industrial ecology

a primer on
green strategy
for business

where do you fit?

making waste out of industrial money?

or making

money

out of industrial

waste?

Industrial Ecology: A Primer on Green Strategy For Business

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Industrial Ecology Module
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About This Primer

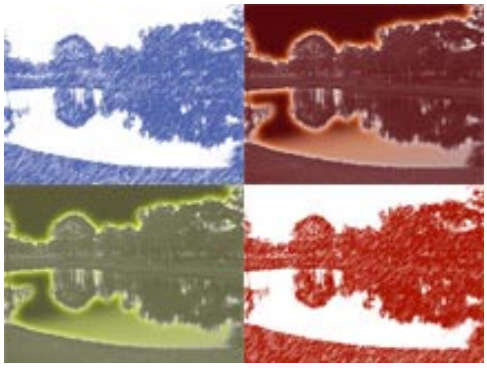
This is an introduction to industrial ecology, a new concept in environmental management already demonstrating value in the Philippines as an innovative business strategy. It is about redesigning industrial systems to be patterned after natural ecosystems, where resources are maximized or utilized for new production.

Industrial ecology is a way of doing business that has emerged in this country because of key business concerns like:

- Competitive advantage - a company continuously searches for a specific factors that will give it the edge over its competitors
- Environmental standards - customers increasingly demand from firms, and firms demand from their suppliers new levels of environmental excellence
- ISO 14001 certification - as more companies strive for this, environmental standards rise, company commitment is strengthened
- Cost savings -realized through input and output costs
- Minimized liabilities -legal and financial liabilities are minimized through a pro-active stance
- Enhanced corporate image - better image translates to a larger market share and increased profitability

We offer this primer to industrial estate owners and developers, locators, planners, investors, industry associations, non-government organizations (NGOs) and community groups. The government will also have a framework for new or modified environmental policies, incentives, guidelines, and programmes. These in turn will help promote industrial growth areas in the country.

Industrial Ecology (IE): Merging Business With the Environment



INDUSTRIAL ecology is a new paradigm, and at the same time, an "old" one.

It is a new way of thinking, of redesigning industrial systems to mimic natural ecosystems. It is an emerging concept in the fields of science, government, and business. Its foundations are in basic sciences, ecology, chemistry, environmental science, engineering and business management. It has provided a rich culture for academic research and debate. But more significantly, industrial ecology has opened doors to rediscovering "the common sense of business." This brings back industrial ecology to being an "old" practice.

Numerous companies in the country have employed environmental management in their respective operations. Most have done this to comply with government laws and regulations to avoid future liabilities and possible plant closures. The good news is that good environmental practices translate to cost savings, improved public image, and generation of revenues. The bottom line is gaining competitive advantage.

In the Philippines, industrial ecology applications are already being practiced. As in other countries, the term has just evolved but the practices are already in place. Concepts like recycling, re-use, re-manufacture, re-processing, and by-product exchange have been used by businesses in various industries like semiconductors, textile, and food manufacturing, among others.

An example of by-product exchange occurring locally is between the Philippine Phosphate (PHILPHOS) and the Philippine Associated Smelting and Refinery Company (PASAR), both in Leyte. From the time the two companies were set up in the early 70s, exchange of waste or by-products have been included in the master plan.

Industrial ecology thinking will often be useful for firms seeking to improve their resource productivity and thus their competitiveness.
Esty and Porter, 1998

San Miguel Philippines' brewery, on the other hand, generates excess yeast which the company's subsidiary, a poultry producer, uses as feedstock.

These practices are only part of a bigger picture of industrial ecology where either the resource recovery happens within just one company or between two. Industrial ecology can also happen among different companies. Such is the case among five industrial estates in the Calabarzon area. Carmelray Industrial Park I, Light Industry and Science Park II (LISP), Laguna International Industrial Park (LIIP), Lima Land, Inc., and Laguna Technopark Inc. (LTI). These estates, mostly composed of light to medium industries, have cooperated in a pilot project to exchange by-products among the locators. This effort is a project of the Industrial Ecology Module of the PRIME Project (Private Sector Participation in Managing the Environment).

These are only a few examples where industrial ecology applications are used as a competitive tool in business. The industrial system is modified to maximize a firm's resources (including energy, water, and raw materials) and minimize the generation of waste or by-products. Ultimately, industrial ecology becomes a corporate management tool where businesses realize cost savings (short-term and long-term), discover hidden opportunities, and enhance their competitive advantage.

On a larger picture, industrial ecology is a tool to achieve a delicate balance between rapid industrialization and quality of living, not only of the present generation, but more importantly of the future's. This new paradigm or way of thinking can help attain sustainable development, i.e., meeting our present needs without compromising the ability of the future generations to meet their own needs.

Defining IE

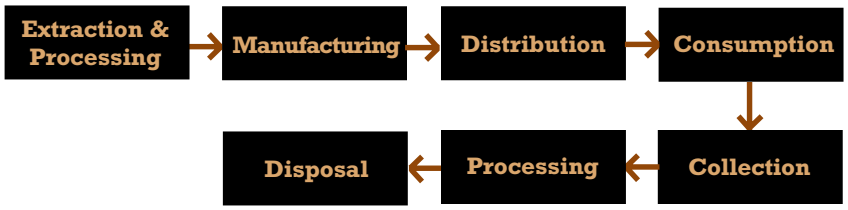
Industrial ecology is a new and innovative strategy for a sustainable industry. Achieving a sustainable industry means meeting a firm's financial bottom line without compromising the state of its surrounding physical environment. Industrial ecology focuses on the interaction of industrial systems and the ecological systems. In the industrial setting,

the process involves designing industrial systems to minimize waste and maximize cycling of materials and energy. As far as possible, production systems, instead of the conventional linear fashion, are closed. This is to prevent the loss of energy or useful materials. Industrial ecology seeks to optimize the total materials cycle from virgin materials to finished material product, and to ultimate disposal.

This innovative concept goes beyond a more efficient management of waste to encompass all activities in a given system, including resources (extraction, optimization, productivity, and recovery), processes (production, manufacturing, distribution, consumption), and disposal (collection, re-processing, final disposal).

Most industrial companies perform the conventional production processes: extraction and processing of raw materials, manufacturing, distribution, consumption, collection, processing, and disposal. In this model, environmental management is pollution control applied at the "end-of-pipe." Notice that this is a linear flow (Figure 1). This is also where the majority of industrial wastes is generated.

Figure 1. Linear flow of materials



Industrial Ecology Proposes Closing the Loop

To minimize the ecological impact of these activities, industrial ecology can be applied to each specific activity. For instance, raw materials can be acquired from another firm where this material is generated as un-utilized by-product (usually called "waste"), thus reducing the use of virgin materials. During manufacturing and distribution, a firm can recycle some of its discarded waste to be used as input to its own processes or traded as a by-product. Consumers recycling a purchased product is the next stage in the cycle. The

Supreme Baby Wear Inc. (SBWI), producer of children and adult's apparel, generates 300 kg of scrap textiles a day. Instead of throwing the scrap away, SBWI gives these for free to the Pasig River Rehabilitation Program (PRRP), a non-government organization.

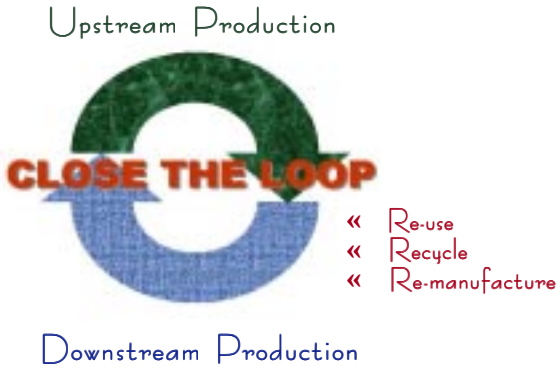
SBWI provides a source of livelihood for the relocated squatters of the resettlement program of the PRRP. By giving the PRRP resettlement program their scrap textiles, SBWI has not only found an alternative to the landfilling of their waste but has also helped the relocated families rebuild their lives.

SBWI now saves P3,000 a month, an amount that used to go to haulers. In turn, PRRP has saved P24,000 a month for buying 3,000 kilos of scrap textiles priced at P8 per kilo.

Industrial ecology provides opportunities for firms to decide based on benefits and costs, whether to stress waste exchange, recycling, or material minimization.

industrial waste generated from production process can be treated, recycled, or re-used. From a linear flow, the production process now becomes a "closed loop" (Figure 2).

Figure 2. "Closing the Loop"



Industrial ecology evaluates the flows of materials and energy in industrial, government, and consumer activities. It examines the effects of these flows on the environment. It looks at the interactions among and between industries and their environment. Industrial ecology takes into consideration the influences of economic, political, regulatory and social factors on the flow, use and transformation of resources.

IE as a Business Strategy

A company can use industrial ecology as a corporate tool in discovering opportunities to advance its competitive advantage. This can be done by analyzing a firm's value chain or the activities within and outside the firm, entailed to produce its goods and services.

One way of doing this is to view competitive advantage in terms of innovation. Finding unexpected ways to lower the cost of producing goods or identifying ways to increase a product's value are probable methods. These result in enhanced resource productivity which can make a company truly competitive.

Resource productivity is the sum of an input's value added, direct costs, indirect costs, and indirect opportunities. The direct value added by a resource to the final product of a firm is central to the company's productivity. As a product becomes more useful and thus worth more to the customers, its value increases. This is why it is important to search for ways to improve the quality, features, or functionalities of your products. Direct costs on the other hand – labor and material inputs – are also traditional parts of accounting.

In addition, indirect or hidden opportunities exist to lower costs or to improve the value of a product.

There are three critical places to look for hidden resource productivity gains: 1) within the firm; 2) within the chain of production (involving suppliers or customers); and 3) beyond the chain of production. In each area of opportunity, industrial ecology may be helpful as a discovery tool, broadening the perspective of corporate decision-makers. This can encourage innovation and facilitate the reconfiguration of product definition, design, production, delivery, and disposal in ways that can be both profitable and environmentally beneficial.

Chaparral Steel Company in Midlothian, Texas is producing 8 metric tons of steel in a 7 metric tonne- market and needs to look at new ways of generating money. Adjacent to the steel company is a cement company and an automobile recycling company. Chaparral Steel decides to join engineers, managers and accountants from each company in quarterly meetings, looking for possible synergies. They have a dream that all raw materials become products.

It turns out that slag consists mainly of calcium silicate, a primary component for cement operations. By using the slag in cement production, the process adds 10 percent to cement production without increasing CO_2 production. The new addition also conserves natural resources while reducing energy requirements 10-15%. Furthermore, the value of the slag is increased 20 times relative to its road construction value. By increasing production capacity 9 percent in 1995, the company has already netted several million dollars of pretax income.

In the future, the scale of our activities is likely to be so great, and arguably is already, that no part of the world will remain entirely unaltered by industrial development.
Hardin C. Tibbs

Within the Firm. A company can improve its resource productivity by identifying and eliminating waste, thereby lowering the costs of production. By merging the concepts of conserving mass and energy with the teachings of economics about efficiency, industrial ecology can go even further in helping a firm obtain maximum returns from a given set of inputs, that is, to optimize resource productivity.

By giving attention to the flows of materials and energy through a firm's possibility of closed loop systems and design for environment opportunities, it can add to the value of a product or reduce the cost of production.

For instance, Dow Chemical in the United States redesigned its process for scrubbing the hydrochloric acid used to make chlorinated organic compounds. The refined producers allowed Dow to eliminate the need for certain wastewater evaporation ponds. This includes recapturing part of the former waste stream for reuse as inputs in other production processes. It also aims to reduce its caustic waste by 6,000 tons per year, and to cut its acid waste by 80 tons per year. With an investment of $250,000 to implement the new process, Dow obtained $2.4 million in annual savings on inputs and lower waste disposal costs – cutting both direct and indirect production expenses.

At the firm level, industrial ecology also spurs attention to opportunities for cost savings that would have otherwise gone unnoticed. In other cases, it has sparked creativity and innovation that has led to unanticipated benefits that go beyond waste minimization. Thinking in industrial ecology terms may also help improve resource productivity by enabling a firm to redefine a product and increase its value to customers.

Within the Value Chain. A firm can unearth hidden sources of opportunities by reducing costs up or down the chain of production. By looking at the interdependence between the production and distribution processes and their potential synergies, industrial ecology can help overcome obstacles to more efficient resource use.

By cutting costs or generating value for suppliers or customers, companies are often able to improve their competitive position. A food wholesaler, for instance, that agrees to take back and reuse packing materials, such as pallets, produces an external benefit: lower waste disposal costs for its customers. These lower costs may yield more loyal customers.

Beyond the Chain of Production. Industrial ecology offers an opportunity to raise resource productivity. This is by closing loops in conjunction with other industrial facilities in close physical proximity but outside of one's own production chain. "District heating" where one company's waste stream is diverted as a source of heat to nearby businesses or residences, offers a well-known example of the sort of symbiosis that is possible. More dramatic examples can also be found such as "eco-industrial parks" (which will be discussed later), where synergistic companies share inputs, outputs, and by-products, thereby reducing waste and cutting costs. The best documented partnership of this kind is the cooperation of Asnaes Power Company, a Novo Nordisk pharmaceutical plant, a Gyproc wallboard factory, and a Statoil refinery in Kalundborg, Denmark.

Benefits of IE to the Company

1. Revenue generation

Companies are sometimes unaware that their by-products have market value and can be sold rather than disposed of. Most manufacturing sectors have had little incentive to investigate by-product exchanges, or to invest in technologies that will facilitate such exchanges.

Interface, a carpet manufacturer providing 40 percent of modular carpets in the US, has planned to effect control over the entire life

Used steel drums have found a second life as trash cans.

Sterling Products International, Inc. produces 300 pieces of used steel drums every month. These drums come from deliveries of glucose, a raw material used by the company in making its products.

Since glucose is a non-toxic and non-hazardous substance, the drums used to store it are not corroded and not contaminated in any way by any harmful chemical. These drums are donated to the Clean and Green Foundation which uses the drums as garbage cans.

These waste steel drums have also found a market in Hoechst Philippines, Inc.

A multinational company, Hoechst manufactures pesticides, pharmaceutical products, surfactants and textile auxiliaries. On the average, Hoechst needs 200-500 steel drums per month. To meet this requirement, the company gathers the used steel drums from its other plants or buys from outside sources. The supply was often not enough. Hence, the acquisition from Sterling Philippines.

⌘

Rhone Poulenc Agro Philippines, Inc., a manufacturer and distributor of agricultural pesticides, decontaminates, collects, and segregates all broken glasses it has accumulated in the past two years.

Collecting and recycling glass can help extend the life of landfills, reduce energy consumption by 25 percent, reduce air pollution by 20 percent, reduce mining wastes by as much as 80 percent, and save water use by 50 percent.

For its part, Rhone Poulenc is able to collect a total of 2,000 kg of amber glass cullets, all of which are sold to the Manila Glass Plant of San Miguel Packaging Products (SMPP). The Manila Glass Plant uses glass cullets in manufacturing various glass bottles and containers. To broaden its cullets collection campaign and to maximize the use of its recycling technology, the company has already accredited a number of consolidators, whose job is to do the preliminary cleaning of the cullets before these are delivered to the plant.

⌘

cycle of its carpets. It has started to lease out carpets to consumers for a certain period of time. After the specified period, the client can trade in the old carpet for a new one at a certain discount. Interface will then have control over the disposal of its old carpets. The company can eventually recycle these to manufacture new ones.

2. Cost savings

The sharing of materials, energy, and water can yield significant costs often with little or no capital investment. Cost savings can also be realized through the shared capital and operating costs of utilities which supply gas, water and other inputs to companies. By combining purchases of shared inputs, firms may also be able to negotiate better prices.

Cost savings often arise from lower disposal costs, fewer environmental penalties, and reduced liability insurance. A company can also realize peso savings through minimization of inputs, substitution of materials, and reduction of energy and disposal costs. If the end result of these savings is a lower product price, this can increase the competitiveness of the firm, expand the market share, and satisfy customers.

Likewise, improved public image can increase market share and equity value. But even when environmental legislation is lax and public awareness is low, companies can still make a profit simply because they reduce the material input costs per unit of output.

The Kalundborg district in Denmark is an example. Novo Nordisk, a pharmaceutical manufacturer, uses excess steam from Asnaes, a 1500 MW coal-fired power plant. Novo Nordisk saves $US 1 million annually because of lower energy costs.

Private firms also avoid imminent disposal penalties and liabilities imposed by the local and national government.

3. Reduced liabilities

Both financial and legal liabilities can be minimized through industrial ecology. Environmental activities can reduce payments related to higher risk premiums and improve a firm's

credibility. Waste reduction may reduce liabilities related to environmental accidents or improper disposal. A firm implementing responsible environmental practices can also avoid penalties and closure orders from the government.

4. Cost savings through regulatory flexibility

In the United States, eco-industrial networking of industrial firms may eventually lead to combined permitting systems (e.g. Environmental Compliance Certificate or ECC), faster approvals and even pre-approvals of new industrial developments. This flexibility can lower the risk and costs of new industrial expansions and give facilities within eco-industrial networks a competitive edge.

5. Improved opportunities for new investment

Potential investors gain advantage if a strategic plan for an eco-industrial network is laid out. This plan consists of baseline information on material and energy flows among existing firms. Using this information, candidate industrial facilities can determine how much current suppliers are redundant, or how to reduce reliance on a single supply of a feed stock.

Information on materials flows combined with incentives can also help industries modify a manufacturing process. The new process may replace a useless waste stream with one that is of interest to another industrial facility nearby. The cost savings from such tend to be greater if they can be implemented at the planning stages, rather than after a facility is built.

6. Enhanced public image

A company consciously employing environmental management in its systems gains an edge over its competitors. Practicing corporate environmentalism empowers a firm to recognize that this conviction can be compatible with good business. Also, it enhances a company's relationship with the community and the local and national government.

With the environment in jeopardy, we need to reconsider the design of products and the organization of industrial and consumer markets with recycling in mind.

Robert A. Frosch
Physics Today, 1994

Industrial ecology can also happen within a firm through resource recovery.

This proved true for Sterling Products International Inc., a manufacturer of pharmaceutical and consumer products.

Sterling recovers waste heat generated by its 40-hp air conditioning system. This heat is used to supply the hot water needed by the company's canteen and boiler stations.

7. Emergence of a firm as market leader

A company may induce stringent environmental regulations and become a market leader. In many cases, regulations depend on technological improvements introduced by the private sector. Also, the government may recognize that a certain technology exists to secure better environmental outcomes which the private sector can comply. In effect, government can enact stricter regulations. Therefore, a firm that is innovative and able to influence regulations will have a competitive advantage.

Benefits of IE to Society

- Enhanced protection of natural ecosystems, habitats, and landscapes
- More efficient use of land, water, energy and other natural resources
- The protection of cultural and archaeological resources
- Reduced risks to human health and safety from industrial accidents and emissions
- Improved health for employees and human communities

IE Applications

In the Philippines, certain aspects of industrial ecology are successfully in place yet these have not been documented as industrial ecology practices.

One such effort is the Industrial Waste Exchange Program (IWEP) of the Philippine Business for the Environment (PBE). PBE has for several years now encouraged industrial companies to dispose of their waste through selling them to another company needing these as part of their inputs.

In particular, Sanyo Semiconductor Manufacturing Philippines Corp. (SMPC) assembles large-scale integrated circuits. In its manufacturing process, the company's molding section generates 2.5 tons of mold runners every month. This large amount of waste plastic resin used to take up a lot of space within the premises of SMPC. The company used to pay a hauler a significant amount to have the waste brought to the landfill. Now,

SMPC discards its mold runner waste to Bacnotan Cement Corporation (BCC), a member of the Phinma Group. BCC has agreed to take the waste which it uses as a raw material in producing cement. The deal is beneficial to both parties.

The Consumer Electronics Factory of Philips Electronics & Lighting, Inc. (PEL) produces color television and videocassette players. The printed circuit boards of these products are made to pass through a soldering machine that used to contain more than 630 kg of solder bar with a 63:37 tin-lead ratio. This particular solder bar, however, produces a solder finish that glares the eyes of the factory workers. Management decided to replace the solder bar with one that contains bismuth.

Meanwhile, the old solder bars have become a problem. One of the options is to have the solder bars reprocessed. This is more expensive because the old solder bars have to be reprocessed abroad and shipped back to the country. Another option is to continue using the old solder bars and add bismuth gradually to reduce the glare. This affects manufacturing operations because a very high temperature must be maintained to make the mixture homogenous at all times.

The third option was to sell the solder bars. O.M. Manufacturing Phils. Inc. eventually bought them. O.M. Manufacturing is a registered recycler of solder waste and a producer of recycled ground metal. In order to meet the needs of recycled solder ground metal in various fields, O.M. constantly looks for new ways of removing impurities from metals. Waste exchange is enabling the company to find a regular source of raw materials for its metal recovery processes.

International Chemical Industries, Inc. (Inchem) is a large manufacturer of basic chemicals including caustic soda, hydrochloric acid, sodium hydrochloric acid, sodium hypochlorite, ferric chloride, potassium sulfate, calcium chloride, and hydrogen gas. The company has conducted a study on how to recover heavy metals from the wastewater of semiconductor firms. The company has succeeded in developing a treatment technology that makes use of the old hydrometallurgical process.

Inchem has developed its wastewater rich in copper chloride through a process that makes use of a reactor, some basic chemicals, and a catalyst. Using this process, the

Bacnotan Cement has found a way to re-use mold runners in producing cement. Mold runners are generated from the production of integrated circuits.

Two such manufacturers of integrated circuits, Sanyo Semiconductor Manufacturing Phils. Corp. (SSMP) and Texas Instruments Phils. Inc., have found a viable market for mold runners in Bacnotan Cement.

SSMP generates 2.5 tons of mold runners every month. Aside from storing these in the company's compound, it used to pay a hauler to bring the mold runners to a landfill.

Texas Instruments, on the other hand, made a study to find out the exact ratio of the mold runners needed such that the resulting cement will not be of inferior quality. The company produces 20 tons per month. They found out that the mold runners should be introduced at a rate of only one percent by weight without affecting the resulting cement quality.

Bacnotan Cement now uses the mold runners from SSMP and Texas Instruments as raw materials in producing cement.

company not only recovers metallic copper from spent copper-chloride solution but also collect ferrous chloride solution. The recovered copper has a purity of as much as 99.9 percent, while the ferric chloride solution has a concentration of up to 40 percent.

In addition, the company has also developed a treatment facility for sludge rich in copper, tin and lead. The waste is processed through a series of reactors, where the toxic sludge is subsequently rendered non-toxic. The facility's capacity is five tons of sludge per day.

Making Things Happen Through Eco-Industrial Estates

An eco-industrial estate (eco-industrial park in the US) is a community of manufacturing and service businesses seeking enhanced environmental and economic performance. Industrial clustering allows the free flow of materials, information, and the speedy action for problems. This can be done through collaboration in management of environmental and energy issues including energy, water, and materials.

The goal of an eco-industrial estate is to improve the economic performance of the participating companies and improve environmental performance. By working together, the community of businesses seeks a collective benefit that is greater than the sum of its individual benefits each company would realize if it optimized its individual performance only. The firms in an eco-industrial park work together to reduce the use of raw materials, reduce outputs of waste, conserve energy and water resources, and reduce transportation requirements.

The following are some of the basic strategies to develop an eco-industrial estate:

1. Energy system should be designed to:

* Maximize energy efficiency
* Optimize use of renewable sources
* Support co-generation and energy cascading
* Realize cost-savings in the entire park

2. Site-wide design of materials flows and waste management

* Emphasize pollution prevention, especially reduction of toxic substances
* Reduce toxic materials risks through integrated site-level waste treatment
* Link the eco-industrial park to companies in the surrounding region as consumers and generators of usable wastes via waste exchange and recycling networks
* Water flows in an eco-industrial park are designed to conserve resources through strategies similar to those for energy and materials

3. Effective eco-industrial park management

* Maintains the right mix of companies needed to best use by-products as companies change
* Supports continuous improvement in environmental performance for individual companies and the park as a whole
* Operates site-wide information system that supports inter-agency communications, informs members of local environmental conditions, and provides feedback

Although regulation has greatly reduced the level of industrial pollution, closing the materials loop is ultimately a better approach.
Robert A. Frosch

Republic Asahi Glass Corp. (RAGC) has found a supplier of glass cullets from Antiques as Accessories (AAA).

RGAC is a manufacturer of flat glass in the Philippines that uses raw materials such as silica sand, soda ash, salt cake, dolomite, limestone, and feldspar. To minimize costs, RAGC also uses glass cullets in its production processes. Glass cullets are scrap glass generated by manufacturers of incandescent and fluorescent lamps. RGAC requires 300 tons of glass cullets per month.

Antiques As Accessories or AAA, on the other hand, manufactures and exports mirrors and other glass products. The company generates waste glass sheets during production at a rate of 2-3 jeeploads per week. Initially, the total quantity of glass sheets supplied by AAA to RAGC is five jeeploads. Every week, sometimes twice a week, AAA collects and hauls what they once considered as wastes. The total volume collected has already reached three tons.

4. Park construction rehabilitation

* Incorporates materials with minimal toxicity and environmental impacts
* Limits draw on non-renewable resources
* Uses recycled materials whenever possible

5. Training

* Training and education resources for eco-industrial estate personnel

Closing the Loop: The Kalundborg Example

PERHAPS the best and the most widely cited example of the by-product exchange strategy of industrial ecology is the exchange network that evolved spontaneously in Kalundborg, Denmark. These exchanges of materials and energy between industrial firms, the community, and farmers began in the late 70s and have generated a significant return on investment and environmental benefits.

The 1500 MW Asnaes power plant supplies the power and heating needs of the area. Generating electricity from coal is at best 40 percent efficient so Asnaes distributes its excess heat to nearly all of the town's 5,000 homes. This is equivalent to 225,000 tons of steam per year, reducing the town's oil consumption by 19,000 tons per year. The excess heat also goes to the Asnaes fish farm which produces 250 tons of fish yearly. The sludge from the fishponds is sold by Asnaes as fertilizer.

Statoil, a nearby large oil refinery uses excess steam from Asnaes to cover 40 percent of its heating requirements. Novo Nordisk, which manufactures pharmaceuticals and enzymes also uses excess steam from Asnaes to cover all its heating and processing needs. Novo Nordisk saves US$ 1M annually because of lower energy costs. A three-kilometer pipe links the three firms.

Asnaes has a $115 million sulfur dioxide scrubber which produces industrial gypsum (calcium sulfate). It sells this gypsum to its neighbor Gyproc, which manufactures wallboards. Two thirds of Gyproc's needs come from Asnaes.

Asnaes also sells 200,000 tons of fly ash and clinker for use in building roads and producing cement, thus it needs no landfill for these wastes. Similarly, Statoil supplies Gyproc with ethane and methane to fuel the ovens that dry its wallboards. Statoil also supplies flare gas to Asnaes to use in its boilers. This created savings and reduced carbon dioxide emissions. Statoil's desulfurization stage produces sulfur that it sells to Kemira, a sulfuric acid producer.

Statoil pipes cooling water to Asnaes which uses it as a boiler feedwater. It also sends 200,000 cubic meters of wastewater to Asnaes for cleaning industrial equipment. This reduced thermal pollution in the nearby fjord and lessened water demand from the industries by 25 percent.

Novo Nordisk distributes for free to thousands of neighboring farmers the nutrient-rich sludge from its pharmaceutical operations. Novo uses the steam from Asnaes to heat the sludge and kill the microorganisms.

The Kalundborg industrial ecosystem is the ideal setting of industrial symbiosis, thus far. It is economically viable, the raw material is cheaper than virgin materials, and it is an inexpensive way of complying with environmental regulations.

The Role of the Private Sector

THE major stakeholder in industrial ecology is the private sector, though government operations and infrastructure are also candidates for its application.

The government provides the conducive environment for firms and industries to be productive. It fulfills its functions through a combination of programs and policies.

Policy makers in government realize that it is necessary for the private sector to work in a framework of profit to commit to environmental goals, and eventually to sustainable development. The key is private sector self-regulation. The government's role is to provide incentives for private firms adopting management practices that reduce pollution and waste, and the intensity of energy use and raw materials.

Currently, most policy responses to environmental problems have rested on "end-of-pipe" pollution controls mandated by "command and control" regulation. End-of-pipe approach to waste disposal is like what we do in our households: put waste into a bag and set it out for the local government to haul off and worry about. Command and control regulation simply sets down policies. Violators incur penalties. But then, penalties cannot compensate for the environmental damage that has already been done. This response is often inefficient: environmentally because pollution could have been prevented during production, and economically because companies had to comply with the regulations regardless of the total costs. Furthermore, the implementation, monitoring, and enforcement of these regulations is costly, sporadic, and often incomplete.

Moreover, given the nature of business enterprises to react based on self-interest to the economic, legal, and social infrastructure around them, the adoption of environmental management will make economic sense to entrepreneurs. Once the company realizes the least-cost ways of complying with environmental regulations and meeting the environmental pressures from the public, it will take the initiative to adopt new approaches to minimize environmental impacts.

Summary

INDUSTRIAL ecology is an emerging concept that will address the environmental impacts brought on by rapid industrialization. This new paradigm or new way of thinking aims to minimize waste and use resources efficiently by redesigning the industrial systems. It intends to emulate the natural ecosystem where practically no waste exists because the output of one organism becomes the input of another. From a linear flow

of manufacturing and production, industrial ecology proposes to close the materials flow.

This innovative concept also becomes a new business strategy. Using the applications of industrial ecology in the various activities of a firm can help improve its margins. Industrial ecology is a new approach to competitiveness where the company improves its economic bottom line and its environmental performance.

While the government provides a favorable investment climate through programs, policies, and incentives, the private sector can continue its operations without compromising its financial objectives and the natural environment. It is a tool towards attaining sustainable development. It aids in meeting the population's present needs without compromising the ability of future generations to meet their own. Through industrial ecology. The green strategy.

The IE Module

Industrial ecology is being pilot-tested in the Philippines under the **Industrial Ecology Module** of the **PRIME Project** (Private Sector Participation in Managing the Environment). PRIME is a project initiated and funded by the United Nations Development Programme (UNDP) whose implementing agency is the Board of Investments, Department of Trade and Industry (BOI-DTI). This project aims to enhance business competitiveness through environmental management.

One of the modules of PRIME is Industrial Ecology. It addresses specific needs of an identified group with the following objectives:

1. **Apply principles of industrial ecology in industrial estates or growth centers through a pilot project.** There should be in operation a cleaner production process that will include efficient utilization of energy, waste minimization, and pollution prevention through waste exchange, resource recovery, and recycling among a group of firms. The network can take place either within an estate or regionally, so long as waste exchanges are economically viable.
2. **Undertake studies on existing government policies on industrial growth areas** and develop policies that will encourage different industries with high potentials for industrial symbiosis (i.e., waste of one firm can be utilized as raw material for another firm) to locate in the same industrial site or growth center.
3. **Develop awareness among decision-makers in government and the private sector** on the principles of industrial symbiosis and the economic benefits derived from implementing these.
4. **Assist DTI, BOI and the Philippine Economic Zone Authority (PEZA) in developing environmental guidelines, policies, and programmes** in the management of ecozones and the industries, in general.

If you would like to know more about the Industrial Ecology Module or the PRIME Project, you may reach us through the following:

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