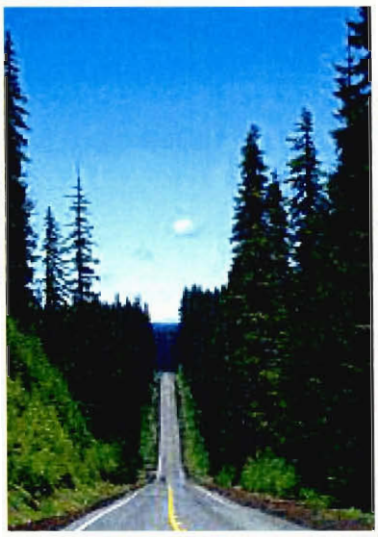
Resource Reuse Paradigms in Costa Rica



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The University of Science and Technology And Life.

CNP+L COSTA RICA

RESOURCE REUSE PARADIGMS IN COSTA RICA

Report Submitted to:

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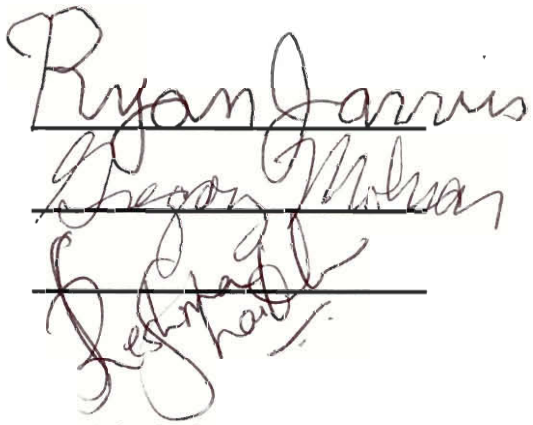

In Cooperation with

Dr. Sergio Musmanni, Director and Ing. Carlos Heinrich, Sub- Director
Centro de Nacional de Producción más Limpia

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This Interactive Qualifying Project Report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of Cento de Nacional de Producción más Limpia.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

Abstract

When one company can supply its unused resources to another company's production process, this is known as a resource exchange. Developed through the cooperation between a team of students from WPI and the CNP+L, the National Center for Cleaner Production in Costa Rica, this proposal outlines a model for a subproduct exchange system, a unique form of resource exchange. This system will not only reduce waste generated by industry at the source but will stimulate economic growth for this developing nation.

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Acknowledgements - All

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Executive Summary (English)

Resource exchanges are common throughout Europe, the United States, Latin America, and other parts of the world. These systems provide communication between businesses in order to facilitate transactions of materials that would otherwise be sent to a landfill or "wasted" in some way. This type of scheme is aided by the use of a database, where listings of offers and demands of industrial process byproducts are posted by company representatives. These companies are either willing to accept these subproducts into their industry as a resource, or to relinquish amounts of materials that are at the end of their life cycle within a given industrial process. A resource exchange provides the information needed for an entrepreneur to find business opportunities in recycling and materials recovery, which in turn creates a potential for new jobs.

Costa Rica currently has no type of broad-scale system in place that handles the communication between businesses for the exchange of materials. There is also, in general, a lack of recycling programs, which makes the handling of resources below the optimum level of usage.

The Centro Nacional de Producción más Limpia (CNP+L) has discovered this problem and asked the Worcester Polytechnic Institute in Worcester, Massachusetts, for help researching the potential for creation of a resource exchange program in Costa Rica. The CNP+L wishes to have this study in order to determine the amount of attention this type of system would receive and also

to establish the costs associated with the implementation of a communication system that facilitates resource exchange among businesses in Costa Rica.

This document gives background about the methods in performing a financial analysis for the proposed type of system and calculating the associated costs of a resource exchange and provides sufficient background about materials exchanges.

This text also outlines the methods that we used in determining the best way to create a subproduct exchange in Costa Rica. We needed to determine current Costa Rican disposal practices and types, available and preferred types of communication, and the level of response that this system might receive. We used a survey, a series of follow-up interviews, and in-depth interviews with important companies in Costa Rican materials handling to offer the needed information.

We sent out 650 surveys to the members of the Costa Rican Chamber of Industries and received responses from 32 companies. This was not enough to provide an accurate model for the industries associated with the Chamber, but the responses provided valuable information about the larger companies in Costa Rica, and the interviews proved to be just as informative. We focused on landfill disposal amounts and discovered them to be the most widely selected disposal option, and these materials to be commonly considered as recyclable in the United States. Although we found that potentially exchangeable materials do exist in Costa Rica, we discovered that it was very difficult to find an appropriate match for such materials.

We also found that email, telephone and fax were popular forms of communication. But, the Internet in the form of web pages has been an area that has not been widely used by Costa Rican businesses, and nobody responding to the survey indicated that they wanted to use a web page for communication. While the survey results indicated this, the interviewees said that an internet system would be a good idea, and the natural networking of companies would make the system proliferate in conjunction with a telephone system.

Due to the fact that there may be difficulties in finding proper materials exchange matches in Costa Rica, we have recommended the creation of a system that actively searches for participants and matches and facilitates the transactions, in essence an active system, based on the Web with telephone, email, and fax.

We also have recommended an extensive marketing plan for this system involving an eco-labeling scheme, including other more common forms of marketing, and have outlined options for the post-implementation phase such as funding and consulting services.

The implementation of this system will be a great step towards sustainable industrial practices in Costa Rica, addressing the need for efficient use of resources and opening up the a prospect for additional jobs in resource recovery.

Resumen Ejecutivo

Los intercambios de recursos son comunes en Europa, Estados Unidos, América Latina y otras partes del mundo. Estos sistemas proveen comunicación entre negocios con el objetivo de facilitar transacciones de materiales que serán de otra forma enviadas a rellenos sanitarios o desechados de alguna manera. Este tipo de esquema se facilita con el uso de una base de datos donde listas de ofertas y demandas de subproductos de procesos industriales son poseed por los representantes de las compañías. Esas compañías están por querer aceptar estos subproductos en sus industrias como un recurso o relingues r cantidades de materiales que están en su última etapa del ciclo de vida dentro de un proceso industrial fijado. Un intercambio de recursos provee la información necesaria para un empresario para encontrar oportunidades de negocios reciclando y recuperando materiales, que a la vez crea un potencial para nuevos empleos.

Actualmente Costa Rica no tiene tipo de sistema a gran escala activo que maneje la comunicación de negocios para el intercambio de materiales. También hay, en general, una falta de programas de reciclaje que hacen que el manejo de los recursos sea por debajo del nivel óptimo de utilización.

El CENTRO NACIONAL DE PRODUCCIÓN + LIMPIA (CNP+L) ha pedido al Worcester Polytechnic Institute en Worcester, Massachussets, ayuda para investigar el potencial para crear un programa de intercambio de recursos en Costa Rica. El CNP+L desea tener este estudio con el objetivo de determinar la cantidad de atención que este tipo de sistema recibirá y también establecer los

costos asociados con la implementación de un sistema de comunicación que facilite el intercambio de recursos entre negocios en Costa Rica.

Este documento le da un trasfondo sobre los métodos para realizar un análisis financiero para el tipo de sistema propuesto y para calcular los costos asociados de un intercambio de recursos y provee suficiente trasfondo sobre el intercambio de materiales. Este texto también define los métodos que se utilizaron para determinar la mejor manera de crear un intercambio de subproductos en Costa Rica. Se necesitó determinar las prácticas actuales de manejo del desecho en Costa Rica, disponibles y preferidos, tipo de comunicación, y el nivel de respuesta que este sistema puede recibir. Se uso una encuesta, una serie de entrevistas de seguimiento, y entrevistas exhaustivas con importantes compañías costarricenses dedicadas al manejo de materiales para ofrecer la información requerida.

Se mandaron 650 encuestas a los miembros de la cámara de Costarricense de Industrias y se recibió respuesta de 32 compañías. Este número no es suficiente para proveer un modelo preciso por las industrias asociadas a la cámara, pero las respuestas proveyeron información valiosa sobre las compañías más grandes en Costa Rica, y las entrevistas comprobaron ser igualmente informativas. Se enfoco en cantidades de desechos en un relleno sanitario y se descubrió que era la opción de desechar utilizada en forma mayoritaria, y estos materiales son comúnmente reciclables en los Estados Unidos. A pesar de que se encontró que existen materiales potencialmente intercambiables en Costa Rica se descubrió que era muy difícil encontrar un acople apropiado para estos materiales.

También se encontró que el correo electrónico, teléfono y fax eran formas populares de comunicación. Pero, el Internet, en lo que corresponde a páginas web es un área que no ha sido altamente utilizado en negocios costarricenses, y ninguno de los que respondió la encuesta indicó que quisiera utilizar una página de Internet como medio de comunicación. Mientras los resultados de la encuesta indicaron lo anterior, las entrevistas mostraron que el sistema de Internet sería una buena idea, y el trabajo en conjunto entre las compañías harían que el sistema prolifere en conjunto con un sistema telefónico.

Debido al hecho de que hay muchas dificultades para encontrar los apropiados acoples de intercambio de materiales, hemos recomendado la creación de un sistema que activamente busque participantes y acoples y que facilite las transacciones, en esencia un sistema activo, basado en el teléfono, e-mail y fax.

También se recomendó un plan extensivo de mercadeo para este sistema y que involucre un esquema de eco-etiquetar, incluyendo otras formas comunes de mercadeo, y se determinaron opciones para la fase de post-implementación como lo son los servicios de financiamiento y consultoría.

La implementación de este sistema será un gran paso hacia las prácticas sostenibles industriales en Costa Rica, dirigiendo la necesidad de un uso eficiente de recursos y dando apertura para convertirse en un prospecto para empleos adicionales en la recuperación de recursos.

1.0 Introduction

The first industrial revolution left us with ominous examples of blatant disregard for worker rights and wanton destruction of the Earth's environment. Today, these lingering human and environmental issues force us to attend to international pressure for fair labor practices and the preservation of dwindling non-renewable resources (Natural Capitalism Website, 2002). While the task can be daunting, this project addresses the need for resource conservation in Costa Rica by identifying ways to recover industrial resources and materials that are no longer useful to a company.

Industrialization is defined as "the transition from a society based on agriculture to one based on industry," and is thought to have its conception in England during the early eighteenth century (Bishop, 2000, pp.6-7). Industrialization only started in Central America immediately following the end of World War II and has, in general, followed the universal historical nature of industrial development: greatly increasing productivity and ameliorating the standard of living, while unfortunately leaving a plethora of social and environmental problems. These problems range from degradation of the environment to vast inequities in the distribution of wealth.

Fortunately, in Costa Rica these consequences have been greatly attenuated by progressive policies of the government and the private sector. Costa Rica has achieved a more equitable distribution of wealth and has lessened the deterioration of the environment more successfully than its

neighbors (Perez-Brignoli, 1989, p.142). Our project sponsor, Centro Nacional de Producción Más Limpia, is a great example of this national concern and informed attitude towards the preservation of the environment.

The Centro Nacional de Producción Más Limpia (CNP+L) is a non-governmental organization dedicated to the promotion of cleaner business practices and the optimization of efficiency within these practices, thereby addressing issues of worker safety, resource preservation, and the health of the environment. CNP+L recognizes the inefficiencies of the current industrial system of resource usage and has proposed developing an exchange system by which businesses can transform their industrial byproducts into materials with a potential use in other industrial applications. Under their proposed system, these industrial materials will have an extended life in industrial processes and will not be wasted in a landfill. We have worked closely with CNP+L to research and develop this new exchange system, which would be able to respond to the needs of the growing industrial economic base in Costa Rica as well as global concerns about the environment.

> Typically, industries have been set up to use only virgin materials because of the expense and complexity of renovating recycled materials into usable quality for manufacturing new products. Therefore, there is often no market for the materials in a product after it has served its useful purpose and it is discarded into a landfill, creating more pollution. It has been only in about the last decade that this practice has begun to change (Bishop, 2002, p.9).

The research and ultimate implementation of this system has been split into three phases by CNP+L. The first phase, the focus of our project, involved research for the implementation of a materials exchange program in Costa Rica.

As part of phase one, our goal has been to research the creation of a system that would enable businesses to perform exchanges of byproducts and material surpluses to reduce the amount of materials that were originally classified as waste, as well as to determine a scheme to effectively market this system to businesses in Costa Rica. This system will benefit industries using the recovered materials by reducing their purchasing costs. The company providing the material also benefits by reducing its disposal costs. In turn, the reuse of materials in industry provides macroeconomic benefits similar to those of recycling, with the potential to create more jobs in Costa Rica. Finally, the system decreases the amount of material that ends up in a landfill, and thereby lessens the negative impact on the environment both in terms of industrial waste contamination of the Earth and excessive consumption of natural resources.

Our project objectives included:

- Researching laws concerning landfills, recycling, and waste transport in Costa Rica.
- Investigating the current situation in Costa Rica concerning recycling and resource reuse practices.
- Examining UN Agenda 21 and its impact on resource reuse in Costa Rica.
- Calculating the economic benefits of resource recovery.
- Identifying the companies that could be the primary beneficiaries of and contributors to a materials exchange system.
- Examining systems in place in other countries concerning industrial resource reuse.

- Identifying the roles of companies in a resource recovery system.
- Determining a materials exchange system that would be most effective for Costa Rica.
- Developing a plan that could successfully market the materials exchange system in Costa Rica.

The final two phases of developing a materials exchange system, which CNP+L will address in coming months, mainly involve the implementation of the system. The second phase is the actual execution of the researched scheme and the creation of the resource exchange system. This phase will receive technical help from the Instituto Technical de Costa Rica (ITCR) and CEGESTI in the actual creation of a resource exchange system within Costa Rica. This phase is expected to begin in September 2002. The third phase will involve collecting data to measure the potential reception of the system and will include any type of maintenance that the system requires. This should revolutionize the Costa Rican management of resources and what their enterprises perceive as waste.

2.0 Background

This chapter includes information necessary to understand the purpose and design of this project. It discusses background of waste management and why this field needs to be improved. This chapter also covers the fundamentals of a resource exchange.

2.1 Cradle to Grave

This first section details the relationship between the environment and capitalistic economics and the consequences of such a relationship.

2.1.1 We have only one planet.

> It is estimated that our materials-dominated society consumes about 10 metric tons of raw materials per person per year in the production of consumer goods. Within six months of...production of these materials, 94 percent of them become residual material that is disposed of as waste.... It is estimated that 70 percent of this waste material could be eliminated through...reuse of materials (Bishop, 2000, preface).

In the past few decades, the world's nations have felt some pressure to begin sustainable development practices and find ways to conserve and reuse their resource pools because of these and similar estimates about waste and consumption. It is important to understand his estimate gives averages based upon the current population size, but this fails to point out that almost 97% of the world consumes way below this average. A few affluent nations, such as the United States, account for most of the ten metric tons of materials consumed annually per person.

In 1992, the United Nations held a conference in Rio de Janeiro where leaders and scientists all around the world discussed the status of the environment. An official report was generated, entitled Agenda 21, which was an attempt to represent a unified, international perspective on this status. It was determined that:

- The ozone layer was being depleted.
- Massive soil erosion was destroying our ability to grow food and manage crops.
- Loss of forests was causing an increase in deserts.
- The oceans could no longer absorb our waste.
- Flora and fauna were undergoing extinction due to environmental changes.
- Pollution levels were responsible for considerable health problems

(Sitarz, 1993, p. 2)

The nations that signed this document also agreed that these problems were the result of human population explosion coupled with the inability of developed nations to adequately manage resource consumption (Sitarz, 1993, p.2). "The modern industrial economy has led to the unprecedented use of energy and raw materials...giving rise to serious environmental problems...[and] such levels of consumption cannot be sustainable over the long term" (p. 38). Unfortunately there are those who do not believe an environmental crisis is imminent.

In addition to the strain on our ecosystem through the excess consumption of Earth's resources, most products are designed with inefficient and wasteful

practices. This leads to a rapidly increasing quantity of waste that must be handled. Unfortunately, pollution prevention has never really been considered a public issue until a few decades ago. This was when the world suddenly realized the limited amount of energy and space that existed with only one planet's resources available to conduct waste treatment. Pollution control, rather than prevention, is the current form of waste management adopted by industry, but that is soon to change.

2.1.2 How many planets for Costa Rica?

Mahatma Gandhi was once asked if after its independence India would attain British standards of living. He promptly responded, "It took Britain half the resources of the planet to achieve its prosperity: how many planets will a country like India require?" His answer is applicable to Costa Rica as it makes the transition to an industrialized economy. It is crucial for any developing country to be cautious when choosing a path of development, so the citizens do not find themselves experiencing the same disasters, such as a crisis in resource availability, as current developed nations. Fortunately, an attitude of adopting resource reuse (where materials are used to a greater efficiency) as the new industrial process paradigm is beginning to emerge that could curb the amount of waste in Costa Rica before it becomes an environmentally threatening problem.

Management of solid waste in Costa Rica has been traditionally approached in a disorganized and irregular way (Moreno, 1999, p.40). Lacking necessary resources, such as an educated labor force and adequate public

funds, local governments are unable to provide a sustainable solution and instead continue the historical pattern of providing low-level public services in waste disposal (Moreno, 1999, p. 43). Lack of government initiative and inadequate planning has forced people to recognize that the key to development is bottom-up participation of citizens themselves. Yet, despite the lack of public or private institutions, communities of people have taken it upon themselves through the creation of grassroots organizations to solve their own problems. Some of these initiatives have taken the form of Micro/Small Enterprises (MSE's) and Co-ops formed by citizens settling for low-income jobs such as traveling to landfills, rummaging around in the garbage looking for materials that can be reused. Such MSE's are common in Guatemala and Ecuador.

Although the development of these MSE's is also increasing resource recovery in Costa Rica, the government is still inactive in a few cases. SINADES, "Sistema Internacional para el Desarrollo Sostenible" (or International System for Sustainable Development) is a group devoted to the promotion of sustainable development within Costa Rica. This organization created a series of questionnaires to assess public opinion about the environment (SINADES, 2002, General Characteristics) [1]. The result was the latest survey of the public's awareness of environmental issues. Two questions were particularly relevant to our work.

The first question identifies the importance of ecological well-being to Costa Ricans.

[1] More information on the SINADES organization as well as additional questionnaires can be found in Appendix C

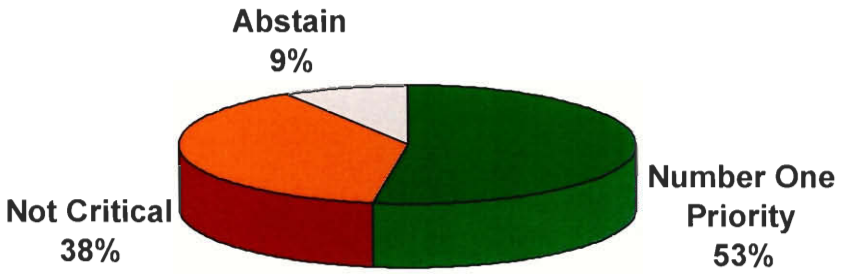

Figure 1: How important do Costa Ricans rank environmental issues?

Source: http://www.mideplan.go.cr/sinades/Proyecto_SINADES/encuesta/index-4.html

The second polls how effective the government is in implementing eco-friendly policies.

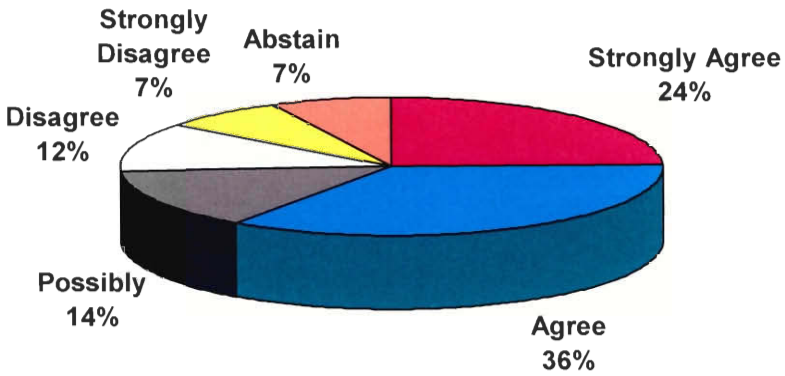

Figure 2: Has the government talked about sustainable development but not done anything about it?

Source: http://www.mideplan.go.cr/sinades/Proyecto_SINADES/encuesta/index-4.html

Some conclusions can be made from these results:

- 53% of the people surveyed responded that the environment is the number one problem in Costa Rica.

- 60% responded either strongly or moderately that sustainable development is frequently the topic of political conversation, but fails to appear in practice.

It is interesting to note that the second question was worded using the term "sustainable development" and not simply a reference to environmental laws or regulations for which the government would have principal responsibility. Provided that these results accurately reflect the true opinions of Costa Ricans we could conclude that the caretakers of the environment do not only encompass people and their elected government. Costa Ricans believe that businesses and private enterprises can have a positive impact on the environment and the people are looking to their government to enforce this. A third question from the SINADES survey, polling where people think the source of pollution is coming from in Costa Rica, demonstrates this.

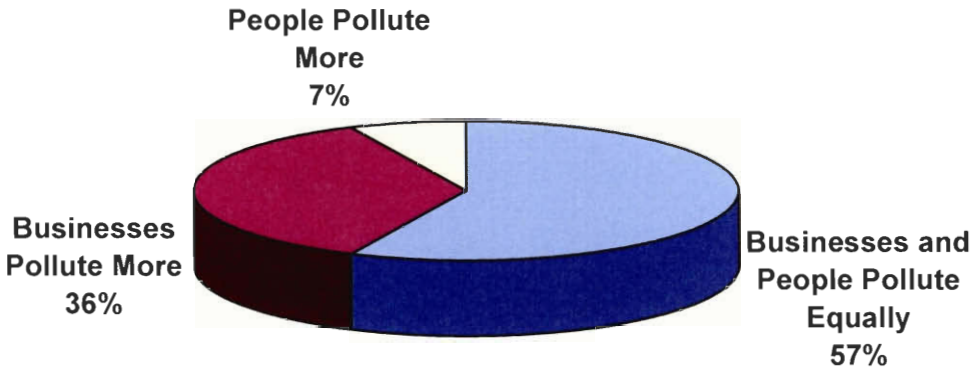

Figure 3: Do Costa Ricans believe businesses or people pollute more?

Source: http://www.mideplan.go.cr/sinades/Proyecto_SINADES/encuesta/index-3.html

Although a considerable number of people voice the opinion that businesses are the main contributors to pollution, fascinatingly the majority believes that both parties are equally guilty. This reveals that Costa Ricans believe that both industrial waste and personal waste are affecting the health of the environment. Costa Ricans also believe that participation from both industry leaders and average citizens is required for pollution prevention.

2.1.3 A New Planet

Whether in Costa Rica or elsewhere on this Earth, it goes without saying that the cooperation of all entities – people, governments, and businesses – is needed to bring the world out of its present environmental crisis and to prevent further damage. Yet the disregard for sustainability in development, as observed in the history of industrialized countries, was a significant factor in contributing to the status of the environment today. Costa Rica's industry and economy demand attention and the proper nurturing to become prosperous as it transforms itself into a more developed nation. The crux of this proposal thus focuses upon what businesses in Costa Rica can do, through ingenuity and determination, to play a positive role in constructing the basis of an industry that can coexist harmoniously with the natural world.

2.2 *Cradle to Cradle*

This section details with new ways of thinking that can correct the environmental degradation brought about by old business practices.

2.2.1 P-Two not P-Squared – Prevention vs. Control

The first solution to industrial pollution was to find the apparent fast and easy way out of pollution generation, through quick-fixes in industrial processes without actually changing the processes themselves. Time, energy and resources were expended by industry to discover ways to "treat" the pollution they were generating in hopes they could postpone ecological deterioration. Thus, a family of waste treatment methods was developed, and industries began to factor these costs into their budgets. In most cases, it was business as usual.

The problem with this strategy, as finally realized years later, is that simply subjecting polluting-causing agents to forms of treatment is only accomplishing pollution *control* as opposed to *prevention*. The disturbing data that spawned the Agenda 21 report accelerated the global understanding that controlling the damage was not going to be enough; what was required was a way to stop environmental harm altogether. The United States Congress and the U.S. Environmental Protection Agency cooperated to create a new strategy that would address the underlying issue. This came to be known as, not surprisingly,

pollution *prevention* (or otherwise informally known as P2) and inspired policies that would influence the way businesses were extracting and releasing materials into the environment.

Pollution prevention is formally defined as "practices that reduce or eliminate the creation of pollution or wastes at the source" (Bishop, 2000, p. 11). Now the priority is to reduce, in any feasible way, the amount of waste or pollution industry generates[2] before it becomes a problem that needs to be controlled. The goal of this new thinking should be rather obvious as it aims to reduce the chance of an environmental crisis as well as curtails the need for elaborate, expensive waste manipulation schemes. Figure 4 illustrates examples of activities that can be implemented according to pollution prevention tactics.

[2] Which is, incidentally, known in P2 circles as *source reduction*, provided the waste is eliminated before production. Otherwise, it is simply referred to as *waste reduction*.

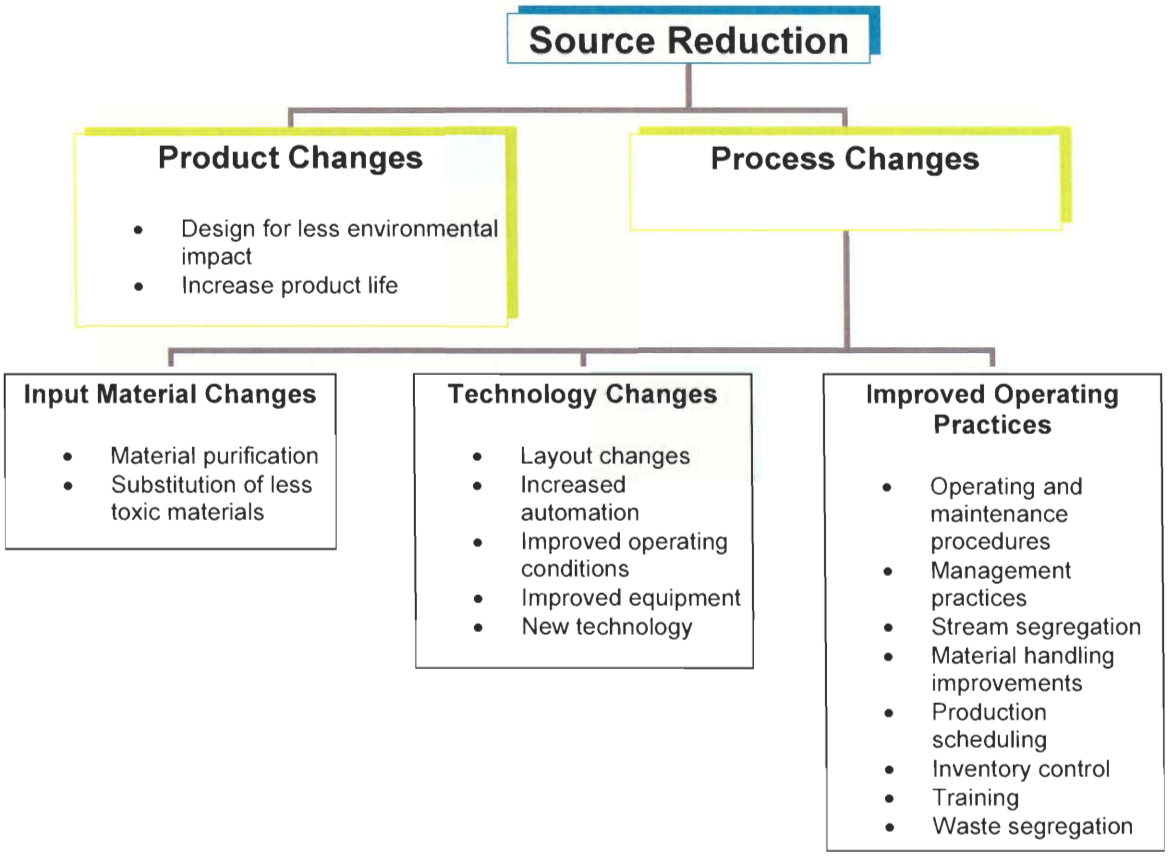

Figure 4: The range of pollution prevention activities

Source: Bishop, 2000, p. 11

Pollution prevention, also known as source reduction, eventually does approach a stage where certain tactics can no longer be feasibly implemented. Economic or technological restrictions could prevent a company from achieving the 100% waste-free goal. The modelers of pollution prevention understood this and modified the concept to establish a Pollution Prevention Hierarchy. It would still stress the importance of source reduction but would also include advice on what to do if all measures have been taken and waste is still produced.

The Pollution Prevention Hierarchy was first drafted by Congress during the passage of the Pollution Prevention Act in 1990 (Bishop, 2000, p.12).

Although it has been drawn up in different ways by various organizations (in fact, CNP+L has its own version), the underlying themes remain the same. A diagram of the P2 Hierarchy is shown here:

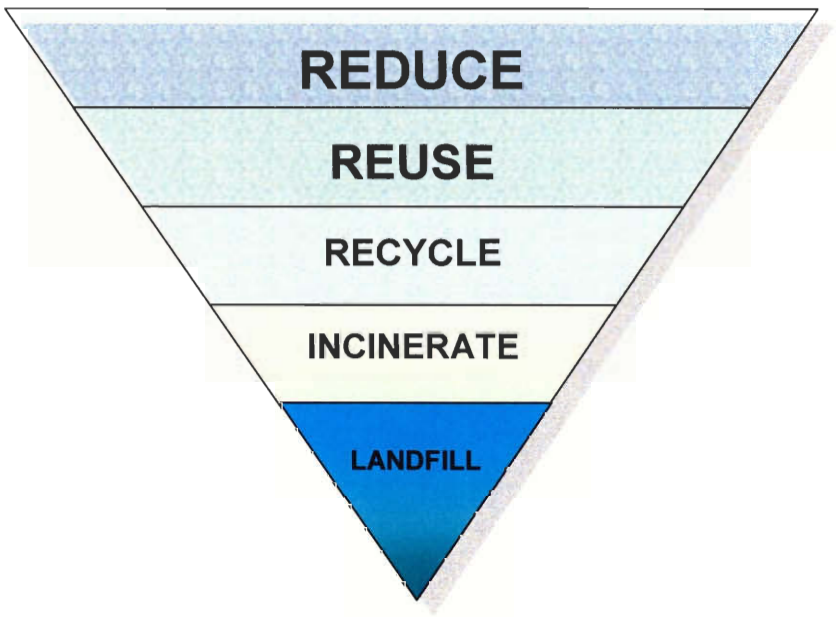

Figure 5: One Source of the Pollution Prevention Hierarchy

This figure symbolizes the order in which companies should implement treatment of their waste or other pollution-causing agents. Reduction, representing the most desired way of handling pollution, is on the highest tier, while the least desired, landfilling, is on the lowest tier. Companies should follow this model so that their pollution is more effectively prevented. For example, a given company should first attempt to reduce the sources of pollution in an industrial production scheme. If there is still pollution being released, then the industry must try and find a way to reuse the pollution-causing agents and so on and so forth. The

absolute last resort, and least encouraged by the U.S. Environmental Protection Agency[3], is to dispose of waste in a landfill.

Pollution prevention has now become the official governmental position of the United States on environmental issues with the corporate world. However, subsidiary philosophies have emerged from this strategy, developed by a few innovative companies and business professionals. They explain in a little more detail how industry can make the economy of the industrial world more compatible with the ecology of the living world.

2.2.2 Philosophy #1 – Eco-efficiency

Consumers do not purchase goods for the sole purpose of physical ownership (DeSimone, 1997, p.47). The acquisition of material things is not the end, but in fact the means. Consumers buy products in order to meet a specific need. To understand this indicates a change in the definition of industrial success. No longer are vast quantities of throughput a criterion for commercial accomplishment. The spoils go to the company that increases the quality of life for the consumer.

"Eco-efficiency is a dynamic strategy that presupposes that social expectations of corporate environmental performance are constantly rising" (DeSimone, 1997, p. 23). Consumer satisfaction has always been a significant concern, as this can lead to improved corporate image and increased sales. But

[3] For the record, the U.S. EPA does not officially recognize recycling as a form of pollution prevention. However, every authority that has written on P2 since its creation has included it in their definition so we have also.

with businesses no longer being characterized simply by the tangible object they create, environmental considerations become more important. Now, the competitive business strategy of a company focuses on how to provide the best application to service a need. With consumers valuing environmental protection, the best application may be the one that is most eco-friendly.

Yet consumers, by and large, can only place environmental preservation as a top priority when they are reasonably well off. Ultimately wasteful, pollution-causing, products are unnecessary to fulfill daily needs for consumers (DeSimone, 1997, p. 49). But does one really care if one belongs to the billions without clothing, shelter, medicine, and nutritious food? Eco-efficiency presupposes that social expectations about environmentally friendly products are rising, but that can only occur if basic needs are also being met.

Eco-efficiency can work in a developing nation whose main concern is to bring the economy to maturity. The principles behind eco-efficiency are not restricted to simply doing more with less or other austerity measures shared by cleaner production and industrial ecology. Eco-efficiency's emphasis on fulfilling needs makes this philosophy have a bigger impact. Production over a long term that neglects the need for a sustainable cycle of consumption will not fulfill long-term needs. Businesses and industries that desire to satisfy the needs of the people (and these enterprises should be abundant in developing countries) would better succeed in their goals by adopting eco-efficient practices.

Eco-efficiency is maximizing ecological and economic gains by minimizing ecological and economic impact. It is not a campaign to force businesses to

replace free market convictions with compassion for the environment. It simply warns that the public sector is going to consistently increase pressure on businesses to produce products with more value, less cost, and less negative ecological impact. If this prediction is correct, eco-efficiency will be the competitive strategy for businesses in the future.[4]

2.2.3 Philosophy #2 – Cleaner Production

A new approach to production is needed because of the increasing public recognition that the wanton consumption of resources and the excessive production of throwaway goods are leading to problems with the depletion of natural resources. Agenda 21 and other environmental documents urge the realization of sustainable development, or development that allows a natural cycle to exist that enables the conservation of resources and the environment. Yet this form of development will not come to be if industry continues to engage in practices that are hazardous to human health as well as all of nature. The United Nations, as part of its environmental program, drafted the design of cleaner production to address these concerns.

According to the United Nations Environmental Programme, (UNEP) cleaner production is the "continuous application of an integrated preventative environmental strategy to process products and services to increase overall efficiency and reduce risks for humans and the environment" (UNEP, 2002,

[4] For convenience, a checklist for creating eco-efficiency in a company is included in Appendix D.

Understanding CP). Industry interacts and affects society through three mediums: manufacturing processes, products, and services. The strategy of cleaner production can be applied to any or all of these mediums.

Eliminating toxic materials and hazardous emissions that are found in the production processes is the first step to cleaner production. The birth of material, no matter what use or value it may have to society, should not, of course, eventually lead to long term damage of human health. Next, the entire life cycle of the product itself should be planned so it leaves little or no ecological footprint. Products that disrupt the integrity of the ecosystem or bring harm to humans through their use, as in the case of leaded gasoline, should be abolished. The final step is analyzing the larger service the product provides or the delivery of the service to human society so that it is risk free and environmentally friendly.

A rather interesting point to note is that a simple explanation of cleaner production encompasses both the philosophies of eco-efficiency and pollution prevention, but is slightly different (UNEP, 2002, Related Concepts). Eco-efficiency focuses on practices of economic efficiency that can also benefit the environment. Cleaner production studies practices of environmental efficiency that can have a positive return on investment. Pollution prevention is related to cleaner production in a rather unusual way. Although ultimately synonymous, the record states that "pollution prevention" is the North-American (read U.S.) version[5] of what the rest of the world understands as "cleaner production."[6]

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[5] Apparently, P2 being the "official environmental policy of the United States" is supposed to compensate for not signing international treaties such as the Basil Convention or the Kyoto Protocol.

[6] Green Productivity is the name used in Asian countries. However, this program differs only by name.

Cleaner production is the collection of all policies that looks long-term and that provides more than tax incentives. It is an active approach that tries to "anticipate and prevent" rather than "react and treat." The key to understanding cleaner production is to acknowledge that it does promote economic growth; however, this growth must be ecologically sustainable. This means that waste treatment is not included under the ideology of cleaner production, (Or pollution prevention, for that matter) due to the history of these conventional practices. Companies must take initiatives that do not simply treat waste or pollution in order to comply with cleaner production.

2.2.4 Philosophy #3 – Industrial Ecology

An ecosystem is built around two important principles, that of symbiosis and diversity. In nature, no matter is ever destroyed. It merely changes form and serves another purpose. Resources that are consumed in one system are converted to supply another system, thus maximizing efficiency and energy use. This conversion of resources also demonstrates diversity, as a single material can often be consumed in a variety of different systems.

"The goal of industrial ecology is to integrate production systems and product cycles with natural ecosystems and material cycles" (Bishop, 2000, p.608). Accomplishing this involves altering production processes to stimulate conservation of resources and energy. It should also include the adoption of new

environmentally friendly development policies by governments. However, primarily the reuse of resources becomes the foundation of industrial manufacturing in the concept of industrial ecology. If a waste material or by-product cannot be used by the company that originated it, then it should be passed on to a company that can. In fact, eco-industrial parks[7] have already been set up to specifically support that purpose.

Bishop (2000, p. 609) states that industrial ecology was developed to counter the historical pattern of producing without worrying about recovering post-consumer and post-industrial products, characterized by the phrase, "extract-and-dump." Others agree. Many industrial ecologists held to the assumption that throughout history, industry has merely exploited resources from the environment, consumed them and abandoned the remains. Yet, some researchers are challenging this claim. An article in the Journal of Industrial Ecology argues that there is evidence that shows not all of history has been "extracting and dumping." Citing the specific example of "animal parts recovery", Desrochers (2000, p. 24) says that resource recovery has been consistently implemented, even as far back as the Neolithic period. Our ancestors were able to derive uses for 7 distinctly different parts of the horn left over from an animal they killed for food.

Economies do not expand by continuing to do what is always done; economies expand by creating valuable things out of once worthless things (Desrochers, 2000, p. 40). Much of what is considered recyclable today was

[7] Although technically not an eco-industrial park, what the Danes created in Kalundborg, Denmark is often referred to as one. A description of this is included in Appendix E.

once considered waste until value or purpose was discovered contained within the material. This discovery could not have taken place if industry did not deviate from its historical path of wasteful thinking.

The overall idea of industrial ecology is that it converts traditional "waste streams", or materials identified as waste, into materials that can be used in production for new products.

2.2.5 Why Ecological Reform Has Been So Slow

Talk of environmental crisis can bring about movements for new ideals and new ideologies. Statistics reflecting ecological damage or depletion in resource availability can motivate politicians to create new environmental policies and can convince citizens to think more in terms of the environment. However, despite all this attention, the corporate world can travel at a snail's pace when trying to implement environmental reform. Critics challenge the feasibility of such reforms (Dupont, 2000, p.286). They object that any green project reform will jeopardize product quality and require additional and excessive financial contributions. The question arises, though, how much of this is myth and how much of this is a valid concern?

While in the most ideal of situations, industrialized nations would curb their wasteful consumption of the Earth's limited materials, even with the advent of recycling, some problems and obstacles still arise for the average manufacturer. In general, the cost required to create a product from a virgin resource may entail many times the amount of cost required in recycling the same item. This alone

should make recycling appealing due to its apparent cost-effectiveness. However, the processes involved in creating the refined byproduct could bring about additional financial concerns that are not readily apparent. Energy and labor expended in physical and/or chemical remanufacture could begin to add up. Taking into account all these hidden variables and revealing the actual cost of pursuing a particular course of action is known as an LCA, or Life-Cycle Assessment. LCA's are important because they essentially provide a resource roadmap of what is necessary for operation, and knowing this will invoke the "Iron Law." This is a mindset that says if the net income on an environmentally-minded project is less than the net income of what is currently being done, chances are there is no way a company is going to initiate that project. In addition, small and medium sized enterprises may not have adequate capital available to them to invest in cleaner production projects (Huhtala, 2000, p.3).

It is true that some environmental initiatives can cost a significant amount of money to implement. First, money must be invested in research and development and feasibility studies in order to determine the best possible ways to implement the system. The company must then invest money in regulatory compliance, such as taxes, reporting fees, and labeling fees (depending upon the country of operation). Companies must also consider any voluntary costs associated with community awareness and training, landscaping, and employee training, and any final costs associated with site surveying, inventory disposal, and other conventional costs (DeSimone, 1997, p.26).

If the environment is recognized as an appropriate investment, then the initial investment becomes more reasonable. The company will have more insurance for fines, worker injury costs, damage costs, and legal fees associated with the disregard to the environment. The business will also receive an enhanced corporate image, which is an intangible benefit that companies often ignore (DeSimone, 1997, p.24). Companies utilizing a cleaner production process, paying attention to the environment, will benefit from higher yields and better quality control with the end products. This will lead to higher profits with the addition of improved and consistent quality (Childers, 1998, p.5).

In some respects then, ecological reform has gotten a bad rap because a few projects had expensive, or relatively more expensive, LCA's.. Yet to say that all environmental reform is too costly of an investment is simply not true. It may be a challenge, but as the philosophy of eco-efficiency maintains, it is a challenge for engineers and managers to develop environmentally responsible solutions that are also cost-effective. Similar to creating a product so that the industry will become more competitive, clever environmental solutions will also make the industry more competitive, provided they are implemented economically. It is not an inherent characteristic of the project, but a choice as to whether production will be economical or not.

It is important to keep in mind that expenses are relative. Costs associated with implementing a project may be a valid concern, but what about the costs associated with not doing anything about it? For example, governmental tariffs on landfill disposal can force companies to think more about

the current waste stream they are producing. This is the perfect scenario on which to run an LCA because it would help determine what is more beneficial in the long run, whether it is letting waste management go or improving methods of management. In this particular case, businesses may still choose the easy way out, because materials have storage costs in a resource reuse program (Powelson, 1992, p.13). The emphasis should be to explore all sides of an issue before making a decision. (Provided that this doesn't take too long or the reform may never come to be!)

Government can be a strong influence in the decisions businesses make by setting up regulations on environmental impact and penalizing those who violate them. However, governmental legislation can work both ways. In the United States, the tax law is currently skewed favorably toward the use of virgin materials versus the reuse of recovered materials. For instance, the United States federal tax law allows tax deductions for companies that either mine resources directly from the environment or decide to purchase raw materials from third-party mining companies. Unbelievably, companies that do *not* use recycled products are given a distinct advantage by such deductions. Lobbyists from mining and material creation industries, in a completely legal way, support these types of fiscal policies that are positioned unfavorably towards resource reuse (Powelson, 1992, p.12). Ultimately, this leads to little or no environmental improvement.

Another reason why ecological reform is avoided is because often only economic negatives are highlighted and not the intangible and most of the time

non-monetary benefits. To some extent this is understandable given current practices, but it is not excusable. The financial benefits attached to environmental projects are often hard to recognize given conventional accounting methods. These analyses usually aren't accustomed to dealing with the specific numbers or variables associated with environmental management, so the actual costs or savings may not be accurately represented. The problem is compounded even more if the lengths of these critical and significant analyses are not long-term enough to capture the full returns. Failing to accurately assess benefits or returns in a financial report will not work in any school of business.

Finally, ecological reform may be hindered because of non-financial factors. Ironically, some cleaner production projects might not be that clean at all. Bleaching recycled paper as an act of resource recovery is an example of an instance where pollution can actually be generated from the process intended to reduce pollution (Ohio State, 2002, homepage). Removing toxic chemicals from a viable resource could also require additional clean-up or hazardous material management efforts. Along with generating pollution, the actual project could be impossible to implement. The material a company wishes to handle could simply be too contaminated for recovery or the technology needed to refine the resource could be beyond the ability of the project or the company (Ohio State, 2002, homepage).

Nevertheless, ecological reform can be done and in an economical fashion. The major mindset that needs to be changed, at least in the case of

resource recovery, is the idea that environmental initiatives must be money-making schemes.

> The economic feasibility of a resource recovery should not, therefore, be based on making a profit from the sale of recovered products, but rather on offsetting a portion of the costs of disposal with these revenues, so that the net disposal cost for resource recovery is equal to or less than the alternative costs (Scwarz, 1983, pp.3-4).

As long as it is clear that profit is not the goal, other obstacles will disappear. All that is required now is a manager with a strong will towards improving the environment or enough evidence to show that it can be economical to reduce costs and improve efficiency. In the case of resource recovery, it can be both.

2.3 Subproduct to Subproduct

This section will detail the areas industry can focus on to achieve environmental sustainability as well as economic growth.

2.3.1 The Treatment Family: Household of Waste Management

Waste management involves how companies choose to treat their waste and other pollution-causing agents. Currently, there are five main modes of waste treatment: land filling, storing, incineration, recycling, and reusing. Three of these options, the ones that have been the most popular in the past, fall under the constraints of mere pollution control. The other two, recycling and reuse, although more environmentally effective than the others, still don't meet the new ideas of cleaner production or pollution prevention because they are forms of

waste treatment rather than source reduction, better known as pollution prevention.

That being said, current renovation in waste management has taken the form of recovering resources from material streams in an industrial process (Dupont, 2000, p.313). Although still not the same as actually eliminating waste from the production process in the first place, recovering a material is a step toward long-term industrial ecology. However, most technology required for actual material separation is available only to industries large enough to contribute considerable amounts of capital and labor. This unfortunately forces smaller industries to resort to more ineffective forms of waste treatment, such as storage or land filling. These methods are often plagued by disposal liabilities and restrictions that incur increasing costs. With most industry concerned with the bottom-line, pressure is placed on more and more companies to explore economical alternatives. Fortunately, most environmentally-friendly projects function as both a way to preserve the environment, and as a way to conserve money.

To maximize efficiency of waste management, one needs to look at how waste is generated. Although "treatment of complex waste streams from industrial processes can be complex and expensive," the secret is that "in many cases, waste generation is a symptom of poor product quality control and low process efficiency" (Dupont, 2000, p.86). Waste management is basically an afterthought, sometimes made unconsciously and implemented to correct previous inefficient and harmful decisions.

How inefficient practices start within a company can be seen in two different ways (Dupont, 2000, p.87). One approach is to view the waste products as generated separately from the main manufacturing process. In other words, the inefficiency lies in how the product is made. This is a restricting approach as often the only solution to reduce waste is to alter the technology involved in product assembly. The second approach is to view the waste product as an unused material in the main product stream. In this case, the inefficiency is a result not of a failed production process but of a failed decision about what to do with these unused materials.

If waste is perceived as a material that has not been harnessed effectively, waste management begins to be transformed from an unrelated treatment problem to an all inclusive material management problem. It is precisely this realization that is causing companies to rethink the procedures involved in waste management.

2.3.2 The Family of Resource Exchange: A New Generation

Up until now, waste management has only involved practices of waste treatment, and treatment was considered only a form of pollution control. If waste management is going to continue however, in a cleaner producing world, new ways of handling materials currently considered valueless to companies must be implemented, otherwise industry risks becoming a primary contributor to ecological damage on the planet.

When a material from one company can be transported to another company as input as a raw material, this is known as a *materials exchange*. When a procedure is set up to trade and transport these materials, this is known as a *materials exchange system*. The system can either be run by the industry interested in performing the exchange, or a third-party could be contracted to manage the details. Materials on the exchange can be bought and sold, or they may just be given away; it is usually up to the parties involved.

Specifically, the type of material being exchanged determines the label that is used. The more general term, "resource exchange," can be applied to any situation regardless of the type of material. These resource exchanges experience a natural progression through various types of exchanges. Figure 6 illustrates this.

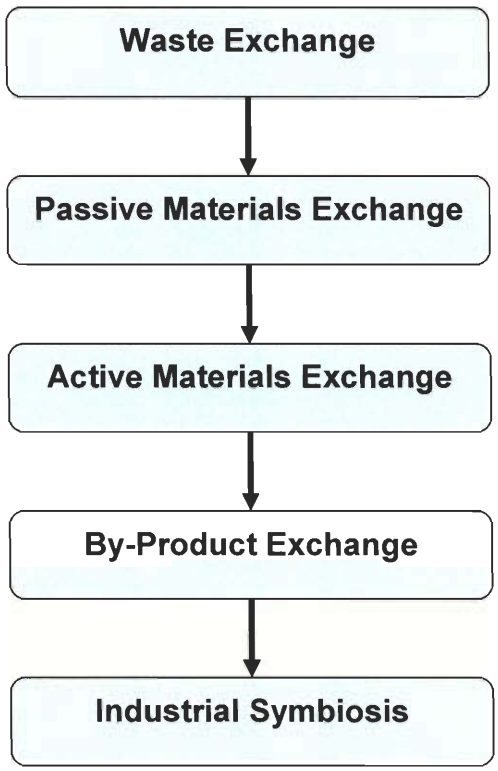


Figure 6: The Flow of Resource Exchange

The waste exchange is the first step by a company to move from the old "extract-and-dump" paradigm towards industrial ecology. Instead of simply disposing of waste products, an industry seeks out a particular business that might be able to put the waste product to use. Contaminated wastewater, for example, generated from one manufacturing process as a wash, could be purified and reused as an effective wash in the same process. It could also be transferred, for instance, to another company that would use it as a cooling liquid for their machines. Although sometimes these exchanges can be beneficial, the problem with most waste exchanges is that they seek to transfer materials that

are simply too polluted or too low of a quality for any use. As a result, not many waste products find interested buyers and thus will end up in a landfill.

The next evolution in thought involves a materials exchange. This is not simply restricted to contaminated waste products. A materials exchange seeks to transfer any material not used by a company to another industry that can use it. Leftover packaging materials, surplus inventory that cannot be rapidly sold on the market, or even surplus energy are often found being traded on a materials exchange.

There are two approaches to a materials exchange: passive and active. A passive exchange is facilitated by a third-party that has a listing of waste and surplus materials. Companies can actively search the listing for materials that can be used in their industrial process, and can post information pertaining to their waste and surplus. While this method can be effective, the active exchange takes this one step further. In an active exchange, the third-party organization will actively seek out companies that have a desire for a certain material, or will search for companies that have a highly wanted waste product. The active exchange requires more resources for searching for participants, but it can prove to be very effective.

By-product exchanges represent the bridge between the idea of optimizing material use and the symbiosis between industries. By-product exchanges are identical to material exchanges except more parties and more resources are implicated. If a material is labeled too contaminated for a use in an application, it is not immediately sent to the landfill. Instead, by-product exchanges will hire

entrepreneurs to establish a start-up company, if none already exists, that researches ways to remove the contaminants and make the by-product exchangeable. Thus, more investment is made in trying to make by-product material valuable and useful. In addition to actively trying to remove obstacles to the reuse of a material, participants in a by-product exchange will often retool their entire production or manufacturing process to adjust to the material that needs to be reused. For example, if one company needs ferrous aluminum as its raw material but another company produces non-ferrous aluminum waste, the engineers from the first company will try to modify their production process to be able to use non-ferrous aluminum. In a by-product exchange, the goal is to make as many materials reusable as possible, by whatever means necessary, provided, of course, they still remain economical and beneficial for the company.

Finally, industrial symbiosis is the goal of industrial ecology. Not one material or resource needs to be treated in a completely symbiotic system. Every material has a purpose that is necessary for production to exist successfully.

Resource exchanges, like any other form of trade, can achieve success through an adequate balance of supply and demand. However, most resource exchange concepts never leave the drawing board because a company may not know how to properly employ a system to perform this activity (Dupont, 2000, p. 298). This has led to third-party institutions setting up the system independently of any market to serve as a sort of brokerage house for an industry's by-products. In essence, the actual resource exchange system

operates as a matchmaking service that diverts the resources left over from one company for use in another.

Resource exchanges, like any other form of trade, can also encounter difficulties. In the US, the greatest obstacle to adoption of a resource exchange has been the lack of a central information databank (Dupont, 2000, p. 283). Companies are forced to struggle on their own to find other companies who would be willing to take their unwanted materials. Costs of transportation can render an exchange infeasible. Companies that are too far away or have too little quantities of materials to exchange might find transportation expenses outweigh standard disposal or treatment costs. Another problem can originate from the kind of material being exchanged. Hazardous materials are often not permitted in an exchange, at least in the U.S., due to liabilities and state or national regulations[8].

Despite all of this, resource exchanges are starting to become popular the world over[9]. Because of their connection to industrial ecology, resource exchanges just might be the future of environmentally responsible industry. Is it enough, though, just to focus on improving waste management to become green? And will resource exchanges be the catalyst for economic growth?

[8] A brief overview of the state of hazardous material transport in Costa Rica can be found in Appendix F.
[9] Appendix G offers case studies of various models of resource exchanges all over the world. In addition, a table highlighting the similarities and differences among these models is located in Appendix H.

2.3.3 The Science of Subproducts

Notwithstanding all the positive scholarly arguments for eco-friendly initiatives – either promoting the ethics of sustainable development or presenting financial benefits – the biggest flaw found in all of them is the use of the negative term: waste. Even in the context of trying to improve waste management or minimizing the harm of waste on the environment, referring to any substance as "waste" still shows that our production systems are not entirely efficient and our ability to use resources is still tainted. Addressing this issue involves more than just arguing semantics; it requires a new approach as to how we view the materials in all steps of industrial operation.

It must be understood that this is not an attempt to produce a regulatory loophole; to try and remove the conditions on handling waste by calling it something else. It is a change in the way of designing the production process that is switching from the historical and outdated cradle-to-grave philosophies to the new ecological cradle-to-cradle philosophies.

Paul Bishop, in his book Pollution Prevention: Fundamentals and Practice, proposes a rather intriguing definition of a waste product. He states "a waste is a resource out of place" (p. 10). If waste is simply a resource out of place, the philosophy of subproducts seeks to implement the proper usage of these out-of-place resources. It accomplishes this environmental correction by correcting how the flow of economics works in a business.

UNEP defines waste produced by a company as a product of negative value. In the world of economics, having products of value is critical to the

success of any industry. In fact, the economic definition of a product is a material that has market value. If waste were perceived as a liability, companies would do everything in their power to reduce the amount of waste they have. This is a good philosophy, yet it is too strict as source reduction is the only avenue of compliance through this way of thinking. Treatment of waste is completely out of the picture and sending waste to an exchange still doesn't constitute the elimination of the liability.

The answer may lie in not painting the picture so black and white. Companies have more than just products and waste. They have a third resource: subproducts. A subproduct is defined as a material that has potential economic value.

It is possible that all materials leftover in a company's industrial process could be used as subproducts. A company can choose to "waste" the subproduct by not putting it to use and having it become a negative asset or they may choose to turn it into something usable and give it positive value. A subproduct is a material that has not yet become either a market product or a waste product.

When industry begins to think in terms of subproducts, all of pollution prevention and waste management, as well as the manufacturing and production processes themselves, take on a whole new perspective. A company's success is then defined by how efficient they are in managing and transforming subproducts. This leads to more than just economic success though. Our project is an attempt to develop a system that will harness the philosophy of

subproducts as a form of economic growth and environmental sustainability. This system is a hybrid of various resource exchange systems.

2.3.4 The New Subproduct Exchange

A subproduct exchange system is a resource exchange system that transfers subproducts from one company to another. This type of exchange does not differentiate between the various roles and responsibilities found in a by-product exchange. All companies that produce goods are, after all, in the business of subproducts, and all of these companies transform subproducts into usable products. Subproduct exchanges also do not need to plan or take extra steps to anticipate industrial symbiosis. A subproduct exchange is industrial symbiosis. The degree to which this is felt is dependent upon how deeply a participant integrates the philosophy of subproducts into the way he or she conduct business.

The benefits of having a subproduct exchange system for use by industry are many. By rerouting the subproducts that are typically treated by one company to other entities that could put them to use, a subproduct exchange effectively behaves as an environmentally-friendly waste treatment program. Although compatible with any of the above philosophies, it is most easily understood as a type of industrial ecology, which creates a cycle of subproducts that promotes a healthy symbiosis and diverse selection of materials for companies. This makes a subproduct exchange a sustainable business practice.

Not only is it a lucrative business venture that corporations and managers can understand, but it doubles as a positive environmental practice for the company.

Another benefit to this system is that subproduct exchanges require no need to adjust current manufacturing processes to meet environmental standards. The hesitancy of companies in implementing previous forms of ecological reform was due to their fear that tremendous changes in manufacturing would need to be made, thus threatening product quality or resulting in loss of capital. A subproduct exchange functions as a supplemental add-on to any existing production process. The exchange performs under a configuration that allows the market product as well as any non-product material to co-exist in one stream. This

> configuration provides the best opportunity for pollution prevention improvements as here the separation process can be focused on for improvement in product recovery rather than the production process itself (Dupont, 2000, p. 87).

This saves engineering costs by involving only supplemental managerial participation instead of a reworking of complex, technical production methods. Subproduct exchange programs also require no additional technology beyond standard equipment found in any industry, thus eliminating the need for further adaptation.

However, Sergio Musmanni, director of CNP+L, states that in Latin America there is a group of "purists" that believe a resource exchange system could provide an easy out for industries by allowing them to continue to pollute by substituting the conventional landfill for a commercial enterprise.

The fear these "purists" have is that because a resource exchange belongs to the second tier of P2 Hierarchy and that it can appear to be a

worthwhile business opportunity, the emphasis on environmental relief could be downplayed or even forgotten.

The concern is valid, and a solution could be for green organizations to continue to push corporations to maintain constant responsibility for the environment. In this case, it is not a flaw of the system itself, but rather unethical decision-making that would lead companies to view a materials exchange as a potential loophole. There does exist, however, another approach that could be a persuasive argument. A subproduct exchange system functions as an instrument of the first tier by truly eliminating waste at the source: transformation of waste into a subproduct. The origin of anything comes at the point of identification and by redefining a material to be used as a subproduct, we kill the concept of waste entirely.

The problem with resource exchange systems is that they are still too oriented toward being an environmental initiative. Subproducts begin to turn it into an economic orientation. This is similar to the difference in the philosophies of eco-efficiency and cleaner production.

Participation in a subproduct exchange system does not require any commitment. Often, managers worry about environmental projects not being a hard asset for their company. Because there is no real commitment to investing, the exchange would not be considered an asset but a market opportunity, although it would perform the same function as a pollution prevention project. In addition, there are no start-up fees associated with this approach for the company. The "investment" is the business's storage and sorting of their

subproducts, and the "return" is reduced cost and effort in removing the subproducts themselves.

Finally, the risks involved with a subproduct exchange are minimal. In most cases, with no new technology to invest in or monetary fees, reliability is dependent solely upon the integrity of the parties involved. A subproduct exchange is a business transaction, just like any other, and only those risks apply here.

A subproduct exchange is the ultimate solution for Costa Rica as it seeks to reduce the impact other nations of the world have had on the world's collective environment as well as promote its own prosperity. The next chapter will discuss the procedures entailed with setting up a subproduct exchange in Costa Rica.

3.0 Methodology

This chapter outlines the research methods and procedures we used to collect and interpret data concerning materials exchange practices. It also explains the research methods we used to determine the potential for such a program in Costa Rica. These data were analyzed and compared with the research done on different material exchange systems found in other parts of the world. The results ultimately led to this proposal for a Costa Rican Subproduct Exchange System.

3.1 Materials Exchanges in Other Countries

It is important to know what a materials exchange system is, and also understand the various ways one could be set up, organized, and run in order to facilitate implementation in Costa Rica. So prior to entering Costa Rica, we studied different materials exchange systems in other countries, through the use of the Internet. To identify the differences between these exchanges, a comparative list was made (see Appendix H).

3.2 Laws relating to Materials Exchanges

Once the various elements that help comprise a materials exchange were identified, it was determined that most materials exchange systems in other

countries did not deal with hazardous materials. This could be because of governmental restrictions on the reuse of these types of materials. In some countries, hazardous materials cannot be transported from one state to another. To make sure that the recommendations we make comply with Costa Rican laws, we researched the laws that pertained to waste management and transportation in Costa Rica.

CNP+L had a booklet complied containing all laws and ordinances that regulate all matters related to air pollution, water pollution, landfills, and energy use. After the booklet was read, all laws that were pertained to materials exchanges were translated. To obtain a copy of laws that regulated transportation, hazardous materials, and transportation of hazardous materials, we visited Cedarena (Centro de Derecho Ambiental y de los Recursos Naturales) and interviewed Eugenia Chin, an environmental attorney. She helped us obtain copies of the laws on hazardous materials and the transportation of hazardous materials and told us to look at the transit laws for specific questions on transportation (see Appendix F). She also provided some important information regarding fines, fees, and penalties with respect to the environmental pollution in Costa Rica (see Appendix I).

3.3 Current materials reuse efforts in Costa Rica

We researched the current recycling and reuse systems in Costa Rica. Currently there is no centralized initiative to reuse industrial wastes or

subproducts. Efforts made have been initiated by individual companies and currently there is a materials exchange program in place that serves the Cartago Industrial Park. We surveyed companies registered with the Chamber of Industries to assess if a centralized resource reuse system could be implemented in Costa Rica. With the help of Sergio Musmanni of CNP+L, we designed a questionnaire (see Appendix J) to get data from the companies. The questionnaire asked about each company's current materials disposal systems, disposal costs, and the company's preferred means of communication (using which we could contact the company easily). The questionnaire was pre-tested on twelve companies to make sure the questions were understood correctly. These companies visited CNP+L and therefore were easy to use in a pre-test. As a result of the pre-test, we realized that a question regarding what types of materials are being discarded needed to be added. This question would help in facilitating exchange by providing information about the materials being discarded.

The questionnaire was sent through email and fax to over 650 companies in the Costa Rican Chamber of Industries database. We received a few responses and a week later a reminder email and fax was sent out to all companies that did not reply to the questionnaire, urging them do so. Initially we wanted to conduct the survey using a stratified random sample of businesses based on industry type. However, using the database proved more effective in reaching a larger number of companies efficiently. We received 32 responses in all and were disappointed that even thought we used the Chamber of Industries

database our rate of response didn't increase. Once we got the responses, the results were recorded and the companies were divided on the basis of type of waste product produced (There are 14 categories in all.) This provided a better understanding of the types of resources, subproducts, and treatment methods particular to one category of industry. This also helped uncover which companies' excess inventories or byproducts could be used by another company as a resource. The responses also helped determine if complementary services, such as providing consulting services to aid in cleaner production and hence minimizing waste from the beginning, might be needed to be considered as a part of the design for the project.

To understand public opinion about pollution, we examined the Sinades (Sistema Nacional para el Desarrollo Sostenible) poll results which proved to be good background information. Sinades conducted a survey to identify the general perception of the Costa Rican public with regards to pollution and who the public thought was most accountable for the pollution. The results of this survey can be found in the Chapter 2, Section 2.1.2 of this report.

3.4 Researching the Needs of Costa Rican Companies

From the research we did prior to coming to Costa Rica, we had a good understanding of how a materials exchange system works. However, to set up a Costa Rica specific subproduct exchange system, we needed to have a better understanding of the needs of Costa Rican companies. We sent out a

questionnaire that contained questions about material disposal methods, preferred means of communication and contact information. After getting all the responses to the questionnaire, we realized that we didn't have enough company-specific information about the raw materials used. Also, we didn't have sufficient information to determine which of the different approaches we researched would work best in Costa Rica, so we decided to conduct follow-up interviews (see Appendix K). We also realized that these interviews were a great way of getting the idea of the materials exchange out into the business community.

We conducted these interviews with the companies that had responded to the questionnaire. From our discussions with Sergio Musmanni and an article we found over the internet about setting up byproducts exchanges (see Appendix O), we realized it would be easier to target small groups of companies (clusters) at a time to try and get them involved in a materials exchange program. We initially were going to target a sample of the companies that replied to our questionnaire but considering there were only 32 responses, we tried contacting all of them. We only spoke to 2 companies that responded to our questionnaire. We wanted to conduct face-to-face interviews, but due to time constraints we conducted telephone interviews. We asked both open-ended and closed questions in the interviews about the features they would like to see in a materials exchange program and the possibilities of financial contributions towards funding the program. Face-to-face interviews were conducted with companies that attended a seminar hosted by CNP+L and these interviews were

later analyzed for content. The results were used in making our final recommendations.

We started actively trying to find companies whose subproducts could be used as raw materials by other companies. This would help in proving that a materials exchange system would indeed work in Costa Rica. To make this process easier, we decided to focus on a specific category of industry and try and find buyers and suppliers of subproducts. We then interviewed Juan Carlos Salas Jimenez, manager of the materials exchange program of the Cartago industrial park (see Appendix I). He gave us suggestions on how to start a centralized materials exchange system. This interview helped support the idea that a materials exchange system could work in Costa Rica.

3.5 Financial Analysis

Implementation of a project like this requires capital investment to cover initial setup costs. In addition to serving the needs of the Costa Rican companies, the system should be cost effective.

After analyzing the data from the questionnaire and the interviews, we had a better idea of the companies' needs, their current disposal costs, and their potential financial contributions to support a materials exchange program. For a materials exchange system to be used by a company, it must provide a cheaper alternative to the current waste treatment methods.

We looked at the different ways CNP+L could implement a materials exchange system, and each option was analyzed for the cost of operation by figuring out the initial cost of implementation, and the day-to-day operational costs. This was then compared to the different ways CNP+L could obtain funding for this project. This includes the amount CNP+L should charge for exchange membership (if any), possible subscription fees, and the possibility of applying for funding from an outside source to cover the initial start up costs. Our analysis can be found in Appendix Q.

3.6 Creating a Marketing Plan

In order to make the materials exchange system an attractive endeavor for companies to join, we decided to research the methods CNP+L could use to market it. Since email is the most popular means of communication among the surveyed companies, we researched the idea of sending email notifications about the progress of the materials exchange system. We realized that our questionnaire and the interviews we conducted were, once again, great marketing tools. We decided to include a section that explained what a materials exchange was in our questionnaire and, likewise, with a little more detail, in our interview protocol. We talked to the companies that visited CNP+L for seminars on cleaner production and a workshop on plastics recycling and, if they had time, do an interview with us.

Eco-labels are another good marketing strategy as they can lead to greater public awareness of a company in addition to improved corporate image.

Although these benefits directly affect individual companies, one of the criteria to receive an eco-label could be participation in our exchange system. Therefore, we decided to research the development of an eco-label campaign that could indirectly bring more attention to our exchange. We studied Blue flag, Energy Star and Green Seal and analyzed the individual criteria of each of the eco-labels to determine what actually defines the specific recognition. Comparison of the criteria allowed us to determine how to actually construct the eco-label. Then we took a look at the principles of our exchange and the principles of CNP+L, figured in the context of Latin America, and assembled what we thought would be the most effective eco-label. More about the Eco Label can be found in Appendix N.

4.0 Results and Analysis

This section describes in detail the information we gathered from the methods outlined in our methodology section. This data was then dissected and analyzed for content and interpreted in context of the companies within Costa Rica. In addition to presenting the information, this section will provide the needed information for a sound conclusion and a series of recommendations for the implementation of a materials exchange.

4.1 Current Company Material Handling

Out of the 650 questionnaires that we sent out to the companies on the Costa Rica Chamber of Industries database, we received only 32 responses. Although it doesn't provide an accurate representation of the opinion of all of the industries belonging to the Costa Rican Chamber of Industries, it still provides valuable information about how the responding companies currently handle materials classified as waste.

The 32 companies that responded have similar waste patterns, and most of them use more then one treatment method.

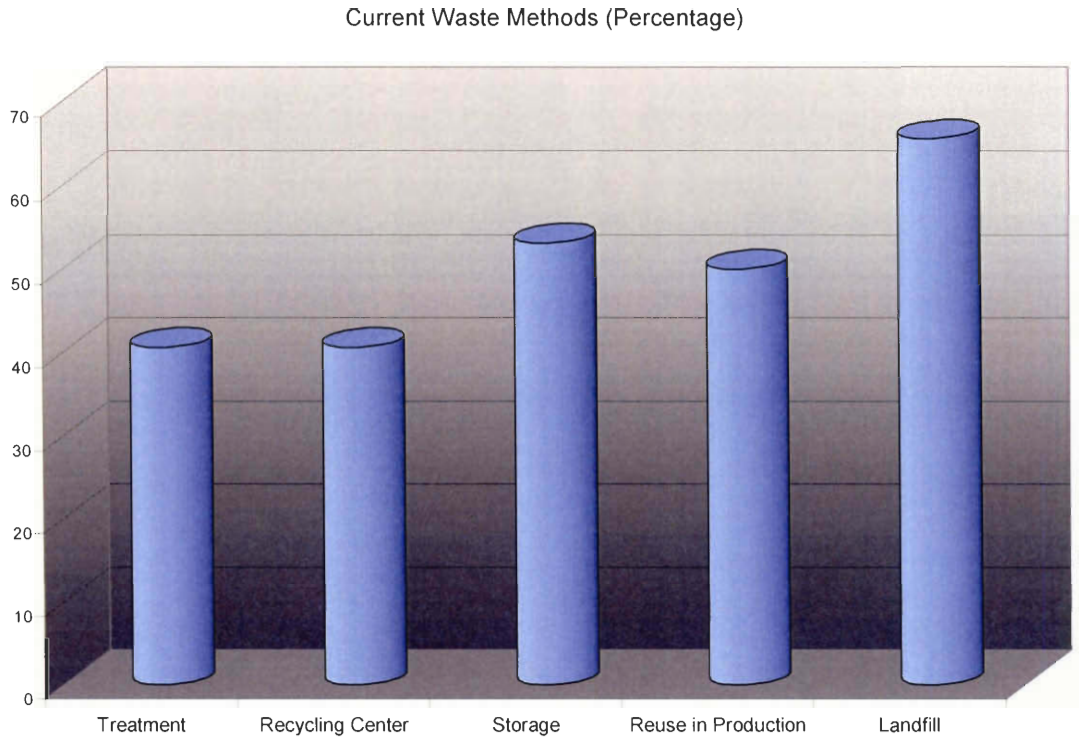


Figure 7: Survey Response of Waste Treatment Methods of Costa Rican Businesses

Only 38% of companies used chemical treatment and recycling centers as a means to treat their waste. Storage, reuse in the industrial process, and land filling were the more widely used methods. According to the survey results, most of the chemically treated wastes usually involved aqueous solutions of waste water, waters with dyes and paints, and assorted chemical solvents. The waste materials that were sent to be recycled were usually cardboard, paper, plastics, and various types of non-ferrous metals. Usually the materials that were reused in production or were stored were more industry specific and usually were reused/stored by the company that produced the waste. The results showed that the materials being sent to the landfill had no direct methods of reuse in the

production process and companies felt like they had no choice but to use a landfill.

Reuse in production and storage were more commonly used than treatment or recycling possibly because it is much easier to implement these types of production practices in industry. Due to the production process of certain industries, it could be that the materials reused by these industries did not need treatment. Another reason could be the lack of recycling industries in Costa Rica that could recycle and treat the materials or the option to recycle or treat such materials may cost more than landfilling, illustrating the infamous Iron Law.[10] A Costa Rican landfill then becomes a very lucrative option since it costs only $10 per ton to landfill.

According to the responses to the questionnaire, some of the "waste" materials that were being sent to the landfill could prove to be viable participants in a materials exchange. Further examination of the types of materials that were disposed of in a landfill revealed that, while not all forms of materials that were landfilled were practical in a materials exchange, there were certain forms of materials classified for disposal that could have a potential use in other applications within industry. There were types of iron and aluminum slags that appeared to have a future resource recovery potential but were currently being landfilled. The cement industry could use this slag as it contained materials that could be used for its production. An integral part of the success in a materials exchange is being able to find and establish matches for such recovered waste.

[10] The Iron law can be found in Section 2.2.1, Appendix Q and the Glossary section.

4.2 Company Communication

Our questionnaire and interview contained questions about the preferred and existing types of communication. The results of the questionnaire showed that not many companies used the internet (only 21%) and almost no one wanted to use the web as a means of communication (Figure 8). We believe that this may be because the question on the questionnaire may have been misinterpreted to ask if the company had a webpage, rather than if they had access or knew how to use the Internet.

A series of other reasons that we do not know could also account for the anomaly. We asked Ms. Giovanna Amador Masis from People Recycling of Costa Rica to give reasons for this discrepancy, and she gave us 3 reasons:

- Jealousy among family owned companies prevents employees from posting information on the web that may show weaknesses or inefficient business practices.
- The Internet in Costa Rica is perceived as not as fast, secure, or reliable as fax or telephone.
- People do not know how to use the Internet/Web, or they do not have access.

We also assumed that the reluctance to use the Internet could be because the companies didn't know how we planned to use the Internet and also the language barrier with most websites being in English.

Ironically, in the interview with Ms. Adriana Soto of Intericiyclando (see Appendix I) she explained about how important a central database over the Internet is, and how she would prefer to use the Internet to access a materials exchange system. However, she does also believe that a telephone system would be more effective in Costa Rica right now.

Nevertheless, Juan Carlos of the Cartago Industrial Park said that the social perception of web pages can change very quickly once a Costa Rican company begins to network. Therefore, it would not be long, he thought, before a large number of people would use the Internet as a form of information exchange for a materials exchange system.

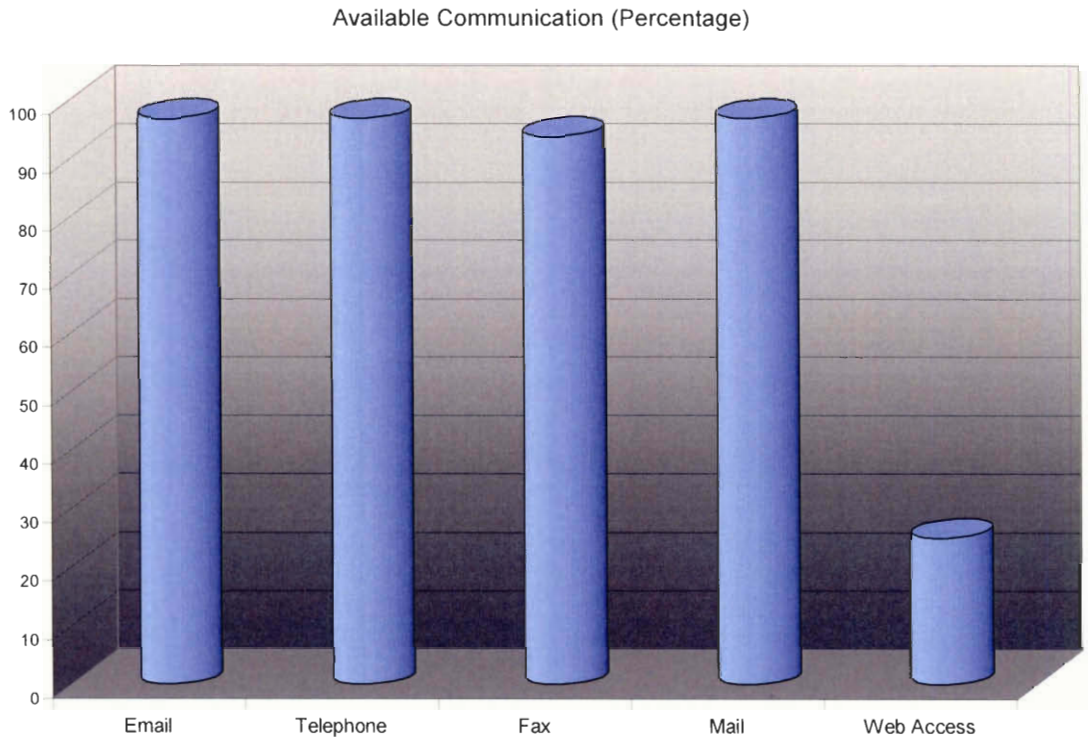


Figure 8: Survey Response of Available Company Communication

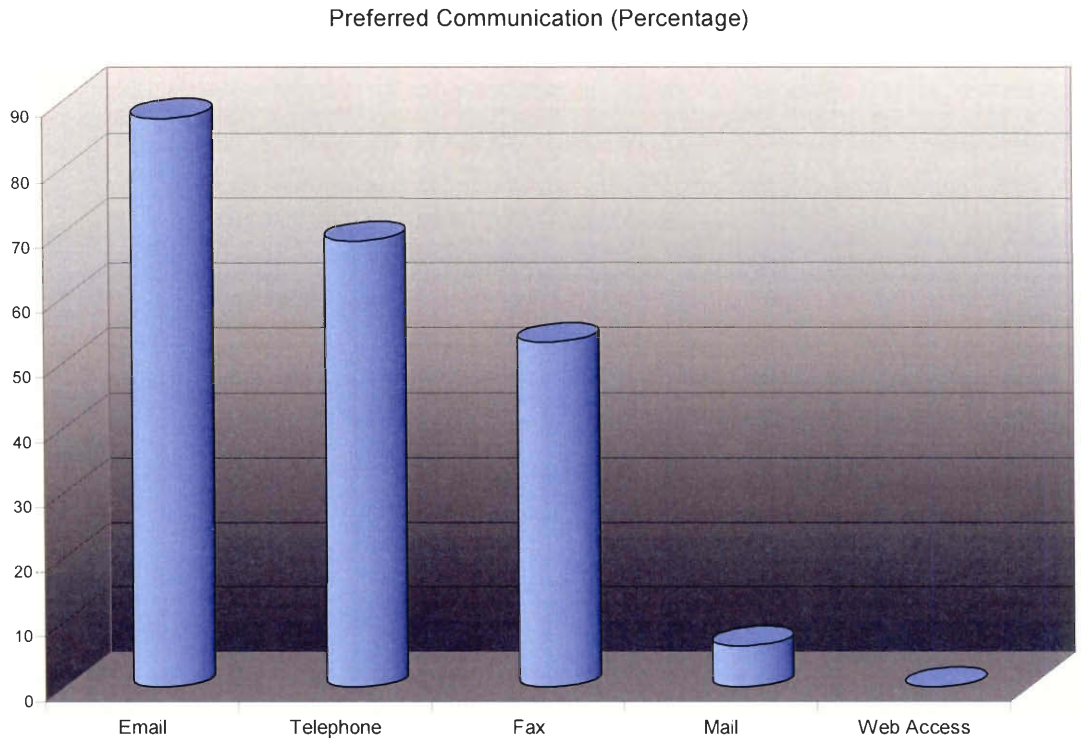


Figure 9: Survey Response of Desired Communication Methods

4.3 Potential Reception of a Materials Exchange

Our survey results and subsequent interviews showed that a large number of companies expressed interest in a materials exchange program (Figure 10)

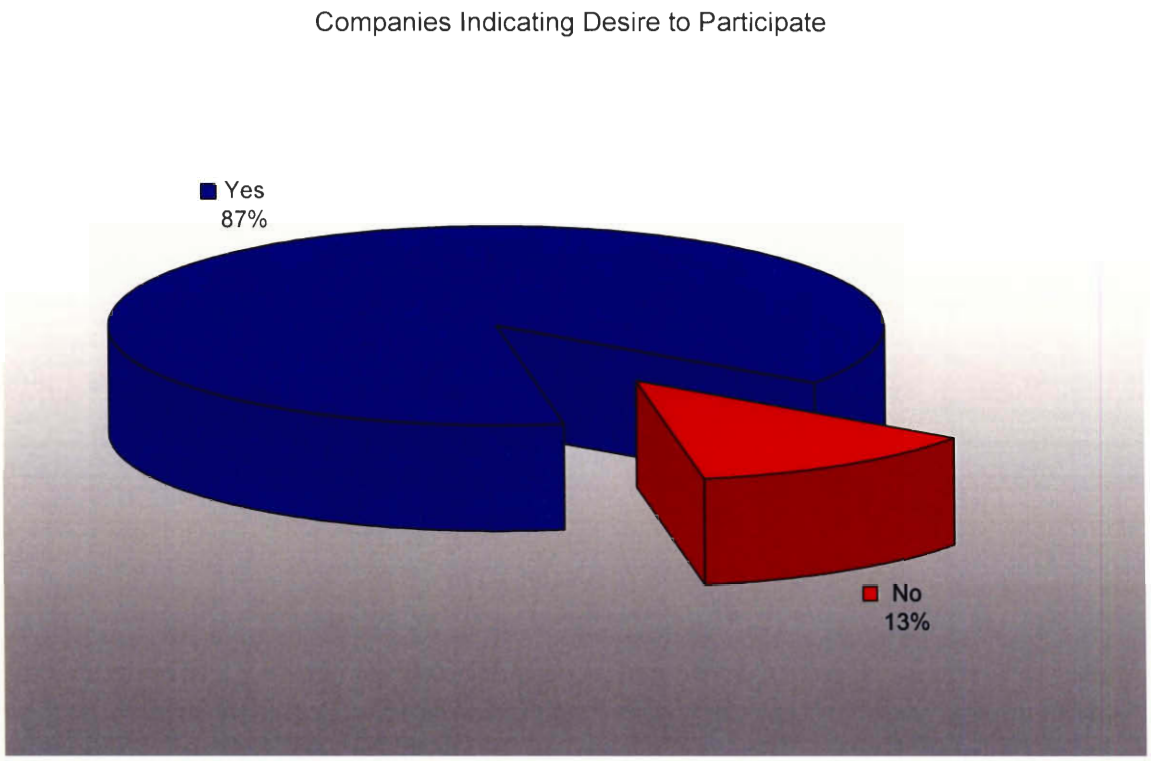


Figure 10: Number of Companies that Expressed Interest in Participating in a Materials Exchange

87% of those who responded were in favor of participating in the system and this indicates that companies are willing to try out the system, but it does not indicate if they have materials that can be reused by another company.

We used the follow-up interviews to determine how effective this system would be in Costa Rica. We contacted a non-ferrous metal recycling company and companies that declared that they had some sort of non-ferrous waste, namely SEYMA. The non-ferrous metal recycling company, Roman Metalurgia, told us that they paid money for mostly pure aluminum, and the majority of people that participated used their own form of transportation. While Roman Metalurgia seemed like the perfect acceptor for aluminum/copper scrap, SEYMA

proved to be extremely efficient with their production practices. SEYMA produced safes and did not produce a viable amount of non-ferrous materials that they did not already recycle. We were unable to find any further companies that were inefficient with non-ferrous metal subproducts; however that does not mean they don't exist.

We also conducted interviews with key attendees at the Plastics Cleaner Production seminar held by CNP+L. Juan Carlos of the Cartago Industrial Park, told us that he was already working with a very active form of materials exchange in the Cartago Industrial Park. He mentioned that this system was similar to the one we plan on proposing, except for that companies physically brought their waste to a central warehouse collection area, and a person from the Cartago Industrial Park actively sought out companies that wished to accept the stored materials. Juan Carlos emphasized that it was very difficult to find companies to accept collected waste, so the active approach has been necessary in Costa Rica so far. He also explained that external funding is necessary for a project like ours, and that CNP+L will need this type of funding in order to survive the non-sustainable starting stage of a materials exchange system.

Our interview with Eugenia Ching, a lawyer at Cedarena (Centro de Derecho Ambiental y de los Recursos Naturales), helped us understand the way regulatory laws were set up in Costa Rica. She explained that it was almost impossible to find all the laws governing a particular material because they were highly dispersed. We learned that there are no tax penalties for pollution or inefficient practices. There are only fines and monetary penalties for pollution,

and the maximum amount that can be imposed is less than $2000. She also mentioned that most effective green initiatives in Costa Rica are usually voluntary and private.

In general, we learnt from the data collected that there are existing materials exchange systems in Costa Rica (e.g. the materials exchange run by the Cartago Industrial Park), however, there is no centralized materials exchange system in place currently and there is a demand for a subproduct exchange in Costa Rica. Companies would be willing to participate in the subproduct exchange but we will have to educate them about what the system really does and the most preferred method of communication was email. The data that we collected was sufficient to provide further recommendations and conclusions about a system of material exchange in Costa Rica. These recommendations and conclusions are outlined in the next chapter

5.0 Conclusions and Recommendations

The Chapter 2 of our report discusses the need for a resource exchange system in Costa Rica. The research we have conducted has helped us to compile specific data on the needs of various industries that might participate in such a system. Following our results and analysis, in this section we will now identify the most effective model for a resource exchange system capable of meeting both industry and environmental needs. [11]

5.1 Public vs. Private Initiative

Costa Rica, and much of Latin America, does not have a history of successful governmental initiatives in the field of waste management. We have noted earlier that many responsibilities for public services, normally considered government controlled, are being privatized either to achieve greater efficiency, or to follow free market economic logic, or because governments no longer have the money. Recognizing this trend, we recommend that CNP+L should organize and run a private materials exchange system. We recommend they create a subsidiary organization solely for the exchange, in the same way the Center for Environmental Technology (CET) created the Mass Exchange (See Appendix G for

[11] We use the general term "resource exchange". Officially, what CNP+L is implementing is a materials exchange.

more on Mass Exchange). However, since this project is without governmental assistance[12], the program would have to seek its own funding (See Appendix M).

The benefits of having CNP+L sponsor the program are clear. The National Center for Cleaner Production (or NCPC, the English name for CNP+L) specializes in multi-industry pollution prevention activities, thus they are the best qualified to oversee the creation of this system. CNP+L also can also provide an impartial medium that is not subject to the bureaucracy of large organizations, or the financially-tainted motives of most private companies. In our methodology we discussed the benefits of a cluster system to create the most stable relationships between companies in the exchange. Since most of CNP+L's programs are industry specific, clusters have already been established. CNP+L can help bring these clusters into the exchange system.

5.2 Active vs. Passive Approach

We recommend the database be modeled on the active approach. Although it would be cheaper for CNP+L to adopt the passive approach, after our conversation with Juan Carlos, (see Appendix I for interview details) it became apparent that the main problem in Costa Rica is finding companies that will use subproducts as raw materials. Initially it will be very important for CNP+L to build a resource database to contain the resources and subproducts companies produce.

[12] CNP+L is a non governmental organization which receives funding for its projects through a grant from the Swiss Government.

Furthermore, although we describe our model as active, we do not recommend CNP+L come in any contact with the actual subproducts. This means they will not handle them, transport them or even operate a storage facility to hold them in, in contrast to the system at the Cartago Industrial Park. We do not want companies to give CNP+L their subproducts so that it won't have to worry about disposal if it can't find buyers/takers of the materials. This is not only expensive; it also doesn't serve our ultimate goal of industrial symbiosis. This exchange is a service to assist the companies in making their own exchanges and, in alignment with the activities of CNP+L, assist them in practicing cleaner production.

5.3 Organization

Since the materials exchange is going to be modeled after the active approach and a program under CNP+L, we have identified the organization of the program as follow.

CNP+L will need to hire 3 Staff:

Webmaster: The webmaster will be in charge of the website and the online database. He/she will be responsible for the design and format of the website and the setting up the initially database. The database will then be accessible by the database coordinator to add and/or remove information as required. Since only design and periodic maintenance of the site is all that is require of the webmaster, CNP+L can contract an external consultant instead of hiring a full time or part time employee for the position.

Database Coordinator: The database coordinator is the contact person companies will reach when they call the exchange. He/She will be responsible for accessing the database and assisting companies in the actually exchange. This person will also be in charge of updating the database as and when new information is available. Since the initial volume of business will be limited, we think the database coordinator should be a part time position which can be extended and more people hired as and when needed.

Resource Coordinator: The resource coordinator will first look to build a comprehensive database with all the companies' raw materials and subproducts together with the grade, quality and quantity produced/ required. We estimate that this database will be an essential tool in the Resource Matchmaking process. Once the database has been established, he will then look to find the most effective method of exchange. This could include using a GIS system to position companies, resources and subproducts which will assist in finding the most efficient method of transfer. The resource coordinator will also aid in marketing and publishing the exchange system and will report directly to the executive director.

Since this system is going to be a sub program under CNP+L, it is natural to have Sergio Musmanni as its executive director. The executive director will be the liaison between the other programs CNP+L hosts and the materials exchange. Below is the organizational chart of this new organization.

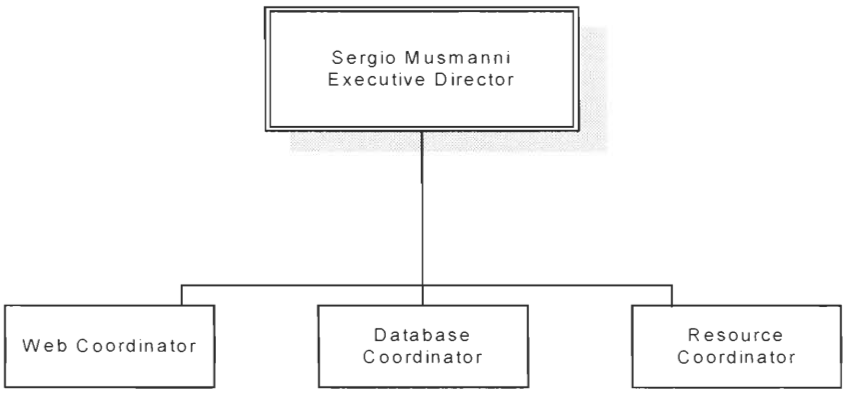


Figure 11: Organizational Chart of the Materials Exchange System.

5.4 The essential elements

Setting up a resource exchange system in any country is never easy. No nation on this planet is completely industrially symbiotic, although Denmark is moving in that direction. Most industries are simply not equipped to be networked to take advantage of opportunities for improved resource management. A centralized system of information can benefit companies that are forced to hunt for raw materials on their own. However, the key is to make everybody aware of the existence of such a system for it to work. Two critical endeavors, then, need to be

initiated by CNP+L from day one for the success of the materials exchange: resource matchmaking and marketing.

5.4.1 Resource Matchmaking

In the beginning, as well as long after the materials exchange has started, a resource coordinator should be allocated for researching and contacting industries that could participate in an exchange. This would involve calling companies up, explaining what this system does, and inquiring about their waste materials and raw materials used in their production processes. The information acquired should be specific, including exact specifications about the materials and their particular grades or quality. The resource coordinator would use this information to compile a database of company information. The coordinator would contact the companies whenever information is uncovered that could lead to an exchange and ask if they would be interested in the exchanging the materials concerned. This resource coordinator would assemble a record of "success stories", which would not only promote the system itself but also introduce the concept of a resource exchange to those who might never have considered the option. This could also promote the development of new companies which could take advantage of the presence of large amounts of particular resources that could be reused but need slight processing.

5.4.2 Marketing

The actual marketing of the system requires more extensive work. It would consist of four main methods. One, the profile of the program (and of the company running the program) should be published in as many ways as possible to make sure that everyone hears about the materials exchange system. This entails frequent press releases and interviews with newspapers, magazines, journals, television, and other media. Two, the materials exchange should at least be mentioned at the various seminars and workshops CNP+L runs, if not worked into the actual program of. This would help emphasize the exchange as a cleaner production initiative. Three, information documents and brochures should be distributed through various media. These documents would be everything from advertisement-like inserts to tutorials (see Appendix L) and explanations of the system itself. One way of distributing these brochures would be through the Chamber of Industries national magazine. Ultimately, this would help illustrate the program as an economic initiative. Four, a Latin American Eco-label Campaign (see Appendix N for more details) can be promoted by CNP+L. This would be more than just environmental regulations for an EMS[13] and would appeal directly to the public, regardless of whether the particular industry produces something for direct public consumption. This would stimulate public pressure and interest to actually see industries participate in a materials exchange.

[13] An EMS is an Environmental Management System. Please refer to ISO 14001 for more details.

5.5 Communication

Now that we have discussed how to set up a subproducts system successfully, we are going to define how the system should be used. The system is going to be manifested in two main forms. Despite the fact that the people of Costa Rica may not be fully comfortable with the power of the Internet, the technology is advancing at an increasing pace, and the benefits of using such power will soon woo others to become familiar with it. With that in mind, we highly recommend that CNP+L set up a web-accessible database system, if for no other reason than to prepare for the future. It is much easier to begin inputting data in a web-accessible database now, than trying to make a database web-accessible long after many entries and transactions have already taken place. An email listserv could supplement web access, as email naturally follows any Internet capability. Email is the cheapest form of communication and also the most efficient. Also it is the most preferred form of communication among companies in Costa Rica. In addition, the system should have a telephone connection where parties can call the database coordinator at the materials exchange and receive personal, detailed assistance with their needs. In Costa Rica, telephone use is second in popularity only to email. The telephone option along with fax capabilities would help companies that are not yet comfortable using the Internet or email.

5.6 The database

The forms of communication discussed above will all be avenues to directly or indirectly access the master database, which is the core of a materials

exchange. The database will be modeled after the BORSI system (see Appendix G) because it is a simple, yet effective system that is based in Latin America. There will be two functions associated with the database: search and post. Whether a company seeks to obtain a certain quantity and quality of material or whether a company wants to give away certain materials, they will engage in the posting process. Posting into the master database is the procedure involved in entering company information as well as the nature of the exchange. This could be done by the company directly through a form on a web page or it could be done by an employee at the exchange who receives the information via a phone call. Either way, the data will be stored in the computer database. Simple, straightforward fields will request contact information from the company, whether they are requesting materials or offering materials, and a description of the materials themselves would be included. After all mandatory fields have been filled in, the database would automatically assign a unique I.D. number for the post and save it onto the database. (A confirmation screen would be displayed if the posting is successful. Otherwise, an error message and a telephone number will be displayed for technical assistance.) The data will be available for searching immediately after successful entry.

The searching process involves accessing the database for information that a company needs to initiate an exchange. For example, instead of posting a request for materials, a company could search the database for a posting that already offers the desired materials. If that happens, the first company will not actually need to post anything, for they will already know an exchange can take place and will contact the database coordinator to arrange it. The same can also

apply in reverse. If a company desires to exchange some of its subproducts, it can search the database for a company that has already posted a request for those specific subproducts.

Once again, searching can either be conducted directly via the web, or a company can request a materials exchange over the phone that an employee can perform. Searching is actually simpler than posting, for there are no mandatory fields. The same fields that are available for posting will be there for the search process except in this case, a company inputs the data that it wishes to locate into the blank fields. After the fields have been filled in, the database will scan itself and find as many matches as possible. It will then display those matches on the screen and give further information on how to participate in an exchange. Not all fields have to be filled to conduct the search in order to facilitate a search.

The interesting thing about a database system is the searching and the posting processes are interdependent. Searching is obviously easier and more effortless than posting. However, searching will not work if nobody posts anything in the database. Also, if everybody simply posts and does not search, then possible matches would go unnoticed. To address this concern, we recommend that the exchange have an email notification system. This system would automatically generate and send an email every time a post is made on a specific material about which companies have identified as having an interest. The email would go to either the company requesting the notification and CNP+L or just to CNP+L. If the email does not catch the company's attention, someone at the exchange could recognize this and follow up on the lead. This further emphasizes the importance of resource matchmaking on the part of the exchange. For the

program to be successful it is going to need to take an active role in case businesses don't post or search for materials themselves.

5.7 Future Services

The materials exchange should only manage industrial subproducts. We do not recommend CNP+L expand to facilitate non-industrial exchanges (exchange materials created by the individual household) at this time. We believe it will carry more weight and validity if it addresses only corporate initiatives.

We, also, wish to recommend a few future plans for the growth of the exchange. We believe a materials exchange for industrial waste is the first step to long-term industrial ecology.[14] As such, we recommend that CNP+L begin to look into offering consultation services, seminars, or workshops (just as they do already with cleaner production) tailored specifically to activities related to the exchange itself or industrial ecology. For example, this materials exchange opens up a realm of possibilities for entrepreneurial start-ups. IRRS, which stands for Integrated Resource Recovery System, could be a start-up company. An IRRS usually takes materials that aren't initially compatible for reuse and transforms them into ones that can be reused. This often involves cleaning or purifying a material or breaking it down and recycling it into a new material. If there are a lot of subproducts in the exchange database that aren't immediately usable, interest in starting an IRRS could be encouraged. In addition, a more organized, centralized way to transport these subproducts (the exchange itself should not to be responsible for

[14] Definition of Industrial ecology can be found in the Glossary section.

transportation) could also inspire an entrepreneur. We believe CNP+L should be ready to expand to include additional services that either they or a third-party could offer and begin building resources and information concerning industrial ecology.

5.8 Funding

Finally, the last thing involved in a materials exchange that CNP+L needs to take into account is funding for the program. The financial analysis of our recommended model is in the following section and gives a detailed breakdown of anticipated expenses. At least initially, we recommend CNP+L apply for grants and loans from agencies and organizations across the world that specialize in investing in cleaner production projects to pay for setup costs and the initial daily operations of the project (see Appendix M for more information). The materials exchange program in Cartago and CNP+L are both funded by grants. In terms of long-term sustainability, however, an additional source of funding is required to make the project self-sustainable. We believe the best way to handle this situation is to implement a *Savings Adjustment Transaction Fee*. Since companies have to communicate with CNP+L in order to obtain specific contact information for an exchange, we recommend charging a mandatory donation of approximately, 10%, of the money saved by using the exchange instead of using conventional disposal or treatment methods. The Mass Exchange uses this method to generate funds, and we think it might work well in Costa Rica as well. We think using the *Savings*

Adjustment Transaction Fee will help prevent companies from being burdened by subscription fees.

We believe that if CNP+L implements all of these recommendations, they will develop a prosperous and successful materials exchange system within Costa Rica that will lead to reduced materials disposal in landfills and to a cleaner environment.

Bibliography

Arroyo, J., Rivas, F., Lardinois, I. (1999). Solid Waste Management in Latin America: The role of Micro and Small Enterprises and Cooperatives. Lima, Peru: Punto y Coma Editors and Printers.

Bishop, Paul L. (2000). Pollution Prevention: Fundamentals and Practice. Boston, Massachusetts: McGraw Hill.

Childers, Darin G. (1998). Environmental Economics: Profiting from Waste Minimization. Alexandria, Virginia. Water Environment Foundation.

DeSimone, Livio D. & Popoff, Frank. (1997). Eco-efficiency: The Business Link to Sustainable Development. Cambridge, Massachusetts. MIT Press.

Desrochers, Pierre. (2000). Market Processes and the Closing of "Industrial Loops:" A Historical Reappraisal. Journal of Industrial Ecology, 4(1):29-43.

Graedel, T. E., Allenby, B. R. (1995). Industrial Ecology. Englewood Cliffs, New Jersey. Prentice Hall.

Hawken, Paul. (1993). The Ecology of Commerce: A Declaration of Sustainability New York, NY. Harpercollins.

Huhtala, Ari. (2000). Promoting Cleaner Production Investments in Developing Countries. Paris, France. UNEP.

Ohio State University. (2002). Recycling. Retrieved April 3, 2002, from the world wide web: http://ohioline.osu.edu/cd-fact/0108.html

Powelson, D. R., & Powelson, M. A. (1992). The Recycler's Manual for Business, Government, and the Environmental Community. New York: Van Nostrand Reinhold.

Ryan Dupont, R., Theodore, L. & Ganesan, K. (2000). Pollution Prevention: The Waste Management Approach for the 21st Century. Boca Raton, FL. Lewis Publishers.

Schwarz, Stephen C., & Brunner, Calvin R. (1983). Energy and Resource Recovery from Waste. New Jersey: Noyes Data Corporation.

Sitarz, D. (Ed.). (1993). Agenda 21: The Earth Summit Strategy to Save Our Planet. Boulder, Colorado: Earthpress.

United Nations Environmental Programme. (2002). Cleaner Production Activities. Homepage. Retrieved May 30, 2002 from the world wide web: http://www.uneptie.org/pc/cp/home.htm

UNEP, WTO, FEEE. (1996). Awards for Improving the Coastal Environment: The Example of the Blue Flag. Paris, France: United Nations Publications.

Appendix A – Profile of the Centro Nacional de Producción Más Limpia

"Integrating the environment with the industrial process."

The Centro Nacional de Producción Más Limpia (CNP+L) is an organization based on the concept of cleaner production and sustainable industrial development (SID). CNP+L provides consulting services to companies requesting information about environmental awareness and efficiency. CNP+L's consulting services also encompass the need for greater efficiency within industrial processes and the reduction of toxic byproducts and danger to workers.

CNP+L was a project created with help from the Chamber of Industries in 1998, with a time-limited grant from the Swiss Government. The Chamber of Industries provides a bridge between the Government of Costa Rica and all of the registered industrial companies in the private sector of Costa Rica. This connection with the Chamber of Industries enables CNP+L to have better communication with all of the industries, making CNP+L more effective overall. Currently, CNP+L is located on the fourth floor of the Chamber of Industries building, 300 meters South of the San Pedro Mall.

The current structure of CNP+L is a linear arrangement of three people, with two groups of employed staff and consultants. The consultants are derived from the Technical Institute of Costa Rica, Cegesti, and the Chamber of Industries. The staff is comprised of a group that compiles the periodicals, a

group of temporary employees, and a group of external consultants that work on different projects.

The CNP+L is currently in the process of researching the potential for the creation of a materials exchange system in Costa Rica. The CNP+L has called in external help of Worcester Polytechnic Institute students in order to perform a two month study on the financial, feasibility, marketing, and various other aspects of the proposed system.

The CNP+L is currently funding many different investigations into the cleaner production in a variety of industries in Costa Rica. Along with this project, the CNP+L is funding studies involving:

- The study of the legal implications and aspects of incineration
- "AID" – Identifying priority sectors that require cleaner production help
    - Studies within Costa Rica
    - Studies within Panama
- "Concept Paper"
- The Biodiesel alternative fuel project

Appendix B- What is an IQP?

The IQP, which stands for Interactive Qualifying Project, is an undertaking that students at Worcester Polytechnic Institute engage in to explore the relationship between technology and society. Although a project may be carried out locally on campus, another option for the student is to complete the IQP at one of WPI's Global Project Centers. These project research centers are established throughout the world and are sometimes funded by local businesses, enabling students to contribute something of value to the host nation and participate in the native culture. Although each project is centered around the societal connections of technical work, it is left to the students themselves, throughout their projects, to establish what those connections are, what they mean to the project and in what context they exist.

The IQP is not meant to be simply a graduation requirement. It is not meant to be coursework imposed upon a student with the aim of teaching students some perplexing ideal. The IQP is an opportunity for the student to give meaning to his or her education. It allows a student to demonstrate the value of education in a form other than mere concept and formulaic reiteration.

The IQP is meant to be interdisciplinary. Exposing students to others who have a different set of skills and allowing them to work together toward a common goal, emphasizing the "worldly" element of "real-world education".

The IQP is meant to produce something. Project work, and all professional work, does not exist in a vacuum. Students are not expected to

reproduce mere academic concepts that have no purpose but to be shelved as a thesis for professors to archive. This project is designed to positively affect somebody, be it an individual or collective body. It is designed to contribute something to society.

The IQP, through the voluntary participation of students, is WPI's way of associating the fulfillment of human needs with professional work. A student who conducts an IQP finds him or herself more mature and more equipped to play a significant role in shaping the world through work.

How this proposal reflects an IQP

The project work we conducted in cooperation with CNP+L revealed something significant about the way industrial manufacturing has operated and the very definition of production. Industry develops around the concept of production, the processes of producing a material object that has use and value.

Is a product really useful if it came at an expense greater than the need it fulfills? It is crucial to consider this consciously for we, as consumers, make this decision every time we purchase a product off the shelves. The very act of carrying a material to a checkout is our statement to the world that everything that went into the production of this product, all the energy, resources and labor that were consumed, is worth what this product means to us.

We do not have an unlimited supply of resources so whenever a product is made we better be sure it is worth any consequences that could result. If it is not, then consumers have a responsibility to not purchase the product and

manufacturers have a responsibility of finding a different mode of production. Otherwise, reckless consumption (which is nothing but apathy towards our material world) could drain our resource pools until life as we know it ceases to exist.

The mechanics of consumerism and production work together to weave the inter-dynamics of the economy. The flow of the economy has a direct connection to personal health and well-being on this planet. Recognizing this, and choosing to be conscious of it as we go about the rest of our lives is what makes this project a successful IQP.

Appendix C – SINADES

Sinades, "Sistema Internacional para el Desarrollo Sostenible" (or International System for Sustainable Development) is a project under the Ministry of National Planning and Economical Politics (MIDEPLAN) that devotes itself primarily to the promotion of sustainable development within Costa Rica. They are located solely on the internet and they can be found at this url: http://www.mideplan.go.cr/sinades/Proyecto_SINADES/index.html. Sustainable development is the idea that businesses, industries, or homes can minimize the consumption and disposal of materials and the impact on the environment.

This organization created surveys, as one dimension of their mission, to assess public opinion about the environment (SINADES, 2002, General Characteristics Section). There have been previous surveys completed in past years, but there has been no recent information about the public's awareness of environmental issues.

The new survey's sample size is 1,800 people and includes an almost equal number of male and female participants. This represents the population of Costa Rica within a 2.35% error of accuracy. The age group, location, and socio-economic status were all recorded for each survey respondent to see if there was a correlation between social variables and survey responses.

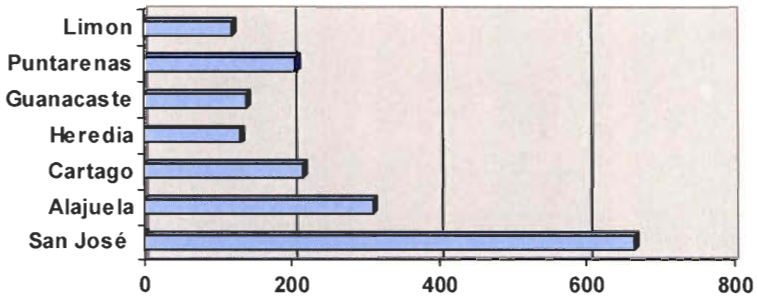


Figure 12: Geographic Distribution of the People Surveyed (by Province)

(Source: http://www.mideplan.go.cr/sinades/Proyecto_SINADES/encuesta/index-2.html)

As shown in the graph above, the majority of the 1,800 responses are from the Provinces of San José and Alajuela, the more populated sections of the country. This survey reflects a response proportional to the population density within the given areas.

In addition to the surveys depicted in Chapter 2, Section 2.1.2, the following results are rather interesting.

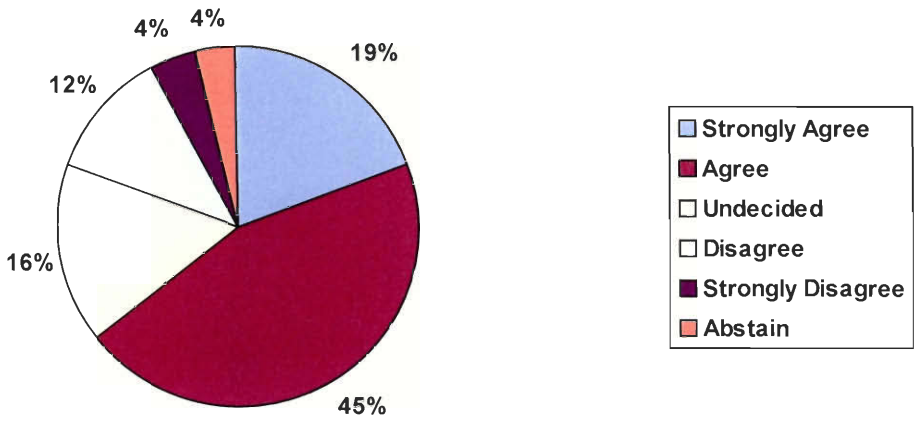


Figure 13: Does modernization equate to more pollution?

(Source: http://www.mideplan.go.cr/sinades/Proyecto_SINADES/encuesta/index-4.html)

This graph gauges the responses given to the question "Do you believe modernization and growth of a country leads to greater pollution and contamination?"

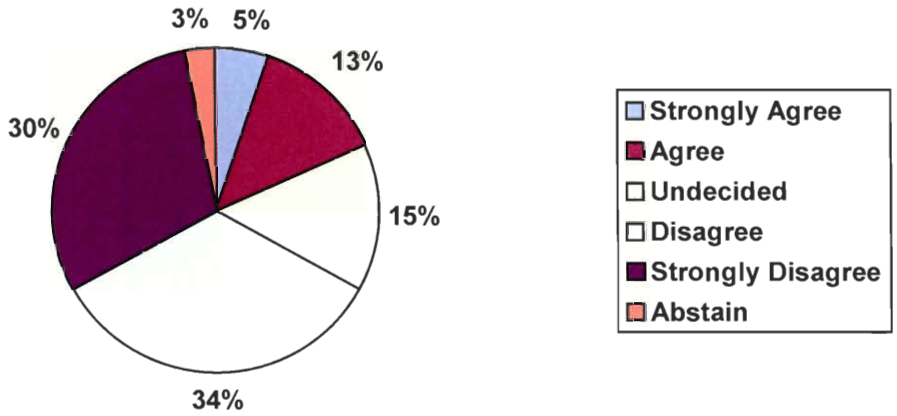


Figure 14: I would welcome employment at a company that pollutes

(Source: http://www.mideplan.go.cr/sinades/Proyecto_SINADES/encuesta/index-4.html)

This pie chart illustrates the responses given to the statement: "I would still take a job at a company that hired me for employment if I found out they were contaminating or polluting."

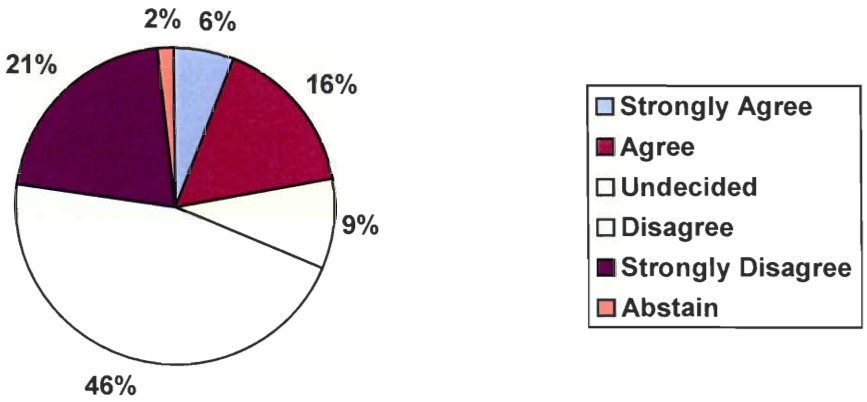


Figure 15: Pollution is a city problem

(Source: http://www.mideplan.go.cr/sinades/Proyecto_SINADES/encuesta/index-4.html)

This graph shows the responses given to the question: "Do you believe environmental contamination occurs only in the city?"

More fascinating results of the survey can be found on the SINADES website.

Appendix D – Eco-efficiency Checklist

(Adapted from DeSimone, 1997, p. 85)

Material Intensity

- ☐ Can the product or service be redesigned to make less use of material inputs?
- ☐ Are there less material-intensive raw materials?
- ☐ Can existing raw materials be produced or processed in less materially intense ways?
- ☐ Would higher-quality materials create less waste in later stages?
- ☐ Can water consumption be reduced?
- ☐ Can water, wastewater treatment, or waste disposal costs be allocated to budgets to encourage greater control?
- ☐ Can yields be increased by better maintenance, control, or other means?
- ☐ Can wastes be utilized?
- ☐ Can products be made of smaller size, or a different shape, to minimize material and packaging requirements?
- ☐ Can the product or service be combined with others to reduce overall material intensity?
- ☐ Can packaging be eliminated or reduced?
- ☐ Can the product be reused, remanufactured, or recycled?

Energy

- ☐ Can raw materials be produced or dried with less or renewable energy?
- ☐ Would substitute materials or components reduce overall energy intensity?
- ☐ Can energy costs be directly allocated to budgets to encourage better control?
- ☐ Can energy be exchanged between processes?
- ☐ Can waste heat be utilized?
- ☐ Can processes be integrated to create energy savings?
- ☐ Can processes or building energy consumption be better monitored and controlled?
- ☐ Could better maintenance of boilers and other equipment improve energy efficiency?
- ☐ Can processes or buildings be insulated more effectively?
- ☐ Can more energy-efficient lighting be installed?
- ☐ Is there scope for better energy housekeeping?
- ☐ Can the energy efficiency of products in use be improved?
- ☐ Can the product or services be combined with others to reduce overall energy intensity?
- ☐ Can wastes and end-of-life products be reused, remanufactured, recycled or incinerated?

- ☐ Can products be made biodegradable or harmless so that less energy is required for disposal?
- ☐ Can transport be reduced or greater use made of energy-efficient transport such as rail?
- ☐ Are there incentives for employees to cycle, walk, use public transportation or car-pool.

Toxic Dispersion

- ☐ Can toxic dispersion be reduced or eliminated by using alternative raw materials or producing them differently?
- ☐ Are products designed to ensure safe distribution, use, and disposal?
- ☐ Can harmful substances be eliminated from production processes?
- ☐ Can harmful substances generated in use be reduced or eliminated?
- ☐ Can any remaining harmful substances be recycled or incinerated?
- ☐ Are remaining harmful substances properly handled during production and disposal?
- ☐ Are equipment and vehicles properly maintained so that emissions are kept to a minimum?

Recyclability

- ☐ Can wastes from raw material production be reused or recycled?

- ☐ Can process wastes be remanufactured, reused, or recycled?
- ☐ Would separation of solid and liquid waste streams make recycling easier or reduce treatment costs?
- ☐ Can product specifications be amended to enable greater use of recycled materials and components?
- ☐ Can products be made of fewer or marked and easily recyclable materials?
- ☐ Can products be designed to facilitate customer use or revalorization?
- ☐ Can products be designed for easy disassembly?
- ☐ Can product packaging be made more recyclable?
- ☐ Can old products and components be remanufactured or reused?
- ☐ Are there any opportunities to participate in waste exchange schemes?
- ☐ Can energy be recovered from end-of-life products?

Resources

- ☐ Can renewable or abundant materials be substituted for scarce, nonrenewable, ones?
- ☐ Can more use be made of resources that are certified as being sustainably produced?
- ☐ Can more use be made of renewable energy in production or processing?
- ☐ Are new buildings and refurbishments maximizing use of passive heating and cooling?

- ☐ Can products be designed to utilize renewable or abundant materials in use?

Durability

- ☐ Can materials or processes be altered in order to improve longevity?
- ☐ Can products or components be made more modular to allow easy upgrading?
- ☐ Can whatever aspects of the product that limit durability be redesigned?
- ☐ Can maintenance of the product be improved?
- ☐ Can customers be informed or educated about ways of extending product durability?

Service Intensity

- ☐ What service are customers really getting from your product? Can this be provided more effectively or in completely different ways?
- ☐ What services will customers need in the future? Can you design new or develop existing products to meet them?
- ☐ Is your product providing other services as well as the most obvious one? Can these be accentuated or enhanced?
- ☐ Can the product or service be integrated or synchronized with others to provide multifunctionality?

- ☐ Can customer's disposal problems be eliminated by providing a take-back service?
- ☐ Can the properties of the product be accentuated or developed for greater customer value?
- ☐ Can products be designed to facilitate customer reuse or revalorization?
- ☐ Can the product be made easier for customers to dispose of?
- ☐ Can production be localized to both enhance service and reduce transport needs?
- ☐ Can products be transported or distributed by alternative means to enhance customer value and reduce environmental impacts?

Appendix E – Case Studies of Industrial Ecology

Industrial Symbiosis in Kalundborg

About 25 years ago, a group of companies got together in a town called Kalundborg 75 miles west of Copenhagen and discussed ways to reduce their costs. They realized that through a series of bilateral exchanges they could not only reduce waste but have substantial financial savings. The system started with a few one-to-one deals that the firms made between themselves. Now, two and a half decades later, this system of exchange has helped these companies save about $160 million in total with $15 million in annual savings and $75 million return on total investment. This system is usually thought of as the Eco-Industrial Park(EIP). Although it is not an example of an EIP, it is however an excellent example of Industrial symbiosis.[15]

The system has 6 core partners, Asaens Power Station, Statoil Refinery, Gyproc (a plasterboard factory), Novo Nordisk (an international biotechnology company), A-S Bioteknisk Jordrens (a soil remediation company) and the City of Kalundborg. Some of the basic transactions are listed below:

- Gyproc uses the butane gas from the Statoil plant which helped Statoil stop flaring the gas .
- Novo Nordisk supplies 1.1 million tons of sludge rich in Nitrogen and Phosphorous (a by-product) to farms to use as fertilizers hence reducing disposal costs.

[15] The definition of Industrial Symbiosis can be found in the Glossary section.

- Asaens provides steam to the city as well as Statoil and Novo Nordisk which helps reduce heating costs for these companies.

There are many more examples of these relations by these industries that have not been illustrated here. Some of the main things that have been learnt by this system have been:

- Contracts negotiated on bilateral terms work the best.
- Green initiatives are more successful if it makes good business sense and is not done solely for environmental purposes (a good example of the iron law in practice).
- The more diverse the companies, the better the system works because there are many different by-products produced rather then one type of industry producing similar by-products and needing similar raw materials.

Triad Energy Resource Inc. and C & H Sugar Company

Triad Energy Resource Company first started when founder Michael Daley realized that there was potential money to be made by reusing gypsum made as a by-product while burning rubber tires for energy. This insight, lead him to create Triad Energy Resource Inc. which uses by-products from companies as raw materials and makes large profits while doing so. "If companies were smart, they'd all locate near sources of waste," Daley is quoted to have said

(http://www.serve.com/commonpurpose/news/nytecoparks.html). After all he has made his fortune by locating near companies and finding uses for their "waste".

Their latest adventure is in conjunction with C & H Sugar Company. Triad makes soil additives from the by-products produced from the sugar filtration process. They were brought together by CalMax[16]. With this new exchange system not only has Triad made money but C & H also saves on disposal costs.

Some of Triads future plans include contracting with fish processors in Oregon to turn their detritus into fertilizers and fish food. As well as using skins and seeds from Australian wineries and fruit processors into fertilizers and compost. With out companies like Triad these materials usually can't be used directly. And hence they are a great example of a resource recovery company.

Peter Paul Philippines Corporation and Chia Meei

Peter Paul located in Philippines is one of the largest firms producing desiccated coconut (DCN). The rated capacity of the plant is about 22,000 tons of DCN per year, which is mainly for export. With such high production, Peter Paul has a large quantity of organic material that it has to dispose off. The company reprocesses the coconut waste to produce coconut oil and copra meal but had to dispose of its 80,000 liters of coconut water it produced daily.

[16] A profile of CalMax can be found in Appendix _.

To curb this problem, Peter Paul underwent a pollution management appraisal (PMA).[17] One of the recommendations was to enter into a joint venture with Chia Meei, which later established a plant next to Peter Paul. The aim was to collect the waste water and sell it to Chia Meei which processed the water and then channeled it to Taiwan where it is sold as a commercial drink. The processing includes concentrating, freezing and final processing. The process was made more efficient by improvements in collection of the water by Peter Paul.

The estimated savings per year in treatment costs amounts to $3700 and increase in output amounts to $370,000 per year.

Naroda Industrial Estate

Located in Gujarat, India, Naroda Industrial Estate (NIE) is one of the largest sites for eco-industrial development in the world. NIE contains 700 companies and employs over 35000 employees. The site has many different types of industries ranging from chemical, pharmaceutical to textile and food production. Formed in 1966, the project is seeking the corporate approach to cleaner production and pollution prevention.

Recently efforts have been made to reduce waste produced by companies in the estate. After some research 4 projects dealing with materials that were being produced in the estate where started. The first project dealt with the spent acid being produced in the estate. Since no one company has enough waste to be

[17] A PMA aims to identify opportunities for reducing pollution using a waste management hierarchy in which waste minimization is the dominant component.

able to deal with it cost effectively, four companies got together and contracted a 5th company to help take care of the problem. Their solution was to use the acid in the production of Ferrous Sulfate. The recycling firm created more jobs and the companies involved reduced disposal costs by half.

Similar programs were started to recycle and reuse chemical gypsum, dyes and intermediaries and organic wastes produced from food processing companies. With the help of these systems the levels of pollution caused by these companies has greatly reduced and it illustrates that a collaborative corporate initiative can help reduce costs and benefit the environment.

Appendix F – Costa Rican Laws

Costa Rican Laws Concerning Hazardous Waste, Transport

It is the responsibility of the company to comply with all applicable laws involving transport of normal and hazardous materials and wastes. The article outlined by MINAE (27000-MINAE) should be a helpful starting point in determining if a waste is hazardous or not. Article 5, Appendix 2, has a complete list of wastes classified as hazardous including the material codes.

The second article in the 27000-MINAE law has a definition of wastes and the definition of special and hazardous. First, waste is described as "...all of those substances or movable objects, defective, unserviceable, not able to be utilized, or without direct use (including the residues of pure substances), whose purpose is to degrade or is obligated to follow the national laws. This includes the subproducts or the by-products of treatment..." (MINAE directive, 1998, article 2)

These wastes can be ordinary or special, also known as hazardous. Ordinary wastes are described as "those wastes that are solid, gas, or liquid in fluid or sludge form that do not require special treatment before being disposed..."(MINAE directive, 1998, article 2) Hazardous wastes are defined as "...those wastes that are solid, gas, or liquid in fluid or sludge form that by their chemical reactivity and their classification as toxic, explosive, corrosive, radioactive, biological, flammable, volatile, combustible or others, or by their

quality and type of exposure, can cause damage to the health of human beings and the environment, including the death of living organisms..."(MINAE directive, 1998, article 2)

The Waste Management Law provides further information about municipal and commercial waste handling. Articles 11 through 13 of the Waste Management Law outlines the particulars about the storage of wastes and articles 23-74 describe the required forms for transportation, separation, collection, and disposal of wastes.

Appendix G – Case Studies of Resource Exchanges

This section describes the various models of resource exchange we uncovered during our background research. These models acted as a base for the model we chose to recommend to CNP+L.

Massachusetts Materials Exchange

(http://www.materialsexchange.org)

The Massachusetts Materials Exchange is a model of a simple yet efficient, approach to a Public Management System. They are a small office located in Northampton, Massachusetts that is part of a larger organization called The Center for Ecological Technology. (http://www.cetonline.org) MME is an offshoot of this larger agency seeking to innovate and find practical solutions to environmental problems. The specific mission of the Mass Exchange is to establish business relationships for the sharing of reusable resources.

Their solution and approach to this goal was to setup an online database containing contact information for businesses to offer materials they had no use for and to identify what those specific resources were. Although the resource information is available to any visitor on the web, to access the contact information for a particular company entails registering with the Mass Exchange. There is no fee associated with this; it is just for record and validation and to allow other companies to make contact, if they see an opportunity in the making.

Any company is encouraged to access this database. If they do not have Internet access or if they just prefer direct contact, they may telephone MME and exchange information that way. They may also request a printed catalog of all the information currently in the database (produced quarterly). Once contact is made, it is up to the target businesses themselves to develop a working relationship and organize the transportation of materials. If a business does not see any present opportunities, they can request an email or other form of notification whenever a business posts an inquiry the materials they are looking for.

Other than the exceptions of telephone or mail communication, the people behind the Mass Exchange have no other responsibilities. They maintain the performance and operation of the site and no other work is needed on their part. Some marketing is conducted to get the word out about their existence and to encourage various companies in any industry to use their services.

Northeast Waste Management Official's Association
(http://www.newmoa.org)

The NEWMOA organization, a subsidiary project of the Pollution Prevention Resource Exchange (http://www.p2rx.org) is an example of a full-blown active model of a Public Management System. Despite being non-profit and non-partisan, this collection of pollution prevention and waste management directors offers a slew of informational and active services and programs that

deal with anything environmental-protection related. One of their areas of expertise is solid waste project development, which includes some programs such as tire and construction material recycling and an updated fact sheet about the various reuses of waste materials.

Although they do not have a simple system such as a database, NEWMOA specializes in custom services for a specific industry's needs. One example of this is the BUD process or Beneficial Use Determination. When a business decides that the cost for disposal of certain products has risen too high, they often draw up proposals to uncover any possible reuses. This company can then hire NEWMOA to evaluate their proposals and conclude whether or not it is worth pursuing based upon feasibility factors and the financial impact on the company itself. Unfortunately, the assessments NEWMOA makes for particular customers are not available to the public; however, they do from time to time generate fact sheets, summarizing their research and findings (an example of this would be the "Beneficial Use of Wood Ash on Agricultural Land").

NEWMOA functions more as a consulting service. Similar to the Mass Exchange, one visits their site to obtain information; however, the site is not all that NEWMOA has to offer. They hold seminars and conferences, produce and distribute publications, organize and promote various projects. They also have special member workshops and provide additional information to any company that is interested in becoming a part of their group. The NEWMOA organization performs leadership and innovator roles towards eco-friendly practices and

provides information as well as resources for any industry seeking to improve their resource efficiency.

BORSI

(http://www.borsi.org)

The National Market of Industrial Remainders and Byproducts of Columbia (BORSI) is an organization very similar in structure to NEWMOA and the Massachusetts Material Exchange, in that it offers a listing of products that are categorized by material type. However, BORSI does not offer the degree of consultation that is offered by a program such as NEWMOA.

BORSI's site has a focus on the available products and the products that are in demand. When a prospective user of BORSI comes to the website, he or she is presented with the option to post or read the current listings. The postings are organized by the type of material (i.e., plastics, chemicals, textiles) and are supplemented with further information concerning the rate of consumption or availability, the quantity offered or desired per rate, and comments regarding the item offered or wanted. The user is presented with a form that will enable the user to contact the person that posted the information.

In addition to a website, BORSI publishes a periodical that offers the same listings as the website, except not in real time. This method provides access to the business people of Costa Rica that do not have immediate access

through the Internet to the extensive database that BORSI maintains. The periodical is organized into 4 different sections:

- Technical documents, which contain statistical and material-related information about the available and wanted resources.
- Available resources organized by the same criteria as the website.
- Resources desired by companies.
- A final section with listings of companies that help with resource reuse, and available literature concerning resource recovery, and conservation and efficiency within industrial processes.

While this model is similar to the other models presented above, its significance lies in the fact that this system provides almost the same accessibility to individuals that do not possess Internet technology, aside from the fact that the periodical lacks the real time updating abilities that the Internet possesses.

California Integrated Waste Management Board
(http://www.ciwmb.ca.gov)

The CIWMB is an organization that belongs to the California Environmental Protection Agency. Their structure and purpose encompass seven main points:

- Developing waste reduction programs

- Providing public education and outreach
- Local business and government assistance
- Market development for recyclable materials
- Encouraging used oil recycling
- Regulating waste management facilities
- Cleaning up abandoned and illegal dump sites

The mission and values of the CIWMB are nearly identical to the previous models described here, however, what makes this agency stand out are the unique programs they sponsor.

The first main program created by CIWMB is CalMax, which stands for California Materials Exchange. This is a database program that functions in the same way as the Mass Exchange. Businesses that visit the site may post materials they have or search what other companies have listed and use this information to establish trading relationships. A rather outstanding aspect about CalMax, however, is that the employees who manage the site keep a look-out for certain materials that could be donated to public institutions. They even have a specific subprogram called KidMax that collects art supplies and other equipment to be donated to local schools for free. This system promotes community involvement and also helps overcome some of the economic challenges that public education faces.

Another special department attributed to CIWMB is the Waste Prevention and Market Development Division. This program is specifically designed to complement the purchasing department of companies choosing to buy recyclable

materials. The Recycling Business Assistance Branch offers loans to eligible companies who promote a market for recyclable goods. The Recycling Technologies Branch evaluates companies' waste streams and devises methods to increase their recovery or transformation into usable products.

The services that CIWMB offer do not end there. Browsing their homepage, a visitor could feel overwhelmed by the number of departments and programs they have. CIWMB seeks to get involved in everything from local and corporate recycling to public health and safety to law enforcement to "green building." A company seeking to explore the possibilities of becoming eco-friendly is sure to find whatever they need on this site.

Philippine Business for the Environment
(http://www.pbe.org.ph)

The Philippine Business for the Environment (PBE) is a non-profit organization brought into existence in 1992 by a group of businessmen who wanted to do something about the declining health of the Philippine environment. They are primarily involved with a number of environmental awareness programs and some of their more important programs are the Environmental Information Center for Business and Industry, the Industrial Waste Exchange Program (IWEP), the Philippines Business Agenda 21 and the PBE Corporate Environmental Training Series 2000.

The IWEP program run by PBE mainly deals with excess inventory and by products produced by industries in the Philippines. The main objective of the

program is to develop a sustainable trade information system among companies in the Philippines where companies can get information about materials they would like to buy and also advertise materials they would like to sell.

The main way IWEP differs from the other exchanges is that it mainly disseminates information through their bimonthly magazine called Business and Environment. The magazine also contains articles about environmental issues and industry. The magazine devotes an entire section to the IWEP program, called the IWEP corner. Here one can find a comprehensive listing of all the materials on sale, and materials that are wanted by companies. This listing includes:

- Quality/ grade
- State the material is in, e.g. solid, liquid, cake
- The amount available
- The frequency in which an industry can find the material
- List of contaminants (if any)
- Other relevant information about the material
- Contact information

The listing is divided by different chemical properties of materials such as acids, alkalis, metals, organic waste, etc. This is then supplemented by an online version of the same list. This online version is only updated as a new edition of the magazine is released. This magazine and program is funded through the

magazine subscriptions as well as advertisement the industries make on the IWEP list and in the magazine.

Waste Exchanges, Ltd.

(http://www.wasteexchange.com)

This website was formed in 1990. The introduction states that the company will recycle, reprocess, and market all types of materials. The website goes into detail about the benefits of the waste exchange:

- Free to use.
- Possibility of generating extra income from the wastes.
- Could be used in order to promote a company's image of being environmentally friendly.
- Can reduce the costs of landfill disposal.
- Is legislatively compliant with all transport and hazardous material laws.

The waste exchange section of the system has individual sections of desired materials and has a separate section that has a listing of surplus materials and chemicals available for purchase. Each section has a few vague listings and recommends that the recycling or logistics manager be contacted with the promise of getting detailed information. The contact section lists the contact information for the Recycling Manager, Recycling Consultant, and the Logistics Coordinator.

Residuos

(http://www.residous.cl)

Residuos is a residual material market magazine and web page with listings of demands and offers. There are no recent updates of the magazine, however, which suggests that the magazine is no longer being produced. The magazine, however, has a great introduction section that provides a background for the creation of the exchange system that is outlined on the proceeding pages. The magazine also stipulates that it was formed from Intec Chile and the Fund of Development and Innovation.

The website is well designed and has a large banner at the top with the title, "¿Residuos?... NO, ¡Subproductos!" A resource exchange program such as Residuos redefines the use of the word waste as used materials that are available for use as another product.

The website is similar to BORSI in types of material listings, but offers a more detailed posting section. The section includes:

Material Posting Code	Units of Quantity
Dates of Availability	Frequency
Material	Price
Waste Family	Process of Generation
Characteristics	Current Form
Quantity	Possible Application

This provides a much more detailed description of the material and its possible uses and would help market the material much more effectively.

The website has more advanced features, for which registration is required. There is a listing of advanced seminars in business and cleaner business practices, including a team building seminar that uses paintball as a training exercise. There are also many more options for technical and resource exchange assistance for registered users.

Wastechange

(http://www.wastechange.com)

The homepage of this website is decorated with rather unattractive banners that link this company to partners and affiliates. However don't let this amateur format fool you. This materials exchange advertises itself as a "free commercial waste exchange" and they have some of Europe's major industries posting entries and conducting trade. Wastechange.com is designed mainly for European companies, however, they more than welcome any international interested parties to participate.

Right away, the web surfer is greeted to a category listing of either Available or Wanted materials that the database hosts. There is no need to describe it in detail as it follows a similar format to other exchanges. However, it is rare for a listing to be made available immediately instead of being buried under a separate link. The listings are abundant, each coded with a specific I.D. number for convenient reference by both the visitor and the system itself, and

one can easily click a small link to reply to a listing of choice. Adding a listing is just as easy and also follows a similar style. The only flaw with the listings, though, is the choice of font and size is rather painful on the eyes.

In addition to the various listings, there are other major links that vie for your attention. The first one is a reference to an online comment card of sorts that offers the visitor a chance to improve Wastechange. Included on this form are questions about the relation the visitor has to the system as well as inquiries about the mechanics of the system. Spaces are provided for an opinion on what the visitor likes about Wastechange, difficulties they may be having, additional services Wastechange should offer, and finally whether or not Wastechange helped their business. This digital comment card offers continual quality control.

The other links on the homepage include a form for email notification of new listings, a 24-7 hotline for any commercial waste assistance desired and a rather interesting page entitled “How Much is Your Waste Worth?” Unfortunately, a click on that link brings up a page with that hideous font again where something about a waste report is barely legible. Apparently, this waste report can be requested by a company and involves "quotations, market analysis and recommendations" to maximize the benefits of your waste.

Finally, a menu at the bottom of the site links to information on how a company could advertise on Wastechange and how to contact Wastechange. They also offer a glossary of common waste management vocabulary and a bulletin board of the latest news in the industry.

What is noteworthy about Wastechange is that they do provide a type of eco-label, called Membership of Wastechange, which illustrates a company's commitment to handling their waste responsibly. Wastechange is also not shy in advertising any sort of material, including toxic waste.

All listings on Wastechange are available for 90 days unless the target company renews its information.

Recycling Council of British Columbia

(http://www.rcbc.bc.ca)

The Recycling Council of British Columbia (RCBC) is a non-profit organization that was founded in 1974. It initially began as an umbrella group for community based non-profit recycling societies but soon flourished to provide various other programs, seminars, conferences, and workshops.

One of the programs done by the RCBC is the Recycling Tool Kit. This agenda consists of three different programs that are aimed to reducing waste in the community. These programs are:

1. Recycling Hotline: Anyone can use the recycling hotline and best of all it is free. People are encouraged to call up to ask questions or get information on recycling methods. The hotline also serves as an information collection point where anyone can call to donate any materials they are not using and find materials they need.

2. Materials Exchange (MEX): The Materials exchange is divided into 3 basic parts:

- BC Plastics Exchange
- BC Paint Exchange
- BC Chemicals Exchange

Originally, the recycling hotline was used to access the materials exchange but the RCBC is now working on a new web based exchange where one can search for materials needed and materials available. Once the system is in place it will make materials exchange easier. The difference between BC MEX and other material exchange programs is its focus. The BC MEX focuses on the community and small quantities of waste produced by SME's in addition to the waste produced by larger companies.

3. Household hazardous waste tool kit: The RCBC prints out a booklet that helps people take care of hazardous materials around the house.

The RCBC is funded through memberships and donations. Anyone can become a member of the RCBC and they get a magazine printed triennially called *Reiteration* and a monthly electronic newsletter called *RECAP.* Members also get discounts on the various other programs that the RCBC offers.

Appendix H – Comparative List of the Different Materials Exchange Databases

Database	Type of approach	Method of providing information	Listing	Other methods of providing information	Additional services	Funding	Additional Programs
Massachusetts Materials Exchange (U.S.A.)	Active	Online database	Resources list available to any visitor but to get contact info must register	Offers a paper catalogue which is published quarterly	Companies can call in to get information as well	Funded through grants and also nominal fee paid by companies being helped	
BORSI (Colombia)	Passive	Online database	List include materials wanted and materials available	Publishes a paper catalogue which contains technical data as well as the listing	Companies can Fax in or call in to get information	Funded by CNP+L EMPA (a Swiss organization)	
IWEP (Philippines)	Passive	Paper based listing published bi monthly	List divided by material and includes materials wanted and materials available.	Also has an online version of their listings	Calling for information not available	Funded through subscription fee for the magazine as well as fee for advertising in the database	
CalMax (U.S.A.)	Passive	Online database	Listing divided into regions and then materials	Also has paper version of database	Calling for information not available	Funded through grants	KidMax: art supplies are collected and given to local schools
Wastechange (Europe)	Passive	Online database	Listing divided into materials wanted and materials available.	Email Notification, 24-7 hotline	Waste report can be requested that includes quotations market analysis and recommendations that can help maximize benefits	Funded thro advertising Banners.	Eco-label called Membership of Wastechange.

Database	Type of approach	Method of providing information	Listing	Other methods of providing information	Additional services	Funding	Additional Programs
BC MEX (Canada)	Active	Phone based	Listing divided Plastics, Paint and Chemicals.	An online version is expected soon	Also serves as a collection point to collect the materials.	Funded thro membership fees and donations	Focuses on the community rather then just businesses and has a house hold hazardous materials reduction program.
Waste Exchanges Ltd. (U.K.)	Active	Web based	Listing divided into materials wanted and materials classified as waste which is further divided into surplus materials and chemicals for purchase	People are encouraged to contact the exchange thro email.	The company recycles and reprocesses materials to be marketed	Funded thro consulting fees	Also owns a Plastics recycling center, a silica gel recycling center and a packaging recycling center
Residuos (Chile)	Passive	Web based	Listing divided by materials wanted and materials needed and then by type of material	Used to have a magazine which helped launch the materials exchange		Funded by Intec Chile and The Fund of Development and Innovation	

Comparative List of Different Pollution Prevention and Resource Exchange Organizations

Organization	Type of Organization	Main Objective	Primary Services	Additional Services	Funding
NEWMOA (U.S.A.)	Non-Profit, Non-Partisan	To help promote and implement economical regional programs for the enhancement of environmental protection.	Consulting services, where a company can hire them to help reduce disposal costs.	Specializes also in customer services for specific industry needs. Also runs seminars and conferences and various other projects.	Revenue generated by grants and consultation fees.
PBE (Philippines)	Non-Profit	To promote sustainable development where economic growth is balanced with environmental responsibility.	The bi-monthly publication Business and the Environment, where it has many articles about reducing pollution by industries and also its materials exchange listing.	It has a resource center for any business and industry to use and also runs seminar and training sessions to improve environmental practices in industry. It was Commissioned by the UNDP to promote Agenda 21 in the Philippines.	Funded through grants from the govt. of the Philippines and membership and subscription fees that the member companies have to pay.
CIWMB (U.S.A.)	State Run	To reduce waste, promote the management of all materials to their highest and best use, and protect public health and safety and the environment.	It conducts programs for recycling and reuse of materials in every field. This encompasses every aspect of environmentally safe practices.	Also provides financial assistance to companies who switch to environmentally safe practices but might suffer some financial set back because of it.	Run through the state government and therefore gets money from the state government.
RCBC (Canada)	Non-Profit		Provided a way for the community to recycle and reuse waste. They are especially active in trying to reduce hazardous wastes in the community.	They hold seminars and conferences and also publish a tri annual publication called Reiteration and a monthly electronic newsletter called RECAP.	Funded through donations and membership fees and small grants from the BC province.

Appendix I

This section contains interviews we conducted with Juan Carlos of the Cartago Industrial Park, Adriana Soto of Intericiclando, Alexander Román of Metalurgia Román and Eugenia Ching of Cedarena. These interviews were instrumental in helping us come up with our propose model.

Company: Industrial Park of Cartago

Juan Carlos is the exchange director of the 18 industries within the industrial park of Cartago. They receive about 470 m tons of waste per month.

Q. What materials do you usually get?

Materials usually found are:

Plastics

Cardboard

Solvents

Textiles

Metal: Copper, Aluminum, Bronze are all sold. Iron goes to Guatemala.

Paper: Vicesa, Kimberly Clark, Scott papers buy materials from them

Wood Pallets: Are repaired and resold.

Intericiclando is a part of the industrial park and takes care of the Plastics.

Q. What are the functions of your company?

The company deals with storage, disposal, transportation and sale.

They try and find who wants the materials. It is hard to find people who can use the materials. If they can't find buyer, the materials are sent to a landfill. If materials are kept and they can't find a buyer, they sometimes are willing to give the materials for free because landfills are expensive.

Q. Who finances your project?

We get financing from Holland. Holland gives Costa Rica money which is then distributed among various projects. The projects have to be sustainable. Once the project starts making money the funding usually stops.

Q. What methods of communication do you think we should employ for our project?

Internet is a good idea. Telephone is the best.

Q. Do you have any suggestions for our project?

Call the newspapers and get interviews. Tell them you have a project that is important. This way people will hear about your project and it is easy and free.

The best methods are Radio, Television and the paper.

It is a working progress and it is very important to get people to know about it.

You need to have people and administration.

The best model is when company and company get in contact with each other and pay the intermediary a small fee.

It is very important that the project has both buyers and suppliers. Because many industries will give waste and there are no takers for the waste. We should build a storage area and then build a contact list.

Company: Intericiclando

Adriana Soto is the founder and director of Intericiclando.

Waste: 35 tons of plastics recycled and processed a month yields about 2-3 tons of waste.

Q. What does your company do?

We buy raw materials i.e. plastics and process / recycle them.

Initially this system was done very informally. People bought and sold materials informally and that is why we started our company.

It started 2 years ago and now we have 18 people working for us.

Q. Are you responsible for Transportation?

It works both ways. Sometimes companies will deliver their waste materials and sometimes we have to pick it up. Also sometimes companies will pick up the material from us and sometimes we have to deliver it to them. It works both ways.

Q. What kinds of plastics do you buy?

Almost all kinds. They have to be clean, with no labels, no residues and we prefer them to be classified.

Q. Are they sold as recycled materials?

Yes, they are sold as recycled materials.

Q. What kinds of waste materials do you have?

We have paper, metals, cardboard, rubber (gloves) and textiles.

Q. What do you do with your waste?

Sometimes we sell it and sometimes we give it away. I really prefer to give it way.

Q. How do you find people to buy the materials?

I find them myself.

Q. Have you ever disposed materials in landfills?

Yes, I have.

Q. Are you an ISO 14000 company?

No.

Q. If you had to use our materials recycling system, what form would you prefer to use it in?

I would rather use it as an internet site. I am familiar with using Plastics Recycling websites. I find them easy to use. It makes it easy to see what materials are available and what materials are needed and also check prices.

Q. If we offered a telephone hotline and a paper based catalogue, would you use it?

Yes. I think that would work best in Costa Rica.

Q. Would you be willing to pay a subscriber fee?

Yes. I usually sell materials to other people. And I like to sell them to a company and not to an intermediary.

Q. Do you produce anything shelf-able or produce something directly for the consumer?

No. We primarily sell to companies.

Q. Would you subscribe to an Eco label?

Yes.

Company: Metalurgia Román

Alexander Román is the director of Metalurgia Román. He expressed a lot of interest in our project. His company buys materials that have been used and then exports them to be reuse/recycled.

Q. What kinds of materials do you buy/require?

Lead

Copper (most common)

Aluminum (most common)

Bronze

Zinc

We mainly buy non ferrous materials.

Q. What grade or quality do the materials have to be in?

Materials must be free of:

Plastic

Iron

Contaminants

Q. How much are you willing to pay for these materials?

Prices per Kilogram usually are about

Car Engine Aluminum: 230 colones

Printing Aluminum: 250 colones

Window Aluminum: 270 colones

Q. Will you be willing to provide transportation if we could find you a supplier?

Transportation is usually provided by the supplier of the material. We can provide transportation but we don't want to compete with transportation companies.

Q. Are there any other materials you would like us to find for you?

Our company is now looking to recycle plastics because our Canadian customers have expressed interest in them. The problem is that plastic is cheap and therefore it is hard to compete with landfills for these materials. This new project will take about 1-2 year to complete.

Q. Do you have any byproducts that you produce?

No, we produce very small amounts of byproducts.

Eugenia Wo Ching S.

Lawyer

Eugenia Ching works for Cedarena (Centro de Derecho Ambiental y de los Recursos Naturales)

We spoke to her when we were looking for the laws and regulations governing transportation and hazardous materials. She helped us first by finding

those laws and in addition finding laws that governed the transportation of hazardous materials. When we asked her if we could find laws governing specific materials, she explained to us that in Costa Rica the laws governing a specific material is dispersed and it is virtually impossible to find all the laws that govern a material. Also she mentioned that the agricultural laws changes rapidly and there would be no point in quoting specific laws in our proposal because they would change anyways.

For the transit laws, she pointed us toward the Procuraria General in San Jose. Also in conversation with her she told us that there are no tax penalties imposed in companies that pollute. Most of the laws are 10 years old and do not apply to the locally owned companies which pollute a lot. The larges fine and penalty imposed is less then $2000 dollars. She also mentioned that in Costa Rica, most of the recycling initiative have been private and in her observation companies are more willing take part in recycling programs if it is voluntary as companies like the green image. She then commended Sergio Musmanni and Carlos Perrera on the work they did with the coffee industry. This industry was once considered the most polluting in Costa Rica but recent reforms have helped reduce wastes by 80%. She mentioned that one of the most polluting industries in Costa Rica is the Recope, the nationally owned petroleum company.

When we described our project in more detail, she mentioned this study done on Rio Azul (the landfill in Costa Rica) and also mentioned that it would be very beneficial to our project. She, unfortunately, could not remember who did the study and we have been unable to find it.

We then thanked her for her help and she gave us her email address for if we had any questions.

Appendix J – Sample Questionnaire

The following page is the questionnaire we sent to 650 companies in the Chamber of Industries. Unfortunately, we only received 32 responses back. The beginning briefly describes our project and the reasons for sending the survey. The first question asks what forms of treatment does a company use, what materials do they treat and approximately how much it costs. The next two questions ask what forms of communication are available to the company and which they prefer to use. The last question inquires, based upon the description we gave them, if the company would be interested in participating in a materials exchange. Finally, the questionnaire closes by assuring them of the confidentiality of their responses.

Encuesta para Mercado de Residuos y Subproductos Industriales

Estimados Asociados de la Cámara de Industrias:

El Centro Nacional de Producción Más Limpia de Costa Rica y la Cámara de Industrias deseamos crear un sistema de intercambio de recursos que proveerá una solución a sus problemas de desechos y una alternativa a la disposición final de sus subproductos y residuos industriales. Este cuestionario nos ayudará a determinar la aceptación e interés de este tipo de esquema en el país.

Este sistema de intercambio de recursos permite a las empresas ofertar sus subproductos y residuos industriales a otras empresas para usar como insumos. Este esquema puede reducir los costos de disposición para los generadores y los costos de compra para los recuperadores. El uso de los desechos de otras empresas es positivo para el medio ambiente y para una mejor utilización de los recursos, congruente con el desarrollo sostenible que buscamos.

La información que usted provee será utilizada solamente por el CNP+L y será confidencial. Nosotros le agradecemos por su tiempo y atención para participar en este cuestionario. Esta iniciativa se hará una realidad en un futuro cercano gracias a su aporte de información.

¿Cómo maneja sus desechos? Favor, indique los tipos de desechos para cada selección.				
☐ Tratamiento	☐ Se Almacena	☐ Se envía a un Centro de Reciclaje	☐ Se Usa en Producción	☐ Relleno Sanitario
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
¿En promedio, cuanto cuesta por mes?				

Favor, indique todas las formas de comunicación que usted tiene.				
☐ Correo Electrónico	☐ Teléfono	☐ Fax	☐ Correo	☐ Páginas de Web

¿Cuáles formas de comunicación prefiere usar?				
☐ Correo Electrónico	☐ Teléfono	☐ Fax	☐ Correo	☐ Páginas de Web

¿Desea participar en un sistema de intercambio de desechos?	
☐ Sí	☐ No
Sí la repuesta es no, favor indique que facilitaría el proceso.	

Le agradecemos remitir la información solicitada en este cuestionario a la dirección electrónica y/ó número de fax señalados a continuación. Muchas gracias por la ayuda prestada.

Nombre:	**Empresa:**
Cargo:	**Teléfono:**
Fax:	**E-mail:**

Centro Nacional de Producción Más Limpia
Apdo 10.003-1000, San José, Costa Rica
Tel: (506) 281-0006 exts. 108 y 144, **Fax**: (506) 234-6163
e-mail: cnpml@cicr.com

Appendix K – Sample Interview Protocol

The following section provides the format and questions we followed when conducting our interviews of various companies in Costa Rica as part of our survey. The interviews were intended to explore more detailed information that the questionnaire could not obtain.

Hi, we are from CNP+L and we are investigating ways of implementing a Materials Exchange Program in Costa Rica.

This is a system that takes the wastes and by-products generated by key industries and recycles them back into the raw material streams of other industries. This could reduce disposal and supply costs for the companies involved as well as establish a more environmentally friendly corporate image.

This system has already been established in Chile and Colombia with excellent results and we are trying to assess the feasibility of developing this system in Costa Rica. We were wondering if we could ask you a few questions about your production processes. All your responses would be confidential.

- Are you ISO 14000 compliant?
- What are the main products or services you produce?
- Could you tell us a little about X?

- What raw materials are needed to make X?

  (Ultimately, if there are proprietary materials you do not wish to share, that is up to you, but we assure you your responses will be confidential)

  - What specifications?
  - Are they transported to you?
  - How do you acquire these materials? Are they acquired from purely virgin sources?
  - Would you accept recycled?
  - Would you be willing to arrange transport yourself?
- What sorts of waste materials or unusable by-products are generated from producing X?
  - How much?
  - What do you do with these?
  - Would you be willing to transport these materials to another company if they could use them?
  - Would you be willing to give them away?
  - What sort of materials do you dispose or recycle?
- Do you need to process or purify any of these materials before you dispose/recycle/reuse?
- What kinds of costs are associated with your waste management procedures? (or, how much do you spend handling your waste?)
  - Have you explored other alternatives to your waste management procedures?

- Are you interested in cleaner production activities?
- Would you be interested in contracting a third-party to help you find new markets for your byproducts and help your find new sources of raw materials?
- If there existed a listing of materials to exchange, how would you prefer to access it? (e.g. telephone, booklets)
- If there existed a listing of byproducts that companies produce which you could use as raw materials, would you like the catalog to be online or in paper form?
- Would you be willing to pay a subscriber fee?
- Along with a listing would you like a have a consulting service help you with other CP projects?
- Would you consider subscribing to an eco-label?

Appendix L – Tutorial of an Online Exchange

Una Introducción a Sistemas de Bolsas de Materiales en el Internet

Un sistema de intercambio de materiales el canje de materiales entre empresas. El intercambio de materias reduce los costos de formas de disposición y los costos de adquisición de materias primas para las empresas.

Los sistemas de intercambio de materiales pueden ser operados de diferentes formas como: fax, email, catálogos por correo, teléfono, y sistemas de intercambio por Internet. Es posible que las personas que no saben como usar el Internet no sepan como participar en un intercambio por medio de una página de web.

Este resumen ilustra en forma de tutoría el sistema de intercambio en el Internet llamado BORSI (http://www.borsi.org) de Colombia. Seguiremos dos empresas, una que necesita aluminio para su proceso de producción y otra que ya no puede manejar el aluminio enviado al relleno sanitario. Estas empresas nunca han interactuado, pero ahora harán un intercambio de materiales.

Jorge Necesita un Proveedor

Este es el sitio web de BORSI. Jorge, un ingeniero de la empresa Metalici, tiene un problema. Su proveedor usual de aluminio no puede encontrar suficiente

aluminio. Es la responsabilidad de Jorge buscar una fuente de abastecimientos de aluminio alterna, en caso de que el proveedor no pueda satisfacer la demanda. Jorge visita el sitio de BORSI a ofertas y demandas para empezar.

INGRESAR

Por favor ingrese la información de su empresa y el tipo de material. Toda la información aquí suministrada es de carácter estrictamente privado.

Debido a que tenemos que comprobar si la información aquí suministrada es verídica, ésta aparecera registrada en nuestra base de datos aproximadamente en 24 horas.

Los campos marcados con * son obligatorios.

Empresa*	Metalici
Nit*	
Teléfono*	506-76
Dirección*	
Fax	
Ciudad*	
Persona de contacto*	Jorge
Email	jorge@metalici.com

En el sitio de BORSI, es gratis consultar la información en la base de datos, pero para exponer una demanda o colocar una oferta de materiales, usted debe completarse información sobre usted y su empresa. El extracto arriba muestra la primera página donde se ingresan los datos. Ya que, él desea hacer un anuncio, él debe completar la información para matricularse con BORSI. Posteriormente, él continúo con el uso de la página.

Después de la matricula de la empresa en la base de datos se debe completar una forma describiendo su material. En el caso de Jorge, su empresa necesita 400 kilogramos de aluminio no ferroso semianualmente para su producción. Primero, él escoge. Demanda para indicar el tipo de canje. Posteriormente completa la información.
La primera casilla "Tipo de Material" tiene 18 categorías diferentes de materiales para escoger (por ejemplo: Goma, Maderas, Plásticos, Textiles y Envases). Jorge escoge metálicos porque se relaciona más con aluminio.

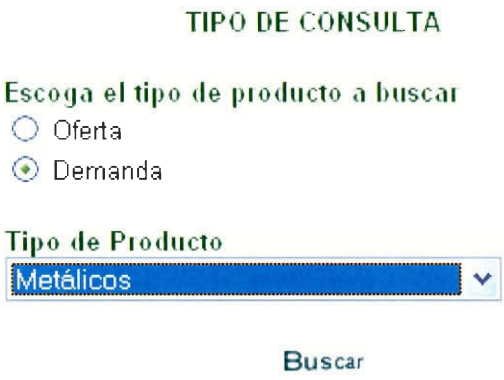
Al completar la información, Jorge acciona el botón "Enviar" y ¡eso es todos! Su demanda está almacenada en la base de datos y alguien en el web que busca materiales en el sitio BORSI puede verla.

Ahora, Jorge espera que alguien pueda encontrar su demanda.

Pedro Necesita un Receptor

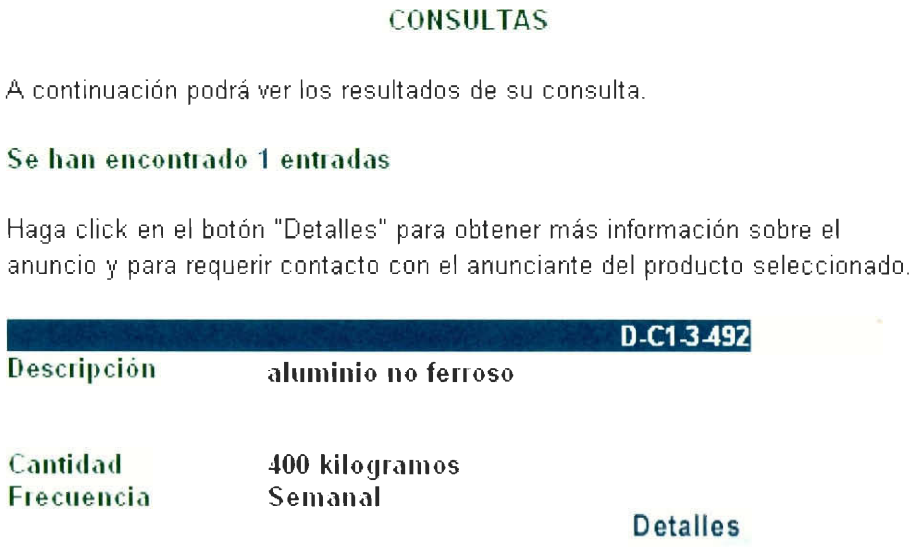
Pedro trabaja en la empresa Aplicaciones Grandes. Él también tiene un problema. Su empresa dispone aluminio no ferroso. Hasta ahora, la empresa ha enviado el material al relleno sanitario, pero el gobierno acaba de pasar una ley sobre disposición de metales en rellenos sanitarios y ha designado una multa de €75,000 por kilo de metal. Su empresa no puede pagar esta multa, de este modo la responsabilidad de Pedro es encontrar

una manera alternativa de disposición del aluminio. Él decidió visitar el sitio de web BORSI para buscar una empresa que necesitará el aluminio.



Nuestro personaje tiene aluminio que desea poner a disposición. Él acciona "Consultar Ofertas" y "Demandas" en la página web porque él desea hacer una búsqueda y así son presentadas las opciones. Pedro escogió Demanda porque él quiere buscar en la base de datos empresas que necesiten un material en particular para ofertar. Él selecciona del menú "Tipo de Producto" la categoría de los materiales que desea buscar. En este caso, metálicos. Ahora, Pedro elige Buscar.

Un Encuentro en el Cielo



¡Éxitos! La base de datos tiene un aviso de una empresa que necesita 400 kilogramos de aluminio no ferroso. Ahora, Pedro solo necesita la información acerca del contacto. Él acciona "Detalles" para encontrarla.

Por razones de seguridad, la información del contacto no mostrará si el usuario no ha inscrito su empresa en la base de datos BORSI. Si el visitante está matriculado, la próxima página mostrará el nombre la empresa, el nombre de la persona que puso el aviso, y una dirección de correo electrónico o un número de teléfono para contactar a la empresa o persona.

Pedro si había matriculado a su empresa en BORSI y por lo tanto los detalles aparecen. La página dice que él debe contactar a Jorge de la empresa Metalici. Pedro procede a hacer la llamada y las dos empresas formarán una relación que ambas aprovechará y podrán ahorrar dinero.

¡Qué fácil es el intercambio de material!

Este intercambio se formó cuando Jorge tuvo una demanda de aluminio y Pedro buscó una empresa que necesitará aluminio. El intercambio tuvo éxito, pero el intercambio puede ser hecho de otras maneras. Pedro pondría un aviso en la base de datos en Oferta. El aviso diría que su empresa tiene aluminio para dar. En este caso, Jorge visitaría el sitio y buscaría las empresas que tienen aluminio. Él encontraría en la lista a Pedro y Jorge le llamaría, para empezar la relación. ¡Trabaja de ambas maneras!

Un intercambio en línea es muy rápido y fácil, aunque no provee asistencia para ayudarle con su problema de material. Este documento puede ayudarle a usar bolsas de materiales en la web, sin embargo, la empresa escogerá la forma más efectiva para llevar acabo su trabajo.

Anexo

Estas son algunas páginas de intercambios de materiales en Internet.

Este es un extracto de la página de "Mercado de Subproductos y Residuos" (http://www.residuos.cl) que está en Chile. Usted puede ver, combinan una "oferta" y una "demanda" en un mismo formulario.

Este es un extracto de la página Wastechange (http://www.wastechange.com), el mayor sistema de intercambio de materiales en Europa. No tiene la opción de búsqueda. Al visitar el sitio de Web, usted puede mirar las listas de materias y buscar manualmente. En otras palabras la figura de arriba simplemente lisa las categorías de materiales y establece vínculos con las ofertas y demandas almacenadas.

Appendix M – Sources of Funding

Listed here are some organizations that CNP+L can request funding from. This list is by no means comprehensive. There are various other organizations that also provide funding for Cleaner Production activities. This list is just a sample of the different types of Organizations.

1. **IDB Multilateral Investment Fund (MIF)**: The Multilateral investment fund was started by Inter-American development bank almost 10 years ago and help fund private sector development projects in Latin America. To be eligible to for the grant, the project has to be innovative and should prove to be sustainable once the funds are given to the project. To apply for this fund a proposal no more then 7 to 15 pages in length should be submitted to the local counterpart of the fund, which will then be sent to Washington D.C. for approval. The organization requesting the funding must be non profit and MIF will provide funding for consulting services, seminars, workshops and some minor computing equipment. It will not however provide funding for any large capital investments like buildings or purchase of raw materials. More information together with the criteria for the funding proposal can be found on http://www.iadb.org/mif

2. **International Finance Corporation (IFC)**: The international finance corporation offers financial services to countries that are a part of the IFC (Costa Rica joined the IFC in 1955). They require that projects that request

funding be in a developing country and must benefit the local economy. They also require that the project must be environmentally and socially sound. Once the project meets all the criteria, the IFC would then provide up to 25% of all financial costs. To apply for a loan the company must create an investment proposal and then has the option to submit it to the regional office in Washington D.C. or to the industrial sector that deals with the loan. More information can be found on http://www.ifc.org

3. **Netherlands Development Finance Company (FMO)**: The FMO offers financing to all small and medium enterprises. They seem to have special programs in Latin America and Costa Rica already has loans from the FMO. The FMO provides long term loans for cleaner production practices and also provides financing for cleaner production promotion activities. Some of the criteria for apply for the loan is that the applicant has to be from a developing country and the project must estimate positive return on investments. The project must also be sustainable and must comply with the local environmental legislations. To find out more about the application process, go to http://fmo.nl

4. **CDC Capital Partners (CDC)**: The CDC is classified as a private venture capital company that has partners all over the world. They are especially prominent in Latin America, the Caribbean, Africa and Asia. They provide funding in the form of equity-based investments. They would be a great source of funding for IRRS companies that would like to start up in Costa

Rica to supplement that subproducts exchange. To apply for funding one can submit the proposal online and then the CDC office promises to get back to you in 2 business days. They have suggestion on how to put together a business proposal and encourage the report to well planned and well thought out. The best part the CDC is that they have an office in Costa Rica. Their website http://www.cdcgroup.com provides more information.

5. **World Bank (WB)**: The World Bank promotes CP activities in various ways. Together with the International Finance Corporation and the Multilateral Investment Guide which forms the World Bank Group, it provided funding to the private sector. They also provide a whole host of support activities such as the Investment Promotion Advisory Service (MIGA) which together with its Investment Marketing Services Department (IMS) helps public and private sectors in member countries facilitate investment through various activities. The World Bank also provides funding. To get more information check out their website http://www.worldbank.org

6. **Organization for Economic Cooperation and Development (OECD)**: The OECD provides funding to many different environmental endeavors. To be eligible for funding the project must take place in a country that is on the DAC List of Aid Recipients. Costa Rica is on the list and is classified as a lower middle income country. The country receives funding from the OECD and the funding is then distributed among different projects. A more direct way to receive funding from the OECD is through the NIS Environmental

Finance network. The NIS is currently trying to establish a network of Cleaner Production centers. They provide funding for CP activities and their website http://www.oecd.org/env has more information about the process.

Appendix N – The "Desecho No Más" Ecolabel

The following section proposes an ecolabel CNP+L can initiate in conjunction with the subproduct exchange. It is a stand-alone campaign that works with the services CNP+L also provides, so it can be promoted independently of the exchange. One of the benefits to this ecolabel, however, could be increased awareness and use of the exchange.

Ecolabeling

The objective of marketing is to sell a product. Marketing has used many different methods in order to make a product appealing to the consumer. In recent years, these consumers have become more environmentally aware so the marketing procedures have begun to tailor themselves accordingly.

Labeling systems are a special form of marketing. They harness the power of "consumer preferences in the effort to achieve better environmental performance" (Graedel, 1995, p. 323). A label is a designation representing certain environmental criteria. By assigning a label to a particular product or service, a company advertises the eco-friendly attributes of such product or service. Usually this label is somehow displayed publicly for target parties to

see. Hopefully, the ecolabel will promote the company as complying with environmental standards.

Ecolabeling is only one part of environmental marketing. The following two diagrams illustrate the classifications various tactics of environmental marketing fall under.

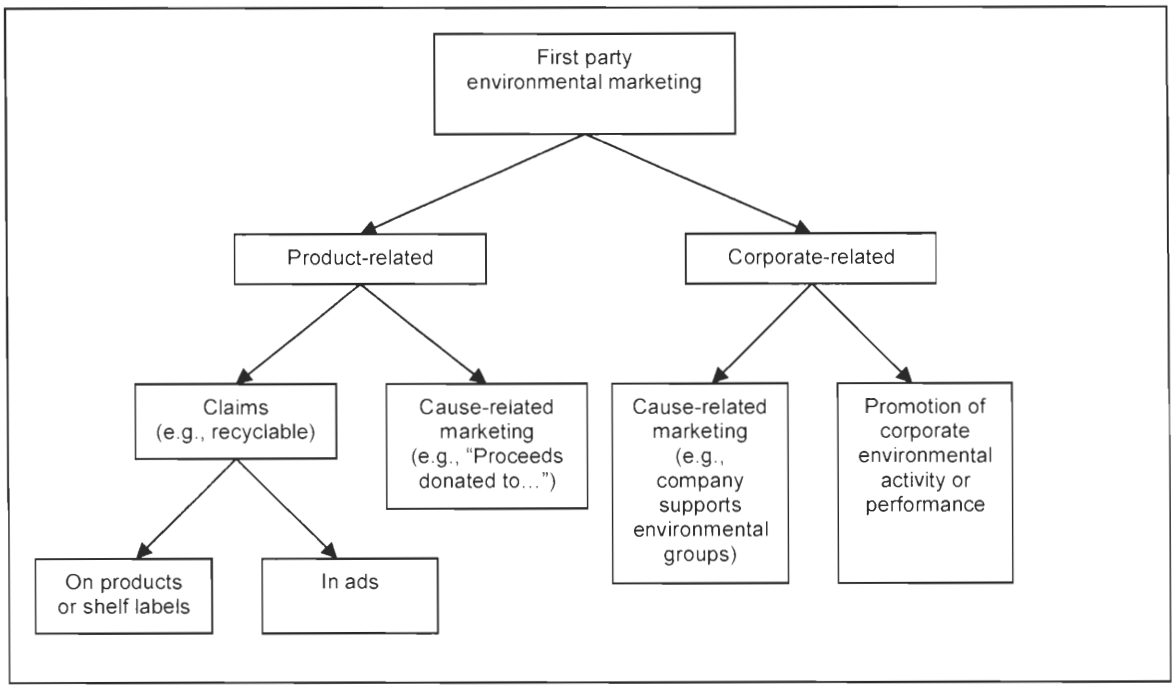


Figure 16: Classification of first party environmental marketing

(Source: Graedel, 1995, p. 319)

Figure 16 is the illustration of procedures the company can create on their own to make their product more valuable.

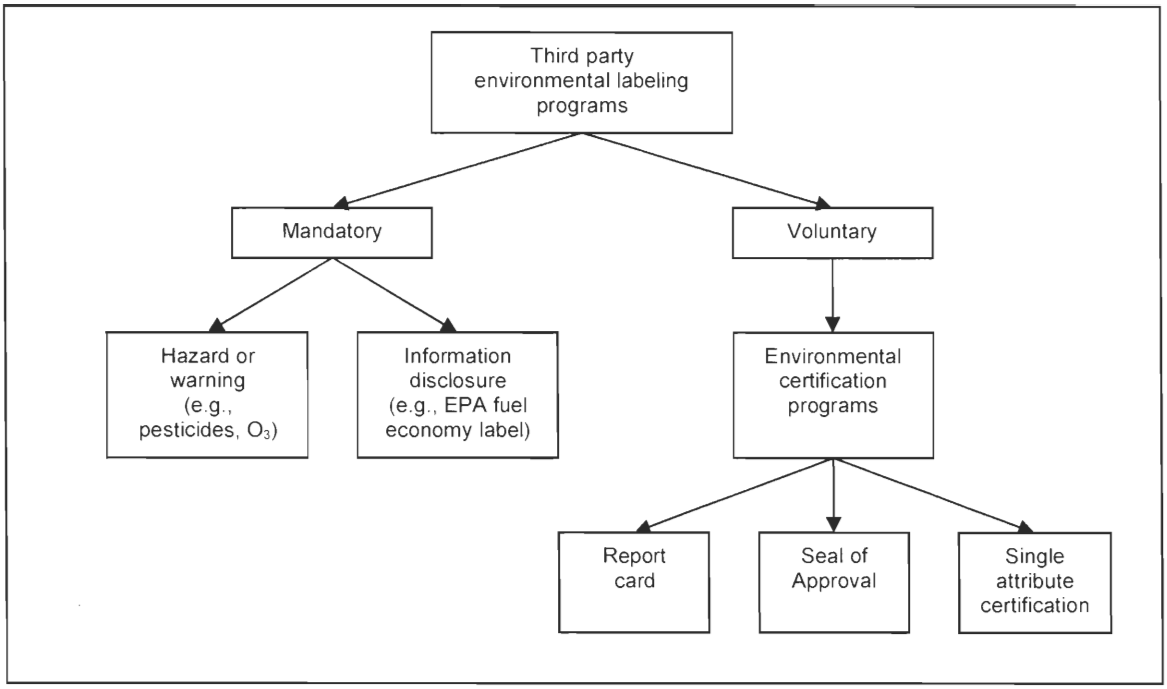


Figure 17: Classifications of third-party ecolabeling

(Source: Graedel, 1995, p.319)

Figure 17 illustrates how ecolabeling actually fits into the scheme of environmental marketing.

There are five main ecolabel programs, differing by the type of knowledge they wish to impart to the consumer. Seal of approval programs designate products or services that have a reduced ecological footprint than other products or services with the same function. For example, the Energy Star program in the United States is a seal of approval program. It was created by the EPA and is awarded to electronic appliances that enter into a reduced energy consumption state when left idle. In other words, these devices have ways of reducing the amount of energy they consume.

Single-attribute certification programs involve the use of ambiguous marketing terms, for example, the use of the word "recyclable" for display on the product. These certification programs often have a governmental third-party whose job it is to define the use of these terms. If a company wishes to use this term in their advertisement, they must be certified by the independent party for approval. Ideally, the goal of this is to give assurance to the consumer that the product really does what it claims.

Report cards for a company are similar to their educational system counterparts. Once again, they are issued by independent third-parties, and these report cards evaluate the company on various categories of performance. Examples of these categories could include energy consumption, hazardous pollution, how much of their product is made from recycled material, etc. These reports cards are not meant to be forms of advertisement, rather just a collection of unbiased information that empowers the consumer to make his or her own decision.

Information disclosure labels are actual labels found on a product but are similar to report cards. They primarily function as tools for comparison as they often highlight key categories of information or attributes that the product is strong in along with other products that may not meet the same expectations.

Finally, warning labels are mandatory labels, usually imposed by the government, indicating potential adverse health effects. In the United States, for example, all trucks transporting hazardous materials must be clearly marked. Another example could be a standard insignia positioned on a bottle of bleach

indicating the product is fatal if swallowed. Companies do not have a choice as to whether to adopt these labels or not. If the product or service meets certain conditions, by law they must have them.

Ecolabels are not restricted to just products and services. Environmental labeling has expanded into grading companies on general ecological performance. The ISO 14000 certification applies to the company entity, regardless of what business they are in. If a company complies with the guidelines found in the ISO 14000 collection, then they are certified as being environmentally responsible. For example, ISO 14001 determines whether or not an Environmental Management System is in place. It doesn't detail what the specific EMS should be in that particular industry; it just dictates what should be present for an official EMS to exist. Some of the criteria applied include: must have an emergency response procedure, must have up-to-date documentation of current environmental legislation and regulations, must have a policy expressing their ecological commitment, must have sufficient training for their personnel to run their duties in an environmentally safe way, etc.

Another example of a non-product ecolabel is the Blue Flag, started in Europe but slowly spreading out across the globe. The award of the Blue Flag, which is a literal banner, is given to beaches and beach resorts who have demonstrated no or minimal ecological impact and impeccable ecotourism. The problem of beaches eroding has been a serious problem for quite some time now. Believing that non-legislative, non-punitive, voluntary award schemes are the most successful ecolabel programs; the Blue Flag was designed to help

protect the deteriorating coastlines. "Self-regulation is proving both more popular and more successful than the older 'command-and-control' procedures by...government" (Blue Flag, 1996, p. 7).

What is most fascinating about the Blue Flag program, and what is also one of their greatest strengths, is that there doesn't exist any written-in-stone criteria for certification. That does not mean that getting a Blue Flag is easy. What it means is that the criteria is constantly changing, as knowledge and technology improves and standards are raised. Judging one company could be completely different than judging another company based upon current practices. And each year, the certification has to be renewed based upon the ecological understanding of the present time period and not based upon what was known in years past. This forces companies to constantly be innovating and staying on top of their ecological footprint.

A few problems arise with adopting ecolabels. If the criteria generated for the ecolabel originated with a company that desired the ecolabel, the program could backfire. The public could view this marketing as "self-serving and potentially inaccurate" (Graedel, 1995, p.319). This first-party environmental marketing is not typically successful for that reason. Another problem associated with ecolabels is having an abundance of them. If a company is granted some ecolabels and denied others, the intention of the label could fail, promoting chaos rather than educated consumerism.

Desecho No Más

Figure 18: The "Desecho No Más" Plaque

Ecolabels are not going to go away. They are operating in over 20 countries and will continue to do so in the coming years. The greatest concern is there lacks a harmonization of all these programs, or a standard for a global scheme. The "Desecho No Más" Ecolabel is proposed not only to create a basis for environmental efficiency throughout all of Central America, and possibly the world, but to promote the use of the CNP+L subproduct exchange as well.

Desecho no más is a direct translation from the English "waste no more." The title plays on a double meaning. It suggests the shift from dealing with the black and white paradigm of products and waste to simply dealing with subproducts. Thus, the term "waste" no longer applies. In addition it expresses to the spectator that the company who holds this award has achieved a standard of environmental efficiency. The industry produces none or very minimal waste.

To acquire the DNM insignia requires only fulfilling two criteria. However, like the Blue Flag, these criteria are constantly changing based upon ever

improving technology and standards. DNM is awarded to any company that has 95% or more of its total subproducts recycled or used in cradle-to-cradle format. No more than 5% of all resource or energy intake can be wasted or used in cradle-to-grave format. In other words, an extensive LCA needs to be taken by an independent party and no more than 5% of all energy or resources consumed can end up wasted, disposed or treated. Any conventional "waste products" generated from production must be harnessed as subproducts and used in another application. In addition, energy is not allowed to be recklessly consumed either. 95% of all energy consumed must be maximized. Finally, the company must not produce any hazardous waste.

This is the epitome of efficiency. This standard of performance finally connects the economic model businesses understand so well (production efficiency saves companies money) with the environmental approach that is needed to save the integrity of the ecosystem (don't take more than you need).

Advertising DNM is not restricted to just products. If it is displayed on a product, the consumer can view it as a positive reflection on the company. To the consumer, the slogan is "We give back." It shows that the company cares about the community that it will not produce products that take away too much from people or the environment. If the ecolabel cannot be applied to a product, it can be displayed as representative of the company in a similar fashion to how ISO 14000 compliance is advertised. In this case, the label would symbolize environmentally friendly manufacturing practices and no presence of toxic waste.

The "Desecho No Más" Ecolabel is sure to bring about increased eco-efficiency as well as understanding of the revolution in waste and material management to public consciousness.

Appendix O – IndigoDev's By-product Exchange

Creating By-product Exchanges Among Companies

In this chapter we review the most familiar industrial ecology concept, one that goes under many different names: *by-product exchange, by-product synergy, industrial ecosystem, industrial symbiosis, green twinning, and zero emissions network*. 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. We review 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. We emphasize the importance of considering by-product exchanges in the broader context of eco-industrial development.

One gap is important to note at the beginning. We have found it difficult to gather more than anecdotal reports of the achievements of BPX or industrial symbiosis projects. Some projects only release qualitative information and limited data on the exchanges companies have actually agreed to. Or they have only completed a planning and analysis stage and do not yet have results to report. There are many maps of hypothetical BPX networks, based upon surveys of the available by-products of companies in a project area. It appears that these opportunity maps are likely to support the next stage of deal-making required to capture the value in these now unutilized resources. *However, there is a very strong need for systematic research on the results of these projects and the most effective way of organizing them.*

This chapter is based upon our own work in eco-industrial projects, a report we developed for the Philippine Board of Investments, the experience and concepts of a number of engineering and consulting firms, and resources at Cornell and Yale Universities. *See the Resources section at the end for references and web sites on by-product exchange.*

Introduction to By-Product Exchange (BPX)

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.

While forming a BPX is a popular strategy, it is only one of many elements in the development of eco-industrial parks or networks. There are many other strategies for achieving higher efficiency of resource use and minimizing waste

disposal. *See the previous chapter on eco-industrial networks and Chapter 2.* A BPX may result in opening of new local business opportunities and jobs so it is worth consideration by industrial park developers and managers. However, this option should be evaluated in the broader context of achieving the full objectives of eco-industrial development.

Forming a BPX may or may not be feasible within any one eco-industrial park project. The companies at one site may not generate a mix of by-products with enough variety and in sufficient quantities to make many exchanges within the park cost-effective. Access to by-product resources may not prove to be a sufficient inducement to attract many businesses to locate at the park. The development or management team of an industrial park should assess the feasibility of trading by-products for the mix of tenants planned for the park or already there. If there are tenants with high volume by-product streams (materials, energy, or water) an internal exchange may work.

A regional BPX, incorporating companies within a number of industrial parks or in an industrial region or zone, may be required to generate the volumes and variety of outputs necessary for an effective exchange. This larger and more diverse pattern of exchange will enable members to gain highest resource efficiencies. Industrial park management can explore the potential for creating a regional BPX through trade associations, chambers of commerce, and economic development or waste management agencies. A regional inventory of by-products will indicate the possible value that could be generated in this way. In this chapter we outline steps in the process for establishing feasibility and developing BPXs.

If the stakeholders decide to move forward to develop a BPX, they may find that an exchange of outputs among existing companies may fall far short of utilizing all available by-products. To achieve optimal use of by-products, a project may require integration with an integrated resource recovery system (IRRS). An IRRS includes hauling, reuse, recycling, remanufacturing, composting, and bioenergy companies. It supports the operation of a BPX by utilizing by-products no company in the BPX needs as inputs. It may offer more cost-effective solutions than direct company exchanges in many cases. *See Chapter 6 for our concept of an integrated resource recovery park.*

There are a variety of approaches for forming a BPX. The organizing body may be a government agency, trade association, public private partnership, broker, by-product utility, consulting firm, or others. In many cases, a private sector actor or public private partnership is probably the most effective organizer. A BPX is essentially an alternative form for supplying resources to companies and needs to meet the basic business requirements of industrial procurement. A by-product utility may be a strong candidate for the organizing entity for both BPX and IRRS. A venture with adequate investment and technical depth could contract with industries in a region to manage their non-product outputs, determine industrial customers for those with current markets, coordinate operation of resource recovery companies for other outputs, and responsibly discard the residues. We discuss these alternative organizational forms below.

The exchange of by-product materials, energy, and water is not an end in itself. It is one means toward reducing resource depletion and pollution. Full eco-industrial development requires institutional support for cleaner production and the economic and social aspects of sustainable development. Cleaner production includes cutting resource input requirements and by-product outputs through more efficient process and product design, using alternative resources that are less polluting and more renewable, and cleaning up production processes to lower pollution. These initiatives can benefit local communities by strengthening their economies and providing venture and job development opportunities.

Kalundborg and the BPX Concept

The story of Kalundborg, an industrial by-product exchange[18] in Denmark, has become the premier case illustrating the BPX concept. In the late eighties local high school children traced the network of exchanges between a coal-fired power plant, a refinery, a pharmaceutical company, a plaster board plant, a sulfuric acid plant, the town district heating system, and farmers. Plant managers were surprised to see the complex system of exchange they had created by simply striking deals, one to one, over a 20 year period. *Their motivation was financial — to gain new revenues by energy or materials sales and to avoid the costs of waste disposal.* By early 2001 they had reduced pollution and waste and by doing so had gained a US$160 million return on an investment of $75 million in infrastructure for conveying by-products from one plant to another. Present annual savings are $15 million. (Symbiosis Institute 2001. personal communication)They call the network an "industrial symbiosis." *See the full case study in the Appendix for details of the by-product flows.*

Champions of BPXs often recommend the self-organizing method by which the companies formed this pattern of exchanges as a model of how others can do it. There are now initiatives around the world inspired by this record of success in utilizing by-products profitably. Some researchers have found other sites where by-product exchanges have developed spontaneously. A team led by Erich Schwartz at Karl-Franzens-Universitat Graz, Austria has identified a larger, more complex pattern of by-product exchange in the Austrian province of Styria, and one near Hamburg in Germany. Schwartz suggests that the pattern of inter-plant exchanges may occur often, but without self-awareness by the participating firms His group in the Institut fur Innovationsmanagement, has developed tools for analyzing inter-company resource flows and facilitating exchanges. Dr. Schwarz and his colleagues have been working with economic development agencies to enable development of regional "industrial recycling networks." ((Schwarz and Steininger 1995, Strebel 2000)

We will outline the typical steps such third party facilitators take with industries in the next section. Then we will explore an alternative model for achieving high utilization of industry by-products – the creation of a business that functions as a by-product utility.

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[18] Some proponents call Kalundborg "the first eco-industrial park," however it is not an industrial park at all. It is more accurate to term it a regional by-product exchange including a number of companies and the municipality.

Selected BPX Projects

Japan has at least 60 Eco-Industrial Projects, primarily focused on by-product utilization and waste reduction. See our report, *Eco-Industrial Development in Japan in the Appendix.*

Naroda Industrial Estate, in **Gujerat, India,** is a 30 km^2 industrial estate with 700 companies in many different industries. The Gujerat Industrial Development Corporation is working with the estate's industrial association to identify by-products that companies there can utilize.

The PRIME Industrial Ecology project in Laguna and Batangas Provinces, the **Philippines** has evolved from a straight BPX project to an eco-industrial network exploring development of an integrated resource recovery system. (www.iephil.com) **Thailand's Industrial Estate Authority** is at the beginning of a similar comprehensive eco-industrial project.

In **Taipei, Taiwan** the Industrial Technology Research Institute has started an eco-industrial project with exploration of by-product exchange as a means of reducing pollution and landfill.

Triangle Joint Council of Governments, **North Carolina, USA** has conducted an inventory of by-products generated in a 6 county area of North Carolina. (The web site contains many reports, tools, and forms of use to anyone developing BPXs) **www.tjcog.dst.nc.us**

The Alberta Heartland initiative in **Canada's province of Alberta** has analyzed by-product streams in this province dominated by petrochemical industry and farming.

In Tampico, Mexico the Business Council for Sustainable Development led a public private partnership in a project it called "by-product synergy", beginning in 1997. The participants identified 63 potentially usable by-products in the outputs of 21 participating industries. Of those, 13 companies immediately pursued those with immediate commercial potential.

In **Namibia** a beer brewery has created a BPX with neighboring companies using its biomass and water outputs. *See case in Chapter 6, Agro-EIPs.*

The value of BPX for industrial park developers and managers

There are many reasons for developers of new industrial parks or managers of existing ones to consider the feasibility of developing a by-product exchange (BPX) within their park or in their region. They want their sites to have advantages for tenants that support recruitment and retention. If their tenants can operate more efficiently *and* reduce their environmental burdens, they will protect the investment in developing the property. The park and its tenants are responsible for managing solid and liquid wastes from production, at significant cost and subject to regulation. Reducing these costs and risks will benefit the industrial park management and the companies it serves. When an EIP has recruited a major anchor tenant with large by-product streams, other tenants may be attracted by the availability of its energy, materials, or water as supplies to their operations.

So we encourage developers to explore how this strategy can fit into their broader recruitment and management process. 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. We describe methods and principles in this chapter which are being used at these different levels of BPX.

As an EIP developer or manager you may implement a by-product utilization strategy yourself or you may recruit a private company, trade association, or government agency to take on the task. Remember, an eco-industrial park is much more than a network of companies engaging in the exchange of by-products. You will gain value from this strategy, if you choose to adopt it, but there are also many other strategies for increasing the competitiveness through the environmental, social, and economic design of your development.

Guidelines for forming a by-product exchange

We will outline the typical steps BPX organizing projects take with industries in the next section. Then we will explore an alternative model for achieving high utilization of industry by-products – the creation of a business that functions as a by-product utility.

Guidelines for forming a by-product exchange

Mobilize and organize support

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 (GIS) 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.

These guidelines are a framework for learning and improvisation, not a rigid formula. They are based upon what we have learned from BPX projects in both developed and developing countries. You may find yourself moving back and forth between the different tasks as they are not necessarily a linear sequence.

12.2.1 Mobilize and organize support

Whenever possible identify a respected business leader to act as project champion.

An important early action is recruitment of a respected business person to champion the development of by-product exchanges. Ideally this person will have direct experience of turning his company's wastes into value adding by-products. With this encouragement, potential participants are more willing to invest their time and resources. The many businesses that have demonstrated the value of trading formerly wasted materials provide candidates for the champion role.

Create awareness of the business, economic, social, and environmental benefits of by-product exchange.

Awareness raising can take many forms: talks before business and trade associations, workshops and seminars, newspaper and magazine articles, and circulation of web site addresses reporting successes in by-product management. Project communications should integrate the concept of by-product exchange with other strategies for efficient use of resources, design for environment, prevention of pollution, and reduction of wastes in every stage of the product lifecycle.

Increasing efficiency of resource utilization and revenues from marketing by-products contribute to the profitability of companies. Chaparral Steel demonstrated this by gaining enhanced sales, reduced waste management costs and environmental liabilities, and enhanced profitability from new lines of business. *(See cases at end of this chapter.)* This business advantage also improves environmental and social performance so it naturally captures the attention of competitive business people. To reinforce the fact that this idea delivers value, participating firms should usually pay a fee toward the development costs for a by-product exchange.

Recruit public sector partners to provide technical and financial assistance, incentives, or regulatory support. Include universities and technical colleges.

Economic development, environmental, and waste management agencies have a self-interest in a more resource efficient economy and are natural allies in the formation of a BPX. They may be able to provide financial or in-kind support for the organizing activity and assist communications. University engineering, business and environmental science departments may be able to support data collection and processing. If so, remember the importance of keeping individual company data secret.

Identify the business entity to manage development of the BPX.
One of the most successful BPXs is the one Chaparral Steel formed with the support of Hatch Engineering. Here the steel company decided to recapture value from all possible by-products because of the strong bottom line benefits it would gain. Chaparral was the project champion and lead partner and the engineering firm did the technical and financial work. This project had a driving force much stronger than that generated by a public agency coming to companies with a "new idea".
We recommend that as early as possible the lead in BPX projects be assumed by a business entity, with public sector players continuing to offer support as required. There are several forms this can take.

- **Industrial park management/ownership** may be interested in filling the park with viable tenants and retaining them.
- **A major anchor firm** may benefit from exchanging materials or energy by-product streams that are not utilized and costly to dispose of.
- **A consulting firm** can manage the whole by-product flow and earn fees and/or commissions. (investment recovery)
- **A by-product utility** could outsource procurement of selected supplies and management of discards for locators at the park.

The industrial park management/ownership is interested in filling the park with viable tenants who will stay. Increasing their resource efficiency and lowering their disposal costs will improve their business performance and promote retention of them. Possibly new companies will be attracted by these benefits. If the park has its own landfill and water treatment plant, reducing wastes and pollution will help preserve the value and capacity of these assets.
An anchor company may become the organizing force for a BPX in order to deal with its own large materials or energy by-product streams. Chaparral Steel in Texas has essentially broadened its business identity to become a materials processor at the hub of one of the most successful BPXs. A firm with large enough by-product generation may be willing to take the business lead in development of a BPX that utilizes its discards and at the same time generates new revenues for it. Iscor Steel in South Africa actually created a subsidiary, Suprachem, with the mission of finding highest value reuse of all unutilized products. *(See this case at the end of this chapter.)*
A consulting and engineering firm that manages the whole by-product flow for a park, across several parks, or in a region would earn fees and/or commissions. A new field of management, **investment recovery**, takes a very systemic approach to ending waste. This is an integrated business that identifies non-productive assets generated in the normal course of business and seeks means of redeployment, recycling or remarketing them. These assets may include:

- Waste stream and process by-products;
- Excess raw materials, operating inventories and supplies;
- Off-grade, out of specification or discontinued products;
- Construction project residues;

- Idle, obsolete, unused or inoperable equipment, machinery and facilities;
- Machinery, equipment and fixtures in facilities scheduled for demolition.

Investment recovery firms develop strategies and procedures to recapture highest value from all surplus assets in a company or a region. They seek ways to reduce operating and disposal costs, ways of preventing the waste, and markets for redistributing the by-products for increased economic value. Phillips Petroleum, BASF-US, and MCI Telecommunications are among the companies that have adopted this approach. (Phillips)

An investment recovery firm could integrate the above functions into a comprehensive strategy for an industrial park or for an industrial region. If the firm's fees were based on a retainer plus percent of savings and/or revenues it would have an incentive for supporting this holistic approach.

An investment recovery firm could also negotiate technical assistance from universities, federal labs, and environmental pollution prevention and energy efficiency programs. With client companies it would target unutilized supplies that need this research input in order to be marketable. It could also recruit the right providers.

Evaluate the BPX utility model as an alternative to this process.

A utility or resource logistics management firm could manage all by-products generated by companies, including actual wastes, and procurement of by-products at an industrial park or in an industrial region. There are some limited examples of this business model that suggest it may be a viable alternative to the usually recommended process for creating BPXs. However, it will require a strong entrepreneur to assume leadership and a significant investment. Since this is such a contrasting model we will discuss it in detail after completing this discussion of the more self-organizing process.

Enable development of self-organizing teams within a pilot site location.

Kalundborg's by-product exchange evolved spontaneously as a series of bilateral deals driven in part by regulatory demands, *not as a planned system.* Environmental regulations made it economically sound to turn some major wastes into products and exchange them locally. Pairs of companies organized themselves into an elegant system of exchange, with market values defining their new relationships. They estimate that so far, the costs of the infrastructure for the exchanges have been repaid twice over.

The transactions between partners in a by-product exchange requires a trust building process. Just knowing a resource or user is technically available may not be enough to generate action. Knowledge may need reinforcement through easy social access. At some sites the meetings of an industrial park locator association may be the right venue. Special workshops dedicated to identifying matches and getting acquainted may be a useful forum. Find the right means of setting the stage for partners to negotiate on the financial, technical, and environmental issues involved in their one-to-one deals.

This ability of businesses to self-organize to achieve goals may be the foundation for success in creating a BPX. The government agencies and the business that supports their effort (as discussed in 1.4.) must remember they are enablers and the primary action is with the participating plants. Help the locator plant

managers and their teams set goals and identify their most troublesome by-products. Then let them take the lead in designing the processes for finding uses and customers for them.

Planning and analysis

Characterize the flows of energy, water, and materials in the target region. Highlight and map existing exchanges of by-products.

This task is for larger BPX projects committed to development of a resource recovery system and with strong public sector support.

The project team can use an industrial metabolism study to gather data on major energy, material, and water flows in the target region, whether it be an industrial park, a number of parks, or a more widespread industrial region. The outcome of this study is an inventory of by-products that are presently exchanged, major discards that could be exchanged, and an assessment of environmental burdens of landfills, incinerators, and possible open dumping. It also indicates high priority points of intervention in the broader system, useful in environmental regional planning and business development.

This study may be conducted by university researchers, or engineering companies. It should begin with a very broad analysis to build a qualitative model of flows in the region and then quantify specific streams that offer good opportunities for by-product trading and pollution reduction. In some cases it may focus on specific high risk substances, such as greenhouse gases, chlorinated substances, or heavy metals. Some of the classes of data to be gathered include:

- Percentages and tons of municipal landfill waste by type of material;
- Characteristics of waste from specific sectors: residential, industrial , commercial, and institutional;
- Materials listed by companies in local or state waste exchanges;
- Types and amounts of materials collected in recycling programs;
- Major emissions of waste heat;
- Sites and amounts of wastewater discharges;
- Types of industries by SIC code; and
- Industrial input/output data.

Your community or region can create economic development strategies through analysis of opportunities emerging from this data. This would include setting community targets for reducing wastes; and developing policies and programs that offer incentives and training to local business and citizens. The primary outcome would be an economic development plan emphasizing generation of new businesses that turn former major wastes into feedstocks for other companies or directly into products.

See the discussion of industrial metabolism in the Appendix.

Provide training, tools, and support to the development process and data gathering and analysis.

Once data has been gathered and processed, possible BPX companies will need support as they consider the value of trading by-products. Conferences enable firms to explore potential exchanges, while learning about other environmental performance strategies like waste reduction, pollution prevention, and energy efficiency. This will also allow company personnel to test the idea of collaborating with neighboring plants. The conference might include a session in which participants role play firms in an operating BPX-testing the feasibility of exchanges, dealing with possible breakdowns, and creating strategies for recovery from them.

A potentially valuable tool for the recruiting team and prospective tenants is an evolving computer model of the exchange network, supported by materials and energy data bases. This enables simulation of process interactions within the potential network of companies, step-by-step. The linked DIET and FAST programs created by the US-EPA are two examples that are available (see discussion below.). However, a recruiting team should not depend too heavily on this sort of computer simulation. Personal interactions are vital to building the trust and business relationships that are the foundation of an exchange network. Project meetings should support this creation of trust.

Gather data on resource flows of companies that have committed to the BPX. (Create a strong firewall around the data collected to insure companies confidentiality.)

Potential participants in a BPX may begin with a relatively simple data collection process and then deepen the level of data as needed. (See plant survey form in Appendix.) This makes the first steps easier to take and indicates the broad opportunities available. Possibly the more detailed level of data is relevant only to the companies actually seeking to transact a deal around a specific exchange. The PRIME IE project in the Philippines enlisted the environmental managers in industrial parks and companies to conduct the surveys and build the database. This helped assure tenants that their trade secrets would not be revealed. Several projects in North America have used engineering and consulting firms to gather and analyze data.

Some regional exchanges, such as the North Carolina Triangle Joint Council effort, have started by requesting a much more detailed data set from businesses and entering it into a database linked to a geographical information system. When this system is in operation companies will be able to search the input and output needs of other companies by location.

Companies often look at data collection on their inputs and outputs as a potential threat. Competitors may use it to learn about proprietary processes. Regulators may use it to impose penalties for non-compliance. For these reasons the data gathering process should be coded to insure no surprise disclosures. Pilot site environmental managers, a trade association, or an environmental engineering firm.

Identify potential barriers in regulations, business practices, and environmental management that need to be overcome. Develop strategies for doing so.

Environmental regulations were designed to reduce risks to humans and ecosystems. Corporate environmental management and production practices developed to meet the regulations. The goal of resource efficiency is a relatively late add-on and in some cases conflicts with the earlier regulations. So the exchange of by-products may require some creative adaptation of policy frameworks and specific regulations. Some of the areas for innovation include:

- What changes (or special permits) in water, waste water and solid waste regulations and ordinances will you need to permit by-product exchanges or shared treatment facilities in the park?
- Will you need changes in current zoning to allow the mix of industries needed for such exchanges?
- Will regulatory agencies enable innovations in environmental management like site-wide or umbrella permitting to establish the whole park as the regulated entity?
- If you are in an export zone, how does this impact trading of by-products within your region?
- What are the implications of companies outsourcing some environmental management functions to park management or third parties?

See Chapter 7 for more detailed discussion of policy, regulations, and environmental management systems.

Identify companies which could process selected materials, provide collection services for specific by-products, or otherwise support the operation of the BPX.

Many facets of industrial park and BPX operation open specific opportunities for developing new businesses or attracting firms that would support the functioning of a materials and energy exchange. An industrial park with space may target this sector or, if the need is large enough, there may be an opportunity to develop an integrated resource recovery park. Business niches in resource recovery include:

- Firms practicing resource recovery, recycling, and reuse.
- Niche collection and hauling firms.
- Remanufacturing plants.
- Environmental monitoring and information firms.

(See Chapter 6 where we summarize the model for a Resource Recovery EIP.)

Resource recovery firms include companies that consume otherwise unusable discards, processing them into usable feedstocks and companies that take apart equipment and market re-usable components and materials. Some utilize recovery technologies that allow extraction of valuable materials from waste streams (i.e., extracting metals from liquid or solid wastes); and recycling technologies that prepare a byproduct for reuse (i.e., shredding plastics). These processor companies play a useful intermediate role and are especially important where they accumulate small flows of residues from companies and generate

economically useful masses. A solvent re-refiner is one example of such a processor.

By incubating or recruiting firms in this category, an industrial park may better fulfill the goal of becoming a closed-loop system, optimizing the reuse and recycling of surplus products or materials. It also gains locators valuable to its other companies.

Niche collection firms are important to keep materials separated and to preserve their quality. They may also help accumulate sufficient volumes of particular by-products when they operate throughout an industrial region. Such a firm might specialize in industrial solvents, wooden and plastic pallets, or compostable discards.

Remanufacturing firms offer potentially strong domestic trade and export opportunities for well-situated industrial parks. An environmental objective is served by extending the life of products (and the energy and materials invested in them). If the rehabilitation process includes upgrades for energy efficiency, process control, and pollution prevention, the resulting products demonstrate environmental and economic benefits beyond extending the products' life.

Environmental monitoring and information systems: A company could assume the role of independent auditor of environmental performance and provide feedback to individual companies, park management, and the community. This firm would operate and maintain monitoring systems and an information system linking all companies. It could also provide third party reporting that is required in many voluntary programs.

The PRIME Project in the Philippines is evaluating the feasibility of creating an **environmental business incubator** that could support such new or expanding businesses. The organization could become a locator in one of the industrial estates. This project is also doing a feasibility study for a resource recovery park. *See chapter 4 for further discussion of business incubators.*

Develop a strategic plan for expanding from BPX to a full eco-industrial network.

The companies in an industrial park, the park management, and the business managing the BPX process can all benefit from applying other methods for improving efficiency of resource use. They can improve both financial and environmental performance by using Cleaner Production tools like design for environment (DFE), pollution prevention (P2), and energy efficiency (E2). The project should include a training program and open access to consultants or university personnel who can support adoption of these practices.

DFE, for instance, enables designers of either products or production processes to view the whole range of options for all potential environmental implications of a product or process being designed--energy and materials used, manufacture and packaging; transportation; consumer use, reuse or recycling; and disposal. DFE enables designers to balance environmental choices with traditional design issues of cost, quality, manufacturing process, and efficiency as part of the same decision system.

DFE tools enable consideration of the implications of design choices at every step of the production process from chemical design, process engineering,

procurement practices, and end-product specification to post-use recycling or disposal.

The right design choices at the beginning of creating a product or a production process may eliminate wastes at each step in the cycle, and thereby reduce the need for exchanging many by-products. *See Chapter 11 for discussion of the eco-industrial network.*

Enable business transactions for by-product utilization

Develop alternative means for companies to begin making deals to trade specific by-products.

Once company managers are aware of the opportunities to cut costs and possibly gain new income through exchange of by-products, they may start negotiating with potential trading partners without need for any encouragement. However, workshop meetings, a private BPX web site, and publications may be required to open a more active network of exchanges. The business entity managing the development process can work with public sector partners to be sure that a number of different channels are open, which we describe in the next section.

BPX projects in India, Canada, and Mexico have created working groups focused on specific resources that the data indicate have major potential for exchange. The Naroda Industrial Estate in Gujerat, for instance, set up teams to evaluate recyling of spent acid, chemical gypsum, chemical iron sludge, and biodegradable waste. (Wilderer 2000, Applied Sustainability 2000)

Provide further support as needed.

Pairs of by-product partners may need technical support or investment to make a particular trade work. The supplier may require process redesign to assure the level of quality required by the consumer. One or both partners may need to construct infrastructure for conveying or storing the by-product, such as pipelines or conveyor belts. These investments may require external sources. The BPX team may be able to attract funds for these purposes dedicated to improving environmental performance of industry, particularly for reducing greenhouse gas emissions.

The partners are basically just creating a new supplier-customer relationship and they both know how to guarantee quality and reliability of supplies. Most deals will require little external support.

Monitoring and communications

Create a map (GIS) of the network of exchanges and opportunities for exchange.

The North Carolina regional BPX project is connecting its data base of industrial and municipal by-products into a geographical information system (GIS). This allows mapping the by-product data and company locations against any other relevant data sets such as transportation systems and resource recovery locations. The GIS helps participants evaluate the logistics of possible exchanges. (TJCOG 1999)

Set performance measures and targets.

While a BPX is essentially a network of one-to-one transactions, its members can benefit from monitoring their individual and collective performance against goals for continuous improvement. Since the fundamental goal is increasing efficiency of resource use, these metrics become valuable business performance tools. The feedback on cost savings helps maintain motivation so the metrics should clearly indicate the financial impacts of these basic patterns of resource use. Several possible measures enable BPX members to monitor their progress in achieving the standards they set.

- Ratio of virgin to recycled materials (including water);
- Ratio of actual recycled materials to potential;
- Ratio of renewable to fossil fuel sources;
- Ratio of polluting substances to benign substances;
- Materials productivity - economic output per unit of material input;
- Energy productivity — economic output per unit of energy input (calculate the energy waste ratio also);
- Resource input per unit of end-user service —assessment of resource use against the useful function gained and maintained for the end-user (Lowe 1997)

Monitoring socio-economic indicators, such as new businesses and jobs created, will help convey the value of the project to the community.

Create an internal system for giving feedback on what is being achieved to the immediate participants.

A BPX newsletter, a web site open only to BPX participants, regular meetings and roundtables are a few of the ways of sharing news within the membership. The Philippine PRIME Project web site is a good example of both internal and public outreach. www.iephil.com. Peer pressure and peer support help participants use such feedback to improve their performance. In the US, public released data such as the toxic release inventory has often created competition among companies to better their scores.[19]

Create a public outreach program.

Training seminars in BPX development, tours of the site, a public web site, radio and tv programs, newspaper articles, and talks at meetings of service clubs and trade associations are a few of the obvious channels for communicating the project's achievements to the world. Perhaps a local university could develop a course on BPX development for industrial park managers and entrepreneurs interested in creating enterprises to establish BPXs.

A Valuable Resource on By-Product Utilization

In the late 1970s, Nelson Nemerow, a chemical engineer, started to recommend creating complexes of companies using each other's "wastes" as feedstocks. His phrase for this is "Environmentally Balanced Industrial

[19] In Japan the Ministry of International Trade and Industry and the Environment Agency have created a parallel toxic inventory and reporting system known as the Pollutant Release and Transfer Register system.

Complex (EBIC)." (Nemerow 1995) His book, *Zero Pollution for Industry: Waste Minimization Through Industrial Complexes,* is a very valuable resource for anyone developing by-product exchange networks

After summarizing issues of waste reduction and reuse within a plant, Nemerow describes 10 possible environmentally balanced industrial complexes (EBIC) involving 16 different industries. Like current BPX projects, an EBIC is a co-located materials and energy exchange network. He analyzes the way these potential complexes of plants can become mini-"foodwebs", reducing pollution/waste generation. For instance, four of his complexes focus on connecting fossil fuel power plants to consumers of waste heat and material by-products (the pattern of the Kalundborg industrial symbiosis). Here the partners include cement and cement block, lime, and agricultural facilities. (Nemerow does not account for the CO2 emissions or the residual emissions from the scrubber and other treatments.)

Several complexes are biomass waste intensive as with a sugar plant directly linked to an alcohol fermenter, internal power plant, and an agricultural area. Others involve a tannery, an animal feedlot, and wood mill complexes.

Nemerow's conceptual examples illustrate how industries can benefit from jointly redefining wastes as by-products and thereby maximize resource use and minimize pollution. However, a major limitation is that his strategic thinking is primarily focused on technical process compatibility and ignores the many economic, financial, management, social, and institutional elements that are necessary conditions for a successful multi-company project. Forming an industrial complex or ecosystem requires coordination of diverse stakeholders and these non-technical elements must be addressed in the early stage of development.

Nevertheless, the book is a very useful guide for anyone creating BPXs or industrial estates with anchor tenants producing large volumes of by-products.. Nemerow's formulation of strategy and the diverse examples he gives will stimulate creative responses in teams designing such projects. (based upon Lowe and Hovarongkura 1997)

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. (Chertow 2000)

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. *(See a representative*

listing of such company-to-company deals in the Appendix.) 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. *(See discussion of the petrochemical EIP in chapter 6.)* Many food processing plants also have found profitable uses for their discards. (Desrochers 2000) 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." (Symbiosis Institute 2001. personal communication).

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. We have discussed these initiatives in the previous chapter and the Appendix. 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. These three examples are all centered on energy generation plants. 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. (See this case in the Appendix.)

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. We include in the Appendix a major study of these efforts conducted by Indigo Development.

Waste Exchanges

Waste or materials exchanges are related to BPXs in a very general way. It appears that they are much weaker strategies to attain higher efficiency of resource use in a comprehensive way. Researchers at Rutgers University (Andrews & Mauer 2000) conducted an exploratory survey of U.S. materials (or waste) exchanges, with sixty-three respondents. They found that:

- Few exchanges handle hazardous materials;
- Most focus on pre-consumer items such as building materials or post-consumer durable goods such as appliances;
- Non-profit organizations and state/local government agencies are the most frequent operators;
- There are three implementation strategies: passive listers of materials, active brokers who become involved in each transaction, and operators of warehouses for storage and display of materials and products;
- Warehouse operations are the most frequent form of exchange; and
- The adoption of Internet technology is improving their viability.

Potential Issues Concerning Creation of a BPX

In industrial ecology and cleaner production, increasing efficiency of resource use at every stage of production is a higher order priority than utilizing by-products at the end of the cycle. Effective design upstream will reduce and in some cases eliminate by-products. This suggests that BPX efforts should be started in a full eco-industrial network context and partners to exchanges should expect changes that may eliminate the outputs they trade.

While participation in a by-product exchange may offer significant revenues and/or cost savings, such activity is still seen by most plant managers as quite separate from producing their primary products. "Waste" management is usually buried in overhead budgets and the staff responsibility is solely to dispose of wastes in a cost-effective manner within regulatory constraints. When a company's by-products are produced in relatively low volume their standard disposal is viewed as financially insignificant. Even with substantial volumes of by-products, the transaction costs involved in seeking markets may grow too high to continue. One of these costs is the risk that regulations may make the supplier of a by-product liable for damages generated by a customer.

Douglas Holmes, a co-author of our original EIP Handbook, suggests an ideal solution would be, to give every unmarketed by-product a product number and a line in the operations budget. It would show up in the books as a separate production and disposal cost rather than being assigned to overhead. A manager of by-product operations would then be responsible to either find markets or to redesign processes to eliminate by-products without value.

The manager of the Northern Industrial Estate in Thailand indicated a potential obstacle to utilization of by-products is location of companies in export zones. Regulations do not allow these companies to supply any local companies outside of the zone.

While there are strategies for dealing with these issues, an alternative business model may be required to develop the highest utilization of by-products.

The BPX utility business model

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 fear entering into so many new relationships around issues separate from their core businesses. These issues have prompted us and other's involved in eco-industrial planning to formulate an alternative business model, in which a by-product utility takes responsibility. (Slone and Cohen-Rosenthal 2000 personal communications)

Possible transaction costs of participation in a BPX include

- Time in BPX planning, data reporting, collection and processing, dealing with regulators, and negotiating deals;
- Perception of increased technical, legal, or business risk not present in straight disposal;
- Process changes to yield by-product in form and at quality required;
- Transportation;
- Construction of infrastructure.

A possible means of reducing such transaction costs and streamlining utilization of by-products is to create a by-product utility in an industrial park or region. This might operate as a business within the management structure of an industrial park or as a stand-alone business that creates a profit-sharing relationship with park management. In its fullest form, this utility could manage energy, water, and materials procurement and disposal for all client companies. Its advantage lies in the capability and experience concentrated on by-product utilization. By making this the core business, the utility can handle the technical, business, and economic issues of by-product utilization. It also becomes a force in the political economy supporting regulations and land fill fees that discourage wasting and increase the value of by-products.

The utility would be responsible for creating an optimal price structure for firms, at the level of quality they require. In negotiating prices with clients it would balance reuse of by-products, avoidance of disposal costs, acquisition of external supplies, and on-site and local generation of energy from renewable sources. It could own and maintain infrastructure required for movement, processing, and storage of energy, water, or materials.

The utility would negotiate contracts with each BPX company, offering significant reductions in their transaction costs and other overhead for supply and disposal management. In some cases it could go beyond supplying by-products to outsourcing procurement of chemicals and other commonly used production inputs as well as office supplies and equipment.

The business model for the utility would balance revenues from procurement of external supplies, sales of by-products, services to enhance efficiency of client resource use, and possibly sales of locally generated renewable energy. Services to improve the energy, water, and materials efficiency of its clients will be a major profit center. The utility could negotiate to share in client cost savings

from greater resource efficiency to insure that it will not be forced to maximize throughput to boost profits.
The utility would phase its infrastructure investments to avoid large sunk costs requiring continued production of by-products whose quantity can be reduced through tenant facility, process, and equipment redesign. (Newer modular systems for water processing, energy generation, hazardous materials management, etc. will support this phasing of capital investment.)

Existing Firms Embody Aspects of the Utility Concept

There are partial precedents for a by-product utility. Several firms reflect aspects of this business concept.

- Suprachem is a wholly owned subsidiary of the major South African steel company Iscor, responsible for managing all company by-products. This internal resource recovery company researches new uses and means of generating higher value from familiar by-products; operates reprocessing plants; and markets all of the reclaimed materials.
- SafetyKleen is a familiar US-based international company that manages the full lifecycle of selected chemicals, particularly solvents, for many companies. It also collects used oil from clients for re-refining.
- In 1997 Strategic Chemical Management Group successfully sold the outsourcing of chemical procurement to major power utilities in the US, including Southern California Edison and Florida Light and Power. Previously these companies had dealt with up to 5000 suppliers. Its initial vision included eventually handling all aspects of chemical management, including waste prevention, pollution prevention, and end-of-life recycling, reuse, or disposal. Radian International is also providing similar chemical management services.

This business model for comprehensive resource management is still relatively new, but it suggests that the BPX utility we have outlined could play a role in industrial parks or eco-industrial networks.

We encourage eco-industrial networks and BPX projects to explore the feasibility of creating such a by-product utility. Are there industrial park developers or entrepreneurs who could manage such a business start-up? Does the local pattern of industrial development and available by-products provide the foundation required to write an effective business plan? Could such a utility increase its business by linking to development of a resource recovery park? Are there sources of capital willing to invest, possibly including some major providers of large by-product streams, such as power plants?

Software for BPX

Software supporting an analytical approach to creating BPXs is available for testing. Data is collected from individual companies and assembled in a database. Various mathematical programming techniques are then used to identify and optimize possible trades of by-products. In some tools a portion of the database includes generic data on a broad range of industries that are not present in the community. By matching residual by-products from businesses in your community with the generic database, the model can be used to identify the types of businesses that can be targeted to expand the local by-product exchange. Public agencies may encounter some resistance in industry to disclosing proprietary information. An industrial association might be a stronger agent for leading this sort of effort.

The following examples provide a flavor of the types of analytical tools that are under development.

The DIET Model

The "Developing Industrial Ecosystems Tool", or DIET is a decision support tool to help urban planners, developers and community groups identify the optimum mix of industries (and their plant size) for a specific industrial resource exchange site. Industrial Economics, Inc. is developing DIET on contract to US-EPA. DIET, has the following attributes:
Planners can consider objectives, with weights assigned by the planner to: economic output, number of jobs, and environmental gains.
Results generated by the DIET model include:

- Waste generation per unit of activity;
- Size and revenue per unit of activity;
- Opportunities for waste exchange;
- Waste generation at each facility.

DIET includes a database of generic data profiles for a set of representative facilities to assist users where facility information is not known or is difficult to obtain.
Future versions of DIET will integrate the model with Geographic Information Systems (GIS) software and data to:

- Map the surrounding environmental landscape;
- Account for transportation modes with access to the eco-park;
- Test various methods for using GIS to guide eco-park planning. (Giannini-Spohn 1999)

Bechtel Corporation
Bechtel Corporation has developed a planning model that links a linear programming analysis capability to an industry database that identifies company input and output streams, production processes, disposal costs and utility requirements. The model defines multiple possible materials exchange links to allow potential trading partners to be identified. By incorporating both data from actual businesses in a specific community and generic industry-based data the model can be used to identify existing exchange potential and recruitment targets to expand the industrial recycling network. The Business Council for Sustainable Development – Gulf of Mexico and its spinoff, Applied Sustainability, have used Bechtel's model in a number of their by-product synergy projects. (Applied Sustainability 2000)

Resources & references

There is a very large body of literature on the many variants of by-product exchange. We will include here key references and web sites we have drawn upon and we continue to update links on our own web site, www.indigodev.com/Links.html
Andrews, Clinton J. and Maurer, Jamie. 2000. "Materials Exchanges: An Exploratory U.S. Survey", Department of Urban Planning and Policy Development, Rutgers University, New Brunswick, NJ 08901 to be published in *Local Environment*. A draft is available at http://radburn.rutgers.edu/andrews/projects/matex/default.htm

Allen, David T. and Behmanesh, Nasrin. 1996. "Wastes as Raw Materials" in *Greening of Industrial Ecosystems*, National Academy of Engineering, Washington DC.
Applied Sustainability. 2000. Tampico, Mexico BPS™ Pilot Project. Austin, TX. Applied Sustainability has facilitated development of "by-product synergy" projects in North and South America. Contact: Lee Zarnikau, Applied Sustainability, Austin TX. 512-892-4413 lee@as-llc.com or http://www.as-llc.com/index.html
Ayres, Robert U. 1996. "Creating industrial ecosystems: a viable management strategy? *Industry and Environment,* Vol 19 No. 4 UNEP, Paris. www.unepie.org to order
Canadian Eco-industrial Network http://www.peck.ca/cein/main.htm
Chertow, Marian. 2000. "Industrial Symbiosis: A Review." *Annual Review of Energy and the Environment Vol. 25.*
Côté, Raymond (1998): "Industrial Ecosystems - Evolving and Maturing", *Journal of Industrial Ecology,* Volume I, No 3.
Côté, Raymond P. 1998. Thinking like an ecosystem. *Journal of Industrial Ecology,* Vol. 2, No. 2.
Desrochers, Pierre. 2000. Market Processes and the Closing of "Industrial Loops", *Journal of Industrial Ecology,* Vol 4, No. 1, Winter 2000. MIT Press, Cambridge, MA.
Ehrenfeld J, Gertler N. 1997. Industrial Ecology in Practice: The Evolution of Interdependence at Kalundborg, *Journal of Industrial Ecology.* 1 (1) MIT Press, Cambridge, MA.
Engberg, Holger. 1995. "The Industrial Symbiosis at Kalundborg", in Gladwin, Thomas, Freeman, Tara, Ed.. *Business, Nature and Society: Towards Sustainable Enterprise,* Richard D. Irwin, Burr Ridge IL.
Environment Canada. 1997. Opportunities for Eco-Industrial Parks in Canada: Summary of Case Studies. March
Forward Gordon, Mangan Andy. 1999. By-Product Synergy. *The Bridge.* 29(1) http://www.hatch.ca/ExpertAreas/sustainabledevelopment/Default.htm (go to "articles")
Gertler , Nicholas. 1995. *Industrial Ecosystems: Developing Sustainable Industrial Structures.* http://www.sustainable.doe.gov/business/gertler2.html Dissertation for Master of Science in Technology and Policy and Master of Science in Civil and Environmental Engineering at Massachusetts Institute of Technology, Cambridge, MA Gertler's dissertation is one of the most comprehensive reviews of conditions for creating intercompany by-product exchanges. He gives a detailed description of the exchange pattern at Kalundborg, the Zero Emissions Research Initiative, regulatory changes needed, and organizational options for creating and managing such exchanges. http://www.sustainable.doe.gov/business/gertler2.shtml
Giannini-Spohn, Suzanne. 1999. Presentation Overheads on DIET and FAST. US-EPA. Washington, DC.

Hovarongkura, David and Lowe, Ernest. 1997., Review of *Zero Pollution for Industry* by Howard Nemerow. *Journal of Cleaner Production,* 1997, Vol 5, Number 1-2. Elsevier Science, Oxford.
Integrated Bio-systems Online Conference. For anyone dealing with biomass this site has many case studies and theoretical papers.
http://www.ias.unu.edu/proceedings/icibs/ibs/
Investment Recovery Association, www.invrecovery.org 5818 Reeds Rd., Mission, KA 66202-2740, 913-262-4597, fax: 913-262-0174.
Long Island City Business Development Corporation. 2000. www.licbdc.org See Inwrap BPX program
Lowe et al. 1997a. *Discovering Industrial Ecology - an executive briefing and sourcebook*, Battelle Press, Cleveland, OH.
Lowe, Ernest. 1997b. *Regional Resource Recovery, and Eco-Industrial Parks An Integrated Strategy.* Indigo Development Working Paper # 3. RPP International, Indigo Development Center, Emeryville, CA. (prepared for a Symposium on Industrial Recycling Networks at Karl-Franzens-Universität Graz, Austria, April 28-29, 1997)
Lowe, Ernest. 1999. *Industrial Ecosystems: Methods for Creating By-product Exchanges Among Companies.* Prepared initially for the Philippine Board of Investments PRIME Project, Industrial Ecology Module in June of 1999. Indigo Development Working Paper # 7. RPP International, Indigo Development Center, Emeryville, CA
Lowe, Ernest. 2001. *By-Product Exchange: New Approaches.* Indigo Development Working Paper # 13,. RPP International, Indigo Development Center, Emeryville, CA
Martin, Sheila et al. 1995. *Developing an Eco-Industrial Park: Supporting Research, Volume 1, Final Report,* Research Triangle Institute Project Number 6050, Research Triangle Park, NC. Includes a case study and papers on regulations and technologies, all focused on by-product exchange. To order write RTI Information Services, POB 12194, Research Triangle Park, NC 27709. Summary available on the web: http://www.rti.org/units/ssid/cer/parks.cfm
Morikawa, Mari. 2000. *Eco-Industrial Developments in Japan.* Indigo Development Working Paper # 11. RPP International, Indigo Development Center, Emeryville, CA
Nemerow, Nelson, L., *Zero Pollution for Industry: Waste Minimization Through Industrial Complexes*, John Wiley & Sons, NY, 1995
Peck and Associates and Raymond P. Côté. 1997. Promoting Eco-Industrial Development: Exploring benefits, challenges, drivers and opportunities for progress in Canada. A report to Environment Canada and Industry Canada, Ottawa. (Available from www.peck.ca).
Pelletiere, Danilo. 1997. *Defining the Ecoindustrial Landscape: The Role of Agglomeration, Industrial Parks, and Economic Exceptionalism.* Master of Arts thesis, George Mason University, Center for Regional Analysis, The School of Public Policy MS:3B1, George Mason University, Arlington, VA 22201

Pelletiere, Danilo. 1999. "Eco-restructuring and the “Friction of Distance.”" in Gowdy, John et al eds. *Sustainability in Question: the search for a conceptual framework*.. Edgar Elgar, Cheltenham, U.K. (1999)
Phillips Petroleum, Cleaner Earth, Investment Recovery and Recycling, company brochure. Tulsa, OK. no date
PRIME Project, Industrial Ecology Module. A web site for the Philippine Board of Investments eco-industrial network project that includes valuable material on BPX and resource recovery systems development. www.iephil.com
Schwarz, Erich & Steininger, Karl W. 1995. The Industrial Recycling-Network: Enhancing Regional Development. Research Memorandum No. 9501. April. Institute of Innovation Management, Karl-Franzens University of Graz, Johann-Fux Gasses 36, A-8010, Graz, Austria.
Strebel, Heinz. 2000. Industrial Recycling Networks. Proceedings Helsinki Symposium on Industrial Ecology and Material Flows
http://www.jyu.fi/helsie/pdf/strebel.pdf
Suprachem, is a wholly owned subsidiary responsible for all by-products generated by Iscor Steel Co. in South Africa. http://www.suprachem.co.za/
Thorensen, Johan. 2000. Development and Testing of a Concept for Ecopark Cooperation. Helsinki http://www.jyu.fi/helsie/pdf/Thoresen.pdf
Triangle Joint Council of Governments (TJCOG) A BPX project in North Carolina, US offers extensive documentation on its web site, including detailed facility survey forms, a mapping of existing exchange patterns, and an extensive project report. The Triangle Joint Council of Governments in surveyed material by-products available in a six county area of North Carolina and built a geographic information system with the resulting data. www.tjcog.dst.nc.us
Work and Environment Initiative web site at Cornell University is a major source of material on eco-industrial development and BPXs: www.cornell.edu/WEI/
World Business Council for Sustainable Development. 1997. By-Product Synergy: a Primer. WBCSD. Geneva, Switzerland..
http://www.wbcsd.ch/printpdf/byprod.PDF

Appendix P- Integrated Resource Recovery System (IRRS)

An Integrated Resource Recovery System (IRRS) is defined as a collaboration of service companies that compliment a Material Exchange Program. Their functions can include (and are not exclusive to) hauling, reuse, recycling, remanufacturing, composting and producing Bio-energy. IRRSs usually support the operation of materials exchanges by utilizing subproducts that no other company in the exchange system can use as input directly. They take these materials in and refine them or recycle them by using industrial processes to produce materials that can be then sold / exchanged for a profit.

The concept of IRRSs stemmed from the ideology of industrial ecology and is usually used as a precursor to an existing Eco-Industrial Park (EIP) and complimentary to a by-product exchange (BPX) system. The IRRS can take on many different functions such as acting as a hub between companies and an EIP. It can also be the intermediate step between two companies to convert materials that can not be directly reused.

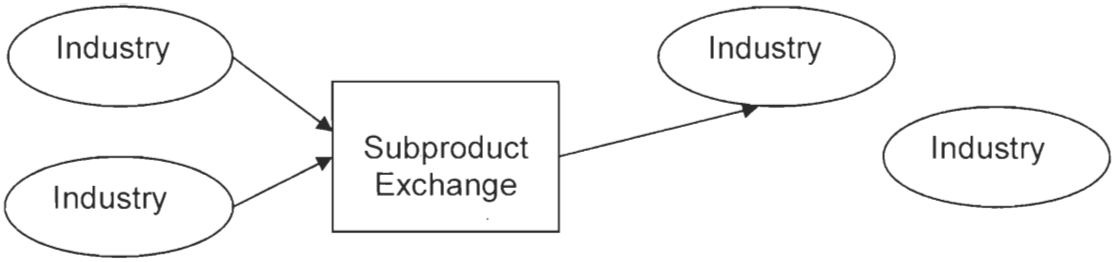

Figure 19: Basic Model with out an IRRS

There are many advantages to setting up an IRRS. They help minimize the use of virgin materials by assisting in resource recovery. This helps reduce the stress on the environment by contributing materials for reuse. They also help in easing disposal costs and in providing a new source of materials and goods. In most cases, IRRSs can provide a more cost effective solution then conventional resource recovery and materials exchange. They also provide entrepreneurial opportunities.

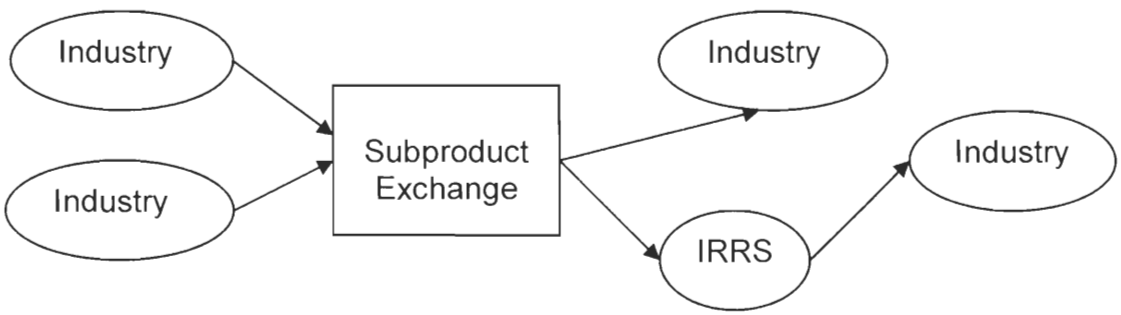

Figure 20: Basic Model with an IRRS

Most IRRSs are set up with a Resource Recovery Facility (RRF) as its main "headquarters". This site acts as a drop off point for consumers and business and also a rerouting point to send materials to companies in the EIP.

The site also usually hosts a research department where the IRRS investigates materials not currently being recycled and the methods needed to reuse these materials. The EIP acts as the processing station. Since it is usually physically close to the RRF, it helps save in transportation cost and energy costs.

In Costa Rica similar IRRSs have the potential to being set up. With services to recycle some of the more processed materials such as the Tetra pak containers produced and ferrous materials used not available Costa Rica, these companies have to resort to dumping in landfills or shipping these materials abroad to be recycled. With IRRS set up in conjunction with these companies (either on their site or near their site), these materials can be reprocesses to produce either goods or recovered materials which then can be sold/exchanged using the materials exchange system.

Appendix Q - Financial Analysis

With net profit and cost minimization being the catch phrases of the 21st century, the average green initiative has to prove to be cost effective and provide competitive prices to conventional production methods. In this section we plan on analyzing the recommendations to estimate the costs that will be incurred in the implementation of the project

The Iron Law

The Iron law states that:

Cost of Recollection		*Income*	*must*	*Cost to deposit*
+	-	*from sale*	*be*	*in a*
Cost of Segregation		*of product*	<	*Landfill*

From the above equation, the cost of any green initiative must be less then current method employed for companies to implement it. Therefore, for the subproduct exchange system to work, companies in Costa Rica must find it advantageous to exchange their subproducts rather than treating it using conventional methods. Also companies have to understand that generally, there is no profit to be made in a resource exchange. At the most the cost of treating the waste will be minimized leading to large savings.

Cost of the Program

From the survey, it was evident there were many methods we could use to implement the final project. The most preferred forms were electronic mail and a telephone hotline. From our interviews, a few companies also expressed an

interest in having a website they could browse. Since in the future, most of the transactions will take place over the web, it is an essential investment.

Below are the costs CNP+L would incur in setting the system up. The section is divided by the different factors CNP+L would have to invest in and also by the initial setup costs and the average monthly operational costs. We did not include the cost to market the program because we can't predict the amount of marketing CNP+L plans on doing. All figures are subject to 35% operational overhead costs.

Communication

Cost to set up a telephone line:	*$47*
Deposit:	*$54*
Avg. Monthly operational costs:	*$ 6*
Cost to set up a fax line:	*$ 47*
Deposit:	*$ 54*
Avg. monthly operational costs:	*$ 6*
Cost of installation of internet:	*$ 50*
Cost of Cable modem:	*$150*
Average monthly costs of the connection (128/64 Kbps):	*$190*

(all facts and figures obtained from the ICE website: http://www.ice.go.cr/)

Employees

Wages of web coordinator: *(@$4 per page designed *approx.10 pages)*	*$ 40*
Monthly wages of database coordinator: *(Part time position)*	*$ 300*

Monthly wages of resource coordinator:	*$ 635*
(figures obtained from Sergio Musmanni)	
Equipment	
Server	*$ 2000*
Computer (1)	*$ 1500*
Software	*$ 500*
(figures obtained from Sergio Musmanni)	
Initial setup costs	
Cost to set up a telephone line:	*$ 47*
Deposit for telephone line:	*$ 54*
Cost to set up a fax line:	*$ 47*
Deposit for fax line:	*$ 54*
Cost of installation of internet:	*$ 50*
Cost of Cable modem:	*$150*
Server	*$ 2000*
Computer (1)	*$ 1500*
Software	*$ 500*
Wages of webmaster	*$ 40*
TOTAL	**$ 4442**
Average Monthly Costs	
Avg. Monthly operational costs:	*$ 6*

Avg. monthly operational costs:	*$ 6*
Average monthly costs of the connection (128/64 Kbps):	*$190*
Monthly wages of database coordinator:	*$ 300*
Monthly wages of resource coordinator:	*$ 635*
TOTAL	**$ 1137**

Glossary

Active Exchange	Servicing the materials or providing additional options besides exchanging them for use in an application.
By-product	A conventional term used to describe a material that was not quite waste yet not quite usable either.
By-product Exchange	The process of transferring materials, by-products or wastes from one company to another as a part of an interdependent, symbiotic production design. This is not a "hopeful" exchange like the others; companies are specifically set up to use a by-product exchange.
Cleaner Production	A preventative environmental strategy applied to the process of production and servicing that improves efficiency but most importantly reduces risks to humans and the environment
Eco-capacity	The level at which a material from the natural world can be exploited from the eco-system before having an impact on the environment. In addition, the term can also be used to describe the limit at which consumption can occur before exceeding natural replenishment in the eco-system.
Eco-efficiency	Maximizing economical practices that also benefit the environment. These actions are usually taken in response to an anticipated consumer demand for ecologically friendly products and services
Ecologic	That which refers to the operation of the eco-system.

Ecological Footprint	A term coined by the Earth Day Network to quantify the amount of resources needed to support an entity in an eco-system given their current way of life.
Ecology	The study of the eco-system.
Economy	The relationship of production and consumption that supports the current way of life for humans.
Eco-system	An interdependent collection of laws, mechanics and elements present in the natural world.
Energy	Any non-tangible substance that has either potential or actualized value in any aspect of company affairs or the production process. However, it is more commonly defined in reference to the scientific concept of work in an industrial process.
Environment	The collection of social, economic, political and ecological factors that sustain the current way of life.
Industrial Ecology	The design of production systems and product cycles to emulate eco-systems and material cycles from the natural world.

INDUSTRIALIZATION	THE TRANSITION OF A COUNTRY FROM AN AGRICULTURAL BASED ECONOMY TO INDUSTRIAL BASED ECONOMY.
INPUT MATERIAL	THE MATERIALS OR RESOURCES, USUALLY COMBINED WITH ENERGY, WHICH ENTERS A PROCESS TO BECOME A PRODUCT.
LIFE-CYCLE ASSESSMENT (LCA)	A REPORT ON THE TOTAL AMOUNT OF ENERGY AND RESOURCES CONSUMED IN ALL PROCESSES INVOLVED FROM PRE-PRODUCTION TO POST-TREATMENT.
MARKET	THE FORCES THAT DRIVE THE ECONOMY.
MATERIAL	ANY TANGIBLE SUBSTANCE OR OBJECT.
MATERIAL EXCHANGE	THE PROCESS OF TRANSFERRING MATERIALS FROM ONE COMPANY TO ANOTHER IN HOPES THAT THE RECEIVING COMPANY CAN USE THE MATERIALS IN THEIR PRODUCTION PROCESS.
NATURAL WORLD	THE SET OF ALL BIOLOGICAL AND CHEMICAL PROCESSES THAT CREATE, DEFINE OR AFFECT LIFE.

Passive Exchange — Simply exchanging materials for direct use in an application.

Pollution — A label commonly used to describe an undesired environmental reaction. Usually, pollution leads to a deterioration of ecosystemic integrity.

Pollution Factor — The ability of a material to cause pollution in any setting.

Pollution Prevention — Formally defined by the United States Environmental Protection Agency, the set of all practices that reduce waste at the source.

Pollution-causing Agent — A material that either actively or passively generates pollution.

Product (market product) — A subproduct a company manufactures for selling in a market. Successful transition into the market assigns the product a positive economic value.

Raw material — Any material that has not been acted on by a manufacturing process. Raw materials are more commonly used as input materials.

RECYCLE	TO EXPOSE A MATERIAL TO PROCESSES THAT WILL ALLOW IT TO PERFORM ITS ORIGINAL FUNCTION OR A COMPLETELY DIFFERENT PURPOSE.
RESOURCE	A SUBSTANCE THAT HAS EITHER POTENTIAL OR ACTUALIZED VALUE IN ANY ASPECT OF COMPANY AFFAIRS OR THE PRODUCTION PROCESS.
RESOURCE EXCHANGE	A TERM USED TO GENERALIZE ALL TYPES OF EXCHANGES, WASTE, MATERIAL, BY-PRODUCT ETC.
RESOURCE MANAGEMENT	THE PROCEDURES AND DECISIONS INVOLVED IN APPROPRIATING RESOURCES AND MATERIALS TO BE USED IN THE PRODUCTION PROCESS.
RESOURCE RECOVERY	THE PROCESS OF TURNING BY-PRODUCT MATERIAL INTO SOMETHING USABLE OR VALUABLE.
REUSE	TO USE A MATERIAL AGAIN TO PERFORM ITS ORIGINAL OR INTENDED FUNCTION. USUALLY THERE IS LITTLE INTERFERENCE REQUIRED TO USE IT AGAIN.
SOURCE REDUCTION	THE PROCESS OF ELIMINATING WASTE PRIOR TO THE PRODUCTION PROCESS.

Subproduct	Any material with potential value. They are generated in either of two ways. 1.) As a result of the production process or subsequent consumer consumption. 2.) From supplementary input materials or processes performed on the product before market consumption. In the past, subproducts have undergone treatment similar to wastes.
Subproduct Exchange	The process of transferring subproducts from one company to another as part of an eco-efficient economy.
Treatment	an action taken upon a material to reduce its pollution factor before being released into the environment.
Waste	an outdated label used to describe any material a business or industry originally had or no longer has any use for. Waste materials traditionally underwent a form of treatment, such as disposal in a landfill.
Waste Exchange	The process of transferring waste products from one company to another in hopes that the receiving company can perform more effective treatment.
Waste management	The processes and decisions involved in appropriating waste to treatment methods.
Waste Product	A subproduct that has been assigned negative economic value due to poor handling of it.

WASTE REDUCTION THE PROCESS OF ELIMINATING WASTE AT ANY STAGE BEFORE TREATMENT.

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