

Endorsement of Industrial Ecology through By-Product Exchange (BPX) concept

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ABSTRACT

This paper considers the By-Product Exchange (BPX) as the most familiar industrial ecology concept. The creation of BPXs has been one of the most frequently attempted strategies for applying industrial ecology. The core intention is creating a system for trading material, energy, and water by-products among companies, within an industrial park. Members expect to use previously discarded resources rather than wasting them, to reduce pollution, to cut disposal costs, and often to gain new revenues. There are also instances of single companies constructing networks of plants designed to utilize their by-products. For example, a sugar company in southern China built a paper mill, alcohol refinery, concrete plant, and other facilities. This paper reviews the benefits of participation in by-product exchanges (BPX) for industrial parks and their companies and also discusses the challenges in their development. This paper discusses steps in organizing exchanges and explores an alternative model for achieving high utilization of industry by-products. The paper emphasizes the importance of considering by-product exchanges in the broader context of eco-industrial development.

Key words: Industrial Ecology, By-product exchange

INTRODUCTION

“While many may attribute the current degradation of the world’s resources to poverty and burgeoning population growth, the inefficient use of resources, high levels of consumption, waste generation, and industrial pollution are equally to blame.”

– (Global Environment Outlook, UNEP 1997)

The concept of industrial ecosystems is one aspect of the emerging field of industrial ecology (IE). IE is much broader than this quest for eco-efficiency. The field basically enables multiple stakeholders to view the system they share as a whole and plan action to tune it to natural systems in an integrative way. Thus, an industrial ecosystem is a community or network of companies and other organizations in a region that choose to interact by exchanging and making use of

byproducts and/or energy in a way that provides one or more of the following benefits over traditional, non-linked operations:

- Reduction in the use of virgin materials as resource inputs.
- Increased energy efficiency leading to reduced systemic energy use.
- Reduction in the volume of waste products requiring disposal (with the added benefit of preventing disposal-related pollution).
- Increase in the amount and types of process outputs that have market value.

The goal of an Eco-Industrial Park (EIP) is to improve the economic performance of the participating companies while minimizing

their environmental impact. Components of this approach include new or retrofitted design of park infrastructure and plants, pollution prevention, energy efficiency, and inter-company partnering. Through collaboration, this community of companies becomes an 'industrial ecosystem'. To be a real eco-industrial park a development must be more than:

- A single by-product exchange or network of exchanges;
- A recycling business cluster;
- A collection of environmental technology companies;
- A collection of companies making "green" products;
- An industrial park designed around a single environmental theme (i.e., a solar energy driven park);
- A park with environmentally friendly infrastructure or construction; or
- A mixed-use development (industrial, commercial, and residential).

The most familiar industrial ecology concept is that of the industrial by-product exchange (BPX). Companies and agencies around the world are seeking to create BPXs under many different names: industrial ecosystem, by-product synergy, industrial symbiosis, industrial recycling network, green twinning, and zero emissions network, among others.

BY-PRODUCT EXCHANGE (BPX)

The core intention of BPX is creating a system for trading material, energy, and water by-products among companies, within an industrial park, a neighborhood, and/or a region. Participants expect to use previously discarded resources rather than wasting them, to reduce pollution, to cut disposal costs, and often to gain new revenues. There are also instances of single companies constructing networks of plants designed to utilize their by-products. For instance, a sugar company in southern China built a paper mill, alcohol refinery, concrete plant, and other facilities.

Thus, the main objective of BPX is to promote the re-use of industrial waste by matching waste generators with potential waste end-users and environmental service providers, such as recyclers and treaters.

Specifically, it aims to:

- Establish a sustainable trade information system for companies that want to publish their inventory of by-products generated or by-products wanted from others
- Match generators/suppliers with users of waste products
- Promote support for the recycling industry and, thus, help close the industry loop, as one solution to the problem of managing industrial wastes.

The goal of the waste exchange program is to reduce the adverse environmental impacts of industrial waste disposal while generating economic returns through resource recovery.

APPROACHES IN ORGANIZING BPX

There are several different approaches to organizing BPXs:

An eco-industrial park (of sufficient scale) initiates a BPX planning process internally;

A major tenant takes the lead because it has major by-product outputs and disposal costs;

A third-party firm contracts to develop the trading of by-products or to act as a by-product utility;

Tenants of an individual EIP participate in a regional program for by-product utilization;

A government agency may be the initiator

A by-product utility manages all formerly discarded outputs for its clients and assumes the responsibility of finding the markets and uses for them.

Some cases suggest that a BPX may be most effective if it includes companies across a broader region, perhaps those in several industrial parks and independents. So a by-product exchange may start out as a regional

initiative with any individual eco-industrial park one of many players.

GUIDELINES FOR FORMING BPX

Paper has outlined the typical steps BPX organizing projects take with industries. Guidelines for mobilize and organize support are as follows:

- Whenever possible identify a respected business leader to act as project champion.
- Create awareness of the business, economic, social, and environmental benefits of by-product exchange among stakeholders.
- Recruit public sector partners to provide technical and financial assistance, incentives, and regulatory support.
- Identify the business entity to manage development of the BPX, whenever possible.
- Evaluate the BPX utility model as an alternative to this process.
- Enable development of self-organizing teams within the network.

PLANNING AND ANALYSIS

- Characterize the flows of energy, water, and materials in the target region. Highlight and map existing exchanges of by-products.
- Provide training, tools, and support for the development process and data gathering and analysis.
- Gather data on resource flows of companies that have committed to the BPX.
- Identify potential barriers in regulations, business practices, and environmental management that need to be overcome. Develop strategies for doing so.
- Identify companies which could process selected materials, provide collection services for specific by-products, or otherwise support the operation of the BPX.
- Develop a strategic plan for expanding from BPX to a full eco-industrial network.

ENABLE BUSINESS TRANSACTIONS FOR BY-PRODUCT UTILIZATION

- Develop alternative means for companies to begin making deals to trade specific by-products.
- Provide further support as needed.

MONITORING AND COMMUNICATIONS

- Create a map of the network of exchanges and opportunities for exchange.
- Set performance measures and targets.
- Create an internal system for giving feedback on what is being achieved to the immediate participants.
- Create an outreach program.

STEPS IN ANALYSIS OF THE BY-PRODUCT EXCHANGE STRATEGY

A recruiting team can work with local and state economic development and environmental agencies to determine the potential value of this strategy in marketing an EIP. The steps include:

- Analyze the material and energy inputs and outputs of major industries in the area; composition and nature of flows of materials and energy; amounts; distribution of flows in time (steady, periodic, episodic, or irregular); a material and energy quality (consistency over time and purity).
- Assess the potential of collecting and pooling small quantities of some materials to create flows sufficient to market. (A possible local business development opportunity.)
- Disseminate information locally and as part of recruitment package and check for matches with existing businesses.
- Determine material or energy processing required to achieve quality requirements.
- Identify potential customer industries (as candidates for recruitment) to utilize existing material or energy flows.
- Define volume requirements of potential customer industries.
- Establish relative importance of by-product exchange in the overall recruiting strategy.
- Test recruitment of industries identified. On basis of results, adjust the strategy.

BPX CASE EXPERIENCE

So far there has been little rigorous research on the achievements of by-product exchange projects. The literature tends to be dominated by champions of the concept rather than

systematic evaluators of the results. It is an appealing concept because it promises to improve the financial performance of participants by improving the efficiency of their use of resources. This integration of business and environmental goals has attracted many companies and other stakeholders to participate in dozens of projects on every continent. However, it is still too early to *prove* that the concept works in practice or to say which development strategy is the most effective one.

We do know that in many cases by-product utilization on a one-to-one basis works. There is an abundance of data on bilateral trades of materials, water, or energy that are at least cost-effective and often profitable. In some industries there has been a long tradition of internal and inter-company by-product utilization. Petrochemical refineries and downstream companies normally seek profitable uses for every output. Many food-processing plants also have found profitable uses for their discards. Finding higher value uses for by-products may be the main value such industries would gain from participation in a BPX. Or they may expand the number and types used.

Many projects to create BPXs have been successful in enlisting industrial and public sector participation in identifying potential exchanges. This survey and analysis process has successfully identified many opportunities in Asian, North American, European, and African projects. There appears to be no inherent barrier to this phase of forming exchange networks. At this point, however, relatively few projects have completed the process to the point where a significant number of trade deals have been made. Many of the deals that companies have struck are one time rather than continuing exchanges.

Projects in Tampico, Mexico, Nova Scotia, Canada, the Province of Styria, Austria and near Hamburg, Germany have released data on the volumes of material and water that are

being exchanged among companies. However, so far only Kalundborg, Denmark has provided data on the investment in infrastructure required and the return. "The latest "back-of-the-envelope" numbers from Kalundborg are: US\$160 Million in total savings to date, \$15 Million in annual savings (today), as return on total investments of \$75 Million."

Asian projects in the Philippines and Thailand are embedding BPX development in more comprehensive eco-industrial networks. In the US the Long Island City Business Development Corporation is expanding by-product exchange to an EIN.

Some eco-industrial park projects have used the BPX strategy to guide recruitment targeting, including ones in Arecibo, Puerto Rico, Burlington, Vermont, and Londonderry, New Hampshire. This appears to work best where there is a large anchor tenant with major by-product resources available. The project in Puerto Rico has analyzed the exchange of value as well as by-products between a proposed waste-to-energy plant, a recycled paper mill, a tire shredding plant, a steel mini-mill, and a neighboring sewage treatment plant. This financial analysis by Recovery Solutions demonstrates that the profits of all firms would be enhanced by this BPX within an EIP.

Japan has launched the most ambitious attempt to develop industrial BPXs and more widespread initiatives to reduce waste. National and local governments are motivated to do this by lack of space for additional landfill, the pollution of conventional incineration, and the country's continuing search for higher efficiency in its production.

ROLE OF GOVERNMENT IN PROMOTING BPX CONCEPT

There is always an opportunity to create, implement, and promote an industrial waste exchange program. The experience and lessons learned from similar national

programs in other countries can serve as valuable references for the creation of an interboundary market for recyclable materials even for Indian Industries.

Efforts is required in India to promote well organized waste exchange programme by either Department of Environment and Natural Resources or the Environmental Management Bureau or by Central Pollution Control Board for establishing the Industrial Waste Exchange Program within Eco-Industrial Park. This Industrial Waste Exchange Program should aim to create a market where generators and users of various types of waste could trade effectively with the support of a trade information system and some educational and communication activities. Even government should establish a non-stock, non-profit organization that by top business executives, government representative members and environmental management practitioner.

Industrialist should also believe that business, together with government and civil society, has a social responsibility to protect the environment and to promote sustainable development. The Industrial Waste Exchange Program should aim to assist businesses in carrying out this responsibility through its role as (a) an intermediary between various sectors in establishing reasonable standards and policies, (b) an educator advocating sound corporate environmental values and promoting efficient and affordable environmental technology, (c) a catalyst in industry and community cooperation, and (d) a databank of environmental resources.

POTENTIAL APPLICATION OF BPX

A waste exchange program or center can be established wherever there are a significant number of companies generating recyclable materials and reusable waste along with a sufficient number of potential users. A waste exchange program needs consistent and

concerted promotional effort through information dissemination, documentation and dissemination of model cases, organization of seminars and other training activities. The program can also benefit from information, education and communication activities promoting waste management in general.

The success of one BPX concept may be replicated in many other areas, with some adjustments and improvements adapted to particular situations. The experience in implementing waste exchanges in the Asia-Pacific Region, offers highly valuable references for the creation of a regional market for recyclable materials even in India. Some of the features of waste exchange programs that require adaptation in new situations are:

- a) Scope of the waste exchange: Will it cover non-hazardous waste only or hazardous waste as well? What added services, e.g., technical services, will it offer and what are the costs?
- b) Cost of participation in the waste exchange: Will the participating sources and users of waste be charged a certain fee? How will that fee be structured?

CHALLENGES AND RISKS IN CREATING BY-PRODUCT EXCHANGES

Developers, investors, property management, and company management will want to assess the potential risks of implementing a resource exchange strategy.

Some of these challenges include:

- Companies using each other's residual products as inputs face the risk of losing a critical supply or market if a plant closes down or changes its product mix. To some extent, this risk can be managed as with any supplier or customer relationship (e.g. maintaining contact with alternative suppliers and writing contracts insuring reliability of supply and

including recourse if obligations are not met).

- Proprietary information could become available to competitors. Information about a company's inputs and outputs can be used to understand and copy proprietary production processes. Waste exchanges usually do not name the source of materials until a buyer wants to connect with them; but in an EIP, it would be easier to identify the source of materials in exchange. Since trades are likely to be bilateral, each company could determine how much information to disclose beyond what the regulations require.
- Uneven quality of by-product materials could cause damage to equipment or quality of products. The handling of this issue is a fairly standard contracting procedure for any supplier relationship. Dealing with a supplier in an EIP would be no different. Both park management and tenant companies would need strong quality control standards and processes.
- Exchange of by-products could lock in continued reliance on toxic materials. The pollution prevention solutions of materials substitution or process redesign should take priority over trading toxics within an EIP site. The commitment of companies to the EIP's performance objectives will keep this basic pollution prevention principle active. Smaller companies should have continuing support from park management and environmental agencies or consultants in finding ways to eliminate toxics from their operations.
- Possible innovations in regulation to enable EIP development may not be allowed by regulatory agencies. Even if they are adopted, ideas such as site-

wide permitting may be attractive for smaller companies, but could be a disincentive to larger ones. In either case, they will have to be designed so that the whole park will not be liable for possible infractions by one company.

The regulatory changes needed to support EIP development are in line with current trends in regulatory policy. It may be possible to design umbrella permits for different groups, so that companies with very different levels of risk would be under different permits.

CONCLUSION

By-Product Exchange offers alternative processes and structures for forming and managing an exchange of material, energy, and water by-products. It emphasizes that this strategy may not be effective within many single industrial parks and may require regional participation. The core of this concept is creating a system for trading material, energy, and water by-products among companies, usually within a park, neighborhood, or region. Paper reviews the benefits of participation in by-product exchanges (BPX) for industrial parks and their companies, the challenges in their development, steps in organizing exchanges, and alternative organizational forms for their management. A by-product exchange (BPX) is a set of companies seeking to utilize each other's by-products (energy, water, and materials) rather than disposing of them as waste. The creation of BPXs has been one of the most frequently attempted strategies for applying industrial ecology. This popularity comes from the promise of companies gaining new revenues from some by-products and saving the costs of disposal of others. On the demand side, customers may gain local sources of supplies at reduced costs. Joining a BPX appears to be an easy way for a company to begin practicing efficiency of

resource use and to learn other ways to improve environmental performance.

Paper outline the typical steps BPX organizing projects take with industries like Mobilize and organize support, Planning and analysis, Enable business transactions for by-product utilization, Set performance measures and targets.

In some projects to create by-product exchanges potential participants have been wary because of the multiple contracts required. These generate transaction costs, which can offset savings or revenues from use of by-product energy or materials. Companies may fear entering into so many new relationships around issues separate from their core businesses.

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