Sustainable Economic Development:
The Case of Implementing Industrial Ecology

By

Shanna E. Wasserman

Bachelor of Arts in Political Science
University of Northern Colorado (1997)

Submitted to the Department of Urban Studies and Planning in Partial Fulfillment of the
Requirements for the Degree of

Master in City Planning

at the

Massachusetts Institute of Technology

June 2001

© 2001 Shanna E. Wasserman. All rights reserved.

The author hereby grants to MIT permission to reproduce and to distribute publicly paper
and electronic copies of this thesis document in whole or in part.

Signature of Author:__________________________

Shanna E. Wasserman
Department of Urban Studies and Planning
May 17, 2001

Certified by:__________________________

Karl F. Seidman, Lecturer
Department of Urban Studies and Planning
Thesis Supervisor

Accepted by:__________________________

Dennis Frenchman
Chairman, MCP Committee
Sustainable Economic Development:  
The Case of Implementing Industrial Ecology  

By  

Shanna E. Wasserman  

Submitted to the Department of Urban Studies and Planning on May 17, 2001 in Partial  
Fulfillment of the Requirements for the Degree of  

Master in City Planning  

at the  

Massachusetts Institute of Technology  

Abstract  

Industrial ecology (IE) is an emerging paradigm for environmental control. IE offers a  
framework for altering industrial activities so that they more closely reflect a closed loop  
cycle, rather than a linear flow of extraction and disposal.  

Implementation of IE is occurring through the eco-industrial park (EIP) model. An EIP is  
a group of businesses that are implementing IE principles, through cooperation between  
one another and/or other organizations.  

This Thesis examines the current practice of implementing IE through the EIP model. The  
research methodology includes assessing the Kalundborg, Denmark EIP example,  
surveying North American EIPs, and studying a case of implementing an EIP in  
Londonderry, NH.  

Findings from the research indicate that there is currently a taxonomy of IE practices  
being implemented through the EIP model. The taxonomy includes practice in land  
stewardship, green building design, individual firm environmental practices, and  
byproduct exchange. Each of the four areas of practice have characteristics with  
implications for how implementation should occur through an EIP.  

EIP planners and developers should craft implementation strategies in accordance with  
their IE objectives. Additionally, the management entity of an EIP should have the  
capacity to implement all IE objects. Finally, a community education process on IE is  
necessary during the implementation of an EIP.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ABSTRACT</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>ACKNOWLEDGMENTS</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>CHAPTER 1: INTRODUCTION</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>CHAPTER 2: INDUSTRIAL ECOLOGY: A NEW PARADIGM FOR ENVIRONMENTALISM</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>CHAPTER 3: OPERATIONALIZING INDUSTRIAL ECOLOGY: INDUSTRIAL ECOSYSTEMS AND KALUNDBORG</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>CHAPTER 4: OPERATIONALIZING INDUSTRIAL ECOLOGY: ECO-INDUSTRIAL PARKS (EIPs) IN NORTH AMERICA</td>
<td>26</td>
</tr>
<tr>
<td>5</td>
<td>CHAPTER 5: IMPLEMENTING AN ECO-INDUSTRIAL PARK IN LONDONDERY, N.H.</td>
<td>38</td>
</tr>
<tr>
<td>6</td>
<td>CHAPTER 6: INDUSTRIAL ECOLOGY AT THE LONDONDERY ECO-INDUSTRIAL PARK</td>
<td>48</td>
</tr>
<tr>
<td>7</td>
<td>CHAPTER 7: LONDONDERY ECO-INDUSTRIAL PARK: LOOKING TO THE FUTURE</td>
<td>61</td>
</tr>
<tr>
<td>8</td>
<td>CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>REFERENCES</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>APPENDIX A: EIP RESOURCES</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>APPENDIX B: EIP SURVEY</td>
<td>120</td>
</tr>
</tbody>
</table>
ACKNOWLEDGMENTS

This Thesis would not have been possible without the effort, assistance, and support of many people. First, I would like to thank my advisor Karl Seidman for his guidance and commitment throughout the process from choosing a topic to submitting a final thesis copy. Karl went beyond the call of duty in his role as advisor by being exceptionally accessible in person and by email. His accessibility and willingness to comment on numerous drafts was critical to completing this project. Additionally, I would like to thank my reader, Bill Shutkin, for his insight into issues of environmental sustainability and for encouraging me to explore this topic initially.

A considerable amount of research in this Thesis is the result of interviews with members of the Londonderry community and those involved in the EIP. Their insight was an invaluable source of information, and I appreciate all the time they took to work with me. I’d like to especially thank Peter Lowitt, Andre Garron, Gwen Mathews, and Anne Fenn for the time they took to work with me, not just once, but on several occasions. Additionally, for staff at EIPs in Burlington, VT, Baltimore, MD, Londonderry, NH, Tucson, AZ, Oakland, CA, Raymond, WA, Skagit Country, WA, and Trenton, NH, thank you for the taking time to fill out and return a survey.

Finally, I’d like to thank my family and friends for their support and understanding during this long and arduous process. I’d especially like to thank Jarrett for his endless enthusiasm for this project and support during the process.
CHAPTER 1:  
INTRODUCTION

In 1996, former President, Bill Clinton's Council on Sustainable Development (PCSD) identified the challenges that face the United States in terms of economic development and sustainability. In a report, the PCSD made the following comments:

The paradoxical challenge that the United States and the world face at the end of the 20th century is to generate individual economic opportunities and national wealth necessary for economically healthy societies while, at the same time, lessoning the environmental risks and social inequalities that have accompanied past economic development. . . The challenge of sustainable development is to find ways to meet those needs without destroying the resources upon which future progress depends.¹

The United Nations World Commission on Environment and Development defines sustainability as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs."² The notion of sustainability has received growing recognition and has been applied to land use decisions, personal consumption patterns, housing development, natural resource extraction, and industrial activities, among other issues. As a concept, sustainability is a powerful expression of how future development should occur.

This Thesis is concerned with applications of sustainability associated with industrial activities. Specifically, this research delves into the notion of industrial ecology as a paradigm for environmentalism and examines how it is being implemented through the eco-industrial park (EIP) model. Industrial ecology is a model for improving industrial activities so that the flow of material and energy more closely replicates a closed-loop cycle, rather than a linear flow. By doing so industrial ecology seeks to "eliminate the cause of environmental problems rather than to work to solve them after they become apparent."³ Largely born out of the engineering and hard science disciplines, planners, policymakers, developers, businesses, and community organizations are beginning to employ industrial ecology, as they seek ways to apply sustainable principles in practice.

One method for implementing industrial ecology is the EIP model. Taking a definition from the PCSD, an EIP is "... a community of businesses that cooperate with each other and with the local community to efficiently share resources (information, materials, water, energy, infrastructure, and natural habitat), leading to economic gains, improved environmental quality, and equitable enhancement of human resources for business and the local community." The only mature EIP that exists is in Kalundborg, Denmark. The Kalundborg case is an example of
an EIP that over time developed into a system of businesses that, in an attempt to reduce costs and meet regulatory demands, created innovative ways of managing waste materials between firms. Over the past 5 to 10 years, communities in North America have begun exploring ways to transfer the Kalundborg model to the United States. This Thesis explores the development of the Kalundborg EIP, surveys North American EIPs, and evaluates the process for implementing an EIP in Londonderry, New Hampshire.

**Research Questions**

This Thesis explores two research questions associated with the implementation of industrial ecology.

1. What are the characteristics of current industrial ecology practices as witnessed through the EIP model?
2. What can be learned from existing EIP practices in order to facilitate future EIP implementation?

**Research Methodology**

In order to answer the two research questions listed above, several research methods were employed. First, a literature review of industrial ecology was conducted in order to determine its goals and objectives. This process involved assessing how industrial ecology compares to existing environmental paradigms and current practices. Second, the Kalundborg EIP was researched by reviewing reports on a case study conducted in 1995 by MIT graduate student Nicholas Gertler. The Kalundborg case is an example of sophisticated byproduct exchanges as a way to operationalize industrial ecology. Kalundborg also offers insight into the motivations behind why firms chose to implement industrial ecology. Third, a survey of 17 North American EIPs was conducted in order to identify examples of EIPs and their characteristics. The return rate was 52 percent, with nine EIPs returning a survey. Three of the surveyed EIPs are discussed in more detail using survey responses and secondary information. Fourth, a case study of the process involved in planning and implementing the Londonderry EIP (LEIP) was conducted. The intent of studying an EIP planning process in depth was to highlight the critical decisions that planners and developers were involved in and to learn from their experience. Through a synthesis of findings from Kalundborg, the EIP survey, and the Londonderry case study, recommends best practices to EIP planners and developers, as well as national policymakers.
Overview of Key Findings

There are three key findings that resulted from studying the Kalundborg EIP, surveying North American EIPs, and researching the implementation process at Londonderry. First, there is a taxonomy of industrial ecology practices being implemented at EIPs. These practices are land stewardship, green building design, individual firm environmental practices, and byproduct exchange. Whereas EIPs are often likened to a group of industrial firms linked through byproduct exchange, practice indicates that the other three industrial ecology activities are being implemented more extensively.

Second, the taxonomy of industrial ecology practices has implications for how EIPs should be implemented. Such implications include the amount of technical assistance that is needed, the type of capacity required by the implementation agent, the extent to which economic benefits are inherent in the industrial ecology practice, and the ability to use regulatory mechanisms during implementation. Those involved in developing EIPs must consider the characteristics that are unique to each industrial ecology practice when crafting implementation strategies.

Third, the process involved in implementing an EIP requires planners to choose an implementation mechanism, a management entity, as well as initiate a community education process. EIP practice indicates that the implementation mechanism should be multi-layered in order to meet all industrial ecology objectives set out for the Park. Furthermore, the management entity should have the capacity to administer the real estate functions of the EIP as well as the ability to implement industrial ecology practices. Finally, a community process should be undertaken that educates residents on the principles of industrial ecology and how they could be implemented at the EIP.

Organization of Thesis

This Thesis is organized into eight chapters. Chapter 1 introduces the topic, defines the research questions, describes the methodology, summarizes key findings, and sets out the organization of the following chapters. Chapter 2 identifies the environmental impacts from current industrial activities and details a history of environmentalism and its limitations. Next, industrial ecology is offered as an alternative paradigm for environmentalism as it relates to industrial activity. Chapter 3 is a synthesis of the Kalundborg, Denmark model of operationalizing industrial ecology. Descriptions of the industrial ecology practices occurring at Kalundborg are provided and lessons to take from the case are highlighted. In Chapter 4, the survey of North American EIPs is reviewed. Specifically, the phase of development for each
EIP is identified, and characteristics of three Parks are described in more detail. These EIPs are the Fairfield Ecological Business Park (FEBP) in Baltimore, the Burnside Industrial Park as Ecosystem (BIP) in Halifax, Nova Scotia, and the Londonderry Eco-Industrial Park (LEIP) in New Hampshire. Chapter 5 is an overview of the process involved in planning and implementing the LEIP. In Chapter 6, the current industrial ecology activities occurring or planned for by member firms at the LEIP are documented. Chapter 7 of this Thesis evaluates the future of the LEIP by identifying three obstacles that the Park faces in its attempt to move from the implementation stage of development to become a mature model for operationalizing industrial ecology. The three obstacles are the use of covenants alone as the implementation mechanism at the LEIP, the choice of a private real estate developer as the management entity for the Park, and the public sentiment surrounding the LEIP and a power plant that is building a facility within the Park. Finally, Chapter 8, summarizes conclusions, offers recommendations to EIP planners and developers, and details specific action items for planners and stakeholders. Additionally, Chapter 8 explores the role of national level policymakers in facilitating EIP development and embracing industrial ecology.
CHAPTER 2: 
INDUSTRIAL ECOLOGY: A NEW PARADIGM FOR ENVIRONMENTALISM

Industrial Ecology (IE) represents a new paradigm for thinking about how industry and the environment relate. Broadly defined, IE is "designed to eliminate the cause of environmental problems rather than to work to solve them after they become apparent." \(^4\) IE is a growing field of research attempting to devise methods that reduce the environmental impact of industrial processes and products on the capacity of the earth to sustain life. These methods are based on the premise that altering the current linear model of industrial practices, where resources are extracted and wastes and final products are discarded, is required in order for sustainability to be attained. Instead of the linear model, a closed loop cycle is preferred where wastes and products are reused instead of discarded. \(^5\) This Chapter begins by detailing the impacts of current industrial practices on the environment. Next, environmental regulation is described and its limitations are identified. Finally, the industrial ecology paradigm is offered as a way to improve the environmental impacts of industrial practices.

**Current Industrial Practices and Environmental Impacts**

Environmental impacts result from the way that products are created, distributed, and discarded. Presently, a linear process of virgin resource extraction to waste disposal characterizes industrial processes. More specifically, resources (both renewable and nonrenewable) are removed from the earth and used to create products. The process of production creates byproducts, including solid and hazardous waste along with atmospheric emissions that impact environmental conditions. Next, products move to the post-consumption stage where disposal is required. This current linear practice creates negative environmental impacts resulting from specific industrial activities, including resource extraction, atmospheric emissions, waste disposal, post-consumption product disposal, and land use and building design. These activities are discussed in more detail in the following section.

**Resource Extraction and Energy Use**

Estimates vary on the amount of nonrenewable resources available for future consumption. However, scholars agree that the earth's ability to generate natural gas, petroleum, coal, and other minerals is limited. Water, a renewable resource is also limited to the extent that it is used faster than it can replenish itself.
Energy use is tied to resource scarcity. The extent to which industry depletes its scarce natural resources is related to its use of energy. For example, manufacturing accounts for 80 percent of industrial energy consumption.\textsuperscript{6} Solutions to resource scarcity include encouraging technological innovations that improve the feasibility of alternative energy sources. Additionally, improving energy efficiency can decrease the environmental impact of industry.

\textit{Atmospheric Emissions}

Historically, industrial processes have been responsible for emitting pollution into the earth’s atmosphere. Emissions of greenhouse gases are of particular concern due to their impact on the depletion of the ozone layer and their effects on global climate change. 1998 data indicates that 81 percent of greenhouse gas emissions resulted from burning fossil fuels.\textsuperscript{7} Again, energy consumption is a significant contributor to environmental impact, in this case the emission of greenhouse gases.

In addition to the environmental impacts associated with emitting greenhouse gases, the environment has been impacted by other industrial emissions, such as volatile carbon compounds. Such emissions have resulted in decreased visibility due to smog as well as threats to human health. Additionally, industrial emissions impact the quality of surface and ground water due to acidic precipitation. While the Clean Air Act in the United States has reduced the impact of atmospheric emissions resulting from point source pollutants, industrial emissions are still a concern to communities. Solutions to industrial emissions include the substitution of non-toxic materials into the industrial process as well as using technologies that produce fewer pollutants during the production process. Such methods are called pollution prevention strategies.

\textit{Solid Waste, Hazardous Waste, and Sludge}

During the production process, industry creates solid and hazardous waste as well as sludge. Sludge is a moist solid mass resulting from wastewater treatment. Past industrial practices have led to toxic waste sites due to the improper handling of waste material. While environmental regulations have improved the extent to which toxic waste impacts human health, landfilling such material has also contributed to increased groundwater and soil pollution.\textsuperscript{8} A solution to the environmental problems of waste disposal is waste reduction, where industry seeks to decrease the amount of waste it generates. Additionally, a complementary answer to the environmental impacts resulting from waste can be found in its exchange, which is a central principal of industrial ecology. Waste exchange is a process whereby a substance with formerly
no economic value is transformed into an input for another production process, thereby taking 
on value. Waste exchange offers an environmental solution that is both economically beneficial 
while decreasing the impacts of disposal. It also offers the opportunity for firms to reuse 
materials instead of relying on virgin products for inputs.

*Products in the Post-Consumer Stage*

While not in the direct control of industry, products that have reached a mature stage in 
their life cycle must be disposed of. To the extent that these products can be recovered and 
used as inputs into the industrial process, environmental impact is improved. Product recycling 
can is facilitated through such efforts as design for environment (DFE), which eases the ability 
for products to be disassembled and reused.\(^9\)

*Land Use and Building Design*

A final category of industrial activity with environmental consequences is land use 
decisions and building design. Suburban sprawl and the development of greenfields are 
receiving increased attention as an environmental concern. Current development patterns are 
destroying natural habitat, reducing wetlands, and polluting natural.\(^10\) By neglecting to reuse 
vacant and abandoned sites in urban areas and favoring greenfields during site selection, the 
potential for sustainable development is being threatened. This trend affects the degree to 
which current development patterns are sustainable for future generations. While this issue is 
of considerable concern in the residential development field, industrial development is also to 
blame for land use decisions that do not take into consideration broader notions of 
sustainability.

Building design also impacts the environment when industrial developments lack basic 
green design principles. Potential environmental impacts include excess energy consumption, 
destruction of natural habitats, and decreasing employee productivity as well as quality of 
health. Examples of green design principles include increasing resource efficiency through 
minimizing the loss of heated air in the winter and the infiltration of hot air in the summer, 
minimizing environmental harm during site development, and developing pedestrian and other 
alternative forms of transportation for employees.\(^11\)

Improving industrial activities in the above priority areas requires a framework for 
reducing the environmental impact of industry before virgin materials are consumed, pollution is 
generated, waste is disposed of, final products are landfilled, and buildings are sited and
designed. Currently, environmental regulations exist; however, a framework for thinking about preventing environmental impact has yet to be implemented. The following section details current regulations and the need to establish a new paradigm for improving environmental stewardship at the industrial level.

**Existing Methods of Environmental Control**

Beginning in the 1970s, in response to growing concern and mobilization around air, water, and ground contamination, several regulations were passed including the 1970 Clean Air Act, the 1972 Clean Water Act, and the 1976 Resource Conservation and Recovery Act (RCRA). Each piece of legislation was responsible for cleaning up its respective environmental media. The results of first generation environmental regulation have been positive. The air is cleaner, water bodies have been restored, and toxic waste disposal is now regulated. Nonetheless, as our understanding of the complex interactions between industry and the environment grows and while current environmental threats change, the limitations to existing regulatory frameworks are becoming apparent.

First generation environmental regulations have been likened to a “command and control” system, where each environmental media is protected through strict regulations on industrial activities. By focusing on controlling specific pollutants without taking into consideration that pollutants do not respect the artificial lines drawn between environmental media, regulatory organizations have been criticized for implementing less effective programs. Concerns have arisen over the extent to which existing regulations improve environmental quality by decreasing pollution instead of reshuffling it from one place to another. For example, in an attempt to reduce atmospheric emissions, scrubbers were required in smokestacks, which resulted in the creation of sludge and subsequently a waste disposal problem.

By differentiating policy according to media, organizational fragmentation at the U.S. environmental protection programs occurred. Fragmentation resulted in disparate implementation approaches to environmental regulations because different standards, definitions, and penalties were applied based on the type of media regulated. Furthermore, the organizational fragmentation of environmental regulators also resulted in less attention being paid to longer-term public health issues, such as pesticide exposure and loss of biodiversity. Increased specialization and resulting fragmentation made it more difficult for organizations to think comprehensively about environmental regulation as well as to tackle less clearly understood environmental threats.
Central to the limitations of existing environmental policy is its inability to slow down the use of the earth's resources. So long as industrial processes meet existing pollution and waste disposal regulations, little can be done to ensure resource use is sustainable. While opinions on the earth's carrying capacity are varied, its eminent limitations are agreed on. The extent to which current industrial practices extract resources without reusing existing final products or wastes, decreases opportunities to realize the goal of sustainable development.\(^{16}\)

Finally, first generation environmental policy viewed industry as environmental delinquents. While there is no doubt that industry has been a serious offender of environmental stewardship, in the future, industry must become a leader. To the extent that future policy can harness the technological capability of industry as a source of knowledge for increasing resource efficiency, moving beyond compliance, and treating pollution across media, the more likely environmental policy can move us to a more sustainable level\(^{17}\). In addition to the role of industry and regulators in shaping next generation environmental policy, communities also play an important part. Communities across the country are organizing around issues of environmental justice, concerns over facility siting, and other land use decisions. However, communities are also attempting to be proactive in their organizing by identifying what they want in their neighborhood. A new approach to environmental policy should help communities plan their economic base with environmental considerations in mind.

The next generation of environmental policy must move away from the command and control focus and toward a longer-term vision for improving industrial processes. This vision must not fall victim to organizational fragmentation but should seek a systems view of the interaction between the economy and the environment. Additionally, a priority for the next generation of environmental policy should be to increase energy and resource efficiency. Furthermore, new players, such as industry, local community leaders, and developers, must take on environmental leadership roles. In order for environmental policy to meet the challenges of cross media pollutants, elusive environmental threats, and resource scarcity (among other growing concerns), a new paradigm is needed to inform its development. Growing discussion among scholars, environmentalists, and communities has turned toward industrial ecology as a model for informing the next generation of environmentalism.

**Defining Industrial Ecology**

As stated in the beginning of this Chapter, the goal of IE is to "to eliminate the cause of environmental problems rather than to work to solve them after they become apparent."\(^{18}\) In
order to do this, industrial ecologists begin with a systems approach to understanding how the environment and the economy interconnect. Instead of examining environmental impacts as they relate to specific media, IE endeavors to understand the entire system. This is accomplished by investigating materials and energy flows resulting from industrial and consumer activities as well as by understanding how those flows influence the environment.¹⁹

The notion of studying the flow of materials and energy as they move from the resource extraction stage to the post-consumption disposal stage offers an opportunity to understand the range of environmental impacts that the industrial process yields. By doing so, the industrial ecologist expands the scope of environmentalism both in terms of breadth as well as by seeking longer-term solutions to environmental problems. Furthermore, by changing the unit of analysis from that of specific media or pollutants to the flow of materials and energy, industrial ecology moves the discussion away from controlling industrial activities within the current extract and dump linear system. Instead, the discussion becomes one on how to alter that system so that it more closely resembles a cyclical natural ecosystem.

The current linear approach to industrial processes is unsustainable given finite resources. However, the natural ecosystem offers an alternative approach to organizing industrial processes by replicating its closed loop cycle. The natural ecosystem is characterized by a closed loop because all material inputs into the process are reused and circulated throughout the system and only the unlimited resources of solar energy are required as virgin inputs. Resources are not extracted, used, and then disposed of without being reintegrated back into the natural ecosystem process.²⁰ While it is unlikely that a complete loop closure similar to natural ecosystem could be replicated at the industrial level, the goal offers a new paradigm for reinventing environmentalism.

The next step is to offer concrete ways that policymakers, planners, developers, and communities can implement the concepts of industrial ecology. One promising approach is through eco-industrial parks (EIPs), which are attempts to apply industrial ecology principles at the local level. In the following chapter, the industrial ecosystem model is defined and characterized by the Kalundborg, Denmark Eco-Industrial Park (EIP) case. In Chapter 4, the North American experience with EIP development is discussed. Chapters 5 through 7 offer a case study of the actual process of implementing an EIP by studying the example in Londonderry, NH.
CHAPTER 3:
OPERATIONALIZING INDUSTRIAL ECOLOGY:
INDUSTRIAL ECOSYSTEMS AND KALUNDBORG

Chapter 3 identifies two distinct ways to implement industrial ecology (IE): product policy and industrial symbiosis. The concept of industrial symbiosis is discussed and the Kalundborg, Denmark example of an industrial ecosystem is presented.

Operationalizing Industrial Ecology

In his 1995 Masters Thesis at the Massachusetts Institute of Technology (MIT), Nicholas Gertler describes a framework for thinking about ways to operationalize industrial ecology. First, IE can be implemented through product policy. Under this framework, the product is the unit of analysis. As the product moves through the various stages of production, interventions are devised to improve environmental performance. Examples of interventions employed through the product policy framework include life cycle assessment (LCA) and design for environment (DFE). Key to this method of operationalizing IE is the notion that because the product is the focus, product policy interventions can be broadly applied. For example, regulations could be implemented that require industry to develop products that meet performance standards based on LCA or DFE principals. Because the unit of analysis is the product, the approach is readily transferable from one context to another.

An alternative and complementary approach discussed by Gertler is industrial symbiosis. Gertler defines industrial symbiosis as an “application of industrial ecology which seeks to optimize the efficiency of material and energy flows through large-scale industrial processes.” Central components of the industrial symbiosis application are energy cascading and byproduct exchange. Unlike product policy, industrial symbiosis focuses on the process of production and seeks to implement the goals of IE through the lens of the firm or group of firms. An industrial ecosystem is what results when industrial symbiosis is repeated. Gertler defines the players in industrial ecosystems as a “community or network of companies and other organizations.” He points out that by “exchanging and making use of byproducts and/or energy,” industrial ecosystems can potentially realize a decreased use of virgin materials, a reduction in pollution generation, an increase in energy efficiency, and a reduction in waste requiring disposal. Furthermore, there is potential for firms interacting in an industrial ecosystem to realize expanded economic benefits including revenue from the sale of byproducts or savings derived from reduced energy and input costs.
Key to the industrial ecosystem model of implementing IE is place-based development and inter-firm relationships. The development of industrial ecosystems must take into consideration the local context during implementation. For example, market forces, community goals and interests, and social and political factors influence the way in which industrial ecosystems can be applied in practice.\textsuperscript{24}

Additionally, developing industrial ecosystems requires strong inter-firm relationships. Gertler writes that "... industrial symbiosis requires interaction and trust among companies that goes well beyond normal business practice, such expanded collaboration is both a component and necessary precursor of industrial ecosystem development."\textsuperscript{25} The industrial ecosystem model of implementing IE requires relationship building between firms within a specific industrial development. Relationships can result in higher levels of byproduct and energy exchange as well as cooperation over ways to improve environmental performance and meet or exceed regulations.

The only mature industrial ecosystem currently in operation is in Kalundborg, Denmark. The following section details the industrial symbiotic relationships that exist at Kalundborg and the factors that led to their creation.

**Industrial Ecosystems: Kalundborg, Denmark**

During the past 25 years an industrial ecosystem has been developing in Kalundborg, Denmark. Kalundborg's industrial ecosystem is based on linkages between four large industries and the Municipality. In the following section, these linkages are described. The source for information on the Kalundborg case study is Nicholas Gertler's 1995 Masters Thesis, which entailed a five-day trip to Kalundborg to study the industrial ecosystems on site.

**Asnæs Power Station**

A central player in the Kalundborg case is the 1,500-megawatt coal-fired Asnæs Power Station. The Power Station produces steam as a byproduct of the coal combustion process. Through a system of underground pipes, the steam is distributed to firms at the industrial park as well as to homes and buildings in the Municipality. As a result of this link, the Municipality of Kalundborg has reduced its consumption of oil by 19,000 tons per year. Novo Nordisk, a pharmaceutical manufacturer, relies entirely on steam from the Power Station to support production. Within two years of building the piping infrastructure needed to transport the steam, the savings realized from using a less expensive energy source paid for the infrastructure.
improvements. Additionally, Novo Nordisk estimates that it saves an additional $1 million per year from accessing a less expensive source of energy.  

The Power Station operates a fish farm that produces 250 tons of fish per year. This fish farm generates sludge that is then sold to nearby farmers for fertilizer. The excess steam created by the Power Station heats the fish farm as well.  

The Asnæs Power Station sells gypsum to Gyproc, a manufacturer of wallboard. In response to a Danish environmental agreement where power companies agreed to decrease their sulfur emissions, the Power Station installed a calcium hydroxide scrubber. During the scrubbing process, enough calcium sulfate (industrial gypsum) is produced to meet 2/3 of Gyproc’s annual input requirements. In meeting the environmental agreement, the Power Station could chose the technology it wanted so long as emissions performance requirements were met. Asnæs choose the scrubber technology because income generated from selling the gypsum to Gyproc covers most of the cost of operating the scrubber.  

Another byproduct of producing electricity at a coal-fired plant is fly ash and clinker, which are residues created during the combustion process. Instead of land filling the 170,000 tons of fly ash and 30,000 tons of clinker, Asnæs opted to sell the byproducts to neighboring builders for road construction and cement production. 

Statoil Refinery  

Another player in the Kalundborg industrial ecosystem is Statoil refinery, which produces petroleum products including gas and fuel oil. A byproduct of the oil refinery industry is ethane and methane, which is traditionally burned off and emitted in the atmosphere as a flare gas. However, since 1972 Statoil has opted to sell the flare gas to Gyproc for use as a fuel for drying their wallboard product. Gyproc derives all of its fuel needs from Statoil because the flare gas is cheaper than oil and maintenance is easier. Gyproc maintains a butane fired fuel source for periods when Statoil reduces its flare gas amount. 

In 1991, Statoil began providing Asnæs with flare gas, which substituted for 30,000 tons of coal. Sulfur is removed from the flare gas before it is transported to the Power Station. This relationship results in a decrease in carbon dioxide emissions by 3 percent. Asnæs was motivated to pursue this linkage due to a greenhouse gas reduction plan it presented to the Danish government. Similarly, Statoil facing community and regulatory pressure to reduce sulfur emissions, choose to clean the gas, which ultimately resulted in it becoming valuable to
Asnæs. In addition, Statoil sells the sulfur byproduct to a nearby business that produces sulfuric acid.

A scarce resource in Kalundborg is fresh water. With this in mind, Statoil and Asnæs devised a plan to siphon 700,000 cubic meters per year of Statoil’s cooling water to the Power Station. Asnæs then uses the water to fuel its boiler. In terms of enhanced environmental performance, Asnæs receives 75 percent of its water needs from recycled sources. Furthermore, Statoil is no longer releasing warm water into the neighboring fjord and causing thermal problems.  

**Novo Nordisk**

Novo Nordisk also participates in the industrial symbiosis at Kalundborg. Since 1976, Novo Nordisk has been piping sludge, which it generates at a rate of 3000 cubic meters per day, free of charge to farmers within a 40-mile area. The farmers use the nitrogen-rich, biomass as fertilizer. Novo Nordisk chose to build the pipes and offer the product free of charge because it was still cheaper than alternative sludge disposal options under existing Danish environmental regulations.

**Lessons Learned from Kalundborg**

*Enhanced Environmental and Economic Performance*

Through the industrial ecosystem at Kalundborg, complex and mature material and energy flows have been created. As a result of these flows, significant environmental and economic benefits have been realized. The Kalundborg industrial ecosystem proves that enhancing environmental performance does not necessarily result in diminishing economic profits, in fact the opposite is true.

The Kalundborg industrial ecosystem has resulted in the following environmental benefits:

- Resource input use has been reduced
- Energy efficiency has increased
- Pollution levels have decreased
- Wastes have been converted into valuable materials thereby solving disposal problems while reducing the use of virgin inputs.
Furthermore, the enhanced environmental performance resulting from the symbiotic relationships at Kalundborg come with economic benefits to the members and the community. These benefits include reduced costs for material inputs both for members of the park and for surrounding businesses and community members. For example, farmers in the Kalundborg region receive an annual savings of $50,000 per farm due to access to the free fertilizer supplement from Novo Nordisk. Additionally, Gyproc receives access to lower cost fuel from Statoil and the Municipality and members of the park use steam, a lower cost energy source, to heat their homes and facilities.\textsuperscript{34}

Economic benefits also come as a result of adding value to material that was previously defined as waste. For example, Asnaes Power Station now sells steam, sludge, gypsum, fly ash and clinker instead of paying for the disposal of these products. Statoil also receives similar benefits from commodifying its flare gas byproduct. By engaging in symbiotic relationships, the industries in Kalundborg have been able to both increase their environmental performance while simultaneously realizing economic benefits for themselves and the surrounding community.

\textit{Motivations for Engaging in Industrial Symbiotic Relationships}

The motivation for firms at Kalundborg to engage in symbiotic relationships was based primarily on economics. If the linkages did not make economic sense, then they would not have been created. However, the extent to which the linkages are economically feasible has been the result of Danish environmental regulation, where performance standards are the norm, not requirements on the type of technologies to use. For example, Danish law required that power plants reduce their sulfur dioxide emissions by 15 percent; however, the technologies used to meet those requirements were left up to each firm. As a result, Asnaes chose to install a scrubber but only because firm leaders calculated that the revenue realized from selling the byproducts from the scrubbing process would help in paying for the infrastructure and operating costs. Ultimately, the choice to move to scrubber technology was made because it was economically beneficial for the Power Station. However, the motivation to improve environmental performance by a 15 percent reduction in sulfur dioxide emissions grew out of Danish environmental policy.\textsuperscript{35}

Valdemar Christensen, Production Manager at Asnaes Power Station maintains that community and regulatory pressure are required in order to incentivize the creation of symbiotic relationships. According to Christensen, “economies alone will bring you a certain amount of symbiosis – the low lying fruit. To go further, you need political impetus – to require pollution
control technologies and/or to adjust prices to make symbiotic arrangements economically viable.\textsuperscript{36} He points out that initially, the linkages between firms in Kalundborg were developed to avoid traditional and costly waste disposal requirements, to increase revenue by selling byproducts or using lower cost inputs, and to conserve resources, such as water. However, the second round of linkages that developed in Kalundborg were an answer to Danish pollution prevention performance standards. Because of these standards, firms at Kalundborg were required to reduce pollution, which resulted in cleaner byproducts that realized a higher value as a potential input. When regulatory pressures were increased, the power plant and refinery chose to implement scrubber and desulfurization technologies, which ultimately resulted in creating economically valuable byproducts. Ultimately, the extent to which regulatory pressures incentivize innovative environmental control methods is a determinant in whether they will be adopted. Nonetheless, barring regulations that require waste exchange (unfeasible both technically and politically), firms will not engage in this process without the economic incentive to do so.

\textit{Relationships Between Firms}

While regulatory pressures provided the incentive for the Kalundborg firms to create industrial symbiotic linkages, the relationship between the organizations was essential to their development. This relationship developed easily in Kalundborg because of existing personal contacts between industry leaders. According to Finn Grob of Gyproc, "managers from the different plants run into one-another and discuss common problems and challenges, from which the realization springs that the different firms should tackle some of them together."\textsuperscript{37} Kalundborg is a small town located where the industrial park is also the home to employees. Industry leaders built up relationships by running into each other through work and socially. This network has been instrumental in facilitating the development of industrial symbiosis at Kalundborg.\textsuperscript{38}

\textit{Insuring Stable Supplier Relationships}

While a strong interpersonal network exists in Kalundborg, the firms must also insure that their supplier relationships are either contractual or that an alternative input source is assured. For example, while Gyproc uses flare gas from the refinery for energy, it maintains a supply of butane that is used when the refinery closes for maintenance every four years. Gyproc must maintain this alternative source because there is inadequate storage space for the flare gas, which is not easily liquefied. Instead, Gyproc receives the flare gas through a direct connection to the refinery. In a different linkage case, alternative inputs sources are available
through the market. Gyproc's use of the Power Station's scrubber derived gypsum is easily stored to insure against disruptions to the supply. Furthermore, Gyproc can readily switch to another supplier of gypsum, should the Power Station fail to deliver.

Other supplier relationships include the contractual basis by which Asnaes provides steam to Novo Nordisk. In this particular case, there is a future possibility that the Power Station could begin wholesaling electricity from hydro power plants at a rate that is less expensive than producing it internally. If this occurs, Asnæs is still bound contractually to provide steam to Novo Nordisk. However, the pricing structure between the two firms reflects this potential change in the Power Station's business plan.

Unique Kalundborg Context

In addition to Danish environmental regulations and strong inter-firm relationships, certain contextual factors make the Kalundborg example ripe for industrial symbiotic relationships. First, the industry mix at Kalundborg fits well together and by nature process industries tend to produce substantial amounts of byproducts. According to Gertler, the industries at Kalundborg are not overtly polluting and they do not generate excess waste because they are inefficient or are using outdated technologies. Instead, process-based industries tend to produce large waste streams; such as flare gas, steam, and sludge. With large waste streams, there is more of an opportunity to turn byproducts into valuable inputs. Furthermore, the dynamic between the four industries results in the byproducts being useful. Without large waste streams and a well-suited industry mix, developing industrial ecosystems would be difficult.

In addition to the suitable industry mix at Kalundborg, the firms were not competitors, which made cooperation less risky. Furthermore, the close geographic distance between the firms helped to facilitate the creation and development of symbiotic linkages because transportation costs are kept to a minimum and organizational relationships were more easily established. Finally, the Danish culture for valuing environmental stewardship has resulted in a push by industry leaders at Kalundborg to find ways to increase environmental performance. Gertler maintains that Mr. Christensen of the Asnæs Power Station "takes pride in bringing about a more sustainable future." The local market, geographic, and political context in Kalundborg has been a factor in facilitating the development of an industrial ecosystem.
Broader Applications for Industrial Ecosystems

The industrial ecosystem model exemplified by Kalundborg represents one way to implement industrial ecology. Optimizing the flow of materials and energy between businesses and organizations as described in the Kalundborg case is an optimal way to “eliminate the cause of environmental problems rather than to work to solve them after they become apparent.” For example, the Asnaes Power Station, which originally was only 40 percent efficient in turning coal into energy, now has a 90 percent efficiency rating. Being able to use the same amount of coal more than twice as efficiently decreases industry’s use of nonrenewable resources. Additionally, the use of scrubber technology by the Power Station reduces emissions, while the sale of the gypsum byproduct eliminates the waste disposal problem.

The industrial ecosystem concept is appealing because of its potential for enhanced environmental performance and economic benefits. The ability to implement industrial ecology through symbiotic relationships offers communities, firms, and policymakers a model for proactive environmental policy where a vision of what is desired can be created. Nonetheless, the Kalundborg model is highly contextual. The industry mix is well matched and offers substantial waste streams to be converted into valuable products. Interpersonal relationships at the firm level have facilitated the development of the industrial ecosystem, and the environmental culture of the industry leaders and Danish environmental policy has led to the creation of the Kalundborg linkages. Nonetheless, within the Kalundborg industrial community, firms were able to create innovative solutions to enhancing environmental performance that also make economic sense. While the economic and environmental benefits of the Kalundborg model have wide appeal, industrial ecosystems may not be feasible in other locations. The following Chapter begins by examining the implementation and the attempted implementation of eco-industrial parks (EIPs) in North America. EIPs are an operationalized form of industrial ecology with characteristics similar to industrial ecosystems. However, unlike industrial ecosystems, waste exchange is not necessarily central to the EIP model.


26 Gertler, Nicholas and John R. Ehrenfeld. "A Down to Earth Approach to Clean Production." 1995. pg. 2

27 Gertler, Nicholas and John R. Ehrenfeld. "A Down to Earth Approach to Clean Production." 1995. pg. 2

28 Gertler, Nicholas and John R. Ehrenfeld. "A Down to Earth Approach to Clean Production." 1995. pg. 2


39 Nicholas Gertler, Former LEIP Advisory Board Member, Telephone interview, February 24, 2001


CHAPTER 4:
OPERATIONALIZING INDUSTRIAL ECOLOGY:
ECO INDUSTRIAL PARKS (EIPs) IN NORTH AMERICA

Chapter 4 of this Thesis offers an exploration into the development of eco-industrial parks (EIPs) in North America. It begins by defining the EIP model. Next, through a survey of nine EIPs, characteristics of the North American experience are identified, and conclusions about EIP practices are drawn.

The Eco-Industrial Park Model

The eco-industrial park model offers a way to operationalize the principles of industrial ecology. Ernest Lowe et al in The Fieldbook for the Development of Eco-Industrial Parks provides the following definition of EIPs.

An EIP is a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realize if it optimized its individual performance only. 42

Noticeably absent from Lowe’s definition of an EIP is the notion of optimizing material and energy flows. The EIP model focuses on the role of collaboration between businesses as a means to enhance environmental and economic performance. This collaboration may or may not include waste exchange or energy cascading. Other principals, such as design for environment, open space conservation, an environmental management system, pollution prevention, and green design are all integral to current EIP development practices. 43

Survey Methodology

During February, 2001 17 surveys were mailed or emailed to various EIPs in North America. The original distribution list was created using the 1996 Presidential Council on Sustainable Development Eco-Industrial Park Workshop Proceedings. At that particular conference, 15 EIPs were in attendance including four Presidential Demonstration Parks. Two additional surveys were sent to EIPs that did not attend the 1996 conference. The rate of return was 52 percent, with 9 EIPs returning a survey. Follow up telephone calls and emails were used in order to increase the survey rate of return. Table 1 identifies which EIPs were contacted, whether they returned a survey, and their stage in the development process.
<table>
<thead>
<tr>
<th>EIP</th>
<th>Location</th>
<th>Returned Survey</th>
<th>Development Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Center for Electronics Disposition Eco-Industrial Park Austin, TX</td>
<td>No</td>
<td>Phase I</td>
</tr>
<tr>
<td>2</td>
<td>Riverside Eco-Park Burlington, VT</td>
<td>Yes</td>
<td>Phase I</td>
</tr>
<tr>
<td>3</td>
<td>Fairfield Ecological Industrial Park Baltimore, MD</td>
<td>Yes</td>
<td>Phase II</td>
</tr>
<tr>
<td>4</td>
<td>Port of Cape Charles Sustainable Technologies Industrial Park Cape Charles, VA</td>
<td>No</td>
<td>Phase II</td>
</tr>
<tr>
<td>5</td>
<td>Londonderry Eco-Industrial Park Londonderry, NH</td>
<td>Yes</td>
<td>Phase II</td>
</tr>
<tr>
<td>6</td>
<td>Hyder Enterprise Zone Hyder, Alaska</td>
<td>No</td>
<td>Phase II</td>
</tr>
<tr>
<td>7</td>
<td>Burnside Eco-Industrial Park Halifax, Nova Scotia, Canada</td>
<td>Yes</td>
<td>Phase II (almost Phase III)</td>
</tr>
<tr>
<td>8</td>
<td>Civano Industrial Eco-Park Tucson, AZ</td>
<td>Yes</td>
<td>Phase 0</td>
</tr>
<tr>
<td>9</td>
<td>East Shore Eco-Industrial Park Oakland, CA</td>
<td>Yes</td>
<td>Phase 0</td>
</tr>
<tr>
<td>10</td>
<td>Raymond Green Eco-Industrial Park Raymond, WA</td>
<td>Yes</td>
<td>Phase 0</td>
</tr>
<tr>
<td>11</td>
<td>Skagit County Environmental Industrial Park Skagit County, WA</td>
<td>Yes</td>
<td>Phase 0</td>
</tr>
<tr>
<td>12</td>
<td>Trenton Eco-Industrial Complex Trenton, NJ</td>
<td>Yes</td>
<td>Phase 0</td>
</tr>
<tr>
<td>13</td>
<td>Brownsville Eco-Industrial Park Brownsville, TX</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>14</td>
<td>The Volunteer Site Chattanooga, TN</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>15</td>
<td>Green Institute Eco-Industrial Park Minneapolis, MN</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>16</td>
<td>Plattsburgh Eco-Industrial Park Plattsburgh, NY</td>
<td>No</td>
<td>Unknown</td>
</tr>
<tr>
<td>17</td>
<td>Shady Side Eco-Business Park Shady Side, MD</td>
<td>No</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

**Survey Results**

The following discussion outlines the findings from the EIP survey. First, for each EIP where a survey and/or secondary information was available, a development phase was identified for the Park. Next, three specific EIPs are analyzed in more detail. The three Parks
were chosen because they returned a survey and are in the implementation phase of development. Being in the implementation phase was a criterion for evaluating an EIP in more detail because Park characteristics could be readily identified and compared between developments.

Development Phase

A phasing system was created in order to catalogue what stage in the development process each EIP is in. The phases are meant to define each EIPs progress in terms of implementation. They are not intended to be normative or to evaluate how well each Park is meeting the goals of industrial ecology. While nine surveys were collected, information on the development phase was obtained for twelve EIPs. For those EIPs where a survey was not collected, secondary information was used to determine the EIP's development phase.

Phase I: Planning

EIPs in the Phase I stage are in the process of planning the Park. Planners, developers, and stakeholders are discussing the principles associated with the park and the ways in which these principles can be implemented and enforced. The Center for Electronics Disposition Eco-Industrial Park (CEDEIP) in Austin, TX and the Riverside Eco-Park in Burlington, VT are in the planning phase.

Phase II: Implementation

EIPs in the implementation phase are recruiting tenants for the Park. Planning during Phase I has lead to the creation of a set of principles and a management system. In the implementation phase, the developers of new industrial parks have acquired the necessary land and EIP planners working with existing industry have begun to implement Park principles with current businesses. According to research and survey results, there are five EIPs in Phase II of the development process.

Phase III: Mature EIP

No EIP in North America has reached this stage as of yet. However, the Burnside EIP in Nova Scotia is the closest to developing a mature EIP. Characteristics of a Phase III EIP include attaining full lease-up and implementing Park principles. For EIPs developed around existing businesses, a mature EIP would be characteristic of full participation by firms in the established environmental principles for a period long enough to evaluate both environmental and economic impacts.
Phase 0: No EIP

This final category is used to characterize those EIPs that for one reason or another are no longer being developed. Five EIPs in this study were unable to move past the planning stages of the development process over a course of five years. This trend indicates that EIP development has been difficult to implement. Reasons given for ceasing the development of these EIPs includes difficulty in land acquisition, legal disputes between developers, and an inability to bring the EIP out of the planning phase and into implementation. However, it is not the case that unsuccessful EIP development has occurred as a result of a flawed EIP model. No Park has implemented industrial ecology through an EIP and decided that the results are not desirable. Instead, it appears the more traditional development obstacles have been the cause of EIP implementation difficulties. Such obstacles as land requirements, financing, and multiple stakeholder processes combined with the difficulties inherent in developing with an environmental mission have made EIP implementation complicated.

General EIP Characteristics

There are three EIPs in the Implementation Phase (Phase II) that also returned a survey. These EIPs are the Fairfield Ecological Business Park (FEBP), the Burnside Industrial Park (BIP), and the Londonderry Eco-Industrial Park (LEIP). Both the FEBP and the Burnside EIP work with existing businesses on implementing EIP principals, while the LEIP has focused on attracting businesses to vacant land.

The FEBP EIP comprises 1300 acres of industrially zoned land in Baltimore, MD and includes 50 existing businesses, of which seven located within the Park following the implementation of the EIP principles. At the FEBP, the industrial mix is varied and includes the production of fiber optics, granite blocks, and petro chemicals, as well as automotive imports, and industrial services.

The BIP is home to 1,300 businesses and covers 2,500 acres. The business mix at Burnside includes "small and medium light manufacturing, warehousing, distribution, and a number of retail sectors."44

The LEIP covers 100 acres and is surrounded by 900 additional acres of industrially zoned land. There are currently three businesses within the LEIP, all of which have located at the site following the establishment of the EIP. The industrial mix at the LEIP includes a soon to
be completed natural gas fired power plant (AES), a medical supply distribution firm (Gulf South), and a company that transforms vans into handicap accessible vehicles (Rideaway).

**Industrial Ecology Practices**

**Byproduct Exchange**

Of the three EIPs, only the BIP is implementing byproduct exchange between firms. Waste exchange is occurring around the sharing of wooden pallets, metals, and packaging materials. One particular example of waste exchange is occurring between a computer assembly firm and a packaging firm. The packaging firm reuses the polystyrene filler from products delivered to the computer company when it packages products for customers. Furthermore, waste exchange at the BIP goes beyond the boundaries of the industrial park. BIP firms use a province wide on-line source to identify potential waste exchange opportunities with Canadian businesses. Additionally, BIP firms engage in other waste exchange opportunities beyond the Park walls including a recycling program for computer hardware, a Dalhousie University run chemical exchange program, and a food rescue program offered by a local food bank.46

However, the FEBP is no longer pursuing waste exchange between firms as a viable option. According to Mr. Neville Sinclair of the Baltimore Development Corporation (BDC), the businesses at the FEBP do not create enough waste to foster economically feasible exchanges. As a result, Baltimore Park planners have decided not to pursue this strategy and to concentrate on other sustainable measures. At the LEIP, the potential for materials exchange will have to wait until the completion of the new gas fired power plant, which will offer its steam byproduct as a source of inexpensive energy. However, as of yet, no waste exchange is occurring at the LEIP.

**Other Industrial Ecology Practices**

At the FEBP, firms reuse oil for heating, while manufacturing businesses are eliminating chlorine from the production process. Additionally, businesses at the FEBP are engaged in a State sponsored carpooling program, open space conservation, and green building design.

At the LEIP, green building design and open space conservation has occurred at the new power plant facility. Additionally, the structure which houses the medical distribution company was built based on green design principles and Ride Away’s new addition will be built in accordance with green design. There are plans for firms to adopt an environmental
management system (EMS), and engage in waste exchange as well as other industrial ecology measures. However, these plans have yet to be implemented.

At the BIP, several industrial ecology practices are occurring. These measures range from product substitution to waste exchange. A detailed list of industrial ecology practices at the BIP is provided in Table 2.

<table>
<thead>
<tr>
<th>Industrial Ecology Practice</th>
<th>Examples</th>
<th>Environmental Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Energy and Resource Conservation</td>
<td>1. Polystyrene product manufacturer constructed water-cooling towers in order to recycle water during production. 2. Several companies installed energy efficient lighting systems</td>
<td>1. Reduction in water use 2. Reduction in energy use</td>
</tr>
<tr>
<td>B. Product Substitution</td>
<td>1. Vehicle maintenance businesses are now using hot water parts washers instead of solvent parts washers. By using this method of cleaning, hot water and detergent are substituted for solvents. Because the detergent is not a hazardous waste, is less expensive than solvents, and is less environmentally damaging, product substitution has resulted in a decreased cost to firms as well as increased environmental benefits. 2. Printing firms are now using vegetable oil or water-based inks as a substitute for the traditional petroleum based inks. Vegetable oil or water-based inks have lower volatile organic compound (VOC) levels.</td>
<td>1. Reduction in atmospheric emissions and hazardous waste 2. Reduction in atmospheric emissions</td>
</tr>
<tr>
<td>C. Waste Exchange Between Firms</td>
<td>1. Reuse of computer firm's polystyrene waste by a packaging firm 2. Reuse of furniture store's wooden pallets by shipping firm</td>
<td>1. Reduction in solid waste, and increased resource efficiency 2. Reduction in solid waste, and increased resource efficiency</td>
</tr>
<tr>
<td>D. Recycling and Product Recovery within Firms</td>
<td>1. Paint company recycles its paint and removes solvents using an in-house solvent recovery system. Once recovered, the solvents are used to clean equipment. 2. Swedwood Canada, an IKEA subsidiary, is recovering wood waste and paint dust, which they are using for heating purposes</td>
<td>1. Reduces hazardous waste disposal and increases resource efficiency 2. Increased energy efficiency and</td>
</tr>
</tbody>
</table>
The Real Estate Services Division of the Halifax Regional Municipality manages the Burnside EIP, which is a public sector agency. In Burnside, the Municipality of Halifax enforces a set of covenants and standards that are applied to building design, landscaping, and natural resource protection. The covenants are intended to “ensure that the Park continues to be developed in a manner consistent with superior aesthetic and environmental protection.

---

E. Product-Life Extension

1. A printing firm is now aware that its fixer composition had changed, and it can now use less fixer in its mixing processes. This has allowed the same volume of fixer to last twice as long.

1. Increased resource and material efficiency.

F. Firms Involved in Scavenging and Decomposition

1. 15 percent of BIP companies are involved in the reuse, recovery, recycling, refurbishing, or remanufacturing of products. These products are then bought by BIP companies for use in the production process.

1. Reduction in wastes and increased resource efficiency.

G. Environmental Management System (EMS)¹

1. Swedwood is developing an EMS and preparing for ISO 14,000 certification.

1. General environmental control and management.

H. Green design and land stewardship

1. Municipality of Halifax has strengthened development standards at the BIP to improve the environmental performance of building and site design.

1. Increased energy efficiency and land stewardship.

---

¹ According to Phillip Stapleton et al in “Environmental Management Systems: An Implementation Guide for Small and Medium Sized Organizations,” an EMS is a “continual cycle of planning, implementing, reviewing, and improving the processes and actions that an organization undertakes to meet its environmental obligations.” There are several EMS models that firms can follow. However, the EPA subscribes to the ISO 14000 model that establishes standards for what an EMS should include. Most EMS models, including ISO 14000, is based on the notion of plan, do, check, act, where companies should develop a plan for environmental management, implement that plan, monitor their performance, and act to improve performance.
standards and with the declared intention of creating a pleasant and harmonious environment for the Park’s residents. If businesses fail to comply with EIP standards and covenants, fines can be levied. However, there is currently no way to limit which firms are admitted into the Park, as long as they can meet the covenants, as well as Provincial and Federal regulations.

Burnside, however, is unique because in addition to the use of covenants and standards, the Park houses a resource center that supports businesses through environmental technical assistance. The Eco-Efficiency Centre “is a model for an integrated set of approaches that is being developed to assist small businesses achieve better environmental and economic performance through resource conservation, reuse, pollution prevention, and general environmental practices through individual and collective actions.” The impetus for developing the Eco-Efficiency Centre was due to survey results indicating firms would consider improving environmental performance if provided with information.

In 1992, the Eco-Efficiency Centre surveyed 278 of the 1,200 small and medium sized businesses at the BIP. Of firms surveyed, 92 percent indicated they would consider ways to make use of their waste products for productive use, and 90 percent were willing to take part in joint waste reduction strategies. However, survey participants indicated that “economic incentives, financial assistance, and information were most likely to influence their decisions to change energy and materials usage, as well as production processes.” Furthermore, the survey illustrated that small and medium sized enterprises would have a difficult time implementing industrial ecology on their own. As a result of this survey, the Eco-Efficiency Centre at the BIP was established to curb the lack of knowledge regarding industrial ecology. This is accomplished by providing fast, reliable, and customized information on ways that businesses can improve their environmental performance.

The Eco-Efficiency Centre manages the Eco-Business Program Burnside, where firms can voluntarily choose to join and commit to improving environmental performance and increasing efficiency. Once a Burnside firm becomes an “Eco-Business,” an environmental review of their facilities and production processes occurs and suggestions for areas of improvement are provided. The Eco-Efficiency Centre acts as a source of technical information on tools, resources, and information to help Eco Businesses improve their environmental performance. Additionally, the Eco-Efficiency Centre conducts an annual awards ceremony in order to reward Eco Businesses who demonstrate improved environmental management.
The Baltimore Development Corporation (BDC), a quasi-public agency, manages the FEBP. In this role, the BDC is responsible for business recruitment, marketing, and assistance with the permitting process. By working with businesses on the front end, BDC ensures that the "right" firms will become part of the Park. The BDC is looking for businesses with an environmental mission, a willingness to implement an environmental management system, and a commitment to the use of green design principles.50

The City of Baltimore plays a role in enforcing Park principles. Because the FEBP is located within an Urban Renewal District, the City is currently in the process of implementing heightened design and development standards through the use of urban renewal tools. The new design and development regulations will be applied across three zones in order to facilitate different types of industry including water related activities in the North Zone, light industry in the Central Zone, and heavy industry in the South Zone. Firms within the FEBP will be required to comply with these design and development guidelines once adopted. However, there is currently no mechanism for the BDC to use around enforcing the implementation of an environmental management system.51 Additionally, the FEBP does not have in place a source of environmental technical assistance for either newly arriving businesses or existing firms.

In Londonderry, a private real estate development company called Sustainable Design and Development (SDD) manages the LEIP. The LEIP operates under a set of covenants that inform the development of ecological principles. Once located within the LEIP, firms are required to submit annual performance goals, which are evaluated by a Community Stewardship Board. Enforcement for the LEIP principals comes in the form of an annual review by the community Stewardship Board, which is available to the public. This mechanism is meant to ensure that firms in the LEIP pursue strategies for improving environmental practices, with the notion that if improvements do not occur then a firm's public image can be tarnished. Additionally, an eco-review, provided by the Town of Londonderry, is required for each firm entering the Park. Besides the initial eco-review, there is no environmental technical assistance program in place at the LEIP.

**EIP Development in North America: Conclusions**

EIP development is difficult. Many potential Parks never make it beyond the planning stage due to land acquisition and other development obstacles. For those EIPs that have made it to the implementation phase, developing mature industrial ecosystems as witnessed in the Kalundborg example has been difficult. While for some EIPs, such as the LEIP, it is too early to
determine whether byproduct exchange will occur, other Parks, such as the FEBP have given up the pursuit of waste exchange because the BDC believes it is not feasible within the existing industrial mix. On the other hand, the Burnside Park has implemented byproduct exchange through the assistance of the Eco-Efficiency Centre. Interestingly, all three EIPs in the implementation phase are pursuing other industrial ecology practices, such as open space conservation, green building design, and environmental management systems. This indicates that in addition to the principles of materials and energy flows exemplified by the Kalundborg example, EIP development in North America is also embracing additional measures to improve the environmental performance of industry.

In terms of EIP management and enforcement, the three EIPs studied appear to have relied on a mix of regulatory measures and technical assistance programs. In the case of both Burnside and Baltimore, the local government is responsible for implementing building design, zoning, and development standards meant to enhance environmental stewardship. Furthermore, both the Burnside EIP and the LEIP offer some form of environmental technical assistance. The Eco-Efficiency Centre offers extensive resources to member firms while the LEIP offers a one-time eco-review for potential businesses. Additionally, there is a range of management structures at the three EIPs. While the LEIP embraces a private sector approach, the Burnside Park is managed by the public sector with a public-private partnership centered on providing environmental technical assistance. Finally, the FEBP is managed by a quasi-public agency, with the City of Baltimore playing an enforcement role.

The definition of EIP development provided by Lowe et al focuses on the role of inter-firm cooperation as a means to enhance environmental performance. Additionally, the Kalundborg model exemplifies how cooperation can create both economic and environmental benefits. In fact, in the Kalundborg example, the development of inter-firm relationships was central to the creation of innovative solutions to environmental problems. These relationships, however, evolved over time and as a result of Danish environmental culture and inter-personal communication between industry leaders. Consequently, when developing innovative environmental control techniques through an eco-industrial park where inter-personal relationships and an environmental culture do not exist, it appears that a third party organization may be required to facilitate cooperation. This is evidenced through the role of the Eco-Efficiency Centre at Burnside. For example, by working with businesses at Burnside Industrial Park, the Eco-Efficiency Centre has fostered partnerships between firms around the exchange of wooden pallets, metals, and packaging materials. Information regarding inter-firm
cooperation at the FEBP was not available. At the LEIP, there is only one firm currently operating within the Park, and two others building facilities. Consequently, it is too early for inter-firm cooperation to be occurring.

In terms of byproduct exchange, a third party organization may be required to play a brokering role in order to facilitate the development of linkages. For example, evidence from Kalundborg suggests that infrastructure must be developed to facilitate transporting byproducts. Furthermore, if the scale of byproduct supply is not sufficient to meet demand, aggregation of byproducts among multiple firms may be needed. In the case of Burnside, aggregation is occurring through scavenger firms that are transforming byproducts into economic products. A third party organization, or group of organizations, that can develop needed infrastructure, balance supply and demand between firms, and transform raw byproducts into useful inputs, may be necessary in order to develop sophisticated byproduct exchanges.

The EIP model of implementing industrial ecology offers an example of how communities can respond to market forces with a vision for sustainable industrial development. For those EIPs that have moved from planning to implementation, the struggle is over how to employ notions of industrial ecology in order to become a mature EIP that can serve as a model for eco-industrial development. Key to moving forward in the implementation process is deciding on the proper management entity, enforcement technique, business recruitment strategy, and community process. The next three Chapters are devoted to studying how a group in Londonderry, NH opted to implement an EIP. The case study is intended to demonstrate the critical decisions that EIP planners should consider when implementing industrial ecology. In Chapter 5, a history of the LEIP development process is discussed. Chapter 6 looks at the industrial ecology practices currently being implemented at the LEIP, as well as those that are planned for the Park. Finally, in Chapter 7, an assessment of the decision to pursue covenants as the implementation tool, the choice to use a private sector developer as the management entity, and the community process surrounding the LEIP is provided.

43. Survey of Eco-Industrial Parks, Shanna Wasserman, February 2001


50. Neville Sinclair, Baltimore Development Corporation, Telephone interview, February 7, 2001

51. Neville Sinclair, Baltimore Development Corporation, Telephone interview, February 7, 2001

CHAPTER 5: IMPLEMENTING AN ECO INDUSTRIAL PARK IN LONDONDERRY, NH

This Chapter describes the process of developing the Londonderry Eco Industrial Park (LEIP). First, the local context and trends leading up to developing the LEIP are described. Second, the history of the LEIP development and planning process is catalogued. Third, the resulting LEIP bylaws are described. Finally, progress to date is depicted. The intent of this Chapter is to detail the process of developing and planning the EIP. In Chapter 6, the realization of industrial ecology practices at the LEIP is discussed, and Chapter 7 assesses the implementation strategy employed by Park planners and developers.

The Local Context for the LEIP

The Town of Londonderry was incorporated in 1722 and remained primarily an agriculture community until 1960, when Interstate 93 was built transforming Londonderry into one of the fastest growing community's in New Hampshire. The population grew from 2,000 in 1960 to 22,000 currently. Additionally, Londonderry is home to the largest area of industrially zoned land in the State of New Hampshire. Furthermore, locational advantages, such as proximity to the Manchester Airport and highway access have made Londonderry a prime location for industrial development.

While Londonderry's unique character and locational advantages brought economic opportunities and population increases to the Town, growth in Londonderry has also resulted in negative impacts for the community. For example, past industrial development created three superfund sites costing over $13 million to clean up. Furthermore, rapid residential development has stressed the community's infrastructure capacity and sprawl has threatened the Town's agricultural heritage through the loss of agricultural land, particularly apple orchards. In order to pay for growing infrastructure needs, the residential tax burden increased resulting in rates that are one of the highest in New Hampshire. In order to meet the community service needs for a growing population, the Town was, and is, interested in expanding its industrial tax base.

The need to develop an industrial tax base while preserving community character and avoiding past environmental mistakes caused the community to think about developing in a more sustainable way. In response, the Town adopted the "Sustainable Londonderry" initiative,
which “is a comprehensive plan to encourage economic growth in Londonderry while maintaining its rural quality of life.” This Initiative was implemented in several specific ways.

First, the Solid Waste Advisory Committee (SWAC) was established to educate and assist residents in recycling, waste reduction, and composting. Through the SWAC, the Master Recycler program was implemented, where community volunteers are educated in recycling. Once trained, volunteers throw eco-parties mimicking Tupperware parties in order to educate the community on ecological principles. In addition, the SWAC is sponsoring a cooperative recycling program for small businesses in order to increase the volume needed to make recycling cost effective.

Second, open space and agriculture preservation was initiated. Through the purchase of open space and agriculture land, the designation of roads adjacent to orchards as scenic byways, and the use of cluster development and zoning regulations, the Town has attempted to preserve its agriculture and open space heritage. Additionally, the Town is using a growth management ordinance to determine whether development is occurring at a sustainable rate. If growth is not sustainable, a building permit cap can be implemented. Additionally, the Town was chosen by the EPA as one of nine public agencies to participate in ISO 14000 certification.

Third, the development of an eco-industrial park (EIP) was initiated as a way to implement the type of economic development that Londonderry wanted. By developing a vision for eco friendly industrial development, the Town sought to be proactive in determining the type of industrial base it wanted. The LEIP was seen as a mechanism to do this.

History of the LEIP

The concept for the LEIP originated at the initiation of Stonyfield Farms Yogurt, a yogurt producer with a green mission and an excellent environmental track record. In 1994, a recycling company interested in utilizing wastewater from Stonyfield to clean its plastics approached the yogurt producer looking to locate adjacent to its facility. At around the same time, the Town acquired 100 acres of industrially zoned land adjacent to Stonyfield due to nonpayment of taxes. As a result, Stonyfield approached the Town in early 1995 with an interest in siting the recycling company on the newly acquired industrial land. While the deal

---

1 ISO 14000 certification is an EPA sponsored program. In order to be certified, a business or an organization must implement an EMS. ISO 14000 establishes certain standards for the EMS including documentation of an environmental policy and procedures for reviewing environmental impacts.
between Stonyfield and the recycling company fell through, the idea of waste exchange between companies blossomed leading to the creation of the LEIP.

**Initial LEIP Planning**

Conversations between the Town and Stonyfield continued, and in March 1996 the Conway School of Landscape Design (CSLD) was commissioned to develop a concept plan for an EIP on the site. The CSLD proposed 520,000 square feet of floor area that would leave a considerable portion of the 100 acres as open space.\(^{59}\)

In the summer of 1996, an Advisory Board was formed to oversee the planning efforts for the LEIP. The Advisory Board was comprised of private industry leaders, representatives from the New Hampshire Department of Health, and the New Hampshire Department of Environmental Services, as well the federal Environmental Protection Agency. Additionally, representatives from local nonprofit and environmental groups were present. Stonyfield Farms as well as the Town continued to be central players in the process.\(^{60}\)

In fall 1996 the Advisory Board created a vision statement for the LEIP. In its final form, it reads as follows:

The Eco-Park Recognizes as its primary function developing systems and processes which minimize the impact of industry and business on the environment, improve the economic performance of the member companies and strengthen the local economy. Through modeling the Park’s industrial systems on natural eco-systems, decreased environmental impact will be realized.\(^{61}\)

In addition to developing a vision statement that would guide implementation of the LEIP, the Advisory Board was interested in creating a set of covenants that would govern the development of the EIP. Protective covenants are used frequently to ensure that business and industrial parks are developed in a specified way. In the case of the LEIP, the Advisory Board decided to use covenants to implement the vision statement because it was a mechanism well understood by the business community. In fact, covenants were being used by existing industry surrounding the LEIP to protect investments and ensure a desirable mix of tenants.\(^{62}\) The next step was to design a set of covenants where ecological principles could be enforced.

While discussion over developing covenants ensued, the Advisory Board began considering whether a private developer, a nonprofit, or the Town would be the optimum management entity for the LEIP. At this time, Justin Bielagus, a private developer from Coldstream Real Estate Advisors, a Bedford, NH firm, approached Peter Lowitt, the Town
Planning Director with an interest in developing the 100-acre parcel. The Advisory Board was unsure about whether a private developer was the best entity for Park management. However, ultimately a decision to sell the land to Coldstream Real Estate Advisors was made. This decision was based on concern that in New Hampshire, a publicly managed industrial park would not be feasible. Because the political climate in New Hampshire leans toward a more free market orientation, Advisory Board members believed it would be difficult to raise the needed funds to adequately develop and market the Park. Consequently, the Advisory Board decided to sell the 100-acre parcel to Mr. Bielagus' firm.

**Continued LEIP Planning:**

**Selling the LEIP Land and Developing Bylaws/Covenants**

In September 1997, the Town entered into a purchase and sales agreement with Coldstream Real Estate Advisors, now called Sustainable Design and Development (SDD). Fifteen months later, on December 30, 1998 the agreement was finalized and the 100 acres was sold to SDD for $600,000. During the 16 months prior to finalizing the sale to SDD, the Advisory Board, which now included Mr. Bielagus, worked to develop the bylaws and covenants for the LEIP. Signing the purchase and sales agreement was contingent on reaching consensus on the LEIP covenants.

Additional planning activities were conducted during this period in an attempt to educate the private developer on the concepts of eco-industrial development, as well as to better define the goals of the LEIP. Such planning activities included a design charrette and a planning study conducted by the Yale School of Forestry and Environmental Management.

However, because the purchase and sales agreement was contingent on adopting the bylaws, Advisory Board members focused considerable energy during the summer and fall of 1998 on reaching agreement on the final set of bylaws. Attention at this point turned away from broader visioning and planning activities toward reaching consensus on what would become the implementation tool for the LEIP, the covenants. During the covenant development process, the original Advisory Board members developed a first draft of the covenants, which was submitted to SDD. However, SDD was not comfortable with the bylaws and they subsequently made changes, which ultimately the original Advisory Board members were not in favor of. By the fall of 1998, it became apparent that a third party was needed to mediate the process and assist in creating the covenants. As a result, Mintz Levin Strategies was hired by the Advisory Board to assist the members in reaching consensus on specific issues.
There were two general areas where considerable discussion occurred during this give and take process between the original Advisory Board and SDD. First, members were interested in developing bylaws with "teeth." They wanted to ensure that Park tenants would adhere to the LEIP vision. However, other members of the Advisory Board including SDD were concerned that restrictive regulations would dissuade potential tenants and make it difficult to develop the Park. Ultimately, the decision to develop a public accountability process was reached as a way to ensure compliance without additional regulations.

A second general issue of debate between Advisory Board members was the concern over confidentiality. SDD was apprehensive about requiring that potential tenants disclose information about their business practices to the Advisory Board without an assurance of confidentiality. However, public sector Advisory Board members were unable to sign a confidentiality agreement because it conflicted with legal responsibilities to disclose information to the public. Eventually, the bylaws were developed without the confidentiality requirement. However, recently the Advisory Board has been revisiting this issue.

As the debate continued, SDD faced penalties by its financing source and pressure mounted to close the sale by the 1998-year end. Mince Levin provided the mediation that resulted in a finalized set of covenants. However, because of the time constraints, the Advisory Board agreed to adopt a set of bylaws that were less than ideal. In a memo dated December 22, 1998, Mr. Lowitt stated that "this is not the document (bylaws) we all would like but in the interests of time, fairness and reasonableness we are recommending that the Town accept these documents and close by tendering a deed of the property pursuant to the Purchase and Sale Agreement between Andover Group, LLC (SDD) and its successor in interest and the Town of Londonderry." As a result, the purchase and sale agreement was signed between SDD and the Town, which committed SDD to adhere to the bylaws created. The following section outlines the LEIP bylaws that resulted.

**The LEIP Bylaws**

The culmination of the Advisory Board planning effort is a 40-page document that defines the bylaws pertinent to the LEIP. This document, called the "Londonderry Eco-Park Bylaws" (hereafter called the LEIP Bylaws) includes detailed language on the tenant approval

---

**ii** More information on the public review process is provided later in this Chapter.
process, the governance structure for the Park, the Park vision, performance requirements, and ecological guidelines and recommended practices.

**LEIP Governance Structure**

The governance structure informing the development of the LEIP includes two Boards: the Board of Directors of the Londonderry Eco-Industrial Park Association, Inc (hereafter called the Governing Board) and the Community Stewardship Board (CSB). The Governing Board is responsible for the management and control of the LEIP and is made up of CEOs from both the Members and Associate Members of the LEIP. Additionally, one seat on the Governing Board is reserved for the Town as appointed by the Londonderry Town Council.

The CSB will consist of 12 members who are appointed by the Governing Board. Once the CSB is established, the Advisory Board will be phased out. The CSB acts as an advisory body to the Governing Board. It has the authority to approve changes to the Performance Requirements and the Ecological Guidelines. Additionally, during the eco-review process, the CSB offers comments. Finally, the CSB is responsible for publishing the annual report for the LEIP.

**Vision Statement**

The LEIP vision statement defines six principles meant to inform the implementation of the LEIP. These principles include developing long-term partnerships between member firms, accountability, and pursuing a goal of continuously improving business practices in order to enhance both environmental and business performance. Additionally, the vision statement identifies land stewardship as a goal along with service to both the local community and firms within the LEIP.

**Performance Requirements**

There are five performance requirements defined in the LEIP Bylaws, which are binding and require that member firms comply in return for location within the LEIP. First, firms are required to adhere to the six principles defined in the LEIP vision statement. Second, each member must agree to participate in the annual public review process. Third, members must be committed to seeking synergies between firms. Fourth, each member must comply with federal, 

---

iii A Member is any firm that either owns land within the LEIP or leases a building within the LEIP. An Associate Member is any firm that chooses to take part in the LEIP, without physically locating within the LEIP.
state, and local regulations. Five, members must implement an environmental management system (EMS).

The performance requirements state that the EMS is a mechanism by which member firms define their own environmental impacts and set goals and objectives for improving them. Additionally, the EMS must include a description of mechanisms used to implement environmental goals. The Governing Board can modify the performance requirements. However, any changes require approval by the CSB with a 2/3rd majority.

**Ecological Guidelines and Recommended Practices**

There are ten ecological guidelines that each member must comply with so long as they are economically feasible. Each ecological guideline is equipped with a list of suggested practices, which are not binding but offer mechanisms for meeting the ecological guidelines. The ecological guidelines offer goals for improving environmental performance in the following areas:

1. Design and construction
2. Land Stewardship
3. Energy
4. Water Conservation
5. Pollution Prevention
6. Transportation
7. Regulatory Compliance
8. Environmental Management
9. Serving the Community
10. Compliance

**Eco-Review**

An eco-review is a required process for each firm that chooses to locate in the LEIP. The goal of eco-review is to assist new firms in identifying ways in which environmental performance can be enhanced. Eco-reviews are paid for by the Town through a fund set up from selling the land to SDD. There are several environmental consultants (called the Eco-Development Team) on retainer with the Town who perform the eco-reviews. During the eco-review process, the environmental consultant is supposed to review the potential LEIP member’s building and site plans as well as its business process. A report is produced documenting where the firm could improve its practices. The potential tenant is responsible for replying to the eco-review report by identifying which recommendations it can comply with.

**Ecological Coordinators**
Each member firm is required to establish an ecological coordinator, who will be responsible for implementing the firm's EMS, complying with the Performance Requirements, and the Ecological Guidelines under LEIP bylaws. In addition, the ecological coordinator is responsible for annually reviewing the Ecological Guidelines in order to insure that they are current and applicable.

**Annual Reporting Procedures**

In order to assure compliance with the performance requirements and ecological guidelines, the LEIP Bylaws require that each member firm submit performance data to the Governing Board. This performance data should include an analysis of how well each firm is meeting its self-defined environmental goals and objectives as established in their EMS. The Governing Board is responsible for compiling each member's performance data into a final document that is to be produced annually. This annual report is then distributed to the CSB, who provides comments and makes the report available to the public. The intent of the annual reporting procedure is to ensure that member firms comply with the LEIP Bylaws out of concern for their public image. However, the CSB has no authority to penalize non-complying firms, beyond publishing the annual report.

**Enforcement Mechanisms Beyond the Public Accountability**

The Governing Board, under advice of the ecological coordinators, is responsible for assuring that the member firms comply with the Performance Requirements and the Ecological Guidelines. The LEIP bylaws state that if there is "material non-compliance,\(^69\) with the Performance Requirements and the Ecological Guidelines, then the Board is required to take action. Consultation between the firm and the Governing Board is the first step to assure compliance. However, if non-compliance continues, the Governing Board can report to the CSB as well as suspending the ability for the violating firm to receive LEIP benefits. If material non-compliance continues, the Governing Board "may take such further enforcement action as it deems appropriate, including suspending the non-complying [member’s] membership rights . . . or debarring the non-complying member from one or more of the common benefits associated with membership in the Eco-Park."\(^70\) Membership rights include voting privileges and use of any common facilities or benefits developed for the enjoyment of member firms. An analysis of the LEIP Bylaws does not indicate that a non-complying firm can be removed from the LEIP based on its actions.
Progress to Date

The LEIP is now controlled primarily by SDD. The CSB and the Governing Boards have yet to be formed. The plan is for the Advisory Board to become the CSB. However, that process is on hold while the Advisory Board and SDD continue discussions on issues of confidentiality. Specifically, the developer is concerned about the extent of information that must be supplied by firms to the CSB without a guarantee of confidentiality by the Board.

In terms of business at the LEIP, there are currently three firms who own or lease land from parcels included in the LEIP. AES, a power plant owns 44 acres and is currently constructing a 720-megawatt natural gas fired energy facility. Gulf South, a medical supply distribution company opened a facility in May 2000 on a LEIP parcel adjacent to the 100 acres of contiguous eco-park land. Finally, Ride Away, a firm that transforms vans into handicap accessible vehicles, is currently expanding into the LEIP. Chapter 6 details the three firms that belong to the LEIP and the industrial ecology practices at member businesses.

Future business recruitment is the responsibility of SDD. SDD’s current strategy is to recruit firms that are looking to expand in New Hampshire by searching the classifieds to identify growing businesses. Growing businesses include those that are hiring or are in search of additional industrial space. SDD is not screening firms based on an environmental mission. Additionally, SDD plans to build three spec facilities totaling 230,200 square feet within the LEIP. SDD plans to sell and/or lease the facilities to interested firms on completion.

Conclusion

After five years of dedication and hard work, the LEIP has progressed to a point where an implementation tool has been developed and three firms have located within the Park. Additionally, as Chapter 6 details, there are industrial ecology practices occurring at the LEIP and others that are planned for the future. Chapter 7 assesses the implementation strategy employed by LEIP planners and developers, including the choice of a management entity and the use of bylaws and covenants. Additionally, Chapter 7 documents the community process for both the LEIP and AES.
CHAPTER 6:
INDUSTRIAL ECOLOGY AT THE LONDONDERRY ECO-INDUSTRIAL PARK

This Chapter explores how the Londonderry Eco-Industrial Park (LEIP) vision is informed by industrial ecology and the current IE practices being implemented. Within the context of IE, the LEIP vision statement and ecological guidelines are discussed. Next, the process of locating three firms within the LEIP and the subsequent IE practices that are occurring at the Park are detailed.

Industrial Ecology and the LEIP Vision

The vision for the LEIP is grounded in the paradigm of IE. As discussed in Chapter 2, IE is a framework for environmentalism that is "designed to eliminate the cause of environmental problems rather than to work to solve them after they become apparent." Such environmental problems as they relate to current industrial practices include unsustainable resource extraction and energy use, atmospheric emissions, solid and hazardous waste creation and removal, post-consumer product disposal, and unsustainable land use and building design practices.

Industrial ecology offers a paradigm for altering current industrial activities by encouraging firms to think about how to reduce environmental impacts before they occur.

In the Londonderry case, the concept of industrial ecology underlies the goals of the Park as stated in the vision statement, performance requirements, and ecological guidelines. The vision statement is reprinted as follows:

"The Eco-Park recognizes as it's primary function developing systems and processes which minimize the impact of industry and business on the environment, improve the economic performance of the member companies and strengthen the local economy. Through modeling the Park's industrial systems on natural eco-systems, decreased environmental impact will be realized."72

By seeking to develop "systems and processes" that lessen industry's environmental impact, LEIP planners are describing a vision with the basic goal of IE as a driving principle.

Furthermore, a set of ecological guidelines developed by LEIP planners further addresses specific industrial activities that are currently causing environmental problems. In particular, the guidelines call for more sustainable practices in the design and construction phases of development. For example, they require that firms "design-in water, energy, and building material conservation; ease of recyclability; and the utilization of low maintenance and low embodied energy building materials and non-toxic materials in construction."73 Under land
stewardship, the ecological guidelines require that firms strive to optimize native species while landscaping so that man-made disruptions are kept to a minimum.\textsuperscript{74}

Energy and water use are also directly addressed under the LEIP ecological guidelines by calling for firms to evaluate and minimize current usage wherever possible. Additionally, the guidelines require that firms implement pollution prevention mechanisms to “reduce and eliminate toxic and hazardous materials, byproducts and wastes . . . using such techniques as source reduction, raw materials substitution, production process modification, finished product reformulation, operational improvements, training or reuse/recycling.”\textsuperscript{75} Furthermore, the ecological guidelines for the LEIP oblige firms to implement an EMS “appropriate to the nature, scale, and ecological impacts of the organization’s activities, products or services.”\textsuperscript{76} The environmental impacts associated with transportation are also addressed by the guidelines where firms are encouraged to implement incentive based programs that encourage car pooling and alternative transportation choices. In terms of compliance to environmental principles, the ecological guidelines require that firms abide by government regulations as well fulfill the Eco-Park annual reporting requirements. Finally, as part of the ecological guidelines, firms are required to implement educational programs to engage community members in the mission of the Eco-Park.

Furthermore, included in the vision statement, performance requirements, ecological guidelines, and tenant approval process are expectations that member firms communicate between one another, the Community Stewardship Board (CSB), and the Eco-Development Consultants. Communication is envisioned as a mechanism to assist member firms in enhancing environmental performance by sharing ideas on ways to improve business practices. For example, ecological guidelines pertaining to design and construction and land stewardship call for discussion between the Eco-Development Consultants and the ecological coordinators for each member firm. This communication is expected to facilitate designing in sustainability measures on the front end of the development process instead of dealing with environmental impacts that result after business processes and physical development have occurred.

The LEIP vision statement, performance requirements, and ecological guidelines are built on the principals of industrial ecology. They specifically detail guidelines for ameliorating environmental impacts ranging from energy and resource consumption to pollution to facility design. It is important to note that while the environmental principles outlined in the LEIP Bylaws allude to byproduct exchange as a potential strategy for implementing IE, the focus is not on creating industrial ecosystems of the scale witnessed in Kalundborg. Instead, planners
envisioned a Park where continuous environmental improvement occurred at member firms. Environmental improvement could include anything from decreasing the impact of development on natural systems to reducing pollution. While it is too early to rigorously evaluate whether this vision has been effectively implemented, there are industrial ecology practices being implemented by three firms who have decided to locate within the LEIP. These firms have all to some degree or another begun to put into practice industrial ecology principles. The rest of Chapter 6 is devoted to a discussion of the process involved in siting the firms at the LEIP and the industrial ecology practices currently being implemented by member businesses.

The Gulf South Facility

Gulf South Medical Supply is part of PSS/World Medical, Inc. a $1.7 billion company involved in distributing medical supplies. Gulf South is responsible for the long term and home health care segments of PSS/World Medical. The Londonderry site is one of 14 national distribution centers owned by PSS/World Medical. A real estate developer, who bought the property from SDD owns the parcel where the Gulf South facility sits. In May 2000, Gulf South opened its Londonderry operation on a LEIP parcel adjacent to the 100 acres of contiguous eco-park land, which it leases from the landowner.

Gulf South and Industrial Ecology Practices

As dictated by the LEIP Bylaws, an eco-review was conducted on the Gulf South project. However, the author was not able to access a copy of this eco-review, consequently an in depth analysis of the industrial ecology practices being implemented at Gulf South was not conducted. Nonetheless, according to Mr. Bielagus at SDD, the eco-review process included a checklist that recommended changes to the physical development of the facility in order to enhance the environmental performance of the building. According to Mr. Bielagus, the developer claimed that some of the eco-review recommendations were not feasible. However, after further discussion with SDD and the Eco-Development Consultants, the developer was able to implement most of the recommendations. For example, a less environmentally damaging paint was suggested during the eco-review. At first, the developer maintained that this paint product was too costly. However, after further investigation by SDD and the Eco-Development Consultants, it was discovered that the recommended paint was actually less expensive than the original paint that the developer was planning to use.77

Additional, industrial ecology practices implemented via the physical development of the Gulf South facility include building reuse potential and siting decisions. The facility was built for the highest reuse possible, and, according to Mr. Bielagus, it can appeal to 90 percent of the
industrial market. This has the added environmental benefit of reducing the potential for demolition and waste of an existing structure. Furthermore, the facility was oriented toward the South so that the loading dock and front door faced the sun. This was done in order to decrease snow removal and salting requirements.  

Key to the story of Gulf South is the fact that a separate corporate entity was responsible for developing the Gulf South facility. The developer of the facility was not Gulf South. As a result, the initial eco-review was conducted with the building developer, and not with Gulf South itself. Because an eco-review occurred with the developer of the facility, changes to the physical development of the building resulted. However, as far as could be discerned no eco-review occurred with Gulf South to recommend improvements to their business practices.

**Gulf South and General Awareness of LEIP Requirements**

According to Mr. Bielagus, SDD agreed to allow Gulf South a two-year window before they had to comply with the LEIP bylaws. Furthermore, discussions with management at Gulf South indicate that since the time of initial facility development, firm leadership has changed. New management indicated they believed Gulf South was not a part of the LEIP. As a result, there is little awareness of the LEIP concept by Gulf South management and the two-year lull in LEIP compliance requirements indicates that implementing industrial ecology principles at the business practice level will be delayed. Except for the improvements made to the building design and site plan by the developer, Gulf South has not been involved in the LEIP.

**The Ride Away Expansion**

Ride Away is a company that transforms vans into handicap accessible vehicles. Ride Away has occupied a site adjacent to the LEIP since 1993. However, due to industry growth, Ride Away is expanding into an LEIP parcel bought from SDD in October 2000. This new structure is expected to be the main facility for Ride Away's New Hampshire operations. Ride Away's new facility is currently in site plan review at the Town office and the firm has completed the eco-review process. Ride Away plans to break ground in summer 2001 with its new facility. The following section details the eco-review and identifies the industrial ecology practices agreed to by Ride Away.

**Ride Away and Industrial Ecology Practices**

Because the new Ride Away facility is yet to be constructed, there are currently no industrial ecology practices being implemented by the company. However, Ride Away has agreed to apply industrial ecology in the physical development of its building as well as in its business practices. The eco-review process for Ride Away included 73 recommendations to
the firm's facility design and construction materials, management and operations, program maintenance, and environmental management system. Ride Away agreed to comply with 30 of the recommendations and an additional 16 with contingencies. Ride Away will further consider or investigate 21 recommendations and will not comply with 6 of them.

Out of 73 recommendations, 83 percent focus on facility design and construction materials, 5 percent concern management and operations, 15 percent center on program maintenance, and one recommendation requires Ride Away to have an environmental management system.

<table>
<thead>
<tr>
<th>Type of Recommendation</th>
<th>Ride Away Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OK w/ contingencies</td>
<td></td>
</tr>
<tr>
<td>Facility Design and Construction Materials</td>
<td>21</td>
<td>57</td>
</tr>
<tr>
<td>Management and Operations</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Program Maintenance</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Environmental Management System</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Will consider or investigate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>73</td>
<td></td>
</tr>
</tbody>
</table>

The facility design and construction materials recommendations include suggestions for the use of building products with a lower environmental impact. Such products include recycled asphalt pavement (RAP), porous pavement surfaces, recycled plastics and concrete, and building products with low levels of volatile organic compounds (VOC) and hazardous air pollutants (HAP). Additional product substitution suggestions include high quality, certified weather-stripping windows, salvaged interior doors, and certified green lumber. In most cases where product substitution is recommended, the eco-review offers contact information for local suppliers of the product. The majority of the time, Ride Away agreed to facility design product substitution recommendations contingent on supply availability and relative prices. As an industrial ecology practice, product substitution is ideal. It offers environmental benefits in the form of reduced emissions and pollution as well as increased energy efficiency.

There were four recommendations offered in the eco-review around the management and operations of Ride Away. They include suggestions for developing programs for routine site maintenance, no-salt winter snow removal, and emergency response plans in conjunction with police and fire departments. Additionally, product substitution was recommended in the form of using recyclable papers for their catalogues and inks with less VOCs and HAPs for printing. Ride Away agreed to three of these recommendations but indicated that they would
only use no-salt snow removal techniques if safety for clients and employees was not jeopardized. Furthermore, Ride Away management agreed to investigate the product substitution recommendations around catalogues and printing.

The eco-review identified eleven recommendations to Ride Away’s program maintenance. Program maintenance applies to all business activities that deal with implementing environmental practices at the firm. Recommendations ranged from educating and evaluating employees on environmental practices to developing a green procurement system. Additionally, the eco-review suggested that Ride Away define performance measures for improving environmental practices as well as interacting with the LEIP Advisory Board to learn more about sustainable business processes. Ride Away agreed to seven of these suggestions but asserted that they would only move to web-based order processing if it was feasible. Furthermore, Rideaway offered to investigate and/or consider four suggestions including evaluating employee performance based on environmental criteria, assessing what support is needed by the LEIP to assist the firm in program implementation, developing a procurement program to choose ISO 14000 certified firms, and defining a method for diffusing sustainability goals to other Ride Away facilities. Finally, the eco-review recommended that Ride Away develop and implement an environmental management system, which firm leadership agreed to without conditions.

Overall the recommendations offered to Ride Away apply to both the physical development of their facility and to their business practices. Product substitution was a popular recommendation and one that Ride Away agreed to on the whole provided it was economically feasible. Additional physical development recommendations include wetlands setbacks, landscaping with native species, and surface water management. The eco-review was helpful to Ride Away in that it provided contacts for businesses selling more environmentally friendly products.

However, the eco-review was not customized to Ride Away’s production process, energy and resource use, and waste stream. For example, the Eco-Efficiency Centre at Burnside offers customized assessments of businesses’ waste streams and energy usage. This helps businesses identify areas were waste can be reused, reduced, or sold to other firms as inputs. Additionally, an energy audit focuses management’s attention on areas where efficiency can be improved. Conversely, the eco-review for Ride Away was not customized and offered no changes specific to the firm’s business processes. This limits the potential environmental and economic impact of the eco-review. Furthermore, while the eco-review included a line item
recommending that Ride Away implement an EMS, it provided no assistance on how this should be done. Instead, the eco-review should speak to Ride Away's environmental impacts and offer suggestions as to ways that management could use an EMS to address them. Additionally, the eco-review should consider suggesting resources that are available to assist management in the process of implementing an EMS.

Ride Away and General Awareness of LEIP Requirements.

According to Mark Lore, Ride Away President, the LEIP vision and environmental principles are a fabulous idea. While Mr. Lore was supportive of the LEIP principles, he was unclear as to the administrative requirements of the LEIP, such as the commitment to be a part of the Governing Board and to establish an eco-manager. Mr. Lore indicated that besides the eco-review checklist, he has had no interaction with LEIP stakeholders around the Park vision.82

A New Energy Facility in New England: AES at the LEIP

Applied Energy Systems (AES) is an international electrical generation company with 100 plants in 19 countries and 1998 profits exceeding $185 million.83 With the emergence of a deregulated electricity industry in New England, AES was interested in locating a facility in the area. During the site location process, AES partnered with CLF Services,1 an offshoot of the Conservation Law Foundation (CLF), a New England based environmental advocacy organization. After a failed attempt to buy out existing New England electricity generators, AES and CLF Ventures discovered the LEIP site.84

Why the LEIP?

The LEIP was appealing to AES because the site conditions were advantageous and the location was within an EIP. On site, there were two interconnections to existing power lines as well as a natural gas connection run by the Tennessee Gas Pipeline. Furthermore, the AES corporation, owned by Roger Sant and Dennis Bakke has a four-point vision for the firm which includes a commitment to fairness, integrity, social responsibility, and fun. Underlying this vision is a regard for energy efficiency and environmental quality. For example, Mr. Sant is chairman of the World Wildlife Federation and demonstrates environmental concern in his personal life.85 Additionally, AES plants demonstrate relatively high standards for environmental performance, with sulfur dioxide emissions and nitrogen oxide emissions at 66 percent and 35 percent of

1 CLF Services relies less on legal mechanism to advocate for the environment but is interested in developing private sector solutions to environmental problems.
industry standards, respectively.\textsuperscript{86} As a result of the corporate mission, siting their New Hampshire facility in the LEIP was especially appealing.\textsuperscript{87}

\textit{The Permitting Process}

As a result of the locational advantages afforded to the LEIP and the principles associated with the EIP, on July 6, 1998 AES submitted an application to the State Energy Facility Site Evaluation Committee (EFSEC) to build a new power plant in the LEIP. Additionally, from December 1998 to February 1999, AES participated on an informal community process with local residents and Town officials to discuss issues related to the new facility. This group was called the Collaborative and CLF Ventures facilitated the meetings.

Furthermore, AES voluntarily went before the Town Planning Board, where community concerns were addressed and added to the permit that was eventually granted by EFSEC in May 1999. In terms of the LEIP process, AES complied with the eco-review process and in February 2000, a report was filed with the Londonderry Town office by Green Village Associates, a firm on retainer by the Town to complete LEIP eco-reviews. Because AES developed its site and building plan in accordance with LEIP performance requirements and ecological guidelines, the Green Village report has minimal recommendations. Furthermore, AES’ energy production technology and use of recycled water yielded an eco review requiring few improvements to their business processes.

However, regardless of the extensive process that AES participated in and the approval of the plan by local, state, and federal regulators, considerable community debate occurred in Londonderry regarding the value of the new power facility. Chapter 7 delves into this issue in more detail. The following section details the industrial ecology practices planned for the AES facility.

\textit{AES and Industrial Ecology Practices}

On completion, the AES Granite Ridge facility in Londonderry will be a 720-megawatt natural gas powered cogeneration facility. The facility will potentially yield environmental benefits in the areas of resource extraction, energy use, atmospheric emissions, land stewardship, building design, and byproduct exchange. Furthermore, AES will help anchor the LEIP by offering steam and heat to future LEIP tenants or neighboring firms.

\textit{Increased Energy and Resource Efficiency}

Cogeneration (also called combined heat and power [CHP]) is a technology that increases the efficiency of energy use by recovering and recycling excess heat for use to create
additional electricity. By recovering and reusing waste heat, energy use can be up to 90 percent efficient. In the case of the AES Granite Ridge facility, natural gas use will reach a 60 percent efficiency rating outpacing the New England Power Pool’s existing efficiency rating of 35 to 40 percent. Furthermore, in the spirit of industrial ecology, AES will treat and recycle four million gallons per day of wastewater from the Manchester Waste Water Treatment Facility (MWWTF) for cooling purposes.

**Improved Regional Air Quality**

In addition to a higher energy efficiency rating, the AES facility promises to improve regional air quality by using cleaner technologies as compared to coal or oil burning facilities that currently exist in New England. For example, estimations indicate that pollution control technology will result in nitrogen oxide emissions rates that are 30 times less than existing plants. Table 4 details the projected atmospheric emissions for AES as compared to average fossil fuel plants.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Annual Emissions from AES</th>
<th>Annual Emissions from Average Fossil Plant</th>
<th>Net Reduction of Pollutants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen Oxides (NOx)</td>
<td>264 TPY</td>
<td>12,488 TPY</td>
<td>12,224 TPY</td>
</tr>
<tr>
<td>Sulfur Dioxide (SO₂)</td>
<td>154 TPY</td>
<td>23,557 TPY</td>
<td>23,403 TPY</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>3,036,916 TPY</td>
<td>6,638,643 TPY</td>
<td>3,601,727 TPY</td>
</tr>
</tbody>
</table>

TPY = Tons per year

**Table 4:** AES Projected Atmospheric Emissions Compared to Average Fossil Fuel Plants

The New Hampshire Department of Environmental Services “anticipates that the construction and operation of AES Energy facility may result in a direct benefit to regional air quality. This benefit would be realized as the facility commences operation, if it displaces other facilities currently operating in the region.

**Land Use and Building Design**
The eco-review conducted by Green Village on the proposed AES facility concludes that the "reports [on building design] generated to date show serious commitment to the principles of the Eco-Park's Vision Statement and principles of sustainability which will lead to an outstanding building project if followed through to logical conclusion and if given committed support by AES management." According to the eco-review, AES plans to improve the aesthetics of the facility by integrating the building with the landscape. Incorporating vegetation into the physical design of the structure and varying the mass of the facility will do this. The building footprint will comprise an existing gravel pad and will not disturb on site wetlands. Additionally, plans indicate that off site transmission lines will not impact wetlands. Furthermore, AES will preserve 120 acres of land as conservation both on and off site. Moreover, the AES facility is being designed to take into consideration surface water control and filtration, which will reduce pollution and turbidity in surrounding waters.

**Potential Byproduct Exchange**

AES is offering to sell steam and heat to neighboring industries for $8 per 1,000 pounds, as well as reduced cost electricity to the Town of Londonderry (25 percent below market rate).

**Economic Benefits**

Economic benefits from the AES Granite Ridge Facility include 200-250 construction jobs and 30-35 permanent positions. Local tax revenues from the facility are estimated at $5 million in the first year. Currently, the top ten taxpayers in Londonderry generate a combined revenue total of $1.8 million. As a result, revenue from AES will allow the Town to lower residential tax rates, preserve additional conservation land, or improve services. Additionally, utility taxes in the amount of $1.6 million will be paid to the State of New Hampshire, which will be recycled to the local level in the form of revenue to cover education costs. The AES Granite Ridge Facility is scheduled to open commercial operations in the summer of 2002.

**AES and General Awareness of LEIP Requirements**

Plans for the construction of the AES facility and a conversation with Development Manager, Gwen Mathews indicate that AES has a significant level of understanding regarding the requirements of the LEIP. Furthermore, as witnessed by the way in which AES planned its facility in concert with the LEIP ecological guidelines; it appears that AES is committed to the Bylaws. A discussion with Ms. Mathews indicated that one of the reasons AES chose a site within the LEIP was the principles associated with the Eco-Park. According to Ms. Mathews the environmental commitment required in the bylaws resonates with the mission of AES.
Furthermore, in addition to AES' awareness of and commitment to the LEIP principles, AES plans to offer a community education program. According to Ms. Mathews, education will be a significant part of plant operations. As a result, part of the facility will house a community education center to teach residents about the energy production and how the AES facility works.

**Conclusion**

Experience to date at the LEIP suggests that industrial ecology practices in the areas of green building design and land stewardship have had the greatest environmental impact. These industrial ecology practices have been agreed to by all three firms and implemented at Gulf South. Because these practices come at the beginning of the development process, improvements to facility design and land stewardship are to be expected at the nascent stages of EIP implementation. Practice at the LEIP suggests that an eco-review process is an effective mechanism for implementing industrial ecology principles that impact building design and land stewardship. Offering suggestions on ways to improve the physical development of industrial facilities provides developers with tangible alternatives to existing designs during initial planning. However, as implementation proceeds, it appears that final tenants will need further assistance in planning and implementing IE principles that impact their internal operations.

Practice at the LEIP indicates that the potential for implementing IE principles at the business practice level depends on the expertise and resources available to the member firm. For example, plans for the AES facility offer potential for the implementation of industrial ecology practices that impact their internal operations. AES plans include the use of cogeneration technology, recycled water, and the supply of steam and heat for reuse. Such practices would improve resource efficiency, emissions levels, and offer opportunities for byproduct exchanges. While the LEIP vision played a role in facilitating ideas by AES management around these practices, the internal corporate resources available to AES in terms of financing, expertise, and green mission played a significant role in their ability to implement industrial ecology practices. For smaller firms, or less environmentally motivated, technical assistance may be required before IE principles can be integrated into operations. The eco-review is an adequate first step toward educating firms on ways to transform business practices. However, the eco-review should be informed by a customized assessment of each firm's production processes and subsequent environmental impact. Additionally, in order to transfer IE practices from the facility development stage to the operations side, it is necessary to offer an eco-review for both the developer as well as the final tenant. In that way, firm management is involved in the LEIP so that more awareness is generated at the front end.
While IE principles are currently being implemented at the LEIP and more strategies are planned for the future, the Londonderry case is still at the emerging stages of implementation. As the LEIP moves forward, several obstacles to its progression must be overcome. These obstacles are informed by decisions LEIP planners and developers made around the implementation mechanism, the management entity, and the community process for the Park. In Chapter 7, these decisions are assessed and their implications for the future of the LEIP are discussed.

Gulf South Management, Telephone interview, February, 2001


Mark Lore, President, Ride Away, Telephone interview, March, 2001


Gwen Mathews, Development Manager, AES Londonderry, Personal interview, February 8, 2001


Green Village Company, “Londonderry Eco-Industrial Park, Environmental Sustainability Review for the AES Cogeneration Facility,” February 8, 2000

Green Village Company, “Londonderry Eco-Industrial Park, Environmental Sustainability Review for the AES Cogeneration Facility,” February 8, 2000

“AES Granite Ridge. "AES Londonderry Cogeneration Steam Standard Offer Basic Terms." No Date.

Gwen Mathews, Development Manager, AES Londonderry, Personal interview, February 8, 2001

Gwen Mathews, Development Manager, AES Londonderry, Personal interview, February 8, 2001
CHAPTER 7: 
LONDONDERRY ECO INDUSTRIAL PARK: LOOKING TO THE FUTURE

The Londonderry Eco-Industrial Park (LEIP) is poised to be a leading model for operationalizing industrial ecology at the local level. There are three firms located at the LEIP who are all to some degree or another pursuing industrial ecology (IE) practices. Furthermore, a five-year planning process has resulted in a set of covenants that serve as an implementation tool for the LEIP. However, in order for the LEIP to move from the implementation stage to become a mature EIP and a model for eco-industrial development, two things must happen.

First, full occupancy at the LEIP must occur, which requires the recruitment of additional businesses. It does not appear that this requirement will be difficult to meet given that three firms have already opted to locate at the LEIP, two of which do not have a green mission. Because two firms have decided to locate within the LEIP for economic not environmental reasons, there is reason to believe that the LEIP bylaws are not overly restrictive and that the locational advantages afforded to the Park are strong enough to compensate for the additional regulations imposed by the Bylaws. However, in order for the LEIP to become a leader in the implementation of IE, another requirement must be met.

Second, the implementation strategy used by LEIP planners and developers must insure that member firms are able and willing to implement IE principles over the long term. This second pre-requisite for turning the LEIP case into a model of eco-industrial development is necessary in order to assure that the Eco-Park does not come to resemble only a traditional industrial park with a green marketing label. However, unlike the first requirement to moving forward in the implementation stage, insuring that IE principles be implemented over the long term is more difficult and requires overcoming certain obstacles.

First, the use of covenants while offering certain benefits is a limited implementation tool when used alone. Covenants are a guide to enforcement, but do not offer the leadership required to stimulate innovation in the areas of environmental practice and to insure that member firms embrace the implementation of IE principles over the long term. Furthermore, the LEIP covenants are not performance based and offer no incentives to encourage continuous environmental improvement at the business practice level.

Second, the current management structure is such that a private developer owns and manages the LEIP. While, Sustainable Design and Development (SDD) has real estate
expertise and some experience in sustainable development, the firm does not have the capacity to assist member firms in implementing IE over the long term. Additionally, as a real estate developer, SDD has a set of financial objectives that it must pursue in relation to the LEIP. Subsequently, in their role as developer, SDD has no incentive to assist firms in implementing IE or in helping to facilitate inter-firm relationships which could lead to enhanced environmental performance.

Third, the current community perspective of the LEIP and specifically of AES is not positive. While there are diverging opinions as to the merit of AES, its introduction to the Town of Londonderry has divided the community. In order for IE practices to be sustainable over the long-run, community support is required both as a way to insure additional industrial development occurs as well as to assist the Community Stewardship Board (CSB) in their attempt to regulate the LEIP members through the public accountability process.

Use of Covenants as an Implementation Tool

LEIP planners consciously chose covenants as an implementation tool for developing the Park. Planners were interested in creating an EIP that could stand as a model for other eco-industrial developments. Because covenants are widely recognized, planners believed that if they could implement ecological principals, the LEIP would become a model for the development of other EIPs. Additionally, the business community is accustomed to covenants, making them a viable choice for implementing ecological principles.97

In terms of enforcement, covenants are legally binding and are attached to the deed and lease of the property. Because of this, they insure that ecological principles are timeless. The ability to transfer the ecological principles from one property owner to another is certainly a benefit to the covenant method of implementation at the LEIP. Essentially, the LEIP bylaws are a written document that defines the rules of the game for developing within the LEIP. Nonetheless, covenants come with certain limitations that should be addressed.

Covenants are Not Environmental Technical Assistance

The use of covenants alone does not engender a high potential for the long-term implementation of industrial ecology principles at the LEIP, especially in terms of integrating IE into business practices. Simply requiring a firm to implement environmental practices does not mean that the firm will have the wherewithal to do so or the desire to continue improving its performance. Because the implementation of IE principles requires changes to existing
More specifically, the LEIP covenants require that an eco-review occur when a new firm seeks to locate within the LEIP. This eco-review, while offering environmental technical assistance at the front end, does not assist firms in their attempt to implement IE over the long-term. The checklist that recommends changes to Ride Away's facility and business practices was detailed in the areas of design and construction, to the extent that contact information for green product suppliers was provided and suggested native vegetation types for sustainable landscaping were described. However, in terms of implementing IE principles relevant to the business practices of Ride Away, the eco-review was less detailed and not specific to their business. For example, the eco-review required that Ride Away implement an EMS but gave no suggestions as to resources that could assist the firm in this process. Because many of the practices detailed in the LEIP Bylaws are new to firms and are difficult to implement, especially for smaller businesses, some type of environmental technical assistance is required to insure a sustainable commitment to IE principles.

In Kalundborg, because the industrial ecosystems evolved from private sector economic motivations and mature inter-firm relationships, no implementation mechanism was needed. However, where environmental regulations do not incentivize applying industrial ecology, and where existing inter-firm relationships do not act as a catalyst for developing innovative environmental solutions, an intervention must be used. At the Burnside Industrial Park (BIP) a dual method for implementing industrial ecology has been applied. First, the Halifax Regional Municipality strengthened the development standards governing the BIP. Applied as covenants, development standards control building and site design as well as protection of natural areas. In this respect, covenants are applied to all BIP members and are used to insure that the physical development of the industrial park occurs in a more sustainable way.

However, at Burnside an additional mechanism is used to implement industrial ecology principles specific to improving business practices. This mechanism is the Eco-Efficiency Centre. As described in Chapter 4, the Eco-Efficiency Centre acts as a source of environmental technical assistance to facilitate the implementation of IE. Receiving assistance from the Eco-Efficiency Centre is voluntary and awards are distributed to firms that demonstrate innovative improvements in environmental management. The Eco-Efficiency Centre has recruited 65 firms to the Eco-Business Program, where each firm is committed to waste reduction and
resource conservation. Results indicate that both economic and environmental benefits are the result of efforts by the Eco-Efficiency Centre. The combined method of regulation with technical assistance and an award program provides both insurance that physical development will be sustainable while assisting firms in integrating industrial ecology into their business practices.

The Burnside case highlights the effectiveness of combining various implementation techniques to create an overall strategy that implements a full range of industrial ecology principles. Covenants, as witnessed at Burnside, are sufficient to insure that green design and sustainable land use practices occur. However, when incorporating industrial ecology into the business practices of firms, covenants may not be as effective. Because a firm's business practice is dependent on a range of variables, such as the type of industry, the cost of inputs, and the management structure, firms may require individual assistance in order to implement industrial ecology. Without the institutional support of the Burnside Eco-Efficiency Centre, it is possible that Eco-Businesses at the BIP would not sustain their commitment to incorporating industrial ecology into their business practices.

**Covenants are Not Incentive Based**

Covenants alone are not an incentive based implementation method. In fact, covenants are regulatory in nature. For example, the LEIP covenants require that firms implement an EMS, adhere to performance requirements, and take part in the annual review process. If this does not occur, firms could potentially face negative publicity through the annual reporting process. However, nowhere in the LEIP covenants is an incentive based approach applied to encourage firms to implement IE.

According to the *Fieldbook for the Development of Eco-Industrial Parks*, Ernest Lowe et al states that an implementation mechanism should "seek a balance between covenants and incentives to create acceptance of shared environmental management activities [it should] emphasize voluntary solutions and incentives wherever possible." The implementation of an EIP should contain both regulatory mechanisms in conjunction with incentive based programs. Regulations, as defined by this Thesis, are implemented via local governments and/or through EIP management entities. In this regard, they can be enforced either through covenants or through local ordinances. Incentives, on the other hand, can range from technical assistance to tax abatement to rent reductions and can be implemented via local governments or the EIP management entity.
EIP planners should consider the industrial ecology practice being implemented when deciding between regulation and incentives. One particular way to decide whether regulations or incentives are most appropriate is to determine what the consequences are if a firm does not comply with the IE goal. For example, land stewardship goals, such as the preservation of wetlands, lend themselves to a regulatory implementation mechanism because noncompliance results in potentially irreversible impacts. On the other hand, energy efficiency is a process of continuous improvement, where a regulatory framework at the local level may not be effective. Instead, it is easy to imagine a scenario where an EIP member firm was able to increase energy efficiency by 5 percent given existing technology. However, due to incentives, either in the form of technical assistance or direct financial aid, the firm was able to improve energy efficiency beyond the initial 5 percent level. Incentives, in the case of energy efficiency, may be able to push firms toward continuously improving environmental performance, whereas regulations would only require a specified reduction that may or may not be the best that the firm could do. Additionally, unlike the wetland protection example, noncompliance with energy efficiency reductions at one point in time does not preclude it from happening in the future. As a result, regulations through covenants at the local level may not be as critical with regard to energy efficiency IE goals versus wetlands protection.

An additional rule of thumb regarding the use of regulations as opposed to incentives is the extent to which the IE goal can be implemented by all member firms. For example, green building design can be enforced on all new facilities being constructed or existing structures that are being retrofitted. However, byproduct exchange may not be feasible for all member firms. As a result, it is optimal to require all facilities to meet certain green design requirements while incentivizing firms to pursue IE practices, where feasible.

Finally, incentives encourage businesses to join the EIP because uncertainty regarding additional regulatory burdens is minimized. If firms know that they will, be compensated in some way for additional costs associated with increased environmental performance, they will be more likely to become members of the EIP. Consequently, wherever possible EIP planners should integrate incentives into the implementation of the Park in order to encourage membership. Again, incentives can come in the form of technical assistance so that the costs associated with changing business practices are in some way compensated. For example, an EIP could require that firms implement green design, but offer technical assistance to ensure that the developer is able to employ the techniques.
At the LEIP, planners initially thought that incentives were the preferred implementation strategy. For example, when planning the LEIP, a design charrette was conducted in 1998. Participants at the charrette concluded that performance based measures would be more successful than covenants and regulations. However, in practice the LEIP implementation mechanism is oriented toward covenants without a complementary incentive program. This regulatory choice for implementation is discouraging firms from participating in the LEIP as witnessed through the hesitation expressed by neighboring firms who are deciding whether to become associate members of the LEIP.

Felton Brush is a manufacturer of custom brush products that moved into its Londonderry site in March 1998. Felton Brush is located in close proximity to the LEIP and chose to locate at their site for business reasons. During the 1999-2000 year, Mr. Mark Godfrey, Manager at Felton Brush, attended 4 to 5 meetings of the LEIP Advisory Board. Eventually, Mr. Godfrey stopped participating in the LEIP planning process because he did not believe the Park offered any benefits that his business could use. As a result, Mr. Godfrey decided not to become an associate member of the LEIP because he could not find any benefits that the Park could offer that would compensate for the costs associated with joining. Mr. Godfrey is concerned about the costs associated with requirements to provide eco-managers by each member or associate member firm, as well as the costs of providing annual reports to the Governing Board and CSB.

Kluber Lubrication, a manufacturer of lubricants, has occupied a site adjacent to the LEIP since 1989. Mr. Glen Boyle, General Manager of Kluber Lubrication has been a member of the LEIP Advisory Board since its inception in 1996. Mr. Boyle likes the principles behind the LEIP and thinks they make sense. However, Mr. Boyle asserts that as the planning process moved forward the covenants became too restrictive. However, Mr. Boyle believes that both SDD and AES brought a needed business perspective to the discussions and he might consider joining the Park under their leadership. However, Mr. Boyle is unwilling to commit to becoming an associate member until he has a chance to review the bylaws in more depth and make sure that they are not too restrictive.

Felton Brush is unwilling to join the LEIP because management does not see any benefits associated with associate membership that outweigh the costs of joining. On the other hand, Kluber Lubrication is willing to consider membership but is uncertain about how restrictive...
the LIP covenants are. In both cases, the use of covenants alone signifies obstacles to bringing in associate members.

Analysis of the LEIP bylaws indicates that the covenants are not overly restrictive. In fact they are based on the premise that each member firm will develop its own set of environmental goals and work to meet those goals. The concept of continuous improvement is not prohibitive and in theory should not deter firms from joining the LEIP. Nonetheless, firms must still weigh the benefits of joining the LEIP with the costs associated. While the covenants are designed to be flexible, firms are still required to establish eco-managers, develop an EMS, and abide by annual reporting requirements. All of these tasks divert company resources away from their business goals and toward meeting the requirements of the LEIP. Of course there are potential economic benefits that could result from implementing industrial ecology principles. Examples include reduced input costs due to the use of byproducts, the sale of byproducts to other firms, and decreased energy and resource costs due to more efficient building design and business practices. Nonetheless, the potential economic benefits that could result from implementing industrial ecology are highly elusive and will not occur in the short term. As a result, it is more difficult for firms to consider those benefits when the costs associated with complying with the LEIP bylaws are immediate.

An incentive based program to bring firms into the LEIP and to insure that they continue to seek new and improved ways to implement IE would help strengthen the current implementation strategy employed by the LEIP. Incentives would not have to come in the form of property tax relief or even rent reductions. Instead, if the costs associated with implementing the required LEIP environmental requirements were in some way reduced, firms might be more willing to join. For example, thinking back to the Burnside case, if an institutional source of environmental technical assistance were available to help firms implement their EMS or train staff to become eco-managers, then potential members might be less unsure about joining the LEIP. Furthermore, an annual award system to congratulate firms that are implementing IE could help to insure that member businesses strive for improved environmental performance not just during the facility development phase but also throughout their tenure at the LEIP.

Covenants Lack Specific Standards

An additional weakness of the LEIP Bylaws is the lack of specific standards that dictate whether the business is in compliance. Firm management may believe that they have substantially altered their business practices and improved their environmental impact.
However, during the annual reporting process, the CSB may not agree, and, subsequently, a negative report is published. Alternatively, the CSB may agree that member firms have complied with LEIP Bylaws; however, the public may not concur with the report and instead view the firms as polluting and not welcome within Londonderry. The Bylaw enforcement mechanism, through both the public accountability report and the options available to the Governing Board for penalizing member firms, leaves room for interpretation and creates a level of uncertainty that discourages firms from joining the LEIP. Instead, as discussed previously, the awards program developed at Burnside offers a positive mechanism for encouraging environmental improvement. Alternatively, LEIP managers may want to consider developing specific standards for determining whether a firm is in material non-compliance with the Bylaws.

Choice of Management Entity: Private Developer

A management entity is a necessary and critical component to the successful implementation of IE principles at an EIP. In *Eco-Industrial Parks: A Case Study and Analysis of Economic, Environmental, Technical, and Regulatory Issues*, Sheila Martin et al identifies the following roles that the management entity must take on.

- championing the objectives of the EIP
- brokering waste materials among EIP members . . . and to organizations outside the EIP
- gate keeping, or facilitating the interactions between the EIP members and the community
- providing flexible networking for EIP members
- providing technical support and information
- providing “public” goods and services (e.g. common infrastructure, such as roads, pipelines, wastewater, and solid waste treatment facilities)102

The above list identifies both traditional real estate development duties, such as providing Park infrastructure as well as responsibilities more specific to eco-industrial development. This implies that the management entity should have the capacity to develop the Park while insuring that industrial ecology is implemented through such tactics as providing technical assistance to member firms or championing the ecological principles of the Park. However, at the LEIP the management entity is a developer with expertise in real estate development not implementing ecological principles. While SDD has the capacity to market the Park and develop the needed infrastructure, they do not have the capacity or the incentive to work with member firms on implementing ecological principles into their business practices. This limits the ability for the LEIP to move to the next level in the eco-industrial development phase, where the Park would be characterized by the long-term implementation of industrial ecology principles. In the
following section the decision to sell to the private developer is analyzed and the benefits as well as limitations to that decision are assessed.

*Decision to Sell LEIP Land to Private Developer*

After two years of planning and visioning around principles that would govern the development of a more sustainable industrial park, a decision was needed on how the park would be managed. Members of the Advisory Board were concerned about the ability of the Town of Londonderry to implement the LEIP adequately given the political culture of New Hampshire. Furthermore, Advisory Board members were interested in insuring that the LEIP would be implemented and in order for that to occur they believed economic feasibility should be a priority. As a result, Advisory Board members decided to sell the land to SDD.

Prior to bringing SDD into the LEIP planning process, Advisory Board members were involved in a visioning process for the ideal eco-industrial park. Ideas for the LEIP included developing mass transit and hiring locally so that there would be fewer commuters. EPA Advisory Board members were interested in pushing the envelope on moving companies to go beyond compliance with existing environmental regulations. Paul Lockwood of the New Hampshire Department of Environmental Services (NHDES) was interested in seeing firms implement pollution prevention strategies. The initial visioning around the LEIP involved brainstorming over what industrial ecology practices should be implemented in Londonderry.

However, the Advisory Board members were also committed to creating an economically feasible Park. As a result, the group faced the difficult task of developing an implementation strategy that would be economically feasible; yet still offer the promises of industrial ecology. Ultimately, Advisory Board members concluded that if the LEIP could attract a private developer, while still insuring IE principles would be implemented then the Park would be a success. Consequently, it was decided that the LEIP land should be sold to SDD contingent on the development of bylaws that would enforce the ecological principles. Mr. Lockwood of NHDES explained that the EIP fantasy turned to reality once Mr. Bielagus' firm was brought into the LEIP planning process. Furthermore, Mr. David Guest of the EPA likened the introduction of a private sector developer to taking a cold shower. With the introduction of SDD into the planning process, the focus of discussions changed from environmental visioning to negotiating the covenants. This change, while dampening the excitement around visioning, provided the impetus to move the LEIP from the planning stage to that of implementation.
The resulting management structure is one where the private sector, through either SDD or the member firms, is authorized to admit new tenants and enforce the LEIP bylaws. While the CSB retains an advisory status and the authority to publicize the annual report of the LEIP, it does not have control over the acceptance of new firms into the LEIP or the enforcement of non-complying member firms beyond the public accountability process. The LEIP Bylaws are written such that SDD retains control over the affairs of the LEIP until the last parcel is sold or leased to a firm. During the period where the developer is in control, SDD retains sixty-six and two-thirds percent of the total voting power of the Governing Board, while the Town is permanently allotted one seat on the Governing Board. Once SDD relinquishes control over the LEIP, the Governing Board, which is made up of members and associate members of the LEIP (as well as one member appointed by the Town), becomes the controlling body. Consequently, during the critical period when new firms are coming into the LEIP, SDD is in control of the Park. Once the LEIP reaches full capacity, the LEIP members will have to create their own management entity through the Governing Board.

The Management Structure in Practice

The intention behind the established management system was to create a privatized EIP where the Town would still remain linked to the Park. The goal was to "create a governance and management structure that assures the park remains an Eco-Park."107 While some form of LEIP privatization was critical given the political realities of New Hampshire, the choice of a private real estate developer as the management entity of an eco-industrial park limits the ability for industrial ecology to be implemented especially in the long term. Because the manager of an eco-industrial park is required to be more than just a property manager, an organization with a stake in seeing that industrial ecology is implemented should have been chosen as the management entity. The following section details evidence of the limitations inherent in using a private real estate developer as the management entity for the LEIP.

SDD's Sustainability Philosophy and LEIP Management Practices

Mr. Bielagus at SDD terms his theory on sustainable business practices ecolonomics. Mr. Bielagus defines ecolonomics as "the intellectual process of combining rational ecological practices with sound economical principles to maximize facility utilization and profitability." Ecolonomics, according to Mr. Bielagus, involves rethinking the way in which a company develops its facility or produces its product so that ecological principles are considered.108 Ecolonomics is compatible with notions of industrial ecology and is the result of a learning process that Mr. Bielgaus has gone through to understand sustainable business practices.
In practice, SDD through Mr. Bielagus has been involved in improving the facility designs for Gulf South and Ride Away. Implementation of ecologonomics by SDD has come in the form of improvements to the physical development of facilities at the LEIP. Because real estate development is Mr. Bielagus' expertise, recommending changes to the physical development of LEIP facilities is a natural place for SDD to apply notions of ecologonomics. However, when it comes to assisting firms with the implementation of their EMS, the reduction of their wastes or pollution, and the introduction of waste exchange opportunities, SDD, as a real estate development firm is not equipped to provide this sort of technical assistance.

SDD's lack of capacity to assist firms in implementing IE at the business practice level is evidenced by the Gulf South case. While the covenants require that LEIP firms implement an EMS along with other ecological guidelines, the developer was able to grant Gulf South a two-year hiatus before these covenants would be enforced. In this particular example, SDD was not only lacking in its ability to assist Gulf South in implementing IE, but they allowed the company to diverge from the agreed upon Bylaws. While SDD has done their share to incorporate green design principles into the development of the Gulf South facility and the soon to be constructed Ride Away expansion, there has been no leadership by SDD in assisting firms in the implementation of industrial ecology at the business practice level.

In addition to its management role in the implementation of IE practices, SDD is responsible for business recruitment and marketing the LEIP both in terms of its economic potential and environmental principles. SDD's current business recruitment strategy is to market the LEIP to all firms, regardless of green mission. Mr. Bielagus is particularly interested in marketing the LEIP to businesses that are expanding and are in need of additional industrial space. In order to find those firms, SDD uses the classified adds to determine which firms are hiring and looking for new facilities. Because SDD is not marketing the LEIP specifically to green oriented businesses, discussing the IE principles with new recruits is critical to insuring that they are willing to comply with the covenants.

However, in a discussion with Mr. Bielagus, he described his process for marketing the LEIP. According to Mr. Bielagus, when contacted by a potential firm, he discusses the locational advantages afforded to the LEIP and does not mention the LEIP bylaws until much later. Mr. Bielagus described his strategy as one where the sustainable principles become the "icing on the cake." In fact, Mr. Bielagus chooses to play down the role of the LEIP bylaws and industrial ecology principles when discussing the Park with potential businesses. While this
approach may guarantee that Mr. Bielagus is able to sell or lease all property at the LEIP, it
does not help to indoctrinate new firms to the industrial ecology principles required of them as
Park members. As a result, new firms may not be committed or even knowledgeable about the
LEIP bylaws.

SDD is a private real estate development firm that is interested in realizing a return on its
investment. As a result, to the extent that they can sell all parcels in the Park or lease out newly
constructed facilities, they will be meeting their financial objectives. As should be expected,
SDD has no incentive to insure that the LEIP Bylaws are complied with, and that the industrial
ecology principles are implemented and practiced by firms. Without an organization with a stake
in insuring that industrial ecology is implemented at the LEIP, there can be no guarantee that it
will happen, especially in the long term.

In addition to the inadequate role a private real estate developer plays in the
implementation of industrial ecology, the same can be said for their ability to generate inter-firm
relationships. As witnessed by the Kalundborg example of creating industrial ecosystems, the
development of relationships between member firms is critical to creating complex linkages that
offer environmental benefits. Furthermore, where highly mature byproduct exchanges are not
feasible nor desirable, relationships between EIP members are still critical in developing
innovative solutions to environmental problems. As revealed by the Burnside case, the Eco-
Efficiency Centre has been a catalyst to developing relationships between firms so that waste
exchange can occur as well as other more mundane approaches to environmental
management, such as recycling wooden pallets between businesses. However, there is no
reason to believe that there would be any incentive for a real estate developer to endeavor to
create such relationships between LEIP firms. SDD is in control of the LEIP until the time that
all real estate is sold or leased and has no interest in seeing that firms begin to develop
relationships that could lead to more meaningful industrial ecology practices.

The Decision to Sell – Looking Back

The choice to sell the LEIP land to SDD and to create a private sector management
entity has reduced the potential for industrial ecology principles to be integrated into member
firm's business practices over the long term. SDD has little capacity to assist firms in the
implementation of IE especially beyond the facility development stage and has no incentive to
help develop inter-firm relationships that could facilitate additional environmental benefits. As
witnessed by Mr. Bielagus' marketing strategy, he is not championing the ideas of the LEIP to
potential firms. Furthermore, while espousing his commitment to ecolonomics in publications for the New Hampshire Business Review, SDD is not an environmental consultant. As a result, there are limitations to their ability to nurture and develop industrial ecology practices at the LEIP. Furthermore, in a personal conservation with Mr. Bielagus, he informed the author that he is pushing forward the design of new spec facilities for the LEIP in order to insure the plans are approved prior to the passage of a wetlands ordinance that would limit the amount of buildable space allowed at the LEIP. This type of activity is to be expected from a private developer. However, because an eco-industrial park requires a commitment to the principles of industrial ecology, the management entity should be embracing new strategies to improve land stewardship not trying to undermine them.

While the Advisory Board's motivation to sell to a private developer was valid, other forms of ownership, characteristic of a public-private partnership could have been used. For example, the Town could have retained ownership of the land but partnered with a New Hampshire University to offer the environmental technical assistance required to assist new firms in the implementation of industrial ecology. However, if the Town was adamant about relinquishing its ownership status, the least it could have done would be to open the sale up to a competitive bidding process. In a request for proposals (RFP), the Town through the Advisory Board could have outlined the type of development it desired and sought qualified developers or environmental organizations with a commitment to industrial ecology. However, none of these options were seriously explored and the LEIP was sold to SDD, a real estate developer with no prior experience in eco-industrial development. By doing so, the LEIP is limited in its ability to insure that industrial ecology will be integrated into the business practices of member firms in both the short and long terms.

**Community Support and Education**

In order for the LEIP to move from its current implementation stage to become a model of eco-industrial development, the general perception of the LEIP in the community must be improved. Negative public opinion of the LEIP could lead to a general disapproval of future industrial projects at the Eco-Park. Furthermore, because the public accountability process at the LEIP uses the threat of negative public opinion as a mechanism to insure compliance with the ecological principles, community members must be educated on industrial ecology principles. Additionally, when the annual report is published by the CSB, community members must be willing to accept its legitimacy and react as expected, either by voicing disapproval at non-complying firms or by congratulating those with improved environmental performance.
However, due to the controversy surrounding the siting of the new power plant, there is currently no consensus in the community regarding the legitimacy of either AES or the Eco-Park. As a result, it is uncertain how the public would react to an annual report. Public opinion is severely divided over the merits of AES, and this is casting a shadow over the LEIP. Regardless of whether community members support AES or not, there is a general sense that the power plant has disrupted the lives of Londonderry residents by becoming a very divisive issue. As a result, there is potential for future projects at the Eco-Park to be contested and little hope that the residents will act as a public opinion mechanism to assist in enforcing the LEIP Bylaws.

In this section the community process and controversy surrounding the siting of AES is described. Next, the controversy is assessed in retrospect to identify lessons that could be learned by other EIP planners. Through this assessment the LEIP community process is evaluated.

The Community Process - AES

The permit granting authority for building an energy facility in New Hampshire is the Energy Facility Site Evaluation Committee (EFSEC), a State agency. The logic behind establishing State authority to permit utility facilities is derived from the desire to combat NIMBYism\(^1\) in regards to siting what tends to be an unwanted land use. However, in addition to undergoing State review for the new energy facility, AES chose to conduct a public process in Londonderry around the new power plant, as well as to go before the Town Planning Board. The resulting permit for AES has contingencies attached to it based on Town and community concerns. The following list identifies some of the critical issues that the AES permit requires as a result of the community process.

- Safety planning and emergency response programs, including an oil spill response plan
- Plume abatement technology
- Treatment of water from the Manchester Waste Water Treatment Facility used for cooling purposes
- The provision of financial support for any technical assistance required by the Town as a result of the AES facility
- Location of transmission lines within a forested buffer to minimize visibility
- Offer low-cost steam to other LEIP members
- 110 acres of land shall be dedicated as conservation

---

\(^1\) NIMBY stands for Not In My Backyard and is a term used to describe public sentiment that wishes to stop certain types of growth in development near residential neighborhoods.
CLF Services facilitated a community process between Londonderry residents and AES in regards to the new power plant. This group was called the Collaborative, which met monthly and then bimonthly for about one year. The Collaborative was made up of 15 members from Londonderry neighborhoods (including residents adjacent to AES), the Londonderry Conservation Commission, the LEIP Advisory Board, the Clean Water Action and Clean Water Fund, the Audubon Society of New Hampshire, the Attorney General's Office of New Hampshire, the Appalachian Mountain Club, the Iron Workers Local 474, and AES as well as CLF Services staff. Eight of the 15 participants represented Londonderry residents. During the course of the Collaborative, issues discussed included air emissions, conservation land, viewsheds, traffic impact, noise levels, fire and safety, residential property values, and regional air quality impacts. Consensus was not reached on all of these issues. However, the approach at Collaborative meetings was to bring in expert speakers to discuss reports and issues related to AES. As a result, residents and other participants of the Collaborative where educated on the complex issues surrounding the proposed power plant.

The Collaborative provided a vehicle for Londonderry residents to discuss the planning of the AES power plant. By creating this community process, AES offered residents the opportunity to comment on the power plant before public hearings at EFSEC where conducted. This type of public process is more advantageous to the community because concerns are heard prior to the finalization of plans. While this type of community process lends legitimacy to planning for the AES power plant, the fee structure set up between CLF Ventures and AES is suspect. CLF Ventures was paid a $1.5 million fee from AES for legal and consulting services. However, the fee was contingent on AES being permitted. This concerned many residents because they believed that CLF Services was not acting as an objective facilitator of the AES community process.

Controversy Over AES

Regardless of the community process initiated by AES and CLF Services around the new power plant, the issue became a divisive one. Opposition to the new AES facility is led by the Londonderry Neighborhood Coalition (LNC) a resident-based community group that opposes the plant. The LNC is a non-profit organization with a mission to “to enhance and protect the quality of life in our town - not only for our members, but also for all the residents of
Londonderry, New Hampshire." LNC's current activities are centered on opposing the soon to be constructed AES facility.

Opposition to the plant is the result of environmental concerns including atmospheric emissions, the cleanliness of the vaporized recycled water, potential effects of electromagnetic fields, the storage of petroleum fuel, noise levels, visibility impacts from the vapor plume, and a decrease in property values. Additionally, an interview with Dr. David Wallace, who was elected to Town Council in 1998 on the basis of his position against AES, as well Londonderry residents Patrick Barry and Ken Barton indicate that there is a lack of trust between the community and AES as well as the Town. Mr. Barton claimed that he was "unsure whether the LEIP could justify its eco name, because it is starting with AES a polluter." Furthermore, Mr. Barton asserted that the Town has not been forthright in supplying information. Mr. Barry maintains that the "EIP is a tool to sneak in a fossil burning plant under the name eco-development." Finally, Dr. Wallace alleges that AES is a scam and a tragedy for the Town and he believes that AES staff along with Town officials are dishonest, incompetent and unethical.

Less militant concerns over the AES power plant were also recorded. Londonderry resident Howard Curtis wrote that he was concerned over the lack of host community fees offered by AES, the low tax assessment that AES felt reflected the value of their facility, and the environmental review being conducted by State of New Hampshire environmental officials instead of independent engineers.

However, Londonderry residents also organized in support of AES calling themselves the Londonderry Coalition for AES, which was led by James Finch. The Coalition is made up of about 1,000 Londonderry voters who are in support of the AES power plant. Support for AES is based on the promised increase in property taxes resulting from the new plant as well as the potential for cleaner air that would result from substituting existing electrical sources with AES power. Mr. Finch stated that he organized the Coalition in order to insure that AES received a fair hearing in the Town of Londonderry. Other AES supporters included Town Councilor Mark Oswald, who believes that AES will benefit the community through increased tax revenues and will also act as anchor for bringing in additional businesses to the LEIP. Mr. Oswald stated that he believed the State regulators would determine the environmental impacts of the plant, and because they approved it, then he supported the plant. Former Town Councilor, Larry O'Neil also supports AES for economic reasons and is not convinced of its environmental
threat.\textsuperscript{121} Other organizations who publicly support the new power plant are the American Lung Association of New Hampshire, the Londonderry Conservation Commission, the Manchester Union Leader, the New Hampshire ALF-CIO, and the Londonderry Budget Committee.\textsuperscript{122} Additionally, members of the Advisory Board for the LEIP have been in support of AES as well as Town planning officials.

The community debate over the AES power plant led to a non-binding referendum in March 1999 where 55 percent of the turnout voted in opposition to the power plant.

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|}
\hline
Ballot Response & Votes Cast & \% of ballots used & \% of registered voters \\
\hline
Yes & 2,468 & 44.69\% & 17.84\% \\
\hline
No & 3,039 & 55.02\% & 21.97\% \\
\hline
Blanks & 16 & 0.29\% & 0.12\% \\
\hline
Total & 5,523 & 100.00\% & 39.93\% \\
\hline
\end{tabular}
\caption{AES Non-Binding Referendum – March 9, 1999}
\end{table}

Registered Voters = 13,833
Ballot Forms Used 5,523
SOURCE: Analysis of Town Election from Londonderry Office of Planning and Economic Development

In addition to the non-binding referendum, the AES issue has dominated local politics since 1998, when the company began discussing plans to locate in Londonderry. This is witnessed through the changing opinions and make up of the Londonderry Town Council. The original Town Council supported AES unanimously. However, beginning in 1998, the tides began to turn and two Town Councilors, Arthur Rugg and Dan Vecchione, were voted out of office because of their position in support of AES. A third Councilor moved from the Town, and a fourth, Andrew Greco, changed his opinion in support of AES after the results of the non-binding referendum. Consequently, by the year 2000 the Town Council was composed of three members in opposition to AES and two in support. Those in support of AES included Mark Oswald, who ran on a platform advocating for the power plant during the 1999 election, and Larry O'Neil, who remained from the original Town Council. Against the power plant was newly elected Dr. David Wallace, Martin Bove, and Andrew Greco.\textsuperscript{123} However, in the March, 2001 election Tom Dolan, an AES supporter, was elected to the Town Council, as well as John
Silvestro, who did not base his election platform on the AES plant. Furthermore, Dr. David Wallace, a starch opponent, was not re-elected during the March, 2001 election and Ken Barton, an opponent of AES, was not elected to the Town Council. 124

Both the non-binding referendum and the change in Town Council make up and opinion indicates the far-reaching impact that AES has had on the political climate of Londonderry. The results of the referendum indicate that opposition exists beyond the abutting neighbors. However, it is important to note that the outcome of the referendum was based on 39 percent of registered voters in Londonderry and does not include all Town opinions. Additionally, opposition to the power plant organized a demonstration against AES on the day of the referendum. According to James Finch, a supporter of AES, the opposition resorted to extreme tactics where opponents wore gas masks to demonstrate the impacts AES would have on human health. 125 As a result, Mr. Finch believes that the referendum may reflect the public's fear of a new energy facility but not an educated opinion of its actual impacts. Nonetheless, at a minimum, it is clear that the referendum indicates that the Town is divided over whether the AES facility should be built in Londonderry.

Furthermore, opposition to the plant was able to generate enough political support to transform the opinion of the Town Council from unanimous support to a three to two stance in opposition to the plant. However, results from the recent election indicate that the political force of the opposition may be waning, due to their inability to re-elect Dr. David Wallace and elect Ken Barton to the Town Council. Instead, Tom Dolan, an AES supporter was elected.

In addition to the electoral implications that resulted from AES, the new power plant has ramifications for the Town in terms of its divisiveness. Discussions with Town Councilors and Advisory Board members, as well as Londonderry residents indicate that AES has been a disruptive topic in their lives. Several interviewees mentioned that they have lost friends over the disagreement. The divisiveness of the issue was illustrated during a rally against the AES facility, when supporters and opponents faced off. According to the Union Leader, "At one point, a Londonderry police officer had to step between two residents who had begun to disagree violently over whether the plant would benefit the Town or not." 126 While public participation in community issues is a positive trend, this type of public dialogue is not necessarily healthy when it results in community tensions and an inability to reach any level of consensus.
How could the Town of Londonderry become so divided over a power plant proposal? There is no simple answer to this question. However, key to thinking back on the controversy surrounding AES is understanding that educated, thoughtful people on both sides of the debate came out with differing opinions. After evaluating similar documents, members of the Londonderry community came out on opposing sides of the AES issue. This indicates that the science of environmentalism is much more political than one might initially think. While Advisory Board members and some Town officials believe AES represents a viable addition to the LEIP, opponents of the power plant are adamant that it is a polluting and undesirable land use. Some opponents have taken issues further by condemning public officials, AES staff, and LEIP planners for alleged corruption and unethical behavior.

However, the purpose of this Thesis is not to determine the environmental impacts of AES nor is it to substantiate either side’s position. Instead, this thesis attempts to understand how the incorporation of a power plant into the planning and development of an EIP led to considerable public controversy and to discern the implications that controversy has on the future of the LEIP. In doing so, the community process surrounding the planning of the LEIP is assessed and evaluated in terms of how it might have lessened the impending AES controversy.

Community Process and the LEIP

The community process that was part of developing the LEIP was minimal and according to Peter Lowitt, former Londonderry Planning Director inadequate. During initial LEIP planning, an Advisory Board subcommittee developed a community process. The goal was to identify contacts in specific neighborhoods and set up meetings in order to facilitate community teas around planning for the Eco-Park. However, given limited resources and existing obligations at the Planning Department, the process never took off. Instead, what resulted was a set of public invitations to attend several planning presentations and activities. These activities included all Advisory Board meetings, a presentation of the Eco-Park idea at Stonyfield Yogurt, and a presentation of the Conway Report at Town Hall. Furthermore, community members were invited to the 1998 design charrette where a discussion occurred around the type of businesses to include in the EIP. At this meeting AES attended and asked whether a utility company would be welcome and attendees indicated that it would.

As Peter Lowitt described, the community process was inadequate. Because an eco-industrial park is a new concept for integrating sustainable principles into industrial development
and business practices, it requires a certain level of understanding regarding the principles of industrial ecology. The first step in a community process surrounding eco-industrial development should be to educate the public on what industrial ecology is and how it could be implemented in their community. By inviting residents to witness presentations on plans for the LEIP, the process moved too fast without first educating residents on the principles of industrial ecology and the potential development that could occur on site. While the design charrette was an optimal time to do this, the participants were all members of government agencies, private industry, environmental organizations, or consultants. None of the adjacent property owners, who were invited to the charrette attended. Whether it was because the charrette was seen as a planning mechanism and did not represent an eminent development proposal, or because the charrette was held on a weekday during working hours, community residents did not attend. As a result, an opportunity to educate residents on the LEIP model was lost.

An EIP Might Include a Power Plant

Eco-industrial development is meant to enhance the environmental performance of industry. In educating communities about EIPs, it is important to emphasize that the economic development focus will be on industry, not on the creation of an office park or a commercial land use. An EIP is not a place for high tech research and development firms or other information or service oriented businesses. Instead, an EIP is an environmentally enhanced version of a traditional industrial park. Industrial parks tend to be made up of businesses involved in the distribution and production of energy and goods. Industrial parks may include manufacturing firms emitting varying degrees of noise, odor, or smoke, or they might also include power plants or warehousing and distribution businesses. An EIP is a model for turning the traditional notion of an industrial park into a group of industrial businesses that are obtaining higher levels of environmental performance. Applying industrial ecology principles to firms in an EIP may improve the firm’s impact on surrounding land uses by decreasing pollution and reducing noise. However, the EIP model is not meant to change the land use from industrial to office or commercial. For example, one Londonderry resident indicated that they believed high tech would be a viable alternative to the AES power plant. Another resident mentioned that by bringing in a power plant to the LEIP, the industrial mix would become too dirty. However, the goal of an EIP is to improve the environmental performance of industry. As witnessed at Kalundborg, the power station is a key component of the EIP’s industrial ecosystems. While the community’s concern over the power plant are valid in so far as they relate to the impacts neighborhoods might feel, residents must be aware that the LEIP is not a mechanism to rezone
industrial land to commercial or office. Had the community process surrounding the LEIP been more about education around industrial ecology and the potential industrial mix, possibly some of the backlash against AES might have been thwarted.

Nonetheless, even if the Londonderry planning staff had been equipped with enough resources to launch a viable community education initiative, residents may not have reacted until the point in which a development was eminent. It is natural for communities to become responsive and even antagonistic once a particular development is actually occurring. However, during the planning stages residents do not see an immediate threat and are less likely to become involved. Consequently, while a more extensive community process may have resulted in more residents being educated on the principles of industrial ecology, it may not have halted the negative reaction to AES once the plans became reality.

AES Controversy – Implications for the LEIP

It is healthy for residents to be outspoken about issues that involve them and to participate in decision-making; however, the debate about AES in Londonderry has not been entirely productive. While opposition to the plant has resulted in specific modifications of AES’s facility design and production processes as discussed earlier in this Chapter, the debate has also been rather polarizing. This has impacts for the LEIP in two particular areas; future industrial development at the LEIP and the feasibility of using the public accountability process for enforcing the LEIP bylaws.

Future Industrial Development

Several stakeholders in the community, including Former Town Councilor Larry O’Neil and AES supporter James Finch mentioned that if it were not for AES, the LEIP would be viewed more favorably. While there has not been any community fallouts from the incorporation of Gulf South and Ride Away into the LEIP, there is potential for future industrial projects to be opposed by residents. The lack of trust many members of the community feel toward Town officials and LEIP planners could feed potential resistance to future industrial developments, especially if future businesses represent heavy manufacturing.

Public Accountability Process

According to LEIP bylaws, every year the CSB is required to publish an annual report detailing the performance of member firms based on a set of criteria each business sets. If a particular firm fails to work toward its environmental goals, the annual report will document that. The intention behind this process is to insure that businesses, out of concern for public image,
will adhere to the LEIP bylaws. Underlying this enforcement mechanism is the assumption that the public will be responsive to the annual report. If an overall negative perception of the LEIP exists, there is no guarantee that the public will respond to the CSB report. Furthermore, because some members of the community are distrustful of Town officials and LEIP planners as a result of AES, there is potential that residents will not believe in the legitimacy of the annual report. For example, if the CSB reports that AES has met all of the requirements under the LEIP bylaws, given existing public opinions, there is no assurance that the community will react positively toward the power plant.

By establishing an enforcement mechanism that requires public involvement, the Advisory Board set the LEIP up to be accountable to the community. This is a positive relationship that could insure a long-term commitment by both the community and member firms to the LEIP. However, in order for it to be effective, public perceptions of the LEIP and those in charge of the LEIP must become more positive. In order for this to occur, the community must come to some consensus over the merits of AES and what can be expected from them. Furthermore, the Advisory Board must take a leadership role in educating the residents of Londonderry on the concepts of industrial ecology and the ways in which AES will fit into the LEIP. These ideas are explored in more detail in Chapter 8 when specific recommendations are suggested for the LEIP as the Park moves forward in the implementation stage.

Conclusion

This Chapter explored the obstacles facing the LEIP as it moves from the implementation stage to that of a mature model of eco-industrial development. Key to moving forward as an EIP is insuring that the LEIP has earned and continues to earn its green label. If the LEIP becomes a traditional industrial park with only a name to link it to industrial ecology, it will do a grave disservice to eco-industrial development in general. Because the concept is an innovative approach for communities, planners, and policymakers to define what type of industrial development they want to see, any industrial parks that consider themselves and EIP must truly be informed by industrial ecology. Otherwise, the model will lose legitimacy and will be perceived as a defunct environmental strategy that uses a green name to market itself.

While progress has been made at the LEIP, in the future, three obstacles need to be addressed in order for the LEIP to become a legitimate model of eco-industrial development. First, in terms of implementation the LEIP must provide environmental technical assistance to member firms in addition to the use of covenants as an implementation tool. Second, while
SDD offers the LEIP needed real estate development skills, an additional organization is needed to manage the LEIP and assist in the implementation of industrial ecology. Third, the community perception of the LEIP and of AES must be improved in order to increase the potential for future industrial development at the LEIP as well as to insure that the public accountability process defined in the LEIP bylaws works properly. Specific recommendations on how all three of these issues should be dealt with are provided in Chapter 8.


Mark Godfrey, Manager, Felton Brush, Telephone Interview, February 16, 2001


Peter Lowitt, Former Planning Director, Town of Londonderry, Personal interview, January 16, 2001

Anne Fenn, United States Environmental Protection Agency, Telephone interview, February 2001

Paul Lockwood, New Hampshire Department of Environmental Services, Telephone interview, February 22, 2001

David Guest, United States Environmental Protection Agency, Telephone interview, March 23, 2001

"Presentation of LEIP Status." Town of Londonderry. No Date


Alan Wilson, Vice President, Conservation Law Foundation Services, Personal interview, February


Nancy Hirchberg, Stonyfield Yogurt, Group discussion, November 2000


Ken Barton, Londonderry resident, Telephone interview, March 2000

Patrick Barry, Londonderry resident, Telephone interview, March 7, 2001

David Wallace, Former Londonderry Town Councilor, Telephone interview, March 2001

James Finch, Londonderry resident, Londonderry for AES, Telephone interview, January 17, 2001

Mark Oswald, Chair, Londonderry Town Councilor, Telephone interview, March 2001

Larry O'Neil, Former Londonderry Town Councilor, Telephone interview, March 5, 2001


Andre Garron, Planning and Economic Development Director, Town of Londonderry, Personal interview, January 16, 2000; Telephone Interview, Mark Oswald, Chair, Londonderry Town Councilor,
Larry O'Neil, Former Londonderry Town Councilor, Telephone interview, March 5, 2001; David Wallace, Former Londonderry Town Councilor, Telephone interview, March 2001.; Szczesny, Dan J. “Anti-AES Gathering Leaves No Doubt of Mood.” *Union Leader.* No date.

124 Mark Oswald, Chair, Londonderry Town Councilor, Telephone interview, March 2001; Town of Londonderry, web site, [www.londonderry.org](http://www.londonderry.org), April 11, 2001

125 James Finch, Londonderry resident, Londonderry for AES, Telephone interview,

126 Szczesny, Dan J. “Anti-AES Gathering Leaves No Doubt of Mood.” *Union Leader.* No date.


CHAPTER 8:
CONCLUSIONS AND RECOMMENDATIONS

Chapter 8 of this Thesis offers conclusions and recommendations around implementing industrial ecology through the eco-industrial park (EIP) model. First, conclusions are drawn about EIP current practices. Next, based on key findings from this Thesis, recommendations to EIP local planners, developers, and managers are made. Third, specific action items for the Londonderry EIP (LEIP) are identified. Finally, Chapter 8 returns to the notion of industrial ecology as an alternative paradigm for environmentalism. With this in mind, recommendations to national level policymakers on how to facilitate industrial ecology (IE) practices are offered.

Conclusions

Research on Kalundborg, North American EIPs, and the Londonderry EIP has resulted in several conclusions regarding current EIP practices. First, the only mature EIP development exists in Kalundborg, Denmark and EIP development in North America is nascent. Second, industrial ecology practices are occurring both at virgin-EIPs and with existing businesses. Third, there are four distinct IE practice areas being implemented through the EIP model. These areas are land stewardship, sustainable building design, individual firm environmental practices, and inter-firm byproduct exchanges. This taxonomy of IE practices has implications for the design of EIP implementation strategies.

An Overview of the EIP Experience

Kalundborg, Denmark offers the only mature example of EIP development. In North America, EIP development is nascent and complex. Out of twelve EIPs where information could be obtained, five Parks have failed to move out of the planning stage and are no longer attempting to operationalize industrial ecology. Furthermore, two of the twelve EIPs remain in the planning stage, while an additional five are currently implementing industrial ecology to some extent. No Park in North America is at the stage where a mature EIP exists and industrial ecology practices have been sustained to the extent of Denmark. However, the Burnside Industrial Park (BIP) is close to reaching that point.

Eco-Industrial Development: Virgin EIPs and Existing Businesses

Practice indicates that IE principles are being applied via the development of new EIPs or through a transformation of existing industrial parks. Virgin-EIPs are attempts to attract new industry to sites and implement IE practices during the physical development of facilities and
within business practices once firms have located at the Park. This model is exemplified by the LEIP case. Alternatively, the EIP model has been employed at industrial parks, where the implementation of IE occurs with existing businesses. This model is highlighted through the Burnside and Baltimore cases. When working with existing businesses, IE practices focus on changes to internal business operations and less on the physical development of industrial facilities. However, practices at the BIP and the FEBP indicate that new firms must adhere to stricter design and development standards. Indeed it is worth appealing to existing industrial businesses before, or while, attracting new firms to an EIP. It is advantageous to implement IE with existing businesses while working with new recruits on sustainable physical development both for environmental and implementation reasons. In addition to the expanded environmental benefits that result from extending IE to existing industrial firms, it lends credibility to notions of IE because new recruits witness IE practices in action.

A Taxonomy of IE Practices

A key finding in this Thesis is the notion that there is a taxonomy of IE practices with various specific implications for implementation. Through evidence from existing EIP practice, there are four specific ways that the goals of IE are being implemented. These four practice areas are land stewardship, sustainable building design, individual firm environmental practices, and inter-firm byproduct exchanges. EIP planners should be cognizant of the four areas and the various players and levels of capacity required to implement them. Table 6 highlights the differences inherent in each of the four practice areas. In the following section, these four IE practice areas are described and implications for implementation are highlighted.

<table>
<thead>
<tr>
<th>Table 6: Industrial Ecology Areas of Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land Stewardship</strong></td>
</tr>
<tr>
<td>Examples of IE Practice</td>
</tr>
<tr>
<td>2. Sensitive ecological area protection</td>
</tr>
<tr>
<td>When it occurs</td>
</tr>
<tr>
<td>Firm operations</td>
</tr>
</tbody>
</table>

87
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of technical assistance required</td>
<td>1. Little to none</td>
<td>1. Moderate</td>
<td>1. Extensive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potential economic benefits to member firms inherent in IE practice</td>
<td>1. None</td>
<td>1. Potential benefits from increased resource efficiency</td>
<td>Potential benefits from...</td>
<td>Potential benefits from...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. None</td>
<td>1. Increased resource efficiency</td>
<td>1. Sale of byproducts</td>
<td>1. Increased resource efficiency</td>
<td>1. Purchase of lower cost inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Decreased waste disposal costs</td>
<td>4. Transforming wastes into viable inputs</td>
<td>1. Increased resource efficiency</td>
<td>1. Sale of byproducts</td>
<td>1. Increased resource efficiency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Land Stewardship**

By conserving land, preserving ecologically sensitive areas, and integrating buildings into the natural landscape, industrial activities will improve their environmental impact. At the BIP and the FEBP, land stewardship is being implemented through local government regulations. For example, the City of Halifax enforces development covenants that apply to landscaping, protection of natural areas, and the preservation of green space. At the FEBP, the City of Baltimore is using Federal Empowerment Zone and Urban Renewal status to segregate industrial land uses according to environmental impact. In Londonderry, the LEIP is located adjacent to residential areas and is part of a community that values agricultural and open space protection. Within this context, land stewardship is a priority for the LEIP. The siting of the AES facility on an existing gravel pad, and their designation of 100 acres of conservation land is an example of land stewardship at the LEIP.

Land stewardship represents an industrial ecology practice that occurs initially during the development of a virgin-EIP. Decisions over where to site facilities, how much land to consume, and how to naturally landscape the site are required during initial planning stages. Players involved in land stewardship decisions include architects, landscape architects, construction managers, and real estate developers. Strategies for implementing land stewardship as an EIP practice might be made under the auspices of the EIP management entity. However, as in the case of the BIP and the FEBP, local governments can play a significant role in land stewardship by strengthening zoning regulations and site plan standards to enforce goals.
As compared to the other three areas of IE practice, land stewardship requires the least amount of technical assistance during implementation. Through land use planning, regulatory action can effectively designate where to build, without relying on technical assistance to ensure that developers are able to follow through on requirements. As a result, the capacity needed to implement land stewardship is not as extensive as that needed to assist firms in the long-term implementation of industrial ecology. Instead, land stewardship requires an organization with expertise on how to identify key ecological land areas, ways to landscape with native vegetation, as well as other ecological land use practices. This capacity might be available in local planning offices as well as through environmental advocacy groups.

An important distinction between land stewardship as an EIP practice and the other practice areas is the extent to which it can create economic incentives. Unlike efficient green building design, efficient resource and energy use, as well as waste exchange, land stewardship, in and of itself, does not offer developers any financial incentives. For example, at the LEIP, SDD is interested in pushing forward plans for new facilities before stricter wetlands legislation is passed. Their motivation is based on the increased profit level they would receive if able to build larger structures. Furthermore, AES's motivation for land conservation was due in part to their green mission as well as their interest in offering community benefits. However, in both cases land stewardship practices did not offer potential economic benefits to firms in coincidence with enhanced environmental performance.

The lack of economic incentives associated with land stewardship has implications for the development of effective implementation strategies. Because there are no inherent economic motivations for developers to implement land stewardship on their own, even if educated on the practice, regulation by local government might be required. Alternatively, incentives might also be used, where developers are offered increases in buildable space in return for protection of key natural areas. Another option might be to offer equally cost effective land use alternatives to developers during site plan review. Essentially, through the eco-review process, this is what is occurring at the LEIP around land stewardship.

Additionally, land stewardship goals when implemented only within the EIP could potentially discourage new development at the Park because alternative sites appear more attractive given less regulation. For example, in Londonderry, LEIP management has the added burden of attracting business to the Park when adjacent land is not restricted by the additional land stewardship requirements. As a result, by implementing land stewardship goals
beyond the boundaries of the EIP, the more extensive the environmental benefits will be and the less likely the EIP is to face competitive pressures from neighboring sites.

**Sustainable Building Design**

At the EIPs in Halifax, Baltimore, and Londonderry, sustainable building design is being implemented. In an attempt to increase resource efficiency, reduce the use of toxic materials, and improve human health, green design techniques are being employed. Such techniques include substituting in less environmentally damaging products during construction, orienting buildings on site in order to maximize solar energy, and developing structures that maximize reuse potential. For example, in Londonderry, through the eco-review process, two firms are substituting less toxic paints into the construction of their facilities. Furthermore, in the case of Gulf South, the facility was sited with a southern exposure and built to appeal to 90 percent of the industrial market. Similarly, in Halifax and Baltimore, development standards have been or are being created in order to improve the environmental impact of facility development. However, research was unable to uncover the specific green design techniques being implemented at these two sites.

Green building design falls within the physical development category of industrial ecology practices, and like land stewardship, it occurs during the initial development stages of implementing a virgin-EIP. Unless the objective is to work with existing firms on retrofitting structures, implementing green design occurs at the beginning of the development process. Because green design falls within the physical development of industrial structures, architects, construction managers, and real estate developers will be involved in the implementation process. As the Gulf South case at the LEIP highlights, those concerned with developing facilities may not necessarily be the firm that eventually occupies the building. This creates the potential for implementation strategies that focus on both the development team and the firm that becomes and EIP member. Additionally, those involved in enforcing green design principles may include the EIP management entity and/or local or state government. The capacity to implement these techniques requires persons familiar with green building design. If implemented through the EIP management entity, the organization must have the capacity to work with existing firms by offering suggestions on ways to improve their building plans. However, if a regulatory approach is taken via green design implementation, the local or state government will have the capacity to mandate these changes.

1 There is potential for green design principles to be applied to existing industrial parks by retrofitting facilities.
government should have the expertise to design flexible standards for sustainable facility development.

As compared to other industrial ecology practices, green design offers the potential for both enhanced environmental performance as well as economic benefits. By building so that energy is used more efficiently and employee health is improved, businesses can realize cost savings while improving environmental performance. This suggests that implementation should consider the potential incentives inherent in green design and develop strategies accordingly.

Practice suggests that implementing green building design through an EIP requires a mix of technical assistance as well as regulatory approaches. However, technical assistance need not be extensive, but instead could be a list of suggestions for changing construction practices. In Londonderry, the Bylaws require that new firms undergo an eco-review process in order to receive recommendations on how to improve their building design. The eco-review process offers the necessary technical assistance to ensure that firms buy into the new techniques for building and siting facilities. Key to this review is the identification of suppliers who offer more environmentally friendly products. When designing implementation strategies for green building design, it is important to take this into consideration. By educating developers on ways that green design can be implemented and its potential cost effectiveness, it is more likely that developers will buy into the new techniques.

**Individual Firm Environmental Practices**

A third area where IE is being implemented at EIPs is through individual firm environmental practices. This practice area includes the implementation of pollution prevention, resource and energy efficiency, and environmental management systems (EMS). Research on Burnside, Baltimore, and Londonderry indicate that all three EIPs are involved, to some degree or another, in the implementation of individual firm environmental practices.

A key characteristic of IE practices in this category is the focus on changing internal business practices in order to improve environmental performance. Unlike land stewardship and green building design, implementing pollution prevention, resource efficiency, and EMS requires changes to the business practices of individual firms and is not involved in the physical development of the facility. As a result, key players in this IE practice area are firm managers.
As compared to land stewardship and green building design, current EIP practice indicates that implementation of individual firm environmental practices necessitates extensive technical assistance. Because this type of IE practice requires changes to a firm’s internal operations, customized information on ways to improve environmental performance is critical to implementation. As discussed in Chapter 4, 92 percent of surveyed BIP firms indicated that access to information was a key obstacle to implementing innovative waste disposal or reduction practices. The Eco-Efficiency Centre in Burnside has attempted to curb the information gap by assisting businesses in implementing environmental practices through the provision of waste and energy audits. Additionally, information is offered via the web, through networking events, and personal interactions between Centre staff and BIP firms. Furthermore, evidence from the LEIP indicates that in order for firms to begin implementing IE beyond the facility development stage, a management entity with the capacity to offer technical assistance is required.

Because of the need for extensive technical assistance within this area of IE practice; the management entity requires capacity on ways to integrate industrial ecology into business practices. For example, the management entity should have the capacity to assist firms in reducing their waste streams, substituting in less environmentally damaging products, and increasing resource and energy efficiency. Potential organizations with the capacity to offer these services include universities with industrial ecology departments or research centers, environmental consultants, and industry associations. Another potential organization with the capacity to offer the required technical assistance is the Manufacturing Extension Program (MEP). Implemented through the National Institute for Standards and Technology (NIST), the MEP is a national network of non-profit technical assistance providers with the goal of working with small and medium sized manufacturing businesses to improve business practices. Within their current set of services, the MEP offers assistance in process improvement, materials engineering, plant layout, energy audits, and environmental studies. Partnering with an MEP center might offer needed technical assistance around how to work with businesses on the implementation of individual firm environmental practices.

In terms of the relationship between enhanced environmental performance and economic benefits, there are opportunities for firms to realize both through the implementation of individual firm environmental practices. For example, at Burnside firms are involved in product substitution to reduce pollution and waste. This results in both a decrease in
environmental impact as well as an increase in economic benefits through a reduction in waste disposal costs. Furthermore, similar to green building design practices, increased resource or energy efficiency reduces input costs to firms.

Practice suggests that implementing individual firm environmental practices requires technical assistance with less of an emphasis on regulatory measures. Because there are economic incentives inherent in these IE practices, customized technical assistance on how to implement techniques should be a sufficient implementation strategy. Additionally, as witnessed at the BIP, the use of an awards system encourages firms to implement innovative environmental practices. However, the LEIP's reliance on covenants requiring firms to implement an EMS, conserve water and energy, and prevent pollution limits the success of implementation because there is no long-term source of environmental technical assistance around these practices. Because there are economic incentives inherent in many of these practices, teaching business how to employ the techniques should be a priority over regulations that dictate their implementation.

**Byproduct Exchange**

Byproduct exchange represents the fourth area of IE practice, as well as the most difficult to implement. In North America, the majority of EIP practices are in one of the other three practice areas. In fact findings from the survey conducted by the author indicates that waste exchange is only currently occurring at the BIP. Instead, pollution prevention, resource efficiency, green building design, land conservation, and product substitution are popular industrial ecology practices.

The lack of byproduct exchange practices at North American EIPs is the result of the complexities inherent in this practice. According to research on Kalundborg, several factors are necessary in order for byproduct exchange to occur. First, both the supply and demand side of byproduct exchange must be readily available. This requires an industry mix such that one firm's output is another firm's input. Furthermore, the scale of byproducts supplied must be large enough to meet demand. Additionally, transporting byproducts between firms requires infrastructure investments, especially if gas and liquids are to be piped between facilities. Finally, byproducts in their raw state are not always sufficient as an input without treatment. As a result, byproducts may need to be treated before sold or given to firms.
Beyond the technical difficulties inherent in byproduct exchange, certain institutional conditions must be met. First, practice indicates that regulations, which inform firm decisions regarding waste disposal, emissions control, and environmental performance, should incentivize byproduct exchange. As witnessed in Kalundborg, Danish environmental regulations require strict limits on emissions from power facilities, without mandating the type of technologies to be used. This led the power plant at Kalundborg to rethink how it controlled emissions by taking into consideration which technologies might offer added economic benefits through byproduct exchange. Furthermore, with strict solid waste disposal regulations, firms at Kalundborg were motivated to consider byproduct exchange as a cost effective alternative to traditional compliance techniques. While United States environmental regulations are strict, many times they prescribe technologies and limit exchanges of hazardous and solid wastes due to permitting requirements. This does not incentivize firms to seek byproduct exchange as a solution to environmental control requirements.

Second, businesses must be able to recognize ways to exchange byproducts. In Kalundborg, firm leaders became cognizant of potential byproduct exchanges through the interpersonal relationships that were developed informally. However, where those relationships do not exist, a third-party organization is needed to identify potential waste exchange opportunities. Once opportunities are identified, an organization must be responsible for bringing businesses together to begin planning exchanges between firms. The role of the third-party organization could also be to facilitate the development of relationships between firms so that future linkages are recognized via discussions between managers.

Furthermore, in order to tackle the technical difficulties inherent in waste exchange, an organization might be required to broker exchanges between firms. This organization could work to develop needed infrastructure or be responsible for negotiating supplier contracts between firms. Alternatively, as practice at Burnside highlights, private sector firms are beginning to form in order to meet growing demand for scavenging wastes and transforming them into viable products. Moreover, private firms or brokering organizations may be needed to aggregate byproducts in order to generate the scale necessary to serve as an input. In this case, going beyond EIP boundaries may be required in order to generate the necessary scale to create a balance between supply and demand. Consequently, in order to implement byproduct exchange at an EIP, the institutional capacity to identify potential waste exchange opportunities, broker the linkages between firms, and potentially treat and aggregate byproducts is needed.
Similar to individual firm environmental practices, byproduct exchange requires changes to the internal operations of businesses. As a result, players involved in byproduct exchange include firm leadership. The organization involved in implementing byproduct exchange must have the capacity to develop the conditions necessary to develop linkages between firms. Potential organizations include university industrial ecology departments or research centers, environmental or industrial consultants, industry associations, or the MEP. Although in the case of waste exchange, the MEP may not be in a position to work with multiple firms on cooperative environmental solutions because their current practices focus on assisting individual firms.

In terms of economic incentives, byproduct exchange offers the most potential for businesses to realize significant economic benefits while simultaneously improving environmental performance. Because savings can result from decreased waste disposal costs as well as from the sale of byproducts, firms can potentially make money while improving environmental performance. However, unlike individual firm environmental practices, the combination of potential economic benefits and technical assistance is not sufficient to implement byproduct exchange. Instead this IE practice requires developing links between businesses and consequently extends beyond the internal operations of firms. As a result, implementation requires more than just technical assistance on what potential exchanges are available. As described above, where inter-firm relationships do not exist, the implementation agent must be able to broker linkages between firms, aggregate supply to a scale sufficient to meet demand, and treat byproducts so they can become viable inputs. This goes beyond the role of a technical assistance provider and requires that an organization or group of organizations develop a third party role in administering byproduct exchange.

However, similar to individual firm environmental practices, the implementation of byproduct exchange requires extensive technical assistance with little emphasis on regulation. It would not be feasible to regulate that firms develop linkages without knowing whether the conditions required to create byproduct exchanges are met.

To summarize, the four areas of IE practice represent a taxonomy for EIP planners, developers, and managers to think about when crafting implementation strategies. As research from this Thesis suggests, each of the four IE practices offer unique characteristic with implications for implementation. These characteristics include the extent to which technical assistance is needed, the type of capacity required by the implementation agent, the players involved, the degree to which economic benefits are inherent to the IE practice, and the ability to
use regulatory mechanisms during implementation. Thinking carefully about the nuances between the four IE practice areas will improve the success of an EIP implementation strategy.

**Recommendations to Local EIP Planners, Developers, and Managers**

*Assess the local context and determine the best approach to implementing IE*

The local context is a significant variable to the successful implementation of IE. As witnessed at Kalundborg strong inter-firm relationships, the environmental culture of the Danish people, and the existing industrial mix facilitated the development of complex and mature industrial ecosystems. When deciding on whether to pursue a strategy to implement industrial ecology in your community, it is critical that the local context be assessed.

During assessment, planners should identify whether IE is to be implemented with existing firms, with newly recruited businesses, or with both. If, for example, your community is comprised of a large concentration of industrial activity that is spread throughout the region, an EIP may not be the most effective model for implementing IE. Instead, developing a program that assists businesses in the enhancement of environmental performance may be sufficient. This program could be built through the local university and could draw on the characteristics of the Eco-Efficiency Centre in Nova Scotia, where firms who volunteer to join receive environmental technical assistance and the potential for green awards. In this particular context, the place-based characteristics of the EIP model are not as applicable. Instead, it is more critical for firms in your community to be educated on the principles of industrial ecology and assisted in their attempt to implement the concepts.

Conversely, if your community is one where there is a large portion of vacant industrial land or a concentration of industrial activity at a specific site, the place-based EIP model might be more applicable. As in the Londonderry case, the Town acquired 100 acres of industrially zoned land and sought to proactively develop the parcel into an environmentally enhanced industrial park. If your local context resembles the Londonderry case, the EIP model provides a framework for creating a vision for what type of economic development should exist in a particular place.

*Define your IE objectives at the beginning of the process*

In much of the literature on EIPs, waste exchange is discussed as tantamount to the implementation of IE. However, as this Thesis has pointed out, the goal of IE is to "eliminate the cause of environmental problems rather than to work to solve them after they become
apparent. Mechanisms to implement this goal are occurring through the four practice areas. In developing a vision and a strategy for implementing IE, it is important to clarify your IE objectives. For example, if you are working with an existing industrial park that has an industry mix comprised of process based companies with significant waste streams, byproduct exchange might be the focus of your efforts. However, if your objective is to develop an industrial park where enhanced environmental performance characterizes newly recruited member firms, then a broader set of IE mechanisms would be more useful. In this case, you might want to consider land stewardship, green design approaches, and individual firm environmental practices in the short term. Once businesses have located at the EIP, you might want to think about the implementation of byproduct exchange. Regardless of what your objectives are, it is important to be specific about which areas of IE practice you plan to focus on.

Choose an implementation strategy that meets all your IE objectives

Once the IE objectives have been identified, it is essential that an implementation strategy be created which meets each goal. In creating this strategy it is important to think back to the differences between each of the four practice areas and design programs to meet them.

As Table 7 points out there are various types of best practices relevant to each of the four areas of IE practice. As a result, if you are planning to implement more than one area of practice, a multi-layered approach to implementation should be used. For example, if you are interested in preserving open space on your industrial land, mitigating wetlands, and landscaping naturally, you might want to work with local planning offices to strengthen zoning regulations. Furthermore, in order to implement green design practices, you could offer an eco-review similar to the one performed at the LEIP in order to suggest alternative ways of building. Once firms have located at the EIP, you might consider partnering with a university or research center to offer firms technical assistance on how to implement energy and resource efficiency, reduce pollution, or develop an EMS.
Table 7: EIP Implementation Best Practices

<table>
<thead>
<tr>
<th>Land Stewardship</th>
<th>Green Building Design</th>
<th>Individual Firm Environmental Practices</th>
<th>Byproduct Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should you use technical assistance (T.A.) or regulation?</td>
<td>Regulation</td>
<td>Mix of moderate T.A. and regulation</td>
<td>Extensive T.A. and no regulation</td>
</tr>
<tr>
<td>What are some implementation best practices?</td>
<td>Local government regulations</td>
<td>Local or State government regulations</td>
<td>Energy use audits</td>
</tr>
<tr>
<td>1. Local government regulations</td>
<td>2. Checklist of recommendations during site plan review</td>
<td>2. Review of waste stream</td>
<td>1. Identification of potential byproduct exchanges</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Encouraging new businesses to collect and sell byproducts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. Targeting a specific waste exchange and recruiting businesses based on it.</td>
</tr>
</tbody>
</table>
Finally, in order to implement byproduct exchange, there are three different options for implementation. First, you could develop information on available waste exchanges within the EIP and distribute the information to member firms. Once the information was distributed, it would be the responsibility of the firms to implement byproduct exchange. As a result, firms would be required to overcome the obstacles inherent in developing exchanges, such as creating a balance between supply and demand, treating wastes, and developing the required infrastructure to transport byproducts. In this option, you might want to consider planning networking events or work sessions between businesses in order to help facilitate inter-firm relationships. If created, inter-firm relationships might lead to the implementation of the byproduct exchanges initially identified. Second, in order to develop byproduct exchanges, you could recruit or develop businesses that would scavenge wastes, treat them, and resell them to businesses as inputs. Third, you could target a specific waste exchange that would be feasible given existing industries. For example, you might have a group of firms that produce byproducts, which could be used by other businesses. In this case you might attempt to recruit businesses to your EIP that could use the byproducts supplied. In this case, you are targeting a specific byproduct exchange at your EIP.

Because you will most likely have several EIP objectives, creating a multi-layered approach to implementation appears to be the most effective route to implementing various IE practices. For example, the BIP exemplifies a strategy that takes into consideration various IE objectives. In the BIP example, the local government serves to enforce the implementation of IE at the physical development level by imposing stricter development standards to improve environmental performance. Additionally, in Baltimore, the City is working to create development standards that will reduce the impact of the building and site design on environmental conditions. In both cases, a regulatory approach was used to implement IE through the physical development of the structure, while other implementation mechanisms were used to encourage businesses to pursue IE in their business practices. Alternatively, limiting yourself to one method of implementation, as is the case at the LEIP, creates obstacles to realizing all of your IE goals. While covenants have been effective in altering the land stewardship practices and building design of Gulf South, Ride Away, and AES, they may not be effective, and have not been effective, in their ability to implement IE practices that pertain to business operations. As a result it is important to define your IE objectives and develop implementation strategies that meet all goals.
Develop a management structure with the capacity to implement IE as well as manage an industrial park.

When developing an EIP, a decision on how to manage the Park is required. The management entity at an EIP is required to do more than administer the Park real estate. Instead, it must be willing to champion the goals and benefits of IE, assist firms in the implementation of IE, and act as a link between the community, outside firms and member firms. Furthermore, the capacity required of the management entity will depend on the four areas of practice that you focus on at the EIP. To this end, partnerships between organizations with different types of expertise should be considered.

While a real estate developer is a suitable partner in the implementation of an EIP, it may not have the capacity, or the motivation, to fulfill the additional duties required of an EIP manager. A community may want to retain control over the future of the EIP and contract out the marketing and development tasks to a private sector firm. Or, a community may want to think about partnering with a local university. In *The Fieldbook for the Development of an Eco-Industrial Park*, Ernest Lowe et al recommends a university as a likely candidate for an EIP management entity because of the potential research capacity it yields around IE practices. Additionally, an environmental non-profit or community development corporation might be an adequate candidate for managing an EIP if part of their mission is to work with the business community on enhancing environmental performance. Furthermore, as described earlier in this Chapter, the Manufacturing Extension Program (MEP) is a potential partner for the EIP management entity. Because a MEP exists in all 50 states, these organizations are poised to be partners in managing the EIP by offering the technical assistance required especially around implementing individual firm environmental practices. Regardless of the choice for administrative entity, the management structure should include the capacity to develop and run an industrial park as well as an interest in seeing the implementation of IE principles come to fruition.

*Integrate incentive-based measures into implementation*

Discussions with businesses and literature on EIP development indicate that performance based measures are critical to insuring that firms partake in the implementation of IE. While the Kalundborg example highlights how economic incentives motivate firms to participate in the industrial ecosystems, not all contexts offer incentives to improve environmental performance. If it is cheaper to dispose of wastes through traditional regulatory mechanisms or if locating at a site without EIP bylaws reduces uncertainty, then firms are more
likely to chose the non-IE approach to doing business. However, if IE principles are implemented in a way where the punitive approach is minimized and the performance approach is maximized, management may be more willing to join and commit to IE over the long term. An incentive-based approach could include an award system such as the one developed at Burnside. Additionally, in situations where a community is comfortable incentivizing the process for locating at the EIP, rent reductions or tax relief could be tied to the environmental performance of the firm. This is occurring in Cape Charles, Virginia where incoming businesses are ranked according to the IE principles they are willing to implement. If they meet the minimum criteria, firms are offered a standard leasing rate, however if the business exceeds the minimum criteria it can receive up to a 12 percent reduction in the cost of the lease.\textsuperscript{133}

\textit{Initiate a large-scale community education and planning process around IE}

An EIP offers an opportunity for communities to plan for the type of industrial development they desire or ways to enhance the environmental performance of existing industries. While in the past, industrial activity has resulted in environmental degradation; an EIP offers an alternative to past mistakes by providing a model for economic development that is also environmentally sustainable. However, because industrial activity has been notoriously detrimental to the environmental health of communities, the extent to which popular consensus is reached in support of a type of industrial development the more likely it is to occur. If residents are not involved in planning for an EIP, they may view new industrial development as a negative addition to their community instead of a potentially positive force in improving economic and environmental conditions.

Industrial ecology has been largely a part of the engineering and hard science disciplines and the concepts have only recently begun to transcend to the community level. As a result, a large-scale community education process should occur around IE and ways that it can be implemented. Key to this process is educating residents on the types of industry that could qualify under an EIP plan. While many community members might support environmentally friendly industry in theory, they may not be receptive to a power plant or to certain types of heavy manufacturing. Explaining how IE can help firms minimize their environmental impact and improve the sustainability of the earth’s resources could increase the extent to which industry is welcomed into a community.

When developing an EIP it is important to establish a vision statement based on the local context of your community, while carefully crafting an implementation strategy that
incorporates environmental technical assistance, incentive-based measures, and the potential to facilitate inter-firm relationships. Furthermore, is important to choose an adequate management entity with the capacity to administer the implementation of IE practices. Finally, community education and process are instrumental in assuring that the EIP is linked to the residents and acceptable to the community. In the following section, the concepts behind these recommendations are translated into specific action items for the planners, developers, and businesses of the LEIP to think about as they continue to implement industrial ecology.

Recommendations to LEIP Stakeholders

As discussed in Chapter 7, the LEIP is poised to move from the implementation stage to become a mature EIP that can serve as model for eco-industrial development. However, specific issues pose obstacles to the ability for the LEIP to move to the next stage of the development process. These issues are the reliance on a covenant based implementation mechanism, the choice of a private real estate developer as the management entity, and the negative public opinion surrounding AES and the LEIP. The following short and long-term action items offer suggestions for LEIP planners, member businesses, and the community for dealing with the obstacles.

Short-Term Action Items

Convene the Community Stewardship Board

Even though there are only three members of the LEIP, two of which have not built their facility, the processes outlined in the LEIP bylaws should be initiated. Specifically, this means that the Advisory Board should begin meeting as the Community Stewardship Board (CSB). As it stands now, the Advisory Board has been meeting less frequently with the last meeting held in the spring of 2000. The momentum created during the initial planning of the LEIP and during the development of the covenants must be carried over into the implementation stage. As a result, the Advisory Board should become the CSB and members should begin to meet regularly.

Once convened, the CSB should begin thinking about ways to assist member firms in the implementation of industrial ecology. Additionally, CSB members should tackle the issue of AES and create a strategy to begin moving the Town of Londonderry beyond the divisiveness that has resulted from the new power plant. A third topic that the CSB might want to consider is how the Town of Londonderry should spend the remaining funds in the Expendable Trust Fund (ETF). The ETF is funded by the proceeds from the sale of the LEIP land to SDD. The money
is to be used to conduct an eco-review for each firm. However, the ETF could be used to begin working with existing firms around the implementation of IE.

**Convene the Governing Board**

In addition to convening the CSB, the three members of the LEIP along with SDD and the Town should begin meeting as the Governing Board. Even though the LEIP has not reached full capacity, the existing stakeholders should begin meeting to discuss future plans for the LEIP. Additionally, by initiating Governing Board meetings, the current member firms could begin to develop relationships with each other. Through these relationships, management might begin discussing ways in which they plan to comply with the LEIP bylaws and sharing information on how to enhance environmental performance at the Park.

The key to convening the Governing Board is leadership by one of the member firms. Ultimately the success of the LEIP will be the result of the IE practices implemented by businesses at the Park. As a result, leadership by the private sector is necessary. Because each of the three member firms have varying degrees of awareness regarding the requirements associated with the LEIP, the firm most committed to the ecological principles related to the Park should initiate the process. In the case of the LEIP, AES is poised to be that leader. According to Gwen Mathews at AES, the company is committed to the principles behind the LEIP. Furthermore, during the process of locating at the LEIP, AES embraced the LEIP vision and adapted its plans in accordance with the ecological guidelines. Additionally, AES is a firm with significant resources and capacity. As a result, they are in the position to act as the leader in beginning to develop relationships between member firms by convening the Governing Board.

**Begin Discussions with Neighboring Businesses**

Once the Governing Board is convened, members should open discussions with neighboring businesses on joining the LEIP as associate members. Kluber Lubrication has indicated that they will consider joining once more information is obtained. Felton Brush might have similar thoughts if an attempt is made to reach out to them. Additionally, Stonyfield Yogurt, a leader in environmental performance might be convinced to join the Park if management witnesses a commitment to the principles of industrial ecology by LEIP members.

**Hire an Industrial Ecology Coordinator at the Town**
The initial impetus behind planning the LEIP came primarily from two individuals; Peter Lowitt, the former Londonderry Planning and Economic Development Director, and Nancy Hirchberg, owner of Stonyfield Yogurt. However, during the course of planning the LEIP, Mr. Lowitt resigned from the Town of Londonderry and Ms. Hirchberg has opted to refocus her energy more toward her business and less toward the LEIP. As a result, there is no longer a leader to tout the vision of industrial ecology. While the new Director of Planning and Economic Development at the Town is excited about the LEIP, the Planning office is responsible for numerous other projects and has limited resources. As a result, the Town of Londonderry should consider hiring an Industrial Ecology Coordinator to work with members of the LEIP as well as all businesses in the Town around improving environmental performance.

The new position at the Town should be held by an individual with a strong background in environmental science and industrial ecology. With this background, the Industrial Ecology Coordinator would champion the environmental and economic benefits associated with IE and assist both LEIP firms and Londonderry businesses in the implementation of enhanced environmental practices. Because the new Industrial Ecology Coordinator would focus most of his or her work on the LEIP, the newly convened Governing Board should consider funding part of the costs associated with this position. Again, because of their position as a strong supporter of the LEIP and access to resources, AES is poised to take on some of this fiscal responsibility. As required in their permit, AES agreed to fund additional technical assistance as related to their plant. The Industrial Ecology Coordinator position could be a potential avenue for those funds to be directed.

Develop a Strategy for Improving Public Opinion of the LEIP

It is critical that the public opinion of the LEIP and of AES be improved in order to mend the divisiveness that has occurred between residents. In doing so, the Town must reassure the community that AES will benefit residents as promised. At a minimum the permit signed off on by EFSEC must be enforced completely. However, in addition the Town should develop a plan for reducing residential property tax rates in concert with the increased revenues realized as a result of AES. While not all of the additional revenue should go to cover the cost of reduced residential taxes, community members must see a tangible benefit to AES. Simply increasing or improving public services may not impact residents as directly. Additionally, as mentioned earlier, AES should take a leading role in the Governing Board and contribute to a new Industrial Ecology Coordinator for the Town. By doing so, AES can increase its presence as a
leader in the implementation of industrial ecology and continue to earn its reputation for environmental stewardship in the Town of Londonderry.

**Standardize the Eco-Review Process**

Currently, it is not clear as to the scope and detail of the required eco-review process as described in the LEIP bylaws. Furthermore, the eco-review for AES was expansive, customized to AES’ facility and business plans, and was based on the ecological guidelines outlined in the LEIP bylaws. However, the Ride Away eco-review was not customized and was less expansive, especially in relation to IE practices at the business process level. Additionally, the Ride Away eco-review was not based on the ecological guidelines defined in the LEIP bylaws. LEIP planners and developers should consider adopting a process for the eco-review that includes a detailed outline of what should be included as well as the scope of work. By allowing some eco-review to be less detailed and not customized, members within the LEIP are being treated differently and are not receiving equal benefits under the eco-review process. Additionally, as witnessed by the Gulf South case, an eco-review was performed with the developer but not with the company. Instead, LEIP stakeholders should consider an eco-review of facility plans for the developer and an audit of energy and waste streams for the businesses.

**Long-Term Action Items**

**Plan for a Long-Term Management Entity**

According to LEIP bylaws, SDD will relinquish control of the Eco-Park once the last parcel is sold or leased. At that point, the LEIP will be at full capacity and an organization will be required to administer both the property management and industrial ecology aspects of the Eco-Park. The Governing Board, CSB, and the new Industrial Ecology Coordinator should begin discussions on how the management entity should be structured. Potential administrators could be an environmental non-profit or a university. Furthermore, a management structure may require contracting out the property management responsibilities separate from the industrial ecology expertise.

**Develop an Environmental Award Program for the LEIP**

Modeled after the program administered by the Eco-Efficiency Centre at the BIP, the new Industrial Ecology Coordinator, Governing Board, and CSB may want to consider creating an environmental award process for the LEIP. Currently, adherence to the LEIP bylaws is enforced through the annual reporting process and punitive measures administered by the Governing Board. However, in concert with the general recommendations outlined in this
Thesis, LEIP planners and developers should consider implementing a performance-based awards program to congratulate improved environmental practice.

**Consider Adopting Ecological Design Standards for all Industrial Land**

In order to level the playing field between the LEIP and surrounding industrial land, the Town of Londonderry should consider adopting ecological design standards that are applicable to all new industrial facilities. This would increase the area where industrial ecology could be implemented at the physical development level. In concert with the development standards enforced by the Municipality of Nova Scotia, the Town of Londonderry could adopt guidelines that seek to improve the impact industrial buildings have on the environment. Examples of ecological design guidelines include mitigating wetlands, use of impervious surfaces, choosing native species for landscaping, and clustering buildings on site. Furthermore, green design principals such as day lighting, material substitution, and energy efficiency could be incorporated in the ecological practices through a review of industrial site plans. This activity could be the responsibility of the Industrial Ecological Coordinator. By extending the sustainable development principals inherent in the LEIP to industrial areas outside of the Eco-Park, industrial ecology will be more widely implemented. Furthermore, the disincentive to locate in the LEIP versus surrounding land will be minimized because regulations will be extended to firms outside of the Park.

**National Level Recommendations Regarding EIP Development**

This Thesis examines the industrial ecology field of practice through the implementation of EIPs. EIPs represent a local intervention to alter current industrial activities in order to improve sustainability. However, there is a role for national policymakers in the implementation of industrial ecology. This role involves supporting local efforts at implementing IE, as well as seeking ways to integrate notions of IE into current environmental policy. Policymakers should consider developing flexible regulatory approaches that facilitate IE practices, involving staff in local EIP planning processes, and encouraging knowledge sharing around EIP development through information dissemination. Beyond the role of national policy in shaping EIP development, there is room to form partnerships between various public and private stakeholders that offer expertise in the implementation of IE. This Thesis specifically speaks to the potential role that could be created for the National Institute for Standards and Technology (NIST) as well as for entrepreneurial environmental nonprofits around EIP development.
Finally, national policymakers should consider the extent to which industrial ecology practices can be integrated into environmental policy extending beyond the facilitation of EIPs.

**National Policy Should Facilitate EIP Development**

National policymakers can support local EIP efforts in several specific ways. First, the United States Environmental Protection Agency (EPA) should review existing regulations to determine areas where policy discourages the implementation of byproduct exchange. Specifically, the Recourse Conservation and Recovery Act (RCRA) described in Chapter 2 requires solid and hazardous waste to be disposed of in specific ways that discourage byproduct exchange. Part of the problem is the definition of solid and hazardous waste and the subsequent activities required to dispose of these products. Currently a RCRA permit can be obtained to exclude byproducts from solid and hazardous waste regulations. However, the permit is time and money intensive, effectively discouraging firms from applying for it.\(^{134}\)

In addition to regulatory hurdles involving waste disposal; EPA regulators should seek to implement policy that is performance based instead of regulations that mandate specific pollution control technologies. Whenever feasible, EPA legislation should set high standards on emission and pollution levels and allow industry to determine the technologies it will use in order to meet standards. As occurred in Denmark, firms might choose to pursue byproduct exchange options because of the economic benefits associated with this activity.

Second, in addition to changes in environmental policy, the EPA should support local efforts at implementing industrial ecology by involving itself in the development of EIPs throughout the country. At the LEIP, two members of the EPA were part of the Advisory Board. Comments from stakeholders in the process indicated that their involvement was critical to ensuring that the national regulations would not discourage potential environmental solutions at the Park. The expertise from two national level regulators proved to be an invaluable asset to designing an EIP because planners were able to talk directly with EPA staff about potential IE practices. This type of activity by the EPA should be encouraged.

Third, policy at the national level should continue to support the development of EIPs as was done under the Clinton administration. The President’s Council on Sustainable Development (PCSD) was involved in researching EIP development and eco-efficiency in order to make recommendations to practitioners. Furthermore, the PCSD convened conferences between EIPs to facilitate discussion and idea sharing. The PCSD also designated four
demonstration EIPs to receive funding and assistance. In addition to the PCSD, the United States Department of Energy (DOE) has been a resource for the development of EIPs with case studies and reports printed on their web site. The Economic Development Administration (EDA) has made financial contributions to the development of EIPs as well. This level of financial and technical assistance should, at a minimum, be maintained during the Bush Administration.

A fourth area where national policymakers can become involved in developing EIPs is through the NIST. As mentioned earlier in this Chapter, NIST administers the Manufacturing Extension Program ( MEP) to provide technical assistance to small and medium size firms. While the MEP currently works on assisting firms in environmental studies and energy audits, NIST should consider expanding their role to include the four areas of IE practice. Given that the centers already exist, the infrastructure is set up to deliver technical assistance to industry. However, expansion into industrial ecology practices would require hiring experts in IE to work with firms in implementing practices. This could occur via burgeoning EIPs or through existing industrial businesses.

The role defined for the MEPs speaks to the need to foster new institutions for the development of EIPs. While expanding the services offered at the MEPs offers one potential avenue for assisting firms in the implementation of IE, other partnerships or organizations may be needed to develop EIPs. For example, there is the potential to involve local environmental nonprofits in the development of EIPs beyond their more traditional advocacy role. A new responsibility for environmental nonprofits could be managing and/or developing EIPs. While this requires additional capacity, there is potential for entrepreneurial organizations to effectively build their competence around management and development in order to spearhead the implementation of EIPs. A similar transformation occurred as community activists expanded their role from advocacy to take on the implementation of affordable housing and economic development projects through community development corporations. At the LEIP, work by CLF Services exemplifies the proactive role that environmentalists should consider for the future. Again, national policymakers have a role in disseminating information around EIP practices that could educate local level environmentalists on how to implement IE principles. Furthermore, national policymakers may want to consider ways to train local environmental groups on the skills required to develop industrial parks and work with businesses on implementing IE practices.

*National Policy Should be Informed by Industrial Ecology*
Finally, in thinking beyond ways that national policy can facilitate the development of EIPs, there is also a role for environmental policymakers to embrace industrial ecology and integrate it into all areas of policymaking. As described in Chapter 2, the current command and control system serves the purpose of regulating air, water, and disposal. However, as environmental impacts become more complex and inter-related, the industrial ecology paradigm becomes more attractive as an alternative framework for environmentalism. To this end, national and state policy should seek to embrace IE not only through its role in facilitating the development of EIPs, but also in product policy, environmental regulations, and energy policy, among other issues. While this Thesis specifically examined how to implement IE through the EIP model, IE is a powerful paradigm for altering environmental control methods beyond eco-industrial development.

**Final Words**

The extent to which IE is implemented, offers hope that an alternative to existing industrial practices will become a reality. While EIPs are a local intervention with limited impact in terms of geographic scale, they represent a concrete model for IE implementation. If successful, EIPs offer tangible examples of how to implement industrial ecology. This type of model is invaluable as a means to move the theory of IE into conventional industrial practice. Furthermore, because IE was born out of the engineering disciplines, there is potential for its principles to be integrated into future industrial designs. Without the need to convince hard scientists of its merits, IE has the potential to inform future industrial practices and subsequently become the mainstream way to do business.

Underlying the implementation of IE, is a shift in the way that environmental control is conducted. Industrial ecology is a powerful paradigm because it offers a proactive vision for how to organize industrial activities. Instead of regulating behavior, IE attempts to alter it. Instead of cleaning up pollution, IE offers ways to reduce or reuse it. The implementation of IE through the EIP model is a step toward creating a more sustainable economy.


REFERENCES

Interview List:
Patrick Barry, Londonderry resident, Telephone interview, March 7, 2001

Ken Barton, Londonderry resident, Telephone interview, March 2000


Glen Boyle, Executive Vice President & General Manager, Kluber Lubrication, Telephone interview, February 22, 2001

Mathew Cahillane, Sustainable Solutions, Former Advisory Board Member, Telephone interview, March 22, 2001

Walt Cudnohusfsky, Cudnohusfsky Associates, Telephone interview, February 22, 2001

Anne Fenn, United States Environmental Protection Agency, Telephone interview, February 2001 and Personal interview, March 14, 2001

James Finch, Londonderry resident, Londonderry for AES, Telephone interview, January 17, 2001

Nancy Hirchberg, Stonyfield Yogurt, Group discussion, November 2000

Andre Garron, Planning and Economic Development Director, Town of Londonderry, Personal interview, January 16, 2001 and Telephone interview, November 14, 2000

Nicholas Gertler, Former LEIP Advisory Board Member, Telephone interview, February 24, 2001

Mark Godfrey, Manager, Felton Brush, Telephone Interview, February 16, 2001

David Guest, United States Environmental Protection Agency, Telephone interview, March 23, 2001

Gulf South management, Telephone interview, February 22, 2001
Peter Lowitt, Former Planning Director, Town of Londonderry, Personal interview, January 16, 2001

Paul Lockwood, New Hampshire Department of Environmental Services, Telephone interview, February 22, 2001

Mark Lore, President, Ride Away, Telephone interview, March, 2001

Gwen Mathews, Development Manager, AES Londonderry, Personal interview, February 8, 2001

Larry O’Neil, Former Londonderry Town Councilor, Telephone interview, March 5, 2001

Mark Oswald, Chair, Londonderry Town Councilor, Telephone interview, March 2001

Neville Sinclair, Baltimore Development Corporation, Telephone interview, February 7, 2001

David Wallace, Former Londonderry Town Councilor, Telephone interview, March 2001

Alan Wilson, Vice President, Conservation Law Foundation Services, Personal interview, February 7, 2001

Printed Material


AES Granite Ridge. “AES Londonderry Cogeneration Steam Standard Offer Basic Terms.” No Date.


Conway School of Landscape Design, Concept Diagram, Londonderry Eco-Industrial Park, 1996.


Cote, Raymond P. "Industrial Ecology and Small Business: Experiences from Burnside Industrial Park." Dalhousie University, 2000


"Presentation of LEIP Status." Town of Londonderry. No Date


Szczesny, Dan J. "Anti-AES Gathering Leaves No Doubt of Mood." Union Leader. No date.


Town of Londonderry, web site, www.londonderry.org, April 11, 2001

"Town of Londonderry, New Hampshire: Zoning Regulations as amended through July 20, 2000."
Vellinga, Pier, Frans Berkhout, and Joyeeta Gupta. *Managing a Material World.*

Wallace, David. "A Review of the Effects of the Proposed AES Power Plant." No date
APPENDIX A: EIP RESOURCES
EIP RESOURCES

Eco-Industrial Parks
Cape Charles Sustainable Technology Park
Cape Charles, VA
888-200-1778
www.sustainablepark.com

Eco-Efficiency Centre in Burnside
Halifax, Nova Scotia
902-461-6704
www.mgmt.dal.ca/sres/eco-burnside

Fairfield Ecological Business Park
Baltimore, MD
410-837-9305
www.buildfairfield.com

Organizations Involved in EIPs
Indigo Development
Oakland, CA
(510) 530-6521
www.indigodev.com

Research Triangle Institute (RTI)
Triangle Park, NC
919-485-2666
www.rti.org

Work and Environment Initiative
105 Rice Hall
Ithaca, NY 14853
617-254-5089
www.cfe.cornell.edu/wei

The Smart Growth Network
www.smartgrowth.org/casestudies/casestudy_index.html

Research Papers
Nicholas Gertler’s MIT Masters Thesis
“Industrial Ecosystems: Developing Sustainable Industrial Structures”
Provides and in depth case study of Kalundborg, Denmark
http://www.sustainable.doe.gov/business/gertler2.shtml#table%20of%20contents
APPENDIX B: EIP SURVEY
Eco-Industrial Park Survey

Please answer the following questions regarding the Eco-Industrial Park (EIP) being developed in your community. Once completed, please return the survey, by Friday, February 9, 2001, in the self-addressed, stamped envelope provided.

If the EIP you are working on is still in the planning stages, please indicate as such in Question 5. However, even if you are in the planning stage, please answer any questions that you can by describing planned practices for the EIP, instead of existing practices. If you feel that supplemental material can better answer any of the survey questions, feel free to send the information in lieu of responding to the question. Please contact Shanna Wasserman at 617-864-5847 (home) or 617-290-8259 (cell), or by email (shanna@mit.edu) with any questions or comments. Thanks in advance for your assistance.

1. What is the name of the EIP ____________________________________________

2. How many acres is the EIP? __________________________________________

3. How many development sites are designated at the EIP? ________________

4. How many square feet of business space is planned for the EIP? __________

5. What stage of the development process is the EIP in?
   a. Planning
   b. Design
   c. Under construction (including site or infrastructure improvements)
   d. Construction complete
   e. Other ____________________________________________________________

6. Please circle all steps taken to recruit businesses to the EIP
   a. Identification of targeted industries
   b. Identification of potential businesses
   c. Marketing of EIP to the business community
   d. No steps have been take to recruit firms to the EIP
   e. Other recruitment tools
      used______________________________________________________________
      ______________________________________________________________
      ______________________________________________________________

7. How many businesses have expressed an interest in locating at the EIP (please provide an approximate number if possible)? ________________

8. How many businesses are located at the EIP (include lots sold and lots under construction)? ________________
9. Once firms are admitted to the EIP, are they tenants of the park or do they own the land themselves?

Tenants _______ Land owners _______ Can be either _______ Other _______

10. In what year did planning for the EIP begin? ______________

11. Did the EIP originate out of a broader planning agenda, such as an economic
development plan or a sustainability initiative? _______Yes _______ No

If yes, please describe the planning agenda that led to the creation of the EIP.

12. Please briefly describe the vision/goals of the EIP. (A copy of the EIP vision statement
or bylaws is a welcome substitute to this question).

13. What is the name of the managing entity in charge of the
EIP? ________________________________________________________________

14. What sector is the managing entity in? (please circle one)
   a. Public sector (example - Town or City)
   b. Private sector (example - private developer)
   c. Quasi-Public (example - redevelopment authority, economic development agency)
   d. Nonprofit (example - community development corporation, environmental
      organization)
   e. Other (please describe) ____________________________________________

15. Please circle all sustainable measures being implemented at the EIP.
   a. Vanpooling/carpooling b. Recycling
c. Zero emissions d. Waste exchange/Material
e. Open space conservation f. Green building design
g. Other (please list)

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
16. Please circle all sustainable measures being planned for the future at the EIP.
   a. Vanpooling/carpooling  
   b. Recycling  
   c. Zero emissions  
   d. Waste exchange/Material exchange  
   e. Open space conservation  
   f. Green building design  
   g. Other (please list)  

17. Please circle all criteria used to determine whether a firm can be admitted into the EIP.
   a. Business has an environmental mission  
   b. Business agrees to use green design principles to construct its building  
   c. Business agrees to meet the environmental vision defined for the EIP  
   d. Business agrees to work toward meeting the environmental vision defined for the EIP  
   e. Business agrees to involve itself in waste exchange between firms  
   f. Business agrees to undergo an environmental review paid for by the firm  
   g. Business agrees to undergo an environmental review paid for by the EIP  
   h. Business agrees to abide by recommendations made through an environmental review  
   i. Business is of an industry that fits within a waste exchange study conducted for the EIP  
   j. Business agrees to create a certain number of jobs (if so, how many?)  
   k. Business agrees to hire employees from the local community  
   l. Other criteria used to determine a firm's eligibility  

18. Please circle all measures that can be used to enforce the vision of the EIP with member firms. (please include measures planned for the future as well).
   a. Business can be removed from the EIP for failing to comply with the EIP vision  
   b. Business can be fined for failing to comply with the EIP vision  
   c. Business might face bad publicity from failing to comply with the EIP vision  
   d. Business must undergo an environmental review to bring it into compliance  
   e. Incentives are in place to assist firms in complying with the EIP vision  
   f. Business cannot be penalized from failing to comply with the EIP vision  
   g. Please describe other measures used to penalize firms for violating the EIP vision
19. Please circle all benefits provided by the EIP managing entity, which firms receive when they become a member of the EIP (please include benefits planned for the future as well).
   a. Firms realize more favorable public relations through good publicity by the managing entity
   b. Firms receive a reduction in taxes.
   c. Firms receive an eco-review to help identify ways to improve their environmental impact
   d. Firms receive reduced cost electricity
   e. Firms receive reduced cost water
   f. Firms receive reduced cost steam
   g. Firms receive benefits of transit, carpooling, or other means to transport employees to work.
   h. No benefits are provided by the EIP managing entity to the firm in return for locating at the EIP.
   i. Other benefits provided by the EIP managing entity to firms

20. Are businesses in the EIP co-located? ______ Yes _______ No

21. What are the names of the businesses in the EIP?

22. How many jobs have been created by the EIP? _________

23. What is the projected number of jobs to be created by the EIP? _________

24. Please estimate the average salary of jobs at the EIP. _________

25. Has an analysis (such as input-output analysis) been conducted to determine material flows between potential or existing businesses at the EIP? ______ Yes _______ No

26. Please list obstacles that you have encountered in planning for and implementing the EIP?