal with waste already produced.</td>
<td>• Upstream resource utilization is targeted to reduce pollution output. 3R and CPs are the strategies applied.</td>
</tr>
<tr>
<td>• Cost of pollution abatement is higher as only one industry is responsible for investing in equipment and technologies. Thus the chances of buying low cost and low efficiency equipment are high.</td>
<td>• Cost of pollution abatement is shared among the clusters and hence the cost becomes lower. Innovative and high-tech equipment can be installed favoring technology advancement.</td>
</tr>
<tr>
<td>• Small and scattered industries make it difficult for the national/local administration difficult to monitor the pollution control activities; hence it acts as a loophole, whereby industries try to avoid environmental compliance.</td>
<td>• Clusters make it easy for the policy control administration to monitor environmental performance compliance.</td>
</tr>
</tbody>
</table>

Source: Authors.
3.a.3 Tools for Measuring Environmental Performance

An environmental management system (EMS) is a tool to monitor, report, and verify the environmental performance of firms, individually and collectively, at the cluster level. An EMS is a planned and coordinated set of management actions, operating procedures, documentation, and record-keeping, implemented by a specific organizational structure with defined responsibility, accountability and resources, and aimed at preventing adverse environmental effects as well as promoting actions and activities that preserve and/or enhance environmental quality.

(a) Recognizing material flow analysis in legislation and/or as standardizing environmental norms (e.g., ISO 14,000) could be effective tools for industries to be aware of their environmental performance. Creative solutions are needed to motivate SMEs to adhere to environmental standards and move beyond resource utilization, and EICs are a good starting point.

(b) In the EMS, apart from downstream pollution control, the possibility to improve legislation to monitor and enforce upstream resource utilization has to be included. Singapore has a strong 3R concept integrated into policy, involving carrying out and monitoring a waste resource audit.

(c) Business performance ratings, through color-coding, were introduced in Indonesia as a way of empowering the local community to rank companies’ environmental performance. Since 1995, the government of Indonesia through Proper Prokasih Index Indonesia (PROPER—Program Penilaian Peringkat Kerja Perusahaan dalam Lingkungan Hidup, Evaluation Program on Corporate Performance Rating of Living Environment), evaluates the environmental performances of industries and ranks them in the order of gold, green, blue, red, and black. A gold rank means zero emission production, whereas a black rank means the business activity is not making environmental efforts and has a negative impact on the environment.

Policy intervention that could facilitate business participation and stakeholder involvement should be carried out to promote EMS in EICs.

3.a.4 Case Studies

A. An Individual Industry Initiative: Reuse—A Shoe Recycling Program by Nike, Inc.

Nike, Inc. is a major publicly traded sportswear and equipment supplier based in the United States. It is the world’s leading supplier of athletic shoes and apparel and a major manufacturer of sports equipment. In 2006, Nike created a business model to stabilize the market for granulated rubber from footwear manufacturing through its Reuse-a-Shoe recycling program. The model resulted in more than 1.2 million kg of rubber going into useful products and Nike has processed more than 25 million pairs of used, counterfeit, and defective shoes. This has helped to construct more than 210 sport surfaces in communities around the world. Reuse-A-Shoe collects old shoes returned by customers at Nike stores and other venues and transfers them to one of the processing facilities. The old shoes are sorted for the recycling process, with the bottom parts of the shoes separated and grinded...
to produce a material called Nike Grind that is subsequently used to produce sport surfaces like tracks and playgrounds. Without this initiative old shoes would end up in landfills or dumpsites causing environmental problems. The program also has extra benefits such as new business creation, job opportunities, better environmental performance, and waste and resource utilization (Figure 3a.7).

What are the possible benefits and costs in the above example?

- Continuous environmental performance improvement
- Reduced waste and better resource use
- Increased protection of natural eco-system
- More efficient use of natural resources
- New employment and poverty reduction
- Expanded business opportunities
- Boost to the economy

**B. An Eco-Industrial Cluster Initiative: Case of Agro-Industry Cluster, Sri Lanka**

Industrial Networking for Waste Management—Paddy, Fruits, and Vegetable Cluster in Dambulla Dedicated Economic Centre (DDEC) Sri Lanka. Dambulla city is situated in the northern part of the central province of Sri Lanka. The location of Dambulla city is strategically important for the collection and distribution of agricultural produce. Recognizing this potential, the DDEC was established in 1998 to provide a wholesale market for vegetables and fruits cultivated in the rural areas, thus serving as the hub of all agriculture-based economic activities in the region. Nearly
180 wholesale dealers, 23 rice-processing mills, and 20 warehouses operate in and around DDEC. Post-harvest losses in vegetables and fruits vary between 30% and 40% of the total production and occur either in the field or during transportation and marketing. Moreover, vegetables that rot between harvest and reaching the market also contribute enormous quantities of waste. The DDEC is closely connected to the livelihood of the farmers and has a socio-economic bearing. A waste-to-energy plant consuming the organic waste would reduce the environmental threat resulting from illegal waste disposal. Reflecting experiences elsewhere, anaerobic digestion is a lucrative option for a waste-to-energy plant, giving farmers the option to sell waste vegetables providing them with a source of income.

The material flow in Figure 3a.8 shows the potential pathways of industrial networking in DDEC.

![Figure 3a.8: Quantitative Material Flows and Networks in the Dambulla Cluster](image)

**Figure 3a.8: Quantitative Material Flows and Networks in the Dambulla Cluster**

*Source: Authors.*

Eco-industrial clustering principles bringing together all the producers and industries in the region would help eliminate the threats to sustainable development. Table 3a.3 gives a SWOP analysis of such an industrial network:
### SWOP Analysis of the Dambulla Agro-Industrial Cluster

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Well-developed economic center (the biggest in Sri Lanka) for agricultural products in Dambulla</td>
<td>• Lack of proper infrastructure such as a well-developed road network</td>
</tr>
<tr>
<td>• Centralized location: connectivity to major cities, ports, and local markets</td>
<td>• Wastage due to poor post-harvest technology and poor storage facilities</td>
</tr>
<tr>
<td>• Irrigation network</td>
<td>• Lack of awareness of recycling and resource recovery in agro-products</td>
</tr>
<tr>
<td>• Fertile flat land suited for agriculture</td>
<td>• Poor waste management and indiscriminate disposal of agriculture residue</td>
</tr>
<tr>
<td>• Ample land availability</td>
<td>• Poor pollution control</td>
</tr>
<tr>
<td>• Market for paddy husk for power generation</td>
<td>• Lack of necessary infrastructure such as industries</td>
</tr>
<tr>
<td>• Inflow of people</td>
<td>• Variable market prices—no preservation or storage facilities</td>
</tr>
<tr>
<td>• Very high waste generation</td>
<td>• More waste produced during low price periods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Potentials</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Establish collection centers</td>
<td>• Establishment of new industrial estates</td>
</tr>
<tr>
<td>• Facilities for storage and processing of vegetables and fruits</td>
<td>• Seed packing, processing, and canning of food products</td>
</tr>
<tr>
<td>• Invest in medium to large-scale industries to process agro-products. This will give good market prices to farmers and reduce waste</td>
<td>• Organic farming practices—composting paddy straw, etc.</td>
</tr>
<tr>
<td>• Need for efficient and cost-effective solid waste treatment and management programs</td>
<td>• Introduction of modern, eco-friendly technologies in agro-product processing</td>
</tr>
<tr>
<td>• Waste-to-energy plant relying on agro-waste and residues</td>
<td>• Introduction of vegetable and fruit preservation techniques</td>
</tr>
<tr>
<td>• Clean Development Mechanism (CDM) project on large-scale methane reduction from agro-waste</td>
<td>• Environmentally-friendly business practices in agriculture waste management</td>
</tr>
<tr>
<td></td>
<td>• Infrastructure development</td>
</tr>
</tbody>
</table>

Source: Authors.
Annex II:
Strategies That Work: Environmental Performance of Eco-Industrial Clusters

Worksheet

Learning Objectives:
On completion of this exercise you will be in a position to understand what environmental performance should comprise of. You will be able to appreciate how current approaches have to be shifted to ensure improved environmental performance.

You are leading a team made up of a policymaker, a representative from a local community-based organization, and a representative of a small industry association. The cluster employs hundreds of local people. Figure 3a.9 explains the process of producing desiccated coconuts including the intermediate processes of de-husking and de-shelling. These processes produce various by-products and waste, leaving scope for reusing the water, husk, shell, and other materials to produce other products in an EIC. The objective of the team is to report on the environmental performance of a Coconut Processing Cluster. Your task is to think of ways to improve the environmental performance of the EIC through upstream resource efficiency with inter-firm collaboration. Think in terms of potential industries (such as beverage, charcoal, coil fiber, and vinegar) in the region to share the waste by-products, infrastructure, and knowledge, etc.) to increase the environmental performance of the cluster while generating multiple socio-economic and environmental benefits.

Fig. 3a.9: Production Process of Desiccated Coconut
Source: Authors.
Workshop Duration:

1.5 hours [Study Time—45 minutes; Group Discussion—45 minutes]

1. Cleaner Production (CP) and end-of-pipe (EoP) technology are two types of strategies for pollution prevention. Provide an example of each and compare it with an EIC approach.

2. You have seen the case of Nike shoes. Under the business-as-usual (BAU) scenario all factory waste is moved to a landfill or dumpsite. Trace the value chain and list the businesses and jobs the Reuse-a-Shoe scheme has created compared with BAU practice.

3. What type of administrative, management, and legal tools are used in your country to assess the environmental performance of an industrial sector? What is the level of importance given to SMEs in these tools? And are cumulative effects of pollution considered in these tools?
4. Effluent and discharge standards dominate environmental performance assessment. 3Rs—Reduce, Reuse, and Recycle, and sustainable consumption and production are equally important to improve environmental performance. Do you agree? What policy instruments do you think are required to enhance environmental performance of clusters beyond meeting the pollution standards? List the broad steps to be taken to assess and improve environmental performance of industrial clusters.

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5. What tools will your team use to assess environmental performance? Are cumulative effects of pollution considered in these tools?

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6. Considering the potential for EIC formation in the coconut sub-sector, what could be the possible administrative, financial and technical issues you need to focus on? Please perform a SWOP analysis.

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7. After reading the case studies presented you realize that though the cluster complies with the legislation (downstream pollution control), there are problematic areas (upstream resource efficiency) that have to be addressed. What will be your recommendations? Which industries could use what sort of wastes and technologies to achieve up-stream resource efficiency?

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8. In your opinion, should social inclusion in environmental performance assessment of industries occur as a voluntary response or be stimulated through policy mechanisms? What change will you propose for including social aspects in environmental performance assessment? Defend your statement with three important reasons.

9. Considering the example of Nike’s new recycling model, please express your thoughts in the form of “dos and don’ts” regarding a value chain and list the broad steps to be taken to improve environmental performance of the food-processing cluster in the question.

References and Reading Materials


Module 3b: Social Capital Creation in Eco-Industrial Clusters

3.b.1 Key Concepts: Social Capital

Social capital represents one of the most powerful metaphors of eco-industrial clusters. Broadly understood as referring to the community relationships that affect firm-level interactions, social capital has been used to explain an immense range of phenomena, from sharing of technology and financial resources to the marketing success of EICs. Within an EIC, well-established social networks between clusters, local governments, institutions, local communities, and knowledge institutes greatly facilitate collaboration and diffusion of new technologies within the greater community. It also reduces the transaction costs and increases the diffusion of technologies. From a practical point of view, three main underlying ideas of social capital can be distinguished that help EIC formulation, which very much depends on inter-firm networks. Social capital generates positive externalities for member firms of eco-industrial clusters, and these externalities are achieved through shared trust, community norms, environmental values, and their consequent effects on expectations and behavior of individual firms. Shared trust, norms, and values arise from informal forms of organizations based on social networks and associations within an EIC.

Social capital provides a policy alternative. Community clubs formed within EICs for macro-economic purposes have leaders. In the absence of public good provision by policymakers, these leaders decide to mobilize club members to provide missing environmental public goods. The diffusion of environmental technologies across firms also benefits from social capital creation and EIC as a whole, and increases their environmental performances through conversion of waste to energy, wastewater treatment, and use of renewable materials.

3.b.2 When Social Capital Matters for an Eco-Industrial Cluster?

Eco-efficiency of a cluster is a combination of economic and environmental performance. The need for social capital to have an impact on eco-efficiency arises for a variety of reasons including externalities and free riding, imperfect information and enforcement, imperfect competition, and the like. For social capital to be beneficial, it must therefore resolve or compensate for one of the sources of inefficiency within the EIC. In the case of inefficiency or the absence of the public sector, social capital provides a leadership or coordination role. Social capital improves eco-efficiency of industrial clusters through a number of channels. Most of the channels fall into one or a combination of the following three categories:

(i) Information sharing,

(ii) Group identity for a brand value, and

(iii) Explicit coordination.

Social capital may be initiated with the intent of acquiring a specific price for information sharing. In that case, transfer of information is the purpose of
socialization. Because interacting with other firms is also a consumption good, collecting information through social capital creation becomes a kind of subsidy relative to explicitly organized market-based forms of information collection. Under a group identity, modification of preferences for selected works occurs as individual firms’ preferences and choices occur differently within the EIC networks. Group identity within an EIC brings consistency of preferences. In very informal groupings within an EIC, leadership is essential to alter individual preferences and elicit voluntary contributions to common goods such as sharing of waste for beneficial purposes. While social capital accelerates the dissemination of strategic business information, it may result in favored group identification within the cluster, and hence the process of social capital creation needs quality leadership within the EIC community. Purposeful coordination can also be obtained through formal rules by adherence to which decisions are made and where deviance is penalized.

3.b.3 Social Capital for Inter-Firm Networks

Social capital is the goodwill that is engendered by the fabric of social relations in which an individual or a firm is embedded, and which can be mobilized to facilitate action. In eco-industrial clusters, such as the one in Maniwa, opportunities for cooperation are created by unintended spillovers and intended agreements that result in inter-firm networks (Figure 3.b.1). Benefits of such inter-firm networks include:

(a) Efficient resource use: Exchanging materials and energy in a mutually advantageous manner and sharing access to knowledge and collaborative networks to introduce cleaner production practices, innovation, and eco-product development are possible due to the presence of inter-firm networks.
(b) **Eco-innovation:** Inter-firm networks could also lead to innovation, new eco-product development, a new value-chain, and market opportunities. 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. Helping businesses 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.

(c) **Technology advancement:** For individual companies to become environmentally friendly and economically competitive a range of different technologies will have to be available to them. Well-established inter-firm collaboration facilitates diffusion of new technologies, as it leads to sharing of infrastructure, and machineries, and technology facilities thus reducing transaction costs and sharing venture costs.

### 3.b.4 Approaches for Strengthening Social Capital in Eco-Industrial Clusters

The existence of social capital in an EIC depends on the ability of firms to associate with each other and the extent to which their shared norms and values allow them to subordinate their individual interests to those of the EIC community. Figure 3.b.2 shows the attributes of social capital creation. Interventions that may build social capital in an EIC include providing incentives to activate local businesses and civic
associations or to activate new associations; and requiring or including incentives for multiple form sponsorship or inter-firm collaboration to share resources, both economic and environmental. Local business associations as in the case of the Maniwa industrial cluster, for instance, also contribute to the development of the social infrastructure needs to leverage social capital. In the startup phase of an environmental company, there may be greater dependence on social ties to identify business partners because of the limited experience in the market. More established firms have worked with different business partners and therefore can rely on past experience to obtain needed resources. In renewable energy and waste to energy sectors, for example, small start-up companies have extensive experience in technological innovation but often lack the resources needed for marketing and distribution possessed by large incumbents. Hence, social capital may be more important for startup firms than for those that are in a later phase of development.

Firms are better able to create knowledge as they can benefit from social relationships and knowledge exchange through their interactions with other companies inside the cluster. Firms in clusters take advantage of high-level social capital that bonds cluster members and provides opportunities for informal interaction and learning. Compared with firms not part of a cluster, those in clusters have the social infrastructure that keeps information flowing continually, sparking new ideas, generating networks, and encouraging new firm startups. These factors may improve eco-efficiency of the cluster in terms of innovativeness, efficiency, sales, quality of eco-products, and new market opportunities. Relations with suppliers and customers also contribute to the stock of social capital. This could be augmented by organizing social events that bring company owners and employees together, thus impacting the quality of their relationship and in turn the firm’s market outcomes.

3.b.5 Case Study: Social Capital Creation and Inter-Firm Networks

The Japanese wood-industry cluster in Maniwa presented below is a good example of social capital creation that translated into a successful eco-initiative.

Maniwa, a small town about 100 km from Osaka, has been a historical trade center for wood. Forest land use accounts for 80% of its total 82,435 ha geographical area, and local economic activities of the area are generated by the vibrant wood industry. The area has 34 timber factories, 16 dry wood factories, dozens of furniture makers, and two major trade centers, effectively interacting with each other to share raw materials. These wood industries contributed a gross production of 2,730 million yen and employ 10.3% of the total work force of 52,958 people, who are engaged in forestry, especially lumbering (METI 2003). About 142,000 tons of wood biomass are generated annually in the Maniwa region. This includes waste from the raw material market and timber factories, which comprises 78,000 tons of wood logs, 40,000 tons of chips, and 24,000 tons of bark. An estimated 10,000 tons of wood remains in the forests and about 1,000–2,000 tons of it can be readily utilized (Maniwa Municipality 2004). Following a change in the biomass waste treatment law in 2002, open incinerations are prohibited so the remaining wood biomass is left in the forest. Huge amounts of leftover forest residue are unaccounted for, which not only inhibit the growth of the plantation but also degrade the water resources. Creating an economically resilient biomass waste disposal and conversion system has become a challenge for the local community.
As young people were moving to nearby Osaka for jobs, the challenge for the local community was to re-vitalize the wood industries and retain employment through innovations such as converting industrial waste into wealth. This was achieved through the active cooperation between the two forest associations, the local municipality, and leading firms. Another challenge to the cluster was the introduction of the Dioxin Law in 1998, which banned wood waste burning. Moving the waste to dispose of it in landfills entailed high transaction costs.

Four innovative developments in industrial networking occurred in the Maniwa wood cluster over a five to seven year period to effectively convert biomass waste into energy and material form: First, power generation from wood waste; second, conversion of woody biomass into other materials in the form of pellets and heat; third, a bio-fuel inter-linkage that turns wood cellulose material into ethanol; and fourth, utilization of wood waste as material for construction and other domestic purposes. Intelligent use of discarded materials has also been increasing in the construction industry. Another company, a manufacturer of concrete products started producing wood-based concrete. This cascade use of waste biomass use eventually transformed Maniwa wood industrial cluster into a zero emission zone.

The crucial component for inter-firm cooperation was believed to be social capital and it was becoming increasingly important to retain and augment it. Social capital is inherently related to local community culture, openness to new ideas, and flexibility of permitting easy entry of firms, local leadership, deliberate cooperation and joint actions by cluster members to identify common problems, and find and implement common solutions. This social capital creation occurred under the stewardship of a group called the 21st Century Maniwa which was concerned about the future of the cluster. It performed the role of a catalyst, networking and connecting Maniwa to the market through symposiums and seeking alliances. There were multiple stakeholders: firms, demand side moderators (economic agents who create demands for environmental goods), and customers.
The supply side moderators were encouraged to share resources and knowledge, to ensure effective business performance. Hence, the new business strategy for local firms had a cluster focus, indirectly linking local residents to jobs, and creating new supply-chain relationships, so that products could be sold outside the region. Social capital could be by stimulated or supported by policy interventions too. In Maniwa, it was the Dioxin Law that forced the cluster to be innovative considering the past practice of incinerating wood waste. Moreover, the Ministry of Industry supported by the Japan Development Bank (JDB) funded SMEs in the agriculture and forestry industries, the New Energy and Industrial Technology Development Organization (NEDO) provided funding for research and development, and the Ministry of Education allowed alliances of universities with businesses for eco-innovations. Okayama Prefecture was made into a customer niche market to support eco-products produced and promoted through the Maniwa NPO through their Eco-vision 2010.

3.6.6 Case Study: Social Capital and Marketing of Eco-Products

The Salem region in Tamilnadu, India houses around 450 SMEs that process sago into starch and other value-added products. Prior to 1981, these SMEs faced a lot of problems relating to credit, marketing, warehousing, and modern technology, and, being small and scattered, these companies, despite their collective strength, did not have a common marketing strategy, or environmental goal. In an attempt to overcome such difficulties, the starch and sago manufactures formed “SAGOSERVE”, The Salem Starch and Sago Manufacturers Service Industrial Cooperative Society, in 1981. Since then the bargaining power of manufacturers has substantially increased in terms of marketing of starch products and value-added eco-products such as sago cakes for premium markets. Cooperative-owned waste water treatment plants and waste-to-energy power plants were envisaged by Sago-serve. The menace of middlemen between processor and primary wholesaler has also been eliminated, leaving more profits for the producers. The following incentives provided by the government have played a vital role in strengthening the eco-activities of the sago-starch industry cluster in Salem: (i) State participation in the share capital structure of the cluster society; (ii) Reduction of the value-added tax rate from 5% to 1% on sales of eco-products routed through SAGOSERVE; (iii) Commercial sales tax exemption for goods sold to other states out of the stocks purchased from the cluster; (iv) Subsidy for modernization of sago and starch manufacturing units into more ecofriendly ones. Due to sustained efforts of the cluster-based cooperative activities, the sago industry cluster has become the backbone of the local economy, providing employment for more than 500,000 people in the fields and in factories. In 2011, SAGOSERVE received the Best Primary Industrial Co-operative Society Award from the Government of India.

The experiences of the Maniwa wood industry cluster and the Salem Sago Industry cluster clearly shows the following:

a. Creation of social capital will help to establish inter-firm networks and attract enabling technologies. The benefits of sustainable development strategies include efficient sharing of local resources, improved environmental quality, and equitable distribution of economic gains. Enhancing the stock of social capital for industrial networking for effective utilization of biomass waste through an integrated policy framework is a promising way to maximize those
benefits. It was becoming clear that inter-firm networks could be used as a main strategy to make clusters environmentally friendly, but high social capital was a pre-condition for that.

b. A focused business leadership with clear objectives and good market orientation, based on a continuous consultation process, supportive educational networks, and outreach activities, would promote eco-innovations at cluster level. The strategy was to build around existing social capital such as trust, norms, and networks that would bind resources, technology, businesses, and people. Investing in these assets through integrated policies and linking those to broader economic objectives would create new commercial opportunities. This is a promising way to connect disinvested and isolated regions to the national and international markets in a sustainable way.

c. Social dialogue processes could be used to enable social capital growth that would lead to better environmental performance. There is a social aspect that would become the pre-requisite for other factors to add value. Raising awareness of business risks and opportunities, through firm level dialogue, would improve both environmental and economic performance to reach higher levels, which eventually drives the formation of policy communities and social dialogues within clusters and actors to influence national development policy.

Worksheet

Learning Objectives:

On completion of this exercise you will be in a position to understand the relevance of social capital for the successful implementation of Eco-Industrial Clusters (EICs). You will be able to identify the key drivers promoting inter-firm networking and its potential to raise the innovation and competitiveness of industrial clusters.

You are asked to lead a multi-sector team to identify, develop, implement, and administer a couple of SME cluster development projects. Working within general policies, principles, and goals of national development plans, those clusters are supposed to be high in environmental and economic competitiveness. Inter-firm networks within the clusters will help to realize the commercial value of converting waste resources into material and energy forms. Environmental stewardship and participation by business in community based social networks have the potential to increase availability of market information for eco-products and to lower transaction costs. Improving the stock of social capital can also allow the cluster to reach higher levels of collective decisions and implement actions together. Governments must devise strategies on social capital to work at different levels to bring benefits, which enhance the overall competitiveness of the clusters, sectors, or the economy as a whole. Considering the example of wood Industrial clusters and bio-waste generation in Maniwa, Japan, please propose strategies for social capital building.

Study Time:

1.5 hours [Workshop—45 minutes; Group Discussion—45 minutes]

1. Referring to the case study of the wood-based EIC in Maniwa, four innovative components can be identified:

   (i) power generation from wood waste,
   (ii) conversion of woody biomass into pellets,
   (iii) 2nd generation ethanol production from wood biomass, and
   (iv) utilization of wood waste construction—essential for promoting industrial cluster sustainability by converting biomass waste into potential energy resources.
In your opinion, how did this new material flow emerge? How was the knowledge transfer conducted among the firms? What is the contribution of inter-firm networking to making the material flow into a closed loop one, where zero waste is achieved?

2. Technological proximity between the firms as well as other actors is possible if technology or economic related cooperation can be achieved without one of the actors having to shift its business path. In the cases of the wood cluster and Sogo Cluster, suggest ways to facilitate social capital building through inter-firm networks.

3. Local community networks play an essential role in the economic, social, and environmental development of EICs. How do local community-based actions promote cooperation among policymakers and innovation?
4. Inter-firm networks foster capability within SMEs and support a set of unique skills and resources that enhance cluster competitiveness in the global market. Which are the driving factors behind such skills development within industrial clusters?

5. A fragile supply chain and market price fluctuations are the main challenges of the EIC in Maniwa. Which strategies should be implemented to minimize fluctuations in material flows? What is the role of social capital in promoting constant input material flows and stable market prices?

6. A set of factors including location determines the success of EIC implementation. Locating in rural fringe areas tends to provide several benefits. From the viewpoint of social capital creation, why are these areas competitive? How do they promote social capital networking?
7. A lack of integrated policies by sectorial ministries and the absence of macro-level policy coordination are two main weaknesses constraining the evolution of EICs. How can social capital creation minimize such shortcomings?

8. Tax exemptions have been widely discussed among policymakers as an effective tool to promote eco-product market competition. The Sogo cluster benefitted from that policy choice. The biomass-based EIC in Maniwa obtained concrete benefits from green taxes as it increased the competitiveness of eco-products and the demand for green products. Do you believe this strategy is effective to promote EICs? If so, state your arguments. What is the role of social capital for the success of this kind of fiscal incentives?

9. It is generally accepted that social capital creation is one of the pillars to transform SMEs into Eco-Industrial Clusters (EICs) and to promote environmentally friendly regional development. But social capital is a broad and ambiguous concept. What do you consider social capital to be and why is it important for EIC development?
References and Reading Materials


Module 3c: Technological Advancement for Eco-Industrial Cluster Transformation

Technological advancement for EIC transformation is the deployment of cost effective eco-efficient technologies that facilitate sustainable industrialization in terms of competitive regional economy and improvement of resource use, where such as system change helps to reduce resource consumption and waste generation.

3.c.1 Key Concepts

Eco-technological innovation is a tool to convert resources into products, preferably by optimizing consumption of material and energy, processing them into a usable form and eliminating waste from the process.

Recognizing and understanding the patterns of energy and material flow of industries is imperative for the development of eco-industrial clusters. In particular, industrial clusters are important for the eco-restructuring of industries. Continuous environmental improvement is a cornerstone of eco-industrial development, requiring the advancement of eco-technologies. Eco-technologies convert waste into useful products and changes in the processing technology contribute to greater resource efficiency by optimizing the resource input and minimization of waste produced as by-products. Research and development can result in new ways for businesses to refine waste to be of sufficient quality to become an input. As Desrochers (2000: 13) states, “Because of technical innovation, the market process is in continual flux. Old products and markets disappear, while new ones emerge and make creative use of what were until then waste products.”

The transformation from conventional industrial clusters to eco-industrial clusters is inevitably accompanied by a shift towards modern technology. Technological innovation is essential when shifting from unsustainable mass production systems to eco-technology processes. EICs require a range of green technologies that not only foster resources recovery and reduce waste flows, but also incorporate indigenous knowledge and local context when adapting new technologies in specific regions.

Most Asian SME clusters use intermediate or primitive technologies for their production processes. Since appropriate technologies are not readily available, environmentally friendly technologies need to be transferred between firms in other regions or internationally introduced. Promoting technology transfer is not a simple task. The degree of success is measured through appropriate choice of the technology, capacity building, sufficient knowledge transfer, adequate training, policy intervention, and community participation.

The choice of the technology depends on various factors such as affordability, availability, accessibility, and the need of EICs to move up to the next level of sophistication, where zero waste is achieved and economic gains are fully attained. Choosing the right technology has to be done judiciously without creating
disturbances to the present system. Transfer and management of appropriate technology determine the success of an eco-industrial cluster. Diffusion of appropriate technologies may be facilitated by independent entities that promote knowledge transfer between firms and stimulate trustful relationships among members.

The following factors affect the diffusion of environmentally appropriate technology:

(i) Creating awareness of the multiple benefits of green technologies and encouraging cluster level participation is a first step towards technology transfer (Box 3c.1). This includes educating cluster firms in planning, maintenance, finance, monitoring activities, and sharing ideas to make decisions and to take responsibility.

**Box 3c.1: Eco-Industrial Cluster Transformation**

A successful eco-industrial cluster transformation requires the following:

1) Integration into the natural system by designing the EIC in harmony with the local eco-systems;
2) Minimization of global environmental impacts;
3) Introduction of appropriate energy and water systems to maximize energy efficiency through facility rehabilitation, co-generation, energy cascading, inter-plant energy flows, and use of renewable sources;
4) Monitoring of material flows and waste management for the whole industrial cluster to ensure pollution prevention, increase recycling, produce by-products via resource exchange approach.

All these strategies require appropriate identification, appropriation, and induction of technologies.

![Fig.3c.1: Factors Influencing Technological Advancement](source: Authors)
(ii) Training is a widely used tool to help achieve EIC objectives. For successful technology transfer, adequate training should be given to a carefully selected group in their native language. Training can be either technical or capacity building where technical training covers operational procedures, issues, monitoring or evaluation of activities. Before embarking on international technology transfer, planners should acquire local and indigenous knowledge of a particular region.

(iii) Selection of correct technology transfer is a major challenge faced in clusters located in rural areas (Figure 3c.1). Domestic or traditional technologies can reach the communities faster than introducing a modern and totally new technology. These technologies can be easily implemented as it requires only indigenous knowledge and fewer resources. In fact, international technology transfer needs to be carefully adapted for successful local implementation. All interventional stakeholders, including local government and local communities, should be involved and social and cultural factors should be taken into consideration. However, the basic characteristics of a community, such as its skills and human behavior, social and cultural factors, lifestyle of the people, and environmental awareness among communities are some of the social factors which present barriers to technology transfer in any region.

(iv) Regulatory policies are another tool to control and encourage technology transfer and if required, the regulations, incentive systems, and tax procedures should be modified to facilitate the introduction of innovative technology. Targeted policy interventions will determine the quality of the environment through technological innovation.

3.c.2 Case Studies

3.c.2.1 Industrial Cluster in Chachoengsao Province, Thailand

We use the case example of a successful EIC launched in Chachoengsao, Thailand to show the importance of technology transfer at different levels for successful transformation to an eco-industrial cluster. This EIC is related to rice industries, small power producers, and livestock holders (Figure 3c.2).

Chachoengsao Province located to the east of Bangkok, Thailand, is primarily an agricultural area with vast lands devoted to cultivation and farming. Livestock rearing, especially of pigs and poultry, is a supplementary source of income for many families in this region. In recent years, Thailand has ventured into new markets related to food processing for export, resulting in greater pressure on agribusinesses to meet market demands. This has resulted in more rapid resource consumption and pollution at various levels and in various parts of the ecosystem. Agricultural residues and excreta from livestock farms now pose a severe threat to the region. The potential of using such waste as alternative energy sources remains largely untapped.
For the purpose of illustration, the material flow starts with paddy cultivation and proceeds with the steps of rice milling, polishing, noodle making, etc., until all products and by-products are completely utilized. Similarly, the piggery and poultry sectors, which at first glance do not seem to have a linkage with the agriculture sector, are also connected through vital material flows.

The following technologies are essential for the transformation of a cluster into an eco-industrial cluster.

### 3.c.2.2 Rice Industries

Ideally, these agricultural residues, paddy straw, and rice husks would be used to generate electricity for in-house consumption or for exporting to the regional power grid. For example, the 15 MJ/kg energy potential of rice straw is used for thermal energy generation at lower thermal efficiency. This could be more efficiently used to generate electricity and save costs on power generated from fossil fuels in addition to the environmental benefits.

**Box 3c.2: Present Condition of Industrial Cluster in Chachoengsao Province, Thailand**

The missing or weaker part of the eco-industrial network is the lack of productive or best use of the materials presently discarded as waste or those used in a relatively inefficient manner.

- Rice husk is mostly used for heat generation using primitive technologies resulting in poor thermal efficiency and lesser eco-efficiency of material.
- Ash resulting from combustion is often disposed haphazardly or in some cases used for soil enrichment in agricultural fields.
- Both piggeries and poultry farms generate enormous quantities of waste that have a significant potential value, which in most cases is either totally or partially unrecognized as affordable technology to convert it is not available.
- Environmental awareness and legislation to tackle environmental pollution (setting of standards) have advanced considerably in recent years, but enforcement is lagging.
The energy required for the rice mill can be obtained from the utilization of the husks. In many rice mills, husk is burned in furnaces with low thermal efficiency leaving black ash of high-unburnt carbon. Assuming that all rice husks are utilized for power generation, and theoretically one KWh of energy can be produced from 2 kg of rice husk, the potential is so considerable that rice husk cannot be put to any other use.

**Box 3c.3: What Are the Reasons for Improper Resource Use and Waste Disposal in This Industrial Cluster?**

- Lack of awareness of reuse possibilities and alternative use of materials.
- The latent value of such discarded materials is often unknown or unrealized.
- Lack of awareness of best possible use of materials.
- In some cases, even though materials are reused and recycled, this is not done in the best possible way.

Nevertheless, a consistent and stable supply of paddy for milling and rice straw is essential to establish and operate the electricity generation system. The size of an individual mill and its supply chain are key factors in determining the feasibility of generating sufficient power. At the same time, there is a need to analyze the available technologies, and select the appropriate one to meet local conditions, with the associated technology transfer requirements (Boxes 3c.2, 3c.3 and 3c.4)}
Box 3c.4: Rice Husk and Energy?

A ton of rice husks contains the same energy as 415 liters of petrol or 378 liters of kerosene. A few handfuls of rice husks can boil water in 6 to 9 minutes. Best of all, the rice husks are usually available free of charge from farms or waste dumps that surround rice mills and it is more efficient than using ordinary burners. Also, it reduces greenhouse gas emissions and eliminates toxic fumes inside domestic homes. Even the char left after burning can be recycled to use as fertilizer or bio-coal briquettes.


3.c.2.3  Rice Processing Units

All of the processes to produce rice products in these industries require large quantities of water. Wastewater streams generated at various stages of processing contain large amounts of starch that have been dissolved in it. Almost all industries in the study region simply discard the starch-laden wastewater in their backyards or in nearby water bodies. Starch, typically contains high concentrations of carbohydrates and is organic in nature thus imparting very high Biological Oxygen Demand (BOD). Essential technologies for rice processing industries include recovery of starch from wastewater and (or) anaerobic digestion systems to extract biogas.

Box 3c.5: Technology Leapfrogging

Generating ideas → Basic research → Patenting → Bench scale testing → Pilot scale
Testing → Field testing → Commercial development of technology
Commercially-developed technology → Transferred, with appropriate adoptions or modifications, implemented, and established in other countries via technology transfer

Example: Polymer Energy System, Poland is a very well-known European company for turning waste plastics into renewable energy. This well-established technology was transferred to Rayong municipality, Thailand via North-South transfer to solve the problem of plastic wastes in landfills with the benefit of generating liquid oil.

3.c.2.4  Piggery and Poultry

The piggeries of the study region are predominantly owned and operated at the family level, meaning there is little room for technological advancements due to financial constraints. However, the environmental issues arising from these sectors are so serious that they cannot be ignored. Technologies have been constantly evolving to provide low-cost and efficient solutions for solving the waste disposal concerns of the piggery sector. Integration of waste handling and treatment systems in the business models is essential to ensure environmental and economic sustainability.
Unlike the piggeries, environmental issues arising from poultries are confined to the farm. The open dumping of poultry litter releases huge amounts of methane due to uncontrolled decomposition. Technologies for high-rate bio-methanation are essential to recover resources from this so-called waste.

Anaerobic digestion of piggery/poultry waste has been widely tried and tested in many countries across the world. The results are positive in most of the cases. Piggeries/poultry farms in Chachoengsao need to be familiarized with this technology as a means of reducing cost through engagement in the parallel businesses of electricity generation from biogas generated in anaerobic digesters. The digestate and residue resulting from the digestion process have a potential to be used as organic fertilizer in agricultural fields.

Considering the present economic (new business opportunities, manufacturing efficiency) environmental (resource conservation, resource efficiency), and social issues (employment, poverty alleviation) facing the province, transferring appropriate technology is clearly needed to maximize the sustainability potentials of the cluster.

3.c.3 Key Learning Points

The need to shift to appropriate technologies has not yet been felt by entrepreneurs. A lack of appropriate technologies prevents full resources recovery and full reuse between the existing networks. Most of the small and micro business units in the region are driven by raw material availability and income generation rather than a drive to get new business or find new markets. The local context needs to be taken into account when choosing the appropriate technology, which could be of indigenous origin. In the case of Thailand, paddy straw mushroom cultivation could be promoted. Paddy straw mushrooms are grown on paddy straw beds and picked before they are mature, i.e., before the caps of the mushrooms open. New employment among the rural population in Chachoengsao Province can be created through cultivation of paddy straw mushrooms. Moreover, the waste from pig farms and poultry farms can be utilized for composting and biogas production applying low-cost and efficient technology solutions. The need for knowledge and skills transfer is an important aspect here. For example, in the Chachoengsao Province cluster, some industries use small machines to separate rice and rice husk whereas other industries use manual, traditional methods. A knowledge transfer between industries and firms is required, but this does not occur easily due to competition among similar industries. The Chachoengsao industrial cluster is an otherwise successful example of an EIC, which with technological advancement can be transformed into an even better EIC (Boxes 3c.6, 3c.7, and 3c.8).

Box 3c.6: What Are Possible Technologies That Could Be Used to Treat the Wastewater?

- Aerobic digestion
- Adsorption
- Coagulation
- Aquatic weeds based methods

This wastewater can be reused back in the rice mills for parboiling to conserve water sources in the area.
3.c.4 Technology Transfer Models

Technology transfer can be divided into two types of models—vertical and horizontal—as shown in Figure 3c.4. The vertical transfer model shows the technology transfer within a country undergoing various steps from research to commercialization. The horizontal transfer model depicts the transfer of technology between two countries, which can be done from advanced economies to developing economies or between developing countries through agreements. Vertical technology transfer takes place when two countries work together for developing a new technology or modifying to suit the purpose.

Box 3c.7: What Are Benefits of Anaerobic Digestion?

- Technically feasible to convert organic waste into pipeline quality fuel gas
- Capable of producing refined compost
- Avoids methane entering the atmosphere
- Lower footprint requirement

Box: 3c.8: Green Jobs in Recycling Industries—A Reality?

Recycling industries continue to grow in importance and demand for green jobs is increasing accordingly. Waste management has the potential to create jobs for various sectors based on the needs of the organization. For instance, a recycling facility would need supervisors, coordinators, environmental specialists, waste collectors, waste engineers, specialists, and laborers for operating the plant. When a recycling industry, such as an EIC emerges in a locality, it is expected to create green jobs for the people in the nearby communities. This is considered to be one of the major social benefits of the recycling facility. Sometimes, this is not the case for a variety of reasons, such as the need for skilled technicians, who are not readily available in the vicinity of the facility. While EIC can create green jobs, adequate safety measures should be taken to protect employees, so that the green jobs also become safe and healthy ones.

Developing countries have no clear policies or tax incentives to induce the private sector to create green jobs. Currently, there is a lack of knowledge about and capacity for green jobs due to poor networking and communication between public and private bodies. Moreover, financial support for the establishment of such facilities is not readily available.
Example of Vertical Transfer—A Case Example from Bangladesh

Like any developing Asian country, Bangladesh was confronted with a major challenge due to increasing waste generation in key sectors such as garments and fish processing, where clustered activities are common. The waste characteristics were typical of an Asian developing country: 70%–80% of the waste generated is organic and collection services are poor, covering only 50%–70% of residents. The lack of availability of land for waste disposal was becoming a major concern.

In 1995, Waste Concern, a research based non-governmental organization took the initiative to solve the problem of municipal solid waste management by introducing community-based, decentralized composting technology. Its aim was to produce compost, reduce solid waste management costs, reduce GHG emissions, create job opportunities, improve health and environment conditions, manage landfills better, and improve the soil condition. The technology’s development went through a rigorous process of modification to fit local conditions, which meant the entire diffusion process took a long time to yield beneficial results.

Example of Horizontal Transfer—A Case Example from Sri Lanka

After the establishment of the composting facility in Bangladesh with proven results, the technology was transferred to Sri Lanka via South-South transfer. Sevanatha, an NGO group, established a composting facility called “Matale Enriched Compost Private Limited” in Matale municipality. This project was also aimed at tackling the organic fraction of the municipal solid waste, which was dumped in landfills without segregation. The technology quickly diffused and the project became very viable in many respects.
Annex IV:  
Strategies That Work: Technological Advancement for Eco-Industrial Cluster Transformation

Worksheet

Learning Objectives:

You are part of a team visiting a cluster of SMEs involving different products (Refer to the example of the Desiccated Coconut processing cluster in the previous section). The cluster is spread over a large geographical region and has evolved over seven years. Not much planning has gone into the development of this cluster. The cluster benefits from easy access to markets for its products. However, ever increasing globalization has put them in a tight situation and they are now forced to offer products that are competitive with their international counterparts. The cluster has an SME association that liaises with service providers, regulatory authorities, and banks for their needs. The SME association has recently realized that waste management (coconut water, coconut husks, coconut shell, wash water) has been one of their major costs. Yet, they are not fully equipped, in terms of knowledge, expertise, and finance, to tackle the situation. The objective of the team is to identify and choose the appropriate technologies in the cluster, and to tackle the issues related to technology and knowledge transfer.

Fig.3c.5: Windows of Sustainable Resource Use Opportunity
Source: Authors.
Workshop Duration:

1.5 hours [Study Time—45 minutes; Group Discussion—45 minutes]

1. Technological advancement contributes to resource conservation. Explain how.

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2. Technology transfer includes hardware (equipment) and software (skills/knowledge) transfer. List the factors that determine the success of technology transfer. Discuss in detail the most important factor in the context of your country/region.

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3. What could be the potential barriers (social-cultural, economic, and policy) for technology advancement and knowledge transfer in EIC? How could those barriers be converted into supportive factors?

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4. SMEs are vehicles of integrated environmental and economic growth. As a policymaker, how do you view policy as a catalyst of technology transfer? Does your government have crosscutting policies that are pro-SME, for example where different ministries such as the ministry of industry, the ministry of commerce, etc., interact?

5. Community participation and capacity building to a large extent decide the success of technology transfer. What activities should be undertaken to build social capital in technology advancement?

6. A cluster-level material balance flow revealed that the flow was linear and unidirectional. Please think of possible ways to utilize waste streams generated in the desiccated coconut processing industry and identify the appropriate technologies for doing so. (Example: coconut shells used for production of charcoal). What should be done to improve the technology level of this cluster? How can it be extended to other areas requiring improvement?
7. It was observed that competition between industries hinders technology/knowledge transfer within an EIC. Based on your own experience, indicate how this situation could be improved.

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8. The SME association has realized that the best way to improve competitiveness is to identify domestic indigenous technologies rather than import technologies. What sorts of local technologies and new industries could be useful for improving the environmental performance of the cluster?

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9. Improved market linkages can motivate entrepreneurs to invest in advanced technologies in the EIC. Suggest how market mechanisms/linkages for the new products (from the waste utilization of raw desiccated coconut processing industry) can be improved?

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References and Reading Materials

Module 3d: Financing Eco-Initiatives in Eco-Industrial Clusters

3.d.1 Key Concepts: Financing Eco-Industrial Clusters

Financing is key to success in any kind of business and the key to successful EICs are sound financing strategies to secure SMEs access to financial resources. Potential sources of funding include mainstream investment companies, local commercial banks, pension funds, and insurance companies. Other options might be large foundations, municipal bond financing, and state economic development funds. Municipalities, public and private utilities, and other public and private entities have also supported eco-industrial development projects, in the expectation of benefits from new economic development. Lack of access to finance is frequently considered to be the most serious barrier to eco-business start-ups or growth by potential and existing SME operators.

Given the lack of development of financial markets in rural areas and eco-actions within clusters and the high risks involved in lending to industries operating in the rural sector, private banks tend to be reluctant to grant loans to new entrepreneurs. North and Giannini-Spohn (1999) further expand the financial uncertainties raised in implementing eco-industrial projects. In particular, financiers and investors have difficulties assessing risk associated with eco-industrial activities, typically listing four primary points of uncertainty:

- Businesses and financiers are uncertain how many secondary activities they may be required to underwrite in order to participate in an EIC.
- Lack of precedence on which to base rates of financial returns limits investor enthusiasm.
- Concern about unique social codes of local communities such as collective collaterals, covenants, and restrictions (e.g., deed restrictions). Financiers are weary of any restrictions that may impede their ability to resell or transfer a property should they receive an expression of interest or an offer.
- As with any potential new firm, existing businesses may regard a new EIC as a competitor and may not give political support for public financing of infrastructure development.

3.d.1.1 Death Valley Trap

The uncertainty associated with eco-industrial projects often causes SMEs to face financing problems during the start-up “death valley”, when financing becomes particularly difficult. Innovative financing mechanisms need to be identified and made available to the SMEs to overcome the death-valley. Mostly, this lack of funds to start or run a business due to the inability of the entrepreneurs to articulate and present ideas to appropriate financiers, their failure to attract enough customers, or poor management of finances. Nevertheless, there is a
wide gap between the existing financial intermediation frameworks (assumptions, approaches, methodologies, regulations, and outreach) and the reality of SMEs. Formal financial institutions and regulations require professionally prepared loan proposals presented by credible, formally licensed and traceable applicants and backed by recorded business history and collateral. The reality of SME clusters is different: most are extralegal, few appreciate the need to keep records or build credibility, they have no licenses, and they do not have collateral, and cannot afford or do not appreciate the value of the services of consultants. There is no access to start-up capital from any formal financial institution. So far there is no national identification system, making traceability difficult or impossible in some cases. Traceability is also limited by the fact that most businesses operate from isolated, temporary, informal and even illegal sites or premises. EICs could resolve the issue of scattered businesses as groups of similar businesses are established in one particular area as a cluster. Similarly, the formal financial institutions have not yet sufficiently evolved to understand and respond to the needs of small firms. Their approaches are mainly modeled on the needs and features of corporate entities.

Although policy interventions are necessary to make EICs possible, most SMEs fail during the startup “death valley.” The initial challenge is to get an engineering system in place, and to obtain startup funds. But once the business is up and running, more established forms of funding are available, including micro-credit and venture capital. Once the businesses model is successful, the firms should be able to secure bank and capital market financing. This suggests that the “death valley” could be largely overcome by various financing channels once the firms achieve a certain threshold level of operations that allows them to push past the “death valley,” such as innovative micro-financing models, project financing, non-banking financial institutions, and the banking sector’s interest in promoting social development through industrial clusters, backed up by government regulations. The trouble is that the market is not social or environmentally conscious and financing is only concerned with profit. Different types of business financing could help to integrate social and economic objectives of the firms such as government supported business funds and venture capital. Government-supported business funds could provide finance at a low and subsidized interest rate to support viable EIC business. Subsidized funding can be justified on the basis of social objectives as well as economic benefits to the economy.

![Fig.3d.1: Stages of Lending for an Eco-Initiative](image_url)

Source: Authors.
Venture capital plays an important role in terms of hedging the risk of investment of business activities in an EIC during the development stage. During this stage, businesses are building up their sales and innovative capabilities to sustain their operations. This stage is marked by greater uncertainty and risk of failure. Businesses will be reluctant to undertake key innovations due to high risk of failure. Venture capitalists will be helpful in terms of managing business risk by diversifying business risks for the respective EIC businesses. Moreover, venture capital also helps to identify viable business and their business knowledge will be very useful to assist businesses in mapping the future investment strategies of EIC firms.

3.d.2 Micro-Financing: Bridging the Financial Barriers of Small and Medium Enterprises

Micro-finance is becoming increasingly important as a means of financing SMEs’ activities in an EIC compared with other forms of financing. Micro-financing models, project financing, non-banking financial institutions, and government regulations could help SMEs to overcome the “death valley” of starting up and secure more established forms of funding such as micro-credit and venture capital, and eventually bank and capital market financing when the business becomes gradually successful. The problem with obtaining such innovative financing is that markets are not yet environmentally conscious, and financing remains virtually exclusively profit-driven. However, in the recent past, increasing numbers of these institutions have been expressing interest in working with smaller firms, driven by stiff competition for the few corporate clients and good growth prospects in the SME sector. They have been struggling to learn and develop viable models for reaching out to small enterprises and micro-enterprises. Cut-throat competition for the few officers who have acquired experience in working in this area is commonplace, financial service providers are hesitant to invest in human resources development because trained employees are often snatched by competitors. When it comes to EIC financing, it also depends largely on how clusters form, whether they emerge organically or through government-induced policy. When they emerge organically, more private, non-bank financing options might sometimes be necessary. Whereas commercial banks are obviously profit-oriented, they are also risk averse, or tend to minimize risks. The huge cost involved, from actualizing ideas to making a viable product that sells, is a risk that banks usually want to avoid. So venture capital or micro-finance has a larger role to play here.

Micro-finance is innovative and could become a workable solution in financing start-ups, as it runs on informal finance based on social networking. Micro-finance is a fairly new, yet innovative approach to financing, but interest rates are usually higher to compensate for the higher transaction costs and the higher risk involved in lending without collateral. Micro-financing is driven by micro-financing institutions (MFI), innovative lending methodologies to reach poor or micro-clients with micro-loans or informal finance in cases where banks are reluctant to lend. The typical characteristics of micro-lending are: (a) short-term working capital loans, (b) lending based on character as opposed to collaterals, (c) sequential loans with credit rationing, (d) group lending as a mechanism to substitute collateral, (e) simple loan procedures—quick cash-flow analysis of businesses and households, especially for individual loans, prompt loan disbursement (f) frequent re-payment schedules to monitor borrowers, and (g) higher interest rates to cover the cost of lending. This usually works to offset the risks in the early phase of financing small
and medium scale firms that are ideally within EICs. But the government needs to coordinate due to the risk of market failure and also to reduce disparity of income and poverty.

During the start-up period, governments usually are required to assume risks. As banks and firms are profit-oriented, it is largely up to governments to promote initiatives—be it in terms of coordinating policy, providing viability funding, or subsidizing technology adoption—to improve environmental performance. Governments are crucial in bringing together all the different institutions and stakeholders so that they can assess the risks involved and evaluate if they may wish to provide financing. Some good examples include the Providing Urban Amenities in Rural Areas (PURA) scheme as a development model in Namakkal eco-town in India and Sarvodaya Economic Enterprises Development Services (SEEDS) in Sri Lanka, which provides financing for solar lighting.

3.d.3  The Changing Landscape of Micro-Financing

The micro-financing landscape has been undergoing changes, with commercials banks making headway into the financing of the rural poor as the structure of micro-financing becomes more stable and more profitable. Banks are slowly entering into the micro-finance market that could finance SMEs in an eco-cluster, in three ways in particular: through NGOs, through creating specialized subsidiary micro-finance arms, and through expanding their direct reach to cover poorer groups. One such example is ICICI Bank, the largest private bank in India. Its micro-finance portfolio has been increasing at an impressive speed, from 10,000 micro-finance clients in 2001 to 1.2 million clients in 2010, served by its partner micro-finance institutions. As a result, its outstanding portfolio has increased from US$4.5 million to US$227 million. There is also an increasing shift in micro-financing from grant-giving to investments in viable micro-level projects. Although there are models that allow MFIs to borrow from banks and on-lend the funds to SMEs, most MFIs are only able to grow up to a certain size. Most MFIs are not able to manage the risk of large capital investments, so they rely on the structures provided by private banks to provide greater diversity for the various types of risk in lending to SMEs.

The entry of commercial banks into the micro-finance market has clear advantages as they introduce more stringent regulations (regarding financial disclosure, capital adequacy, and financial prudence), and they bring in their depository institutions (more funds), physical infrastructure (branch network), and internal controls (better administrative and accounting systems). The framework used by commercial banks to decide on their entry into micro-financing and to evaluate the viability of the projects is given in Figure 3d.2. Private banks have entered the micro-finance market in the following ways:

• Micro-finance programs or NGOs have been transformed into banks;
• Micro-finance practitioners have created private banks and specialized micro-finance banks;
• Commercial banks have expanded their business to reach out to the poorer groups.
Box 3d.1: Serving the Underserved—What Makes for Success?

1. Commitment from board and management, strong internal champions, and alignment with the bank’s core commercial strategy
2. Knowledge of micro-finance best practices and how to serve micro-clientele
3. Infrastructure located conveniently for clients
4. Products especially adapted for low-income and informal markets
5. Systems and procedures adapted to the micro-finance operations, e.g., systems that support immediate follow-up on missed payments
6. Appropriate staff training and incentives on new clients, products, and delivery systems formed into banks

- Micro-finance practitioners have created private banks and specialized micro-finance banks
- Commercial banks have expanded their business to reach out to the poorer groups

Box 3d.1 explains the codes of doing business with underserved markets. There are several ways that allow private banks to enter partnerships with MFI.

1. MFI acts as a collection agent instead of a financial intermediary. For example, ICICI Bank initiated a partnership model in 2002. This model combines debt as part of finance to MFI.

2. Private banks can enter a partnership with MFIs by securitization of the micro-finance portfolios through bundling the micro-finance loans with other debt instruments.

3. Training new partners

4. Working with venture capitalists

3.d.4 Models of Eco-Industrial Cluster Financing

Here are some of the micro-financing models explained that are in use and can be used while private commercial banks are involved in partnership with MFIs:

Franchising—MFIs located in remote areas may not have sufficient financial means to fund eco-initiatives for SMEs (like renewable energy technologies), and may also be viewed as not creditworthy by commercial banks. The franchising model can work effectively in such cases. In such a model, the MFI provides loan origination and administration services on behalf of the bank and functions within a clearly defined framework. The bank leverages on the MFI’s proximity to the client base to reduce the risk of the loans. The loan is carried on the banks’ books alone and fees paid to the MFI for services rendered are linked to disbursements and recoveries. ICICI bank in India has successfully practiced this model in generic micro-finance schemes.
Revolving Funds—This is a type of fund that is established to finance a cycle of operations through amounts received by the fund. The interest income of the funds covers the management cost by design. A number of members obtain loans and pay back as per the rules, before the next set of members obtains loans as the former group pays it back. The fund goes on revolving among the members.

Vendor Financing—In this model, the service providers (for instance energy service providers) sell the system/technology facility in credit and collect regular installments from users. Such models are appropriate in areas where the presence of financial institutions is negligible, or where the service provider’s coverage area is very large. Grameen Shakti (an energy company in Bangladesh) is an example of this, and it has successfully installed over 100,000 solar home systems in rural Bangladesh. Vendors advertise low interest rates if the vendor profits from the sale. The disadvantage of this type of financing is that vendor financing is suitable only for small projects, and is limited to the technology or service selected by the vendor.

Leasing—This model of financing (for example, energy services) allows consumers to pay a monthly fee for the service rather than buying the system itself. Guaranteed maintenance and reliable energy services are provided by the system service provider. Grameen Shakti in Bangladesh also has a leasing model called micro utility. It is targeted at communities unable to purchase the system in one go. The system is provided without upfront costs, on the condition that users share the power with other neighbors within the technical limit of the solar home system. The owner of the system pays a monthly installment, and collects a load charge from the other users according to the load capacity used. 50% of the installment generally comes from this power selling mechanism.

Micro-finance institutions are serving a growing number of informal and micro- or small enterprises. However, their products are quite few and limited to the needs of those who require very little money and whose opportunity cost of time is so low that they can afford to spend many hours every week attending meetings in return for the possibility of borrowing a small amount of money. Micro-finance can be important to promote entrepreneurial activities, based on social networks to manage risk, and this would also enhance the role of social capital required to promote EICs. The role of government is important as the private sector and banks will not take social and environmental issues into account; and the government can better judge the trade-off between profit and cost of adopting cleaner and efficient technologies and the social benefits. While MFIs will eventually be important in providing better monitoring and screening services, this could be enhanced by government oversight and policy design through regulation and provision for subsidies. But once EICs get their business model and financing in place the externalities and spillovers of clustering activities are huge, both socially and environmentally. There are other financial products (insurance and factoring), which are required by small businesses, but they are currently not available. However, the future is full of potential as many international banks are introducing green funds, and bilateral and multilateral development organizations are also investing in financing green industrial technologies for sustainable development.
3.5 Case Studies

3.5.1 Integrating Micro-Finance and Renewable Energy Technologies (RETs)

Access to sustainable energy plays an important role in cluster-based poverty alleviation programs, and renewable energy technologies (RETs) represent a promising and economical method to provide sustainable rural energy. Recent evidence suggests that a well-designed market-based financial mechanism and structure such as a planned micro-financing scheme could be the most appropriate and effective tool for the development of a sustainable market for RETs within cluster firms, hence playing an important role in the electrification of the rural poor in many developing countries.

RET-based rural energy services are usually photovoltaic (PV) solar systems. Although micro-financing is appropriate in a competitive market environment, equally important is the availability of post-sale maintenance services, and training for rural consumers on the operation and minor maintenance of RETs. Rural energy supply based on RETs requires taking care of the following:

(i) Educating the cluster firms and rural population on RET-based energy systems:

(ii) Creation of centers (manned by engineers/technicians to provide installation and maintenance services as well as training for the rural customers) in EICs located in remote difficult-to-access areas;
(iii) The addition to these centers of all banking and finance functions related to making loans, and collecting installments and bills.

There are different models of micro-finance institutions, as listed below:


- NGOs Rotating Savings and Credit Associations (ROSCAs)—Pooling of funds by a group of individuals.

- Bank Guarantees—A bank guarantee is used to obtain a loan from a commercial bank.

The development of RETs and micro-financing can be enhanced by the introduction of elements of deregulation and competition. The government could play an important role in promoting sustainable household and small business RET electrification by avoiding import duties and taxes that will increase the RET cost and limit its potential. Secondly, government could provide subsidies to the poorest households to buy and maintain a RET-based system.

### 3.d.5.2 Sarvodaya Economic Enterprise Development Services (SEEDS) in Sri Lanka

Sarvodaya Economic Enterprise Development Services Guarantee Ltd. (SEEDS) is a Sri Lanka-based micro-finance institution that has been in operation since 1986. SEEDS offers a broad range of lending products, including a lending program that focuses on the provision of environmentally-friendly, clean energy technologies and modern lighting to enable productivity after dark. To increase operational efficiency, SEEDS outsources services such as sales, marketing, installation, and maintenance through strategic partnerships with solar technology suppliers and itself focuses only on financing.

### 3.d.5.3 Micro-Financing Renewable Energy Services in Nepal

Nepal’s overwhelming dependence on traditional fuels (fuel wood, agricultural residue, and animal dung accounting for 88% of primary energy use, and fossil fuels-accounting for 11.5%) is a matter of concern for energy security and environment health of eco-industrial technologies. This gives Nepal leverage to promote RETs. The government of Nepal has given priority to promoting RETs and also provides subsidies. The subsidy provision on micro hydro covers almost 50% of the total cost; the rest of the investment has to be managed by community or private sector entrepreneurs. The subsidy on biogas almost covers 40%, and 30%–50% of subsidy on solar technology. Due to the high investment cost of the RETs, the real poor community is still deprived of the benefits and subsidies as they lack the ability to pay the upfront costs required to buy such technologies.
Apart from the provision of subsidies by the government of Nepal (GoN), the concept of micro-financing has been introduced for wide dissemination of RETs to the real poor, with the co-benefits of increased employment, better health, knowledge and awareness, empowerment of women, and business opportunities using access to basic infrastructure like telephone, photocopy, radio station, computer, and internet. The implementation of micro-finance practices started in 2000 in the case of biogas. More than 150 MFIs have been financing biogas and other renewals. Nirdhan Utthan Bank, Purbanchal Grameen Bikash Bank, Sahara Savings and Credit Cooperative, Karnali Savings and Credit Cooperative are some good examples of MFIs involved in RET financing. RETs are a viable area of investment for MFIs due to the huge market potential in Nepal with its large rural population.

A recent market estimate shows that there is an annual financing need of over 1 billion Nepalese rupees for small scale RETs, which is an immediate market for MFIs in Nepal (Basnet and Subedi 2004). Micro-financing in waste management project implementations is increasingly common in developing countries. A couple of examples in India, the Philippines, and Brazil are provided below.

3.d.5.4 Wesco Credit, India

Wesco Credit, the financial arm of Welfare Services Ernakulam (W.S.E.), currently operates in 172 villages and oversees some 2,000 local self-help groups (SHGs) comprising more than 35,000 of the most economically impoverished women in the region of Kerala. Following the outbreak of chikungunya fever, a deadly mosquito-borne virus for which no vaccine exists, in Ernakulam, a city north of Cochin, the commercial capital of Kerala during the 2006 monsoon season, understanding the connection between waste and health, Wesco Finance decided to pursue integrated waste management systems as a preventive measure for future outbreaks. Wesco Credit began promoting and constructing biogas plants, which generate both clean energy and income for families (primarily by reducing household energy costs).

Thus far, they have constructed 350 biogas plants for individual households, as well as for commercial establishments such as industrial clusters. Smaller household units cost approximately $325, servicing a family of five to six. These units are financed by SHGs supported by Wesco Credit with loan terms of two years. One installment loan payment is collected in advance as a security deposit. The villagers are carefully instructed how to operate the solidly constructed plant, which has a life span of approximately 20 years. The waste decomposes anaerobically inside the chamber, producing a mixture of methane-carbon dioxide biogas that is pumped directly to the kitchen’s gas-run stove. The process also generates solid compost called sludge slurry, which serves as a potent fertilizer that Wesco clients use to promote organic farming.

Wesco Credit is now planning to scale up its biogas initiative, as well as other renewable energy products. Over the next year, it intends to install about 1,200 residential biogas units, 1,000 family-size units, and 200 units to be used in rural farms. It also plans to install 50 institutional biogas plants to be used at hospitals, parish halls, and apartment complexes.
3.d.5.5 Smokey Mountain Remediation and Development Program (SMRDP) in Manila, Philippines

SMRDP was initiated with the support of the Asian Development Bank in August 2005. A public-private partnership (PPP) mechanism has also been used here along with micro-enterprise support for the Material Recovery Facilities (MRFs), creating opportunities for micro-financing. Many waste-related projects have been delayed due to reluctance of banks to commit to substantial and/or long-term lending and/or the collapse of bank-syndicated lending for such projects, as well as fluctuating bank terms (M&A Solicitors News 2009, in EMC 2010). Hybrid financing models have been introduced as an innovative solution to address such bottlenecks.

3.d.5.6 Participatory Solid Waste Management (PSWM), Brazil

Micro-credit funds were created for informal recyclers in Brazil through donations, which addressed a major hurdle in meeting the working capital. Such micro-financing approach in Brazil was established in 2006 and has been believed to have opened fresh routes for “micro banking” in solid waste management for developing regions (Hogarth 2009, in EMC 2010).
Annex V: Strategies That Work: Financing Eco-Industrial Cluster Initiatives

Worksheet

Learning Objectives:

You, the credit portfolio manager of a reputed private commercial bank of your country, are leading a team consisting of a policymaker, a representative from a local community-based organization, and a representative of a small industries association. The objective of the team is to report on the feasibility of providing micro-finance eco-initiatives in the food-processing industrial cluster. Refer to the rice and poultry industrial cluster in Chachoengsao Province, Thailand example from the previous session. Consider the potential key energy technologies in the EIC.

Study Time:

1.5 hours [Workshop—45 minutes; Group Discussion—45 minutes]

1. How will you integrate the environment into the economic development of the city? What are the key factors that should be considered for the provision of micro-financing the eco-initiatives in the cluster?

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2. What are the possible technologies or eco-initiatives that your bank can finance for the EIC?

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3. Think of the energy program (bio-methanation in the cluster) and identify how that energy generated can be better shared within or outside the cluster to both be economically and socially viable.

4. You are required to make a recommendation on the type of micro-financing (vendor financing, joint venture, franchising, etc.) your bank should undertake. Since the rationale of commercial banks is to make a profit, you have to convince other banks to join the venture based on both the social capital and profitability of the venture. Please present arguments to convince other commercial banks and finance companies to join the venture.

5. You identify some risks to funding SME activities in terms of collection and monitoring of their activities. What suggestions would your team make to mitigate those risks?

6. Do you think that the government should be part of the team to co-fund the micro-financing of the EICs? Please provide the reasons for your opinion, and the areas where the government can be involved in the micro-financing of SME activities.
7. Identify ways to improve flexibility of loans granted by commercial banks as part of micro-financing programs.

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8. SMEs are unbankable also because they lack innovative ideas and capacity to approach financial institutions for financing. What innovative ideas can your team come up with for enabling EICs to secure access to funds from financial institutions in a more convincing manner?

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9. Illustrate an example each of environmental micro-financing initiatives in your country— micro-financing by Micro-Finance Institutions, through Non-Governmental Organizations (NGOs) or relevant subsidiary entities, and by private commercial banks. What courses of actions are taken by your national government to promote financing of EICs?

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10. What are your suggestions for attracting and motivating national private banks to finance EICs?

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11. EICs can receive financing through a multitude of channels, as many international banks are introducing green funds and there is a general trend towards the greening of bank lending through regulation. What should be the approach taken by SMEs so that international banks can invest heavily in EICs?

12. Financing is still profit-driven and the market does not have a social or environmental conscience. What innovative financing process could solve the problem?

References and Reading Materials


Module 4: Transforming Eco-Industrial Clusters into an Inclusive Business Development Model

4.1 The Stakeholders’ Role in Eco-Industrial Cluster Formulation

A growing number of EICs are operating successfully in terms of achieving the triple bottom lines of poverty alleviation, environmental conservation, and economic growth. The examples in the previous module span a wide range of countries and industries. Each featured EIC developed a solution set, allowing it to succeed in its local context according to unique objectives and outcomes. Yet the case studies reveal common patterns—EICs respond to sustainability constraints, by several stakeholders working together on issues of resource efficiency and by removing obstacles. The key stakeholders in the process are policymakers, businesses, and knowledge institutes (Figure 4a.1).

It is crucial to note that successful EICs as inclusive business model typically combine several strategies to address multiple constraints. To get from broad strategies to focused roles, one must not only identify each constraint but also understand its dynamics in the market.
Module 4a: Role of Policymakers: Can Eco-Industrial Clusters Be Made?

4.a.1 Introduction

EICs should emerge spontaneously, depending on local environment surroundings and entrepreneurial dynamics. However, even the most successful EICs benefit from a propitious policy framework that promotes industrial symbiosis among firms. Although EICs are formed as a result of entrepreneurial culture to explore the benefits of local externalities and synergies, government intervention takes place because policymakers consider “clustering” to be a process that can be harnessed on a local scale. Furthermore, eco-interventions at the cluster level are capable of influencing its competitiveness at national and even global level. In that sense, eco-industrial clustering can embrace many aspects of regional development policy, including state interventions to support supply chain development, collaborative ventures, and inter-firm networks. EIC policies can also embrace interventions in labor markets, skills and training, support for eco-product development, and eco-process innovation. It is this holistic nature of EIC as a concept that enables policymakers to embrace the agenda of different sectoral policymakers and absorb existing practices as well as engage with new policy initiatives.

4.a.2 Practical Actions by Policymakers to Promote the Creation of Eco-Industrial Clusters

In simple terms, EICs are designed to identify and support growth that is environmentally, economically, and socially sustainable, and to become or remain competitive. While not always stated, it tends to be implied that this requires a focus on a certain type of businesses that can be described as eco- and knowledge-intensive or that are capable of generating high productivity growth. There is often a connection, therefore, between cluster policies as widely practiced, the application of new and advanced technologies, and knowledge transfer activities.

Creating synergies between different sectoral policies, such as those related to industry, agriculture, energy, international trade, etc., and avoiding policy conflicts becomes a necessary condition. It is likely that different integrated environmental and economic policy measures will be appropriate for different EICs at different times, as they should be judged on a case-by-case basis, taking into account environmental, social, and economic criteria. Integrated public interventions, such as those shown in Table 4a.1, can work to create or enhance each of the micro-foundations and objectives of eco-industrial clustering.
In terms of system economics, the formation of EICs is approached in either of two ways. One approach is the spontaneous formation of EICs from the bottom to the top of the industrial production chain. The key point of this approach is market function, and elimination of market malfunctioning. The second approach to EIC formation is from top to bottom, with the emphasis on the government giving priority to the development of a certain industry. Figure 4a.2 explains the characteristics of these two policy approaches.
Compared with previous forms of regional industrial policy, EIC-based regional development policy tends to involve the following:

(i) A shift in focus away from supporting individual firms with grants and loans towards networks of linked firms and associated services that constitutes firms’ eco-competitiveness.

(ii) Less emphasis on large firms and inward investment, although there is a role for large firms in some local clusters, and greater stress in local agglomerations on SMEs and indigenous growth processes.

(iii) More sophisticated methods for identifying firms that depend on local resources and focus on areas of competitive strength in the regional economy.

(iv) Less emphasis on financial incentives and greater emphasis on softer forms of interventions to stimulate collective eco-practices, networking, and development of trust relationships and social capital between key players.

(v) Greater role for policymakers as facilitators or brokers between companies, and between companies and regional knowledge institutes.

The way in which EIC policy is formulated in practice can vary considerably in terms of details depending on national priorities, local and regional resources, the characteristics of firms and their access to technologies, and the types of eco-products and services involved.
4.a.3 Cluster-Based Policy Responses to System Imperfections

EIC policy refers to all those efforts of government to develop and support clusters in a particular area. In emerging Asia, policymakers tend to prioritize economic and social development, to the detriment of environmental protection, use EICs to rebalance this bias, and promote inclusive and green growth that can help in tackling climate change. The following are the facilitation policy actions that lower barriers to entrepreneurship and promote public-private–community partnerships.

(i) Incentives to trigger industrial agglomeration

Clustering of firms in a particular location is usually driven by industrial businesses in the private sector and market forces. However, the support of the public sector, both at local and national levels, can play an important role to enhance conditions that influence decisions on investment by local entrepreneurs. At the local level, it is essential that governments provide attractive local conditions for the industrial clusters. Thus, the availability of adequate physical infrastructure and logistics, including roads, transportation systems, access to reliable and affordable energy and water supply, and qualified labor, is a decisive factor in fostering firm clustering. For instance, in the People’s Republic of China (PRC), successful examples of Industrial Parks were triggered by governmental policies targeting specific geographic areas to develop special economic zones in Guangdong and Fujian provinces. At the national level, it is also relevant to guarantee a stable political and macroeconomic environment, as well as a convenient government institutional infrastructure and processes that foster entrepreneurship in local SMEs.

(ii) Creation of dialogue platforms to promote linkages and interactions between industrial clusters

Sharing a common geographic location is not a sufficient condition for the formulation of EICs. A primordial factor to foster EICs is related to efficient use of locally available raw materials and recovery of co-products in order to increase productivity of resource use and lower pollution. Thus, firms need to evaluate their potential synergies and maximize its benefits, by sharing and disseminating information and expertise among themselves. One possible way to do so is by creating a platform for dialogue between all the influential industrial actors to facilitate the information flow between firms and to identify key challenges and opportunities to create industrial symbiosis. The government could take a leading role in this process by being the facilitator of the platform and formulating systematic strategies for planning and implementation actions. The dialogues would result in a common strategy for competitiveness and environmental protection guided by the private sector and supported by the government.

(iii) Enhance capacity for innovation

Creation of linkages between EIC actors and knowledge institutes, including government-supported research institutions, academia, government agencies, universities, and industrial R&D institutions, would provide new opportunities for businesses based on exploiting knowledge and skills towards more environmentally competitive models. This new framework of nodes between knowledge institutes and industrial actors will result in the development of a robust innovative environment and
dynamic cooperation in applying theoretical knowledge and transformation of innovation to environmentally-friendly processes, reduction of waste flows, and increasing recovery of resources. Links between R&D organizations and industries could be enhanced by setting up an innovation service center that facilitates the dialogue between knowledge institutes and firms.

(iv) Promote environmental awareness

Public awareness is key to fostering EIC formation. In Asian countries, there is a general lack of awareness about environmental issues, both among local communities and within the cluster. Most industrial clusters have come about through fast industrialization of national and economic development, while environmental awareness is commonly forgotten. Promoting awareness of local communities and creating social capacity could create public pressure on firms to reduce their environmental impacts and adopt more sustainable production practices. Additionally, providing information to the private sector to help them understand their role in supporting environmentally friendly patterns could also contribute to the development of EICs.

(v) Development of investment tools

Crosscutting and best available technologies are commonly more costly than conventional practices. In developing countries with limited economic resources, firms will find it difficult to afford expertise, even if know-how is available. Thus, few enterprises will be keen to adopt advanced environmental protection technologies and equipment, if they do not have any incentive to do so. For instance, the dumping of solid waste and discharging water effluents without proper treatment are unfortunately a common reality in many Asian countries. Governments need to allow financing capital to support firms investing in environmentally beneficial decisions. Depending on whether the proposed initiatives are for building competitiveness, financing sources may vary between public financing, special community funds to invest in green business, or international finance such as Green Climate Fund (GCF), Global Environmental Facility (GEF) etc.

(vi) Comprehensive legal, regulatory, and institutional framework

In order to foster the implementation of more efficient industrial practices and promote the recovery of resources within EICs, industrial actors need a strong and effective governmental regulatory framework. In fact, one of the greatest constraints when creating EICs is related to the lack of adequate legal regulation that inhibits prevaricating practices. A regulatory framework should establish strict norms to allow firms’ operations according to their efforts in meeting environmental standards and setting financial penalties for those firms that fail to meet the required standards of environmental protection. Another policy to foster the development of EICs is to reduce the regulatory burden that entrepreneurs face. This means implementing tax cuts and reducing the costs of setting up a business.
(vii) Integration of cross-sectoral policies

Lack of coordination at the sectoral level is often mentioned as a major factor in EIC failure (Soesastro 2007). The creation of an EIC involves a large number of sector-specific agencies, including commissions in charge of industrial and economic development and environmental protection. Thus, integration of solutions is likely to depend upon cross-sectoral, inter-disciplinary approaches across multiple levels. While economic planning agencies usually take a leading role in developing EICs, stronger involvement by other sector-specific agencies can also be beneficial. Creation of a centralized agency specifically targeting EIC management to lead and coordinate planning has been raised as a possible strategy to achieve a greater degree of private-sector development. It is also essential that the policies are integrated at the regional and provincial level to achieve a maximum impact on the region and sectors.

(viii) Development of environmental assessment tools at the regional level

At the regional level, countries have different environmental regulations and pollution standards. Thus, it is actually difficult for governments to evaluate the environmental component of EIC from a compliance point of view and determine when an IC is in fact an EIC. Governments usually announce the creation of “Zero-emission Parks” in order to attract foreign investors, but those parks are often nothing other than standard ICs. On the other hand, within EIC, firms might face difficulties in assessing their own energy efficiency and environmental performance. The creation of a regional standardized comprehensive Environmental Pollution Index for EIC, such as the one developed by the Ministry of Environment in India, could raise the competitiveness of EICs and guarantee firms are in compliance with the regulations governing environmental protection. Such a tool would identify polluted industries within a cluster and improve the status of other environmental constituents, for example, air and water quality data, public complaints, ecological damage, and visual environmental conditions. Additionally, it would facilitate the definition of critically polluted areas and prioritize economically feasible solutions to mitigate its impacts.

Summing up, governments are key players in the establishment of EICs, but standalone policy actions will have only limited effect when the aim is to use EICs as a strategy for sustainable regional development. Governmental actions should be consistent with local and economic contexts and further integration of the private sector in the decision-making process is needed. Table 4a.2 summarizes the predicted impacts and outcomes that each of the proposed strategies might have in terms of fostering EIC development. It reveals that one strategy can simultaneously have several impacts both at the industrial, environmental, and financial policy levels.
Table 4a.2: Key Policy Actions for Improving the Creation of Eco-Industrial Clusters and Outcomes

<table>
<thead>
<tr>
<th>Key actions</th>
<th>Industrial policy</th>
<th>Environmental policy</th>
<th>Financial and development policy</th>
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</table>
| **Incentives to trigger industrial agglomeration** | • Development of physical infrastructure, logistics, and other internal market conditions  
• Guarantee affordable and reliable energy and resource supply | • Incentives for insertion of raw materials, products and services in local/national/regional/global value chain  
• Promotion of energy and resource use efficiency by physical exchange of materials, energy, water and by-products  
• Share of common waste treatment facilities  
• Reduction of waste generation and lower air and water emissions | • More competitiveness due to saving cost from lower waste creation and disposal  
• Greater availability of credit  
• Diverting public investments under development portfolio (synergy between national development, provincial development and industrial policy) |
| **Creation of dialogue platforms to promote linkages and interactions between industrial clusters** | • Engage actors by identifying economic opportunities  
• Advantages from collective sharing of resources and exchange materials | • Reduce the energy and material intensity of goods and services  
• Reduction of waste disposal and pollutants discharge  
• Enhance waste recyclability and reuse  
• Engage civil society organizations concerning environmental matters | • Cutting cost through the efficient use of resources |
| **Enhance capacity for innovation**               | • Improvement of scientific capacity building  
• Access to market information  
• Technology upgrading  
• Creation of new enterprises  
• Set up a national R&D program working closely with businesses and universities  
• Online database of best practices, regional share of knowledge | • Support research in green and clean production  
• Study the potential circular life cycle of production outputs  
• Mapping waste production and possible matching with other industrial clusters  
• Technical support and participation in industrial symbiosis programs  
• Appropriate environmental monitoring, reporting, and verification system in place | • Establish national and regional Cleaner Production Centers focusing on small and medium enterprises (SMES)  
• Increased development opportunities through market diversification |
<table>
<thead>
<tr>
<th>Eco-Industrial Clusters</th>
<th>A Prototype Training Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Promotion of environmental awareness</strong></td>
<td><strong>Development of investment tools</strong></td>
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</table>
| - Support to training for industry, including SMEs  
  - Develop guidelines and training on public participation in sustainable consumption and production programs | - Innovative financing instruments including insurance programs, green bonds, and other risk transfer products  
  - Develop a consistent budgetary framework for integrating sustainable production | - Integrated policy across all lifecycle stages of toxic materials and of the product or service design cycles  
  - Institutional set-up and defined procedures for proper coordination from central to local level to facilitate the EIC cluster functioning (minimize obstacles due to policy and institutional overlaps for efficient functioning of EICs) |
| - Eco-labeling and other green sealing program types  
  - Improved training for government inspectors | - Implementation of innovative market-based incentive (taxes, subsidies, incentives, etc.)  
  - Support to future developments on a global environmental agenda  
  - Introduce investment appraisals based on incremental environmental benefits | - Stickier performance standards legislation on environmental protection and resource conservation  
  - Set up a program to more efficiently control emission standards  
  - Higher penalizations to prevaricators  
  - Eliminate subsidies for fossil fuel resources and other natural resources  
  - Provide incentives to encourage resource efficiency and recovery of materials and energy and put disincentives on the disposal of materials as waste  
  - Increase effectiveness of enforcement of regulations and create counter-accomplishment measures |
| **- Improve efficiency, transparency and accountability, by including rating programs and monitoring, reporting, and verification systems linked to credit lines** | **- Coordinate the development of strategic framework for using global environmental financing instruments**  
  - Facilitation for capitalizing on international financing (e.g., setting up of country level green funds, facilitation for CDMs, GEF, etc.)  
  - Affordabile technology  
  - Increasing financing opportunities through public funding | **- Performance-based tax incentive systems for achieving eco-efficiency standards** |
<table>
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<tr>
<th>Integration of cross-sectoral policies</th>
<th>Development of environmental assessment tools at a regional level</th>
</tr>
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<tbody>
<tr>
<td>• Empower local governments to EIC programs and foster cross-sectoral coordination</td>
<td>• Develop green indicators to assess the environmental performance of the EICs and identify potential opportunities for improvement</td>
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<tr>
<td>• Develop sectoral guidelines to overcome specific identified gaps and facilitate uptake of best practices</td>
<td>• Enhance production processes</td>
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<tr>
<td>• Coordination of involved industrial actors</td>
<td>• Increase responsiveness of support institutions</td>
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<td></td>
<td>• Increase competitiveness of clusters</td>
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<td></td>
<td>• Strengthen environmental impact assessment (EIA) tools, standards and methods</td>
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<td></td>
<td>• Driver for eco-enterprise development</td>
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<td></td>
<td>• Explore innovative financing instruments and accelerate R&amp;D support for future industries through EIC agenda</td>
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<tr>
<td></td>
<td>• Conditional cash transfer program for disadvantaged industries</td>
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Source: Authors.
4.a.4  Case Study: Kawasaki Eco-Town, Japan

Kawasaki Eco-town is a promising example of a joint effort between the government and local enterprises to revitalize an industrial cluster based on the industrial symbiosis principles. Driven by stricter waste management legislation and environmental degradation of urban areas, the government and the private sector have taken actions to develop the Kawasaki Eco-Industrial Cluster into an environmentally-friendly production zone. The industrial complex aims to achieve the cyclical use of resources through the establishment of recycling and materials reuse programs between facilities to minimize the environmental impacts of each industry (Figure 4a.3). The actions include the creation of zero-model emission plants, restriction of air emissions and water effluents, implementation of higher pollution abatement standards, promotion of logistical support, coordination of material exchange between firms within the cluster, and development of public education regarding environmental attributes (Kawasaki Eco-Town). Norton (2007) highlighted five strengths of the Kawasaki eco-town project: (i) dense networking between industrial clusters, government, and Kawasaki EIC that work together to improve heat and electricity recovery among industries and urban areas; (ii) public engagement with the project; (iii) existence of anchor facilities, such as cement manufacturing, that allows the use of low-grade waste materials locally; (iv) process synergies between local government and industries; and (v) well-established transportation infrastructure and concentrated manufacturing industries. Since the completion of the project in 2004, the complex has benefited from a reduced environmental burden and operational cost of solid waste treatment plants. Some of the synergies include cement production from incineration of plant waste, heat production from waste oil, and electronic appliance recycling.

Despite the success of the project in terms of environmental and economic performance so far, its greatest improvements are yet to come in terms of achieving an optimal coordination of activities necessary to fully promote eco-products and energy exchanges between firms. Moreover, finding new players to join the Eco-Town Project is also difficult, because firms cannot see the short-term economic benefits. Although firms benefit from environment-related business opportunities, economic profits remain the main priority for the majority of companies. To stimulate firms to invest in more sustainable production processes, business incentives and subsidies, along with education and information sessions, should be provided by the government.
Annex VI:
Role of Stakeholders: Policy Planner

Worksheet

Learning Objectives:
On completion of this exercise you will be in a position to develop efficient EICs and sustainable industrial structures which enhance the development potentials of the local regions and policies of the government at different levels.

Workshop Duration:

1.5 hours [Study Time—45 minutes; Group Discussion—45 minutes]

1. The government plays an important role in facilitating the agglomeration of firms, the development of inter-firm networks, and transforming them into competitive economic zones. While experimentation with cluster policies and strategies by governments has taken place in many countries, the evolution and growth of EICs should be driven by markets and communities. In your view, what strategies should be implemented by policymakers in Asian countries to foster the development of EICs?

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2. Tailoring the policy environment for an EIC is a costly and risky exercise. The payback may not materialize, and even if it does it may take years before the community derives substantial benefits from the new EIC. The process calls for a vision of development centered on specific characteristics such as planning and coordination of various policy initiatives that promote entrepreneurship.

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What specific interventions would you propose under different policies, namely:

(i) Industrial policy
(ii) Environment policy
(iii) Financial/tax policy
(iv) Regional development policy
(v) Provincial policy
(vi) Any other

3. The lack of integrated sector policies and the absence of macro-level coordination of policies are the main weaknesses in EIC evolution. In your opinion, do the individual policy-making communities (agriculture, industry, environment, social development at different levels) as well as business need to discuss and negotiate integrated policies? If so, in what areas and involving whom?

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<tr>
<th>Area</th>
<th>Agriculture</th>
<th>Industry</th>
<th>Environment</th>
<th>Finance</th>
<th>Social</th>
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<tbody>
<tr>
<td>a. Production process</td>
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<td>b. Material use</td>
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<td>c. Energy</td>
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<td>d. Water and air pollution</td>
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<td>e. Waste management</td>
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<td>f. Marketing</td>
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<td>g. Human resources</td>
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<td>h. Quality of life</td>
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<tr>
<td>i. Community connections</td>
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4. Any financing plan involving large-scale reshaping of resource flows within a region in favor of EIC formatting has many parts to it, such as raising money from local taxes, fees, and charges. Obtaining long-term resource transfers from central authorities to local governments is another factor, which can have problematic and time-consuming legislative implications. What would be the differentiated role for central government and local governments in the EICs? How can EICs be implemented more effectively by local governments?
5. Eco-industrial clusters need ready access to a pool of skilled technical force and sources of innovative knowledge. For these vital reasons, EICs tend to be found in regions where the presence of universities was strong in terms of their contribution to the formation of new firms and innovation capability. What is the role of policymakers to reinforce the innovative capacity of EICs?

6. A finely honed technological capability enables EICs to evolve and expand their economic and environmental competitiveness. But the cost of green technology is a barrier in relation to their adoption by SMEs. What is the policymaker’s role in terms of setting technology goals, with particular focus on costs and access to technologies at national and local level?

7. Managing regulations along with market-based mechanisms are commonly referred to as effective tools to support green investments and innovation, when firms cannot directly benefit from tangible economic returns. What type of policy mix can help to stimulate consumer demand and reduce information failure?

8. While different sector policies favor formation and growth of EIC, some clusters may have been formed in an attempt to encourage the emergence of new industries. The emphasis has increasingly been on measures to increase levels of national competitiveness rather than on social benefits and environmental gains at the local level. How can policy attention be given to the overall outputs and outcomes derived from different types of strategies discussed in this training program, and in which ways can the success of an EIC be measured?
9. Kawasaki has been able to clean up its local environment following its Renaissance plan, dating back to 1987, which encompassed a short-term redevelopment of the city as well as a longer-term development of an infrastructure that would support inter-firm networks, eco-innovation, and economic diversity. The extent to which industry partners, local governments, and the central government worked together created the development of a system that focused on environmental issues and pollution control. What are the policy insights that can be applied to its replication in other emerging economies of the region?

10. To sustain its dynamic growth, Kawasaki eco-cluster must rely more on the emergence of local firms that could lead the way, instead of relying on subsidiaries of large firms and government subsidies. This shift of mindset will require a better support system for start-ups and spinoffs. Japan is a leading producer of environmental technology, but the current business structure in Japan tends to be vertically oriented along the traditional industrial sectors. Where do you place Japan in this figure? What policy efforts are needed to match current capabilities with other growth areas of the emerging economies?

References and Reading Materials

Module 4b: Role of Business in Eco-Industrial Clusters

4.b.1 Introduction

EIC is recognized as a managing tool for examining social enhancement, environmental preservation, and economic development of industrial advancement activities. It is a good example of a successful inclusive business model. However, EIC has to deal with continuously evolving markets and dynamic competitive relationships. To navigate this complex terrain, a few practical steps are needed for EIC companies to make progressive use of industrial ecology principles that incorporate IC development and management.

4.b.2 Business Role in Effecting Change in the Community

The first generation of industrial clusters can be traced back to the 1990s, when the backyard factories moved to specialized SMEs in a previously un-zoned area also known as the center satellite system that resulted in increasing productivity. A good example is Japanese just-in-time (JIT) model clusters. The next generation of clustering of SMEs and multinational companies (MNCs) were known as industrial estates or industrial clusters, science parks, corporate synergy systems, and Environmental Management Systems (EMS). By this time, with the growing negative environmental effects of industrial clustering, eco-industrial development (EID) has become an important strategy with different perspectives on attaining higher eco-efficiency: cleaner production, green productivity, eco-efficiency, green economy, green industry, green jobs, and green growth. In many cases of EIC, the environmental goals were achieved by setting regulations and emission standards; through ecological pricing, etc.

A well-known example of an EIC is the town of Kalundborg in Denmark, a successful example of an Ecological Industrial Park (EIP), which shows how implementing industrial ecology concepts can achieve industrial symbiosis of waste flows. Other major EIC initiatives in Asia have been Japan’s eco-towns (self-funded), and the Private Sector Participation in Managing the Environment (PRIME) Industrial Ecology Module (with UNDP) in the Philippines. Until 2004, EIC initiatives were also implemented and strengthened in other Asian economies including Thailand; Taipei, China; the People’s Republic of China; India; Sri Lanka; and Australia, before spreading to other regions including North and South America and North Africa. The initiatives ranged from reducing by-products, to creating a recycling-oriented society based on a knowledge-based economy, to achieving zero-emission goals, and eventually creating eco-cities. In the above cases, the primary change agents were local business or business associations, which advocated institutional innovations.
EIC is not an autarkic industrial production system. Businesses cooperate with each other for eco-efficiency, but also with local economy and culture, resulting in tangible and intangible benefits for a society. As illustrated in Fig 4b.1, EICs utilize the following five distinctive but mutually reinforcing approaches to connect business and local communities, resulting in income-generating activities.

• Starting new and strengthening existing businesses in the clusters to demonstrate the ability of the inter-firm networks that contribute to the increased competitiveness of the EIC, which will also stimulate eco-innovation within.

• Building and organizing supply chain relationships between SMEs located in EICs and outside businesses. Through in-depth knowledge of cluster based eco-products, services, as well as external markets, successful buyer-seller relationships that could benefit individual companies within the cluster shall be identified.

• Linking local residents to new job opportunities. Companies operating in EICs shall focus on the unique strengths of workforces available in rural areas rather than concentrating on labor-constrained urban areas. To ensure a steady supply of qualified workers for companies within an EIC, specialized services like training and workforce development programs are needed.

• Growing the sales of eco-products and services of companies. Supporting the growth of new small business requiring a sustained commitment from the public and private sectors, from micro-finance to market information, to ensure the continued competitiveness of urban-fringe areas improve the prosperity of interconnected cluster companies.

• Relocating existing business operations to clusters by providing affordable technologies and accessible infrastructure that will attract companies to EICs. For start-up companies or existing companies relocating into an EIC is attractive as it offers close proximity to transportation systems, easy procurement of raw-materials, a plentiful supply of labor, and easily accessible consumer markets. Infrastructures and technologies that encourage relocation are to be provided.
4.b.3 Building a Business Case for Eco-Industrial Clusters as an Inclusive Development Model

The first step in developing an EIC program is to evaluate the business actions and understand the external landscape. This will help to identify the highest priority business operations, evaluate risks and opportunities, and build policy support for specific issues.

There are many compelling reasons for businesses to take actions to improve environmental and social impacts within industrial clusters. The business case for a particular company depends on a variety of issues including sectoral regulations, ecological footprint, stakeholder expectations, business strategies, and organizational culture. The most common business drivers for operating within EICs are depicted in Figure 4b.2.

The key focus of businesses is to realize efficiencies by operating within an EIC and reducing operational costs, including energy, water, and natural material use, motivation, and productivity. Productivity and efficiency initiatives within IC require a full understanding of different steps, technologies, and environmental and social impacts (Figure 4b.3). Addressing the root causes of issues through strong communication with cluster firms and shared assessment can drive improvements and result in benefits. By operating within clusters and ensuring compliance with regulations collectively, companies can protect themselves from potential supply chain disruptions, and labor, environmental, and governance risks. Collaboration between companies can foster product and process innovation. EICs embarking on such initiatives can add environmental value to existing products and even generate new eco-products. For example, new eco-products may result in zero environmental impacts compared with traditional products. It is also possible for the eco-products to be the differentiating factor for a particular EIC among all ICs and lead to increasing sales of traditional goods generated by a particular EIC.
4.b.4 Establishing Sustainability Expectations for Eco-Industrial Clusters

Businesses play an important role in EICs and eco-innovation. Business performance is also closely related to supply side moderators linked to markets and demand-side moderators connected to policy instruments (see Figure 4b.4), thus creating economic and environmental value that enables use of green products and services. Business models that incorporate environmental values allow for better understanding of the overall competitiveness of businesses that provide profitable products and services, and deliver convenience and satisfaction to customers.

The four key issues are (a) effective use of raw and waste materials, (b) knowledge and technology, (c) employment generation, and (d) complementary eco-product development. Apart from a macro-level perspective of production systems, waste could be seen as an input for another production system where it could be re-used.

In terms of EIC, there were economic benefits as could be seen in Korea where efficiency and resource utilization largely improved, leading to better ecological and social conditions (improving knowledge sharing and management and other spill-over effects). However, it is difficult to see how clusters combine and improve the 3R’s (Reduce, Reuse, and Recycle) through solid waste management, water use management, and electricity and power use management. It is important to identify the level of policies that can be put into place, with measurable performance indicators and monitoring and supervision capabilities.
4.b.5 Improving Business Performance within Small and Medium Enterprise Clusters

Monitoring, reporting, and verification are important, especially in the context of SMEs. The key issue is how the environmental performance is going to be implemented and evaluated. During the industrial process, two aspects of production are the technology used to produce a product and what is to be done with the waste generated in the process. Instead of ignoring waste as an end-product, it is important to look for partners that could possibly use the waste as an input to their production system, which becomes a fundamental operational principle of an EIC. So the issue is how waste generated during and after production can be reused in another production system. Apart from by-products and waste re-use, downstream pollution control (waste water treatment plan, meeting standards) is taken more and more seriously by countries and requisite legislations are being put into place. But what has been lacking so far is an upstream resource utilization analysis.

Business performance and benchmarking also improves industrial competitiveness through efficiently using resources, and reusing waste. Industries in general are only interested in meeting environmental standards (by the cheapest means) so as to meet regulations, but do not recognize the other benefits that should become more ingrained as they provide social, environmental, and micro-economic benefits of poverty alleviation and job creation. Thus, businesses have to be regulated and provided with incentives to internalize environmental benefits and social costs in their operations.

4.b.6 Developing and Adopting Codes of Conduct for Businesses Operating within Eco-Industrial Clusters

Codes of conduct are critical to establishing and managing expectations for customers, suppliers, and other associated firms operating within an EIC. They create a shared foundation for the success of an EIC. For many companies, code of conduct is a natural extension of business value statements and seen as an affirmation of existing expectations, rather than a new set of requirements. When developing codes of conduct, there are a number of national/provincial environmental, economic, and social laws that should also be consulted and referenced. Box 4b.6 depicts such a code for an SME cluster in India. For social elements of the code, companies within an EIC can establish common expectations on a broad range of issues concerning local employment, social security, and labor rights. Environmental topics that are most relevant will vary from one EIC to another, which makes dialogues and collaboration critical to identifying which issues are most important to be covered in the code of conduct. It is also important to regularly verify the contents of the code to determine whether updated language and interpretation is needed.
Sago Serve industrial cluster

Sago Serve, an agro-industry association of more than 450 progressive SMEs operating as a cluster in Salem, Tamilnadu, India, established a joint code of conduct that provides a united voice for producers’ and customers’ expectations, streamlined their oversight of operations within a cluster, and allowed both to focus on changing environmental and social conditions. Each member company of Sogo cluster had committed to adopting the following codes of conduct and implemented them in their operations:

**Environment**

1. Raw material reuse
2. Recyclability and end of life product
3. Material toxicity and chemicals
4. Greenhouse gas emissions
5. Energy conservation and renewable energy use
6. Water conservation and waste water treatment
7. Air pollution
8. Biodiversity

**Social**

1. Child labor
2. Wages and benefits to local labor
3. Freedom of association and collective bargaining
4. Occupational safety
5. Non-discrimination
6. Industrial hygiene
7. Working hours
8. Social security

**Management**

1. Conflict of interest
2. Accounting and business records
3. Transparency
4. Reporting misconduct

The following steps were undertaken in the development of codes:

1. Consulted with all stakeholders including all suppliers, consumers, governments;
2. Based expectations on existing norms of behavior rather than inventing new standards to avoid undermining national standards and laws and prevent conflicting expectations;
3. Consulted with cross-functional industries operating within the EIC;
4. Reviewed the code at annually scheduled business meetings.
Geographically, EICs have relevance especially when they are located in urban-rural fringe areas. Urban areas tend to have space limitations but high consumption demand, whereas rural areas typically have plenty of natural resources, but lack manpower, industries, and consumption demand. This means fringe areas are ideally located to complement the rural-urban divide in resource use to meet consumption demand.

4.b.7 Case Study: Biotech Industry in Bangalore

Adaptation and scaling up is important in an EIC (e.g., Biotech Clusters in India). Although Biotech clusters were mostly located in the west and south of the country, Bangalore as a city had the largest biotech cluster in the country. The city, apart from being the country’s IT hub, has been gaining prominence in the biotech industry. The State of Karnataka where Bangalore is located, already has premier institutes and has a single contact point for accessing the industries in the state networked by the government.

It was stressed that, aside from national policies, state government actions played a crucial part in the development of this cluster. The Millennium Biotech Policy of the state had already set out the vision of a biotech revolution and set up specific infrastructure for the development of biotechnology by developing biotech corridors. The biotech industry has evolved by integrating the fields of biology, chemistry, and engineering and by offering solutions in application-oriented bio-related industries (e.g., bio-pharma and bio-agri sectors). The biotech clusters in Bangalore are based on an association of hospitals, agricultural businesses, IT and other manufacturing industries, universities, research institutes, and government agencies, thus forming a diamond of businesses of scale and environment with: context (policy, infrastructure, etc.), factor input conditions (natural resources, HR, and R&D, etc.), related and supporting industries (IT, Logistics), and demand conditions (market) as the four vertices.

The rapid growth of the biotech industry has confronted Bangalore with the environmental challenges of pollution, waste management, and emissions. For example, solid waste in bio-clusters in Bangalore amounts to 2,500 tons per day, of which 75% is compostable matter. Most of the Biotech clusters already have their own water recycling and solid waste treatments plants (where solid waste is incinerated and ashes later disposed). This is done in line with international standards, and these facilities are demanded by the clients (mostly located in the United States, Europe, and Japan). Smaller firms still face difficulties in treating solid waste and government coordination for eco-services could be necessary.
Annex VII:
Role of Stakeholders: Businesses

Worksheet

Learning Objectives:

On completion of this exercise you will be in a position to understand how to improve the positive role of businesses in improving the eco-efficiency of Industrial Clusters.

You are leading a team of policymakers to improve the environmental performance of businesses in an EIC. The cluster is made up of several large companies and many small and medium enterprises (SMEs). The large companies tend to operate as silos and enclaves without much participation of the SMEs. You observe that the environmental pollution of SMEs is much higher than that of large companies and that there are only limited links between the community and the businesses.

Workshop Duration:

1.5 hours [Study Time—45 minutes; Group Discussion—45 minutes]

1. Businesses operating within an EIC often take the initiative to meet challenges and harness the opportunities available. Focusing only on business case may add value that should be complimentary to its corporate social responsibility. Identify three key areas that your business could focus on to improve the environmental performance of the EIC.

2. Some EICs have established joint codes and undertake aspects of collaborative engagement. What corporate strategies will enhance the environmental performance of companies and emerging risks?
3. The power and presence of a big company within an EIC can become a unique driver for bringing about positive change. How will you improve the linkages between SMEs and large companies in terms of environmental and economic performance?

4. EICs are closely linked to the social fabric of local communities. How will you improve the linkages between businesses and community? How will you convince businesses that taking into account societal values and the environment will increase the overall welfare and business operations of firms?

5. Cooperation between companies can create significant efficiencies, but also comes with some risks, such as internal commitment, resource draining, and unwillingness to change course by some partners in the short term. What are the benefits of industrial cooperation and how can the risks be minimized?

6. The importance of consumers in the business environment is very important for EIC-innovation. Do you agree? What are the key factors in changing the consumer behavior with a view to improving EIC innovation?
7. While it is important to establish clear roles for key functions throughout an EIC, it is equally important to set comprehensive performance standards. For example, Sogo Serve launched a sustainable supply-chain environmental management program in India, the specific objectives of which include (i) using a set of social, environmental, and management indicators as governing principles of membership, avoiding suppliers whose practices are not in line with regulations, (iii) adoption of fair and open communication, (iii) regular monitoring of performance. What type of data needs to be collected over time to evaluate performance? Develop a matrix to monitor the implementation process.

8. Nestle Indonesia, a food beverage company established a dedicated supplier development department in 2005 to achieve cost savings and improve its environmental performance. The company invested in working with cluster of producers through training programs and providing technical assistance on environmental friendly practices. The following capacity building approaches are adopted by Nestle (i) integrating learning and capacity building into auditing process, (ii) providing supplier/worker training on major areas of non-compliance, (iii) providing tools that supplier clusters can access and use independently, and (iv) creating or supporting a large network. As a result of these programs, by the end of 2009, Nestle had saved US$5 million. By the end of 2009, this initiative had also been replicated in Bangladesh, Brazil, India, Malaysia, and the Russian Federation. Discuss the strengths and weakness of such approaches.

9. When evaluating the growth of clusters, cities may not be an appropriate unit of analysis. New EICs must be viewed by adopting a broader concept, linking the resources available in the rural areas, to be anchored in the fringe areas. Thus, planning for such an EIC requires coordination among principal jurisdictions and allows for penetration of new industries. What sort of incentive mechanisms are needed for the activation or relocation of eco-industries to fringe areas?
10. How does accounting for social and environmental factors improve company profits? If accounting for social and environmental factors improves the profit of companies, why do companies not account for these factors in their business decisions?

References and Reading Materials

Module 4c: Role of Knowledge Institutes in Eco-Industrial Clusters

4.c.1 Introduction: Knowledge Management within Eco-Industrial Clusters

Knowledge is often considered to be a fundamental basis for competitiveness, and particularly tacit knowledge, it can be argued, is a source of advantage because it is unique, imperfectly mobile, imperfectly imitable, non-substitutable and, personally or socially embedded. ICs are a place where knowledge is created, transferred, and made accessible. In EICs, the proximity of firms plays an important role in the interactive learning process in the sense that it makes learning less expensive, more reliable, and easier.

The presence of and linkages with knowledge institutes provide critical inputs for businesses operating within EICs by reducing transaction costs and encouraging innovation. They also facilitate the coordination of economic decisions and stimulate the transfer of knowledge. It is important to note that knowledge is being created by various R&D activities rapidly and continuously to help individuals acquire new skills and to help organizations manage new ways of learning. Knowledge and innovations thus generated are translated into business opportunities by the firms. Information networks facilitate the exchange of knowledge between all economic agents involved and hence increase the diffusion process in the economy. Knowledge diffusion activities involve technology transfer, but also sharing of knowledge in meetings such as workshops and conferences.

Box 4c.1 shows various sources of knowledge within a cluster. The exchange of knowledge between knowledge institutes and firms can be formal or informal. Knowledge institutes are basically think tanks, R&D institutes, and training institutes. Businesses either have their own internal arrangements for R&D and capacity building structures within their organization or they rely on external arrangements with knowledge institutes. As happened in the Maniwa industrial cluster, researchers of the knowledge institutes and managers of firms within the EIC share valuable knowledge with informal contacts. Hence, informal contacts are an important channel of knowledge diffusion.

In the eco-town of Kita-Kyushu, technological, market, and managerial knowledge are exchanged purposely between firms and knowledge institutes to foster innovation. Firms in EICs can acquire knowledge from other clusters through strategic partnerships, facilitated by knowledge institutes. Figure 4c.1 below illustrates the role of knowledge institutes in the EIC development process.

Fig.4c.1: Role of Knowledge Networks in Eco-Industrial Clusters

Source: Authors.
Clusters are agglomerations of interconnected companies and associated institutions, not only business associations, but also those that provide training and technical assistance. This conglomeration becomes a home of innovation, as innovation occurs where actors of different backgrounds interact. A typical characteristic of an EIC is the transfer of knowledge between businesses, despite the fact that they compete with each other. Industrial symbiosis and technological proximity of the firms and inter-firms networks are the key conditions in an EIC favoring the sharing of knowledge, learning, and innovation. Sources of knowledge in EICs are listed in Box 4c.1.

**Box 4c.1: Sources of Knowledge in Eco-Industrial Clusters**

**Intra-firm sources include the following:**
- “Learning by doing,” the passive experience of production;
- Improved processes and practices derived from trial-and-error experimentation;
- Adaptation and improvement of existing technologies (such as reverse engineering); and
- Aligning of products, processes, and practices within the firm.

**Intra-cluster sources include the following:**
- Knowledge spillovers and diffusion between the knowledge institutes and companies;
- Knowledge spillovers, diffusion between users and producers of machinery, and material or production-related services;
- Intra-cluster mobility of skilled labor;
- Training and skill development through cluster-based and cluster-mediated initiatives;
- Links between enterprises and cluster-based technology institutes, such as technology development, adaptation, testing, and certification;
- Collaboration among cluster-based enterprises for adaptation and technology development, including machinery and product design; and
- Links between enterprises and customers located in the cluster, including multinational corporations and large firms.

**Sources outside the cluster include the following:**
- Customers and traders;
- Machinery and other input suppliers;
- Collaborative testing or technology development with technology institutions and enterprises outside the cluster;
- Externally sourced training; and
- Visits outside clusters and firms.
4.c.2  Role and Impact of Knowledge Institutes on the Emergence and Growth of Eco-Industrial Clusters

Key to the development of EIC growth is a strong local technology and knowledge base and access to well-trained human resources. The role of knowledge institutes in EIC formation and growth can be summarized as follows:

(i) Pre-Conditions for Cluster Emergence

— Universities and especially research institutes are important to create an environment conducive to cluster formation;

— In the initial stages, universities have to be the main driver behind cluster formation;

— In a region with an established economic and resource base, related business services, and a good supply of well-trained manpower, a large knowledge institute can be the main factor leading to the emergence of a knowledge-intensive cluster in a field aligned to local economic advantage or in a field in which it would have outstanding research or training capability.

(ii) EIC Transformation and Growth

— Research institutes and technical colleges are a key source of well-trained, specialized human resources with appropriate eco-technological and research skills that are needed to support EIC growth, but their programs sometimes lag EIC needs;

— Focused research activities by local knowledge institutes can be significant contributors to EIC growth by supplementing local private and public sector activities, especially when those activities are limited;

— Close cooperation between industry, governments, and universities is a key characteristic of growing EICs.

4.c.3  Building Cooperation between Eco-Industrial Cluster Firms and Knowledge Institutes

From a regional development perspective, knowledge-based elements are key determinants of EIC strength, as they need to provide products and services in a rapidly changing business and policy environment, where knowledge must be generated and shared continuously. Knowledge, learning, and innovation are the engines of growth in an EIC. Collaboration between firms and knowledge institutes (local universities and research institutes) that assist in developing enabling technologies and diffuse market information is hence another important partnership in the EIC. Similarly, building a good rapport with government regulatory authorities will facilitate the process of EIC development and smooth implementation of the EIC’s plans. These include government authorities forming and facilitating alliances between universities and businesses for research and development of eco-innovations, and providing support for the promotion of eco-products through niche markets.
Box 4c.2: Case of Zero Emission Research Initiative (ZERI)

Zero Emission Research Initiative (ZERI) is an example of non-governmental participation efforts in research and fostering eco-industrial development initiatives in Japan from zero waste emission. Established in 1994, ZERI acts as a think tank of newly formed clusters for providing technical and scientific information. The inter-firm network and proximity of businesses allow learning networks involving research institutes, industry associations, and local government to create knowledge in clusters through inter-organizational collaborative interaction.

Supportive knowledge networks and capacity building activities will create necessary momentum to enable inter-firm networks, eco-innovations, and new business strategies to become a reality within a cluster. This is where knowledge institutes have a role to play. R&D activities can simply be the promotion and development of new materials, and clean technologies and practices. Following innovation and transfer of new technology into the business, capacity building of the firms is equally important for them to operate the technologies with sufficient know-how and skills, to keep pace with the latest innovations. Knowledge institutes serve an important purpose in this regard by designing and delivering training.

Industrial symbiosis is the foundation of an EIC, and is also one of the drivers behind business innovation. Businesses innovation flourishes in clusters rather than in individual firms. EIC fosters inter-organizational collaborative R&D through a strategy of investing in joint research, and the subsequent sharing of knowledge and know-how thus generated. Universities and training institutes play an important role in developing, diffusing, and adopting innovation in the EIC. Government can also play the role of connecting private knowledge institutes and EIC. National R&D policy should work closely with the business and university communities to create an eco-industrial research agenda. Governments should also provide support for innovation by funding R&D activities.

Box 4c.3: United Nations Industrial Development Organization (UNIDO) —Clusters & Network Development Programme

UNIDO through its Clusters & Networks Development Programme is mandated to revitalize clusters and build networks in developing and transition economies. Thus UNIDO also works with local institutions strengthening their capacity. Services provided by UNIDO are in two main areas: (a) Technical cooperation in the formulation and implementation of cluster development projects. UNIDO assist beneficiary countries at all stages of the cluster development methodology; (b) Institutional capacity building and policy advice for the dissemination of cluster development policies at regional or national scale. UNIDO provides training for policymakers, project managers, and policy advisors involved in cluster development. Training programs are delivered in the beneficiary countries as well as at the regional and global level and last from a few days to several months.
3R Knowledge Hub (3RKH)—Asian Institute of Technology

A waste reduce, reuse, and recycle knowledge hub was jointly created by AIT, ADB, and UNEP. This knowledge hub was established with the aim of achieving the following objectives: (a) Supporting and strengthening Asia-Pacific’s regional capacity on 3R in generating innovative development concepts and technologies for 3R relevant to ADB’s developing member countries and promoting networking among the regional institutes for 3R knowledge dissemination; (b) Mainstreaming new concepts of 3R in innovation, science, technology, management, and overall development of related fields in the region; (c) Promoting 3R information exchange and sharing of knowledge.

As a means of achieving its objectives, the prime functions of the 3RKH were as follows: (a) Creating, collecting, and capturing 3R knowledge; (b) Storage and retrieval of 3R knowledge; and (c) Sharing, enriching and disseminating 3R knowledge, mainly through regional networking and training.

Japan International Cooperation Agency (JICA)

JICA provides assistance in three core areas: development of industrial bases, organizational/institutional reinforcement and capacity development. JICA’s projects also promote local industries and economies, such as the “One Village, One Product” program in Malawi. ODA loans and technical cooperation with SMEs are another area of JICA support. In relation to industrial clustering specifically, starting May 2008 JICA supported a three-year capacity building support to the Davao Industry Cluster Competence Enhancement Project (DICCEP) in Philippines for the industry cluster teams, lead agencies, and private sector leaders, as well as frontline staff engaged in SME development.

JICA Research Institute is also involved in research activities aimed at industrial clusters. JICA-RI has conducted an “Empirical Study on Industrial Clusters in Africa, the Role of Space, Infrastructure, Human Resources and Social Capital” jointly with the World Bank Africa Region. The study explored the development process of cluster-based micro and small enterprises in Africa and empirically analyzed the economic situations of such industrial clusters in six countries—Ghana, Kenya, Tanzania, Rwanda, Cameroon, and Mauritius.

At the national level, some catalyst organizations like centers for promotion of SMEs and cleaner productions play an important role in EIC development. These centers are useful in fostering local knowledge and skills and encourage innovation through collaborations between universities and industries. Box 4c.4 provides an example in Thailand, where industrial clusters play an important role by facilitating interaction and knowledge sharing among members with the assistance of government, industry associations, and community-networking organizations.

Box 4c.4: One Tambon One Product (OTOP)

OTOP was established in 2001 and basically promotes Thai products from every village. The purpose of this campaign was to improve rural entrepreneurship by refinement of the locally available resources and produce goods that are acceptable internationally. Typical OTOP products are handicrafts, textiles, cotton and silk garments, pottery, woven handicrafts, artistry items, gifts,
fashion accessories, household items, food crafts, and many other articles indigenous to each community. OTOP promotes: (a) Production of crafts in rural areas; (b) Micro- and small enterprises in the rural communities; (c) Employment and income generation; (d) Traditional skills and creativity to penetrate or/and extend local and external markets.

**Thailand Centre for Transfer of Cleaner Production**

The Thailand Ministry of Science, Technology and Environment (MOSTE) includes the Technology Promotion Department (TPD). TPD was founded in 1992 to be responsible for developing and transferring technologies as well as enhancing and strengthening capability to acquire and transfer technology from both foreign and domestic sources to SMEs, especially household agricultural enterprises. The main formal delivery mechanism of the TPD is the Regional Technology Transfer and Promotion Center (RTTPC), which includes four universities. RTTPC is particularly important for targeting grant funding from TPD, all of which is for university researchers. The universities also provide outreach services to help TPD reach its audience of rural households and SMEs.

TPD’s main activities are: (a) Organize trainings and seminars on selected technologies to the target groups; (b) Publish educational and training materials including audio/visual tools, newsletters, and magazines; (c) Provide grants to academic institutions for supporting R&D in machinery innovation development; (d) Provide soft loans from a revolving fund for R&D in target groups; (e) Provide duty reductions for selected technologies; (f) Stimulate innovation through a national award contest; (g) Set up technology databases and an Internet delivery system.

The Government of Thailand (GoT) has decided to transform the existing Technology Promotion Department (TPD) into the Center for Transfer of Clean Technology (CTCT). CTCT will become Thailand’s national data and web networking center for Clean technologies and Cleaner Production (CP). CTCT will also revitalize its Science and Technology Revolving Fund for R&D and its university grants program to provide new support for clean technologies. MOSTE requested support from the Asian Development Bank (ADB) to strengthen CTCT.

The case studies presented in boxes 4c.2 – 4c.4, outline the evolution of a new type of knowledge institutes—different from the traditional university–teaching and research model—into a more entrepreneurial model with eco-friendly development as an additional important mission. The relationship between EIC and knowledge institutes collaboration is a multi-dimensional relationship involving academic researchers, students, and eco-industry professionals. It takes many forms, ranging from informal exchanges of knowledge during joint research to formal business contacts for the purpose of commercialization.

Universities are among the key knowledge institutes that provide the innovation infrastructure needed for EIC growth and sustainability. Even if they are not necessary for a cluster to emergence, they are needed for an EIC to grow and become sustainable. Empirical evidence shows that knowledge institute–EIC collaboration is very much industry sector-dependent, that physical distance
between the EIC and knowledge institutes matters, and that university research spillover is more prevalent in regions with a networking culture, a critical mass of knowledge workers and business services, and a champion researcher, continuously promoting cooperation and a networking spirit between universities, research institutes, industry, and government.

4.c.4 Case Study: Japan’s Eco-Towns and Industrial Clusters

Japan’s eco-town program was initiated to promote “zero emissions” from local industries. This initiative led 26 various Japanese industrial clusters. Figure 4c.2 depicts the role of multiple actors in the system of innovation in Japanese eco-towns, knowledge institutes being one of those actors.

![Fig. 4c.2: Eco-Towns as Local System of Innovation](image)


Below we present case examples from Japan, where involvement of knowledge institutes explicitly contributed to the success of EICs:

(a) Kitakyushu Eco-Town

Kitakyushu in Japan is a recognized pioneer in the worldwide environmental arena, having received key awards and distinctions for its environmental prowess, such as the Earth Summit 2002 Sustainable Development Award and inclusion in the United Nations Global 500. The key drivers behind the city’s success with its eco-town project are the unwavering focus of its leadership and administrators, its close ties and cooperation with research institutions, and similar ties with companies and industries.

The establishment of the eco-town occurred in phases. In the first phase, a regional development measure designed to integrate industrial activity with environmental conservation took place. During this phase, Kitakyushu’s Hibiki Recycling Complex, Eco-Town Center, and Comprehensive Environmental Complex were the only sites targeted. In 2002, however, the city modified its plans to expand the coverage area to the 2,000-hectare Hibikinada area. Two years later, in 2004, the entire
48,500-hectare expanse of Kitakyushu City was formally covered by the project. Kitakyushu makes use of three distinct strategies through which it aims to promote environmental industries: the first is basic human resource development, the second the organization of experimental studies, the third commercialization. These three thrusts are isolated at present, but collaboration between proponents of each thrust, as well as between the parties concerned, is to materialize in the near future. After Kitakyushu, several other cities have also become eco-towns, e.g., Kawasaki, Minamata, and Naoshima. But Kitakyushu’s approach (Fig 4c.3) and thrust set it apart from the other eco-owns in several key respects. One of these areas is the clustering of recycling and environmental industries, initiatives, and firms within the eco-town area. The complex, as a consequence, contains the largest number of these kinds of recycling projects of all Japanese eco-towns. Secondly, the importance of thorough information disclosure is emphasized. Kitakyushu companies are required to allow the public to access their facilities freely in order to build public confidence in the project. Lastly, Kitakyushu has excelled at getting its myriad commercial industries and research institutions to collaborate and synergize.

(b) Maniwa Eco-Industrial Cluster

The Maniwa biomass industrial cluster described in Module 2, relied more on the partnership of universities located outside the community that can lead the way in eco-innovations happen, instead of relying on subsidiaries and branches of large firms with headquarters elsewhere. This shift required developing joint working groups and implantation plans, including venture capital as illustrated in Fig 4c.4. This experience is in stark contrast to Kita-Kyushu eco-town.
(i) The case studies described above have implications for the design of policies for EIC development. Knowledge institutes that support the emergence and growth of EICs should:

Ensure that development is driven from within a cluster and provide support to the firm or consortium led by it. Exceptions could be made in the case of large universities with a well-established reputation in regions with solid business base, which are big enough and have sufficient visibility to take the lead in EIC development.

(ii) Work jointly with local business and governments to coordinate all cluster support activities and develop a supportive local infrastructure. In particular, there should be better planning for academic programs at universities, research institutes, and vocational colleges to meet local demand for a highly skilled manpower and advanced eco-knowledge and reduce the lag often observed in growing clusters between industry need and knowledge supply.

(iii) Develop at the knowledge institutes an outward looking entrepreneurial culture, encourage industry linkages in educational programs and research activities, and support green technology transfer activities.

(iv) Boost R&D activities, especially applied research activities which tend to have a higher local impact than basic research; attract local/national/international research funding; which should ultimately lead to a higher share of fast-growing startups in the regions where EICs are most active.
Annex VIII:
Role of Stakeholders: Knowledge Institutes

Worksheet

Learning Objectives:

On completion of this exercise you will be in a position to understand the role of knowledge institutes and the policy on knowledge management at EIC.

You are leading a team consisting of a policymaker, a representative from a local community-based organization, and a representative of a small industries association. Your job is to design a strategy to engage a knowledge institute in the cluster for business innovation and capacity building. Please discuss what strategies you would adopt to engage knowledge institutes into the EIC in your country.

Workshop Duration:

1.5 hours [Study Time—45 minutes: Group Discussion—45 minutes]

1. Universities and other higher education institutions have long been considered as key elements of EICs as sources of technological knowledge and qualified manpower. Do you think the businesses operating within a cluster should opt for collaborative R&D with knowledge institutes rather than individual attempts at innovation? If so, why? What are the advantages?

2. Potential entrepreneurs with innovative ideas, often cannot connect with a critical mass of other competitive firms within clusters with a variety of skills and an urge for similar experimentation, which triggers innovation. In such a case, what should be done to promote collaborative R&D?
3. EIC formation and innovations—in the form of technology transfer, human resource development, and new business development—come to fruition only if financing is forthcoming. A closer look at the data of financing of innovation comes from seed capital from investors, university funding, and competitive grants available at national level. What could be the potential strategies for funding/financing collaborative R&D in the cluster?

4. There are notable examples of universities that have promoted innovation and formation of eco-clusters. The truth is that any knowledge institute as a driver of cluster development has only few instruments that it can bring to bear. The scale, disciplinary breadth, quality, and research intensity of the university system in an EIC powerfully affect the local labor market and capacity strengthening of firms. Local universities can set up incubators for start-up activities, set aside small amounts of seed money for new ventures, and provide incentives to their researchers to conduct reach and attempt to commercialize promising eco-innovations. How do you plan to rope in government support for such university–industry collaborations at an EIC level?
5. State-level Industrial Promotion Policies in the United States are summarized as follows:

<table>
<thead>
<tr>
<th>Entrepreneurial policy</th>
<th>Industrial recruitment incentive</th>
<th>Labor regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public venture capital funds</td>
<td>Bond-based financing</td>
<td>Minimum-wage laws</td>
</tr>
<tr>
<td>Technical assistance center</td>
<td>Loans for building, construction, equipment, and machinery</td>
<td>Fair employment laws</td>
</tr>
<tr>
<td>Business incubators</td>
<td>Loan guarantees for building, construction, equipment, and machinery</td>
<td>Absence of right-to-work laws</td>
</tr>
<tr>
<td>Research parks</td>
<td>Aid for existing plant expansion</td>
<td></td>
</tr>
<tr>
<td>Research and development tax incentives</td>
<td>Matching funds for city-country industrial financing</td>
<td></td>
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<tr>
<td></td>
<td>Funds for development-related public works</td>
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<td></td>
<td>Incentives for establishing industrial plants</td>
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<tr>
<td></td>
<td>Tax exemption on land-capital improvements</td>
<td></td>
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<tr>
<td></td>
<td>Tax exemption on equipment and machinery</td>
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<tr>
<td></td>
<td>Inventory tax exemption for goods in transit and in manufacturing inventories</td>
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<td></td>
<td>Tax exemption on new equipment and raw materials</td>
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<td></td>
<td>Tax incentive for job creation and industrial investment</td>
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<td></td>
<td>Accelerated depreciation for industrial equipment</td>
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<td></td>
<td>State-supported training and retraining of industrial workers</td>
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<td></td>
<td>State-financed speculative building</td>
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<td>Free land for industry</td>
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<td></td>
<td>State and city-owned industrial park sites</td>
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<td>State funding of city-country master plans</td>
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<tr>
<td></td>
<td>Feasibility studies for recruitment of plants</td>
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<td></td>
<td>Recruiting and screening of industrial employees</td>
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<td></td>
<td>Training of the long-term unemployed population</td>
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<tr>
<td></td>
<td>Technical assistance with procurement bids</td>
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</tr>
</tbody>
</table>

What is missing in the list? And what policies are needed to promote local innovations from a cluster perspective?

6. Understanding the economic and environmental dynamics of clustering and mechanics of its formation are essential elements for analyzing how a successful EIC operates, but it still does not explain why some groups of clusters are able to optimize the benefits by clustering while others are not. There clearly remains another dimension that considers how regional knowledge networks are formed along with cluster formation and share their collective outcome. In terms of motivation, EICs have the potential to gain more through cooperation of knowledge networks, even though rewards are inevitably asymmetric. In your experience, how do knowledge networks evolve at EIC level and how does a regional knowledge network strengthen EIC innovation in a region?

7. The International Kitakyushu Training Association established in 1980, leveraged on the experience and knowledge of Kitakyushu-based firms in environment renewal and other clusters struggling with pollution. The municipal government later also established an Eco-town as a public-private partnership model, which produced new firms focusing on environmental consulting, recycling, and industrial waste management. This was also made possible by about 40 researchers working on related projects. Some firms working in the area have actively collaborating with local universities. For instance, Mitsubishi Heavy Industries has set up a research and development facility at Nagasaki University and Fuji Electric System is working with Kumamoto University. Eco-industrial revival through clustering by partnership with local universities is a desirable strategy for Kitakyushu and other similar EICs, but danger lies in the fact that existing activity is persistent, especially when it has been previously successful. Perversely, many regions still linked to declining industries without diversifying their economic base until the cycle of decline is entrenched and pervasive. How can a local university help a declining region to set an eco-efficiency goal, and come up with a structure for thinking about achieving this goal and a tool for guiding the strategy?
8. Within an EIC, university-industry collaboration is supported by industry, universities, and governments and through financial and in-kind exchanges and grants. Knowledge institute–EIC collaboration also involves and infrastructure that supports in great part local interactions and exchanges. What could be a list of most common tangible types of support for university–industry collaboration?

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9. In addition to collaborating with local knowledge institutes, it is beneficial for EICs to work with a broad range of international institutes. Most of these institutes are knowledgeable about EIC issues and can be useful partners beyond merely sharing perspectives and providing important advice. How can an international institute help a local EIC in understanding the challenges, help with designing effective policy responses, and bring legitimacy?

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10. While it is important to establish roles for knowledge networks with an EIC, it is equally important to set comprehensive performance goals for knowledge institutes. How can the goals of performance for the knowledge institutes be set and measured?

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References and Reading Materials


Module 5: Eco-Industrial Cluster Initiatives for a New Era

5.1 Eco-Industrial Clusters as a Framework for Policy Interventions

EIC initiatives, organized efforts to improve growth, environmental competitiveness, and social inclusion, are in many countries becoming important ways to structure sustainable development policy and strengthen ties between industry, government, and academia. But policymakers are often faced with a lack of systematic evidence and structured thinking about the factors that distinguish successful EIC initiatives from those that fail. Modules 1–4, based on in-depth case studies in both developed and developing countries of Asia, are part of a number of efforts to fill this void. The modules explain what EICs are, why they matter for regional economic and environmental policy, and how to use EIC strategies as a guide to policy and practice. The key findings for policymakers are:

1. EICs are the key organizational unit for understanding and improving the performance of regional economies. It is the foundation of regional economies as groups of clusters built on economic competition theory and industrial ecology principles. Firms in a cluster have competitive economic strengths, environmental opportunities, and social needs.

2. EIC as a group of firms matters for policymakers because it orients economic development policy and environmental practice toward agglomeration and away from individual firms. It is important and fruitful to work with groups of firms on common problems (such as eco-structuring, training, technological modernization), rather than working with individual firms. The EIC approach means there is no need to rely on economic development subsides and recruitment efforts aimed at individual firms.

3. EIC initiatives offer important lessons for economic development policy and environmental practice. EIC teaches policymakers and business operators to:

   - Build on the unique strengths of their regions and specialized urban-rural fringe areas. Different EICs have different sets of growth opportunities.

   - Go beyond analysis and engage in dialogues with EIC members. Many policymakers and practitioners treat research on and analysis of EICs as a cluster strategy. In fact, they are only a starting point for an EIC strategy. Identifying the competitive strength of a cluster requires ongoing dialogue with the firms and other economic and environmental actors in the cluster. Although the public sector cannot be the executive, it can play a central facilitator role in convening EIC stakeholders and working with other public and private sector organizations.
• Develop different strategies for different EICs. EICs vary from industry to industry and from place to place and operate in many different dimensions. There is no one set of policies that will make all EICs competitive. For example, a wood industry cluster may require help with technology or capital, while a fish industry cluster requires assistance with job training or technology deployment.

• Foster an environment that helps new EICs emerge rather than policymakers creating specific firms from scratch. It is difficult for a sectoral policy to create new EICs deliberately. Instead, policymakers and private sector operators and academia should promote and maintain enabling conditions for new eco-activities to emerge. Examples of such necessary conditions are support knowledge creation, technology transfer, entrepreneurship, new firm formation, and the availability of capital, both finance and social.

### 5.2 Challenges of Eco-Industrial Cluster Formation

Increasingly, industrial clusters are transforming themselves into EICs, against a backdrop of rapid industrialization in Asian countries, accompanied by overconsumption of resources and environmental degradation. At the rate of industrialization seen in Asia, EICs can play a crucial role in creating sustainable growth that integrates environmental protection and balanced consumption growth in the region. However, EICs face several key challenges to fully integrate into the domestic industrial structure and create sustainable growth. It is important to highlight the importance of leadership in business clustering, especially the environmental stewardship and networks that are required by governments and businesses to promote EIC development. The dimensions of such an enabling frameworks is shown in Fig 5.1

![Diagram of Eco-Industrial Cluster Connectivity](image)

**Fig.5.1: Enabling Networks and Forms of Connectivity for Eco-Industrial Clusters**

Source: Authors.
The issues of investment in infrastructure and technology in promoting eco-industrial services are important and can be accelerated by using appropriate forms of public-private partnership models. Furthermore, regional cooperation is also important for sharing knowledge and capacity building in developing countries. Given the key constraints in technology transfer processes in developing countries, future policy interventions must focus on local government involvement in developing technology road maps and attracting private sector investment. To identify and select the best technologies, a bottom-up approach is required, by which local governments evaluate and analyze pros and cons of certain technologies, and evaluate if they can be successfully implemented in their respective countries. For example, even in Japan private sector involvement is key, as eco-towns could only be created through substantial private investment, not only through government investment.

Foreign aid for EIC investment is important. The official development assistance (ODA) agency that provides Japanese technical cooperation, grant assistance, yen loans, Japan International Cooperation Agency (JICA), reemphasized that SMEs have limited human, technological, and financial capital, and information resources, making introducing EICs crucially important to support a nation’s long-term development goals. JICA’s role in India was used as a case study, where JICA provides two-step loans and technical assistance mainly to energy efficiency projects in SMEs, alongside its provision of financial and technical assistance in capacity building, calculating energy saving, CDM projects, and to network and cluster enterprises. Asian Development Bank (ADB) through its Cluster-Based Local Economic Development approach is assisting the emerging economies of Asia in awareness building and financing SME clusters. The importance and role of Business to Business interactions are often stressed by policymakers, as a profitable business model is required to make EICs successful, complemented with the right policy mix and public sector involvement.

Regarding EIC growth opportunities, mechanisms to bring stakeholders together to do business within a cluster need to be developed. Much can be done in terms of streamlining operations, so that businesses can easily integrate environmental standards and cooperate with governments. Although many countries already have put in place environmental laws and regulation for emission reduction, pollution control, and resource efficiency, and certain tools such as the Sound Material System Approach in Japan and the Circular Economy Law in the PRC are available, shortcomings in logistics and technology are still hampering environmental performance. Countries, by and large, have been approaching EICs from an “industry and environment” standpoint through Eco-industrial Networks, and in terms of an “urbanization and environment” approach through eco-communities. Profitable business models and incentives for eco-services are required, as part of a larger vision of sustainability. This is becoming increasingly important in light of looming energy, water, and material crises, especially since most industries are resource-intensive.

Furthermore, capacity building is important for improving the diffusion of appropriate technology to developing countries. The challenges for developing countries in promoting EICs are mainly related to the need for capacity building due to: lack of knowledge, unavailability of adequate technologies and absence of best practice sharing, and inadequate or non-availability of specialized human resources to address environmental problems. Knowledge transfer and creating a platform for sharing knowledge, information, and best practices is important for promoting dialogue among the governments of developing countries.
The modules and case studies emphasized the importance of EICs as development strategy for countries to grow and develop their industries on a sustainable basis. It is now generally accepted by the policy community that environmental issues are affecting growth and individual welfare, agricultural and manufacturing competiveness, individual health (as a result of pollution), and the poor (who are most affected). When it comes to business and development, there are many strategies, like “flying geese” and value-chain theories, but unfortunately none of them actually involve the environment. EIC offers a new virtual cycle, where each stage of the cycle enables growth that improves living standards. Another issue identified was that it is not above all policies and legislation that matter (many countries already have the policies and PPP in place), but operability and results. EICs can become a platform for mobilizing social capital to reduce environmental risks and can provide an opportunity for improving economic performance indicators.

The environmental dimension needs to be brought into EICs using the existing institutions and processes to create business opportunities. The example of Kawasaki eco-town is used to stress the need to help urban centers operationalize eco-industrial concepts. This could also be done using conceptual definitions, vision statements, policy frameworks, and finally action plans. The lessons learnt from regional experiences was that the focus should be on the private sector and to create a constellation of stakeholders that support them, including local governments, universities, citizen groups, customer groups, investors, and banks.

5.3 Setting Objectives and Monitoring Performance

The ability to measure and document the impact of eco-activities within a cluster plays an increasingly critical role for successful EIC initiatives. Clear Performance data is important for the supporters of EIC initiatives. Metrics on sector level interventions and its likely impacts need to be designed to allow for straightforward evaluation of the EIC’s progress in achieving its goals. An increase in competiveness in economic and environmental terms takes a significant time to materialize and subsequently to translate into higher social performance. Planning agencies need to resort to a system of performance indicators that maps both implementation and the impact of EIC activities over time.

Ideally, the measurement of an EIC initiative is an integral part of an ongoing effort to track its competiveness. Public reporting on the economic, environmental, and social performance of an EIC can be a tool to stimulate and enhance its competiveness at different levels. It also demonstrates that environmental and social impacts are properly managed and provides assurances of transparency to both internal and external stakeholders of EICs. Annual sustainability reporting is a logical step after an EIC initiative is implemented. Such reporting can be used for the following purposes:

- Sources of best practices that can inspire others and provide a benchmark for analysis of EIC performance
- Self-evaluation and continuous improvement in the process of implementing economic, industrial ecology, and social inclusion principles
- Benchmarking and assessing performance with respect to laws, norms, codes, performance standards, and voluntary initiatives
- Demonstrating how the EIC influences and is influenced by expectations about sustainable regional development
- Comparing performance within an EIC and with other EICs over time
5.4 Integrating Eco-Industrial Cluster Initiatives in a Broader National Development Policy Agenda

The success of EIC initiatives also depends on the wider micro-economic policy environment of the country and sector of which they are part. The generic flow sequence for the realization of an EIC as shown in Figure 5.2 describes a comprehensive list of actions to be taken towards the creation of an EIC. Only if they are an integral part of broader efforts to upgrade the regional and sometimes national micro-economic environment can they attain their full potential and achieve a meaningful impact on a region’s economic performance.

Fig. 5.2: Flow Diagram for Realizing an Eco-Industrial Clusters
Source: Authors.

In a strong economic and business environment, any eco initiatives with market value, can clearly facilitate EIC formation. In a weak general business environment, EIC initiatives must be complemented with a range of policies to upgrade the microeconomic business environment (including FDI policy, infrastructure policy, educational policy, science policy). A weak business environment can also arise in situations such as post-disaster recovery and rehabilitation plans.

The quality of an EIC initiative is determined by many structural and non-structural factors of the regional economy. To address sets of factors such as infrastructure, technology, market information, skill training, etc., EIC policy can be supported by a set of initiatives on common issues such as public education or infrastructure. EIC initiatives that are not integrated in broader regional efforts and national competitiveness initiatives that lack a cluster focus, often fail to reach their full potential. This especially true in the emerging economies of Asia.

5.5 Rebuilding after Disaster: Eco-Industrial Clusters as an Opportunity

Every year, thousands of communities and regions are devastated by floods, cyclones, and other natural disasters like earthquakes. When a disaster strikes, the initial response will focus on immediate needs. After those immediate needs are met, old industries begin to recover. But as the regions prepare their plans for
recovery, EICs should be regarded as a window of new opportunity—to not just return to the old status quo, but to grow green and change. This means identifying a cluster of new industries based on the region's competitiveness that uses energy and resources more efficiently. By building an EIC as an integral part of a disaster recovery strategy, pioneering regions can inspire other big and small communities to do the same.

EICs are a new way to organize micro-economic policies as EICs draw upon many existing industrial, environmental, and development policies. Their main contribution is to select, adapt, and combine policy measures to maximize the impact on cluster competitiveness given an EIC's specific conditions. To further increase their impact, private sector operators within EICs have to find the right balance between locally created models and international best practices. Furthermore, they need to integrate their activities in any EIC initiative with the broader macro-economic agenda, cutting across EICs. None of these challenges are easy to tackle, but solving them offers huge rewards in terms of the capacity to generate a sustainable increase in economic performance through EIC growth and increased competitiveness.

References and Reading Materials

Module 6: Understanding the Ground Realities of Eco-Industrial Clusters

Field Visit (Optional in the Training Course)

Learning Objectives:

At the end of this module/field visit the participants would be able to

- Use some of the strategies and assessment tools to undertake an assessment of particular EIC and suggest possible interventions to improve competitiveness.
- Recognize the importance of multiple simultaneous strategies and stakeholder participation in EIC initiatives

Field Visit Duration:

One day [Travel: quarter day; Field Visit: half day; Group Work to prepare an Action Plan: quarter day]

Module Delivery:

1. The participants will visit a functional EIC that also faces certain challenges. The participants will be divided into groups.
2. The ultimate objective of the field work is for participants to understand the strategies in use and undertake an integrated assessment of the EIC being visited.
3. Before leaving for the field, participants would be briefed on the EIC and provided all secondary information (maps, statistical data, number of business operating, key policies, etc.).
4. Each group could be further divided into teams and each given a particular theme as follows:
   - Group 1—interact with the business and communities and the issues prevalent in the area and the perception on reducing the risks.
   - Group 2—interact with local government agencies in understanding the developmental issues at the EIC actions being taken. Perceptions on benefits would be discussed.
   - Group 3—interact with knowledge institutes and undertake a survey of the cluster to and try to understand the strengths, weakness, opportunities and threats (SWOT)

5. After the day’s field visit, the groups would work together in coming out with an overall assessment of the EIC.
6. Depending on the number of participants and actual field site, the group formation may differ.
7. Each of the group would present their finding and a discussion would be facilitated to draw important conclusions from the findings.
Annex IX:  
Take it Back Home

Final Course Evaluation Worksheet

Objectives:

- At the end of this module the participants should be able to draw up an EIC action plan based on the knowledge and skills gained from the training course.

- Evaluate the course in terms of course structure, knowledge gained, skills imparted, and session contents. Reassess course duration and provide suggestions for improvements.

Workshop Duration:

1.5 Hours [Defining next steps & formulating actions—60 minutes: Overall Course Evaluation—30 minutes]

AA: Defining Next Steps and Formulating Actions

At the end of the session participants would be able to list the things they would be able to incorporate in their professional work as a result of the knowledge and skills gained from the training course.

Objective: Formulating Individual /Group Action Plan

1 hour  [Exercise: 30 minutes—Presentation: 30 minutes]

Material Required: Flip charts, Markers

Instruction:

1. Each participant is asked to fill out the table below at the end of each module.
2. Participants would present their action plans through peer to peer learning and discussions would be facilitated by resource persons.

<table>
<thead>
<tr>
<th>Module</th>
<th>Knowledge gained</th>
<th>How to use it in your daily professional work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1: Overview</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module 2: EICs as eco-friendly economic zones</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Module 3: Strategies that work</td>
<td></td>
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</tr>
<tr>
<td>Module 6: Observations during field visit</td>
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<td></td>
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<tr>
<td>-----------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a Environmental performance</td>
<td></td>
<td></td>
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<tr>
<td>3b Social capital</td>
<td></td>
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<tr>
<td>3c Technology development</td>
<td></td>
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<tr>
<td>3d Finance</td>
<td></td>
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<tr>
<td>Module 4: EICs into an inclusive business development model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a Policy community</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4b Businesses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4c Knowledge institutes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Module 6: Understanding the Ground Realities of Eco-Industrial Clusters
BB: Overall Course Evaluation

Objective:
- To help determine how effective this course will be for someone with experience similar to the current participants and to find out the scope of improvements for the future.

Session Duration:
Total: 30 minutes [Filling out evaluation form: 15 minutes; Sharing of views: 15 minutes]

About you:
1. How many years have you worked on industry, environment, and sustainable development issues?
2. Please indicate your areas of specialization?
   a) Policy Making  b) Business/Industry  c) Academia/Research
d) NGOs/NPOs  e) Others

<table>
<thead>
<tr>
<th>Overall Evaluation</th>
<th>Excellent</th>
<th>Good</th>
<th>Average</th>
<th>Poor</th>
<th>Very Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your assessment of the overall quality of the workshop?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Please indicate the extent to which you agree with the following statements:</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have obtained new knowledge and skills as a result of this event.</td>
<td>5</td>
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<tr>
<td>2. The workshop objectives were clear.</td>
<td>5</td>
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<tr>
<td>3. The topics discussed are relevant to my current position and my organization.</td>
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<td>1</td>
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<tr>
<td>4. I will be able to use new knowledge gained in my work.</td>
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<td>1</td>
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<tr>
<td>5. Course materials and advance readings were useful and well-aligned with the workshop objectives.</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<tr>
<td>6. The case studies and group discussions were useful in considering practical applications for the workshop content.</td>
<td>5</td>
<td>4</td>
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Module 6
Understanding the Ground Realities of Eco-Industrial Clusters

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1. Do you have any comments or suggestions on the presentations by Resource Speakers/Presenters?

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2. Do you have any comments or suggestions?

(a) Duration of the workshop
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(b) Quality of the discussions
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(c) Participant mix
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(d) Facilitation
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3. What EIC related needs/issues/subjects/themes would you like the organizers to address in their future events?

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4. Other Comments or Suggestions
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Glossary

**Anaerobic Digestion:** An industrial process by which organic waste materials are broken down by microorganisms, in the absence of oxygen, and release energy. It is used to manage waste produced from cluster firms.

**Appropriate Technologies:** Technology that is suitable for the social and economic conditions of the geographic area in which it is to be applied, is environmentally sound, and promotes self-sufficiency on the part of those using it. Utilizing the appropriate level technology results in better use of labor resources and higher production efficiency of the cluster.

**Capacity:** The combination of all strengths, attributes, and resources available within a cluster community that can be used to achieve agreed goals.

**Capacity Building:** Process by which people, business organizations, and policy institutions systematically stimulate and develop their knowledge, skills, and systems over time to achieve social, economic, and environmental goals and thus operational efficiency.

**Cleaner Production:** A preventive, industry specific environmental protection initiative, intended to minimize waste and emissions and maximize product output, by analyzing the flow of materials and energy and finding options to minimize waste and emissions from industrial processes through source reduction strategies.

**Community Development:** Proponents of eco-industrial approaches point to a host of economic, environmental, and social benefits for communities. The objective of these approaches is to add value to a region’s economic base, strengthening its industrial, social, and supporting institutions in a way that attracts new businesses and retains existing ones.

**Dematerialization:** The reduction of total material and energy throughput of any product and service, and thus the limitation of its environmental impact. This includes reduction of raw materials at the production stage, of energy and material inputs at the use stage, and of waste at the disposal stage.

**Eco-Design:** Eco-design, or design for the environment, is a way of incorporating sustainable features into every day products. In creating these products, industrial metabolism and dematerialization are considered.

**Eco-Industrial Clusters:** A community of businesses: 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 common resources for both the business and local community.

**Eco-Towns:** An industrial development strategy that is frequently promoted as a means of reducing the environmental burden of industry in a way that is consistent with economic development and communities.
**Eco-Industrial Parks**: Focus on symbiotic relationships in which companies utilize the waste materials or energy of others; EIPs are excellent examples of contemporary environmental governance systems, in that they involve both the private and public sectors, and the community. EIPs have a larger vision of sustainable community development, which can be looked at as a “closed loop” or one that keeps markets and profits within the local economy.

**Eco-Innovation**: The development of products, services, and processes that contribute to reduced pollutions and emission by applying knowledge to elicit direct or indirect economic improvements. This includes a range of related ideas, from environmentally friendly technological advances to socially acceptable innovative paths towards sustainability.

**End-of-Pipe Methods**: Used to remove already formed pollutants from a stream of air, water, waste, product or similar media. They are normally implemented as a last stage of a process before the stream is disposed of or delivered.

**Environmental Impact Assessment**: Process by which environmental consequences of a proposed program are evaluated. Undertaken as an integral part of planning and decision-making process with a view to limiting or reducing adverse impacts of particular projects or programs.

**Environmental Management System**: Compendium of tools, methods, and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency through consistent control of its operations. At cluster level it is used to monitor, report, and verify the environmental performance of individual firms.

**Environmental Stewardship**: Eco-industrial development seeks to promote environmental stewardship at the firm, industrial park, and community levels. The ultimate environmental goals of eco-industrial strategies are to reduce the use of virgin materials, decrease pollution, increase energy efficiency, reduce water use, and decrease the volume of waste products requiring disposal in landfills. This approach encourages companies to adopt innovative processes and technologies that reduce waste of energy, water, and materials.

**Greenhouse Gases**: Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation of thermal infrared radiation emitted by the earth’s surface, the atmosphere itself, and by clouds.

**Industrial District**: Emerges when a firm develops more than specialization and divisions of labour between firms; the emergence of ‘implicit and explicit forms of collaboration among local economic agents within the districts, enhancing local production and sometimes innovation capability and the emergence of strong sectoral associations.

**Industrial Ecology**: An evolving framework that examines the impact of industry and technology on the biophysical environment. It is part of a larger concept called ecological modernization, which is concerned with the integration of environmental issues into production and consumption practices. Industrial ecology specifically explores material and energy flows in industrial and consumer activities.
**Industrial Metabolism:** The study of a material from start to finish through the economy. It compares economy and industry to a living system, where consumed materials are converted into a form usable to the business or organism.

**ISO 14000:** A family of standards related to environmental management that exists to help business organizations to minimize negative environmental impact of their operations, comply with applicable laws, regulations, and other environmentally oriented requirements, and make continuous improvements in the above.

**Land-Use Planning:** The process undertaken by public authorities to identify, evaluate, and decide on different options for the use of land, including consideration of long-term economic, social, and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation of plans that describe the permitted use.

**Life Cycle Assessment:** Incorporating both industrial metabolism and dematerialization. Life cycle assessment evaluates the entire process: where the materials come from, where they will be going, what they will be doing while there are there, and once they are used, what will happen to them. LCA is used to determine the total environmental impact a product will have.

**Market Orientation:** A philosophy of business management, based upon a cluster-wide acceptance of the need for client/customer orientation, profit orientation, and recognition of the important role of marketing in communicating the needs of the market to all cluster firms.

**Micro-Finance:** Provision of financial services to those excluded from the formal financial systems. Systems of exclusion are based not just on lack of wealth, but also on cultural and economic ignorance. Effective micro-finance is positioned to overcome a variety of access barriers to wide range financial services for many different eco-initiatives within clusters, which are excluded from the formal financial system.

**Policy Benchmarking:** is a relatively new tool to monitor processes, to assess the situation against continuously improving best practice on an ongoing basis. Its effective use requires close consultation and work jointly with the enterprise sector. It serves to assess not just well or poorly performing clusters in a given region as compared with their counterparts in other regions, but also the factors that determine competitive performance. It goes beyond competitive analysis by providing an understanding of the processes, technology, and capabilities that create superior performance. In doing so, policy benchmarking links up with the key medium- and long-term issues of concern to cluster development policy.

**Policy Co-ordination:** Takes place when two or more sectors decide to take a common stand to meet common goals. Policy co-ordination is a more flexible and looser form of co-operation than policy integration since its scope, objectives, and duration may vary from case to case.

**Policy Integration:** Steps taken by sectoral ministries to focus on compliance with common agreements voluntarily adhered to. Adherence usually entails acceptance of some constraints on the scope for autonomous decision-making in specific policy areas for gains in public goods.
**Resource Conservation:** Practices that protect, preserve, or renew natural resources such as water, biomass, materials, minerals, etc., in a manner that will ensure their highest economic or social benefits.

**Resource Efficiency:** The relationship of resource inputs to economic output of system, which is essential to sustain and enhance the wellbeing of current and future generations. It is a core element for transforming an industrial cluster into an eco-industrial cluster.

**Risk Assessment:** A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing financial resources and vulnerability that could potentially harm exposed businesses operations.

**Risk Transfer:** The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a cluster firm will obtain resources from the other party, in exchange for compensatory financial benefits provided to that party.

**Social Capital:** Features of a cluster, such as trust, norms, and networks that can improve the efficiency of the cluster by facilitating coordinated actions.

**Social Dialogue:** A communication activity involving social partners intended to influence the arrangement and development of work related issues.

**Social Networks:** An interconnected group of people who usually have an attribute in common. Trust refers to the level of confidence among the networked people or firms within a cluster.

**SWOP:** A structured planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Potential involved in a project or in a business venture. A SWOP analysis can be carried out for a product, place, industry, or person.

**Technology Death Valley:** The gap between basic research innovation and new commercialized technology where new eco-technologies go to die. It has become an icon for the difficulty of successfully commercializing or implementing proven technologies. It also shows the importance of a long-term partnership between the creators, investors, and end users of a new green technology, which drives an iterative and collaborative process of development, implementation, and acceptance.

**Urban-Rural Fringe Area:** The zone of transition which begins at the edge of a fully built up urban center and becomes progressively more rural whilst still retaining a clear mix of rural and urban land use and influence before giving way to the wider rural side or urban center.

**Venture Capital:** Capital provided to start-up enterprises at the early stage of cluster development. The venture capital fund makes money by owning equity in the companies it invests in, which usually have a novel technology or business model in high technology industries.
Eco-Industrial Clusters
A Prototype Training Manual

Eco-industrial clusters are geographic concentrations of interconnected industries in a specialized field that cooperate with one another to efficiently share resources and information. The concept of industrial clusters has emerged as a central idea for innovation and competitiveness. As more and more efforts are devoted to foster eco-restructuring of rapidly industrializing Asia, the need to understand and train on the sustainability potential of those clusters has become urgent.

This training manual is a pioneering effort to fill this gap. The main objective of this manual is to enhance the capacity of decision makers by translating relevant aspects of cluster research into an everyday working context. This training manual describes the concrete steps of (i) how to obtain relevant eco-industrial cluster information, (ii) how to devise strategies that work, and (iii) how to communicate the resulting knowledge in a responsible way. This is precisely what decision makers, project managers, and civil servants need and has been largely lacking until now. In that sense, this prototype training manual can be seen as the first bridge between policies and practices in a complex and difficult landscape of eco-industrial clusters.

About the Asian Development Bank Institute (ADBI)
ADBI, located in Tokyo, is the think tank of the Asian Development Bank. Its mission is to identify effective development strategies and improve development management in ADB’s developing member countries. ADBI has an extensive network of partners in the Asia and Pacific region and beyond. ADBI’s activities are guided by its three strategic priority themes of inclusive and sustainable growth, regional cooperation and integration, and governance for policies and institutions.

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