

The City of Hamilton's Sustainable Development through Eco-
Industrial Parks

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1.0 INTRODUCTION

There is immense pressure placed upon the ecosystem and biosphere to encompass and support the rising global population and an exponential increase in consumption levels. As a result, the world is facing numerous challenges such as global warming, high levels of air pollution, economic crisis, poverty and global loss of bio-diversity.¹ To meet the needs of a growing world population within the planet's ecological means, Canada and other industrialized nations will be required to reduce material throughput, energy use, and environmental degradation by over ninety percent by 2040.² Therefore, there has been a global drive towards sustainable development as a means of reconciling human development with the earth's ecological systems.³ A synergy between the social dimensions, environmental stewardship, and economical efficiency, also known as the three pillars of sustainability is required when considering sustainability. Advancement of sustainable development will be a means in safeguarding the future. Therefore, the key goals of public policy and decision-making in Canada and around the globe have centered on sustainable development.⁴

Since the mid-90s, municipalities have taken on the challenge of developing practices that will ensure the long-term sustainability of their communities.³ The City of Hamilton is a diverse city which includes a booming industrial sector and a large community encompassed by a vast natural environment. Hamilton has been focused on implementing sustainable development within the city as seen by its VISION 2020. The VISION is a city-wide strategy that looks to implement sustainable development throughout the economic, social, and environmental sectors of the city. However, the problem experienced by the City of Hamilton along with many global governments is that sustainable development may not meet the outlined goals within the time

requirement of the year 2020. The strategies outlined in VISION 2020 do not examine the synergistic relationship that exists between solutions; rather, it focuses solely on resolving the issues of each pillar separately.

Therefore, to obtain sustainable synergy, many have turned towards incorporating Eco-Industrial Parks (EIP) into sustainable development. EIP were initiated as a community of companies exchanged and utilized the by-products and energy of each other. The exchanges were originally created to minimize the cost of product disposal but as more exchanges were introduced, the environmental benefits also came to light and this solution became even more favourable. This research paper will focus on examining the phenomenon of Eco-Industrial Parks in detail by using case studies to illustrate how it is a viable method that can be used to assist the Hamilton region in becoming more sustainable.

2.0 Background

2.1 What is an Eco-Industrial Park?

Ecology is the study of the relationships among and between species and their physical-chemical environments. Three important features of ecology are the unique habitats which species depend on, the communities that species form by grouping together and lastly, the ecosystem.⁷ An ecosystem is defined as the interactions between the assembly of species, habitats, communities, and the physical and chemical components; which will then interact and create a stable ecological system.⁷ The stability of the ecosystem depends heavily on interconnectedness of the species. As an ecological system gradually matures, the connections within the ecosystem begin to expand.⁸ Industrial systems tend to emphasize independence and competitiveness of enterprises, yet they are embroiled in webs and chains of customers and

suppliers which is similar to the chains and webs in a natural ecosystem.⁸ Industries become dependent upon natural resources such as land, building materials, water and hydrocarbons for energy supply. In other words, industries within an industrial ecological setting must be dependent on one another to survive.⁷

The field of study on Eco-Industrial Parks (EIP) is still quite young. In the early 1960s, the idea began to surface about a novel approach to environmentally sustainable economic development.⁸ It is difficult to specifically define an eco-industrial park as each one is unique in specific aspects.⁹ Originally, an eco-industrial park was simply defined as a community of companies located within a single region that made use of each other's energy and by-products.¹⁰ The modern concept of EIP tried to mirror the cyclical process of the ecosystem which included raw material extraction, manufacturing, product use, and waste disposal.^{8,10} In this context, industries were viewed as webs of consumers, scavengers, and producers.⁸ A symbiotic relationship between the industries was encouraged in hopes of achieving the ultimate goal of reusing, repairing, remanufacturing, recovering and recycling products and the by-products.¹¹ By integrating both the principles of environmental stewardship and sustainable design along with the original premises of an EIP, the modern EIP can be defined by the following:

*“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 and environmental quality gains, and equitable enhancement of human resources for the business and local community”.*¹¹

2.2 Eco-Industrial Park Cyclical Loop Systems

To obtain sustainable synergy, EIP must follow the cyclical loop system, from a *Type I* to *Type III* system, of industrial ecology.¹² A *Type I* system is presented as a linear system, where an

unlimited amount of resources enters the system while products and waste leaves the system.

The very early stages of industrial development contained similar characteristics of the *Type I* System.¹² However, as industrial development progresses, it cannot continue to adhere to the linear path of a *Type I* System as the concept can only be applied to an input of unlimited resources that feeds the system and unlimited space to discard waste leaving the system.¹³ One of the primary reasons many have turned towards EIP is due to the diminishing resources and a lack of space to deposit waste and used products.¹⁰

Therefore as industry keeps developing, it will enter a *Type II* System. This System is characterized by the input of limited resources, the limited amount of waste leaving the system, and a partnership to exchange energy and material between components within an ecosystem. A *Type II* System is representative of a developed industrial system incorporating sophisticated technology and a certain degree of waste recycling and pollution prevention.^{12,13} Current industrial systems including EIP fall under this partially closed loop system where the systems recycle and reuse materials and waste in order to reduce their resource inputs and waste outputs.¹³

The equilibrium of ecological systems is represented by a *Type III* System, where the energy and wastes are constantly reused and recycled by the other components of the process with the system. This is a completely closed loop system in which the only input would be solar energy.¹³ A *Type III* system is the ultimate goal of industrial development where the waste outputs would continually be reused and recycled thereby representing the ultimate sustainable process.^{12,13}

The problem is that an EIP will never be able to efficiently achieve the totally closed cyclical loop of a *Type III* System because it may result in the costs exceeding the benefits.¹³

Theoretically, manufactured products must leave the system eventually, diminishing the quantity of material circling within the system. Hence, the EIP system will be in need of new material inputs.¹³ The success of EIP will not simply be a function of its environmental record, but rather, its' ability to compete in the marketplace.¹⁰ As a result, the cost will always be a crucial underlying factor.¹⁰ The goal of EIP is not to mirror the cyclical use of resources in a natural eco-system, but instead to come as close as possible to being a closed-loop system with near-complete recycling of all materials.¹³

2.3 Approach systems to develop an Eco-Industrialized Park

When developing EIP, two main systems approaches must be considered: the engineered systems approach and the self-organized systems approach.

The engineered systems approach relies heavily on detailed analysis of data, resources and energy flows. The approach assumes that once the optimal profit-maximizing interaction is calculated, participants will adopt the process accordingly.¹⁴

The self-organized systems approach believes that facilitating organic growth while excluding an overall master design of exchanges and connections between participants will yield better results. In this approach, participants have ownership over the process and are able to develop a system will suit their unique needs and priorities.¹⁵

The difficulty with an engineered systems approach is that it does not account for the flexibility and unpredictability of individual participants within an EIP.¹⁵ For example, current EIP's may

contain hundreds of participants and exchanges, and a detailed analysis to calculate the most optimal design for all involved can be difficult if the goals and criteria for each individual participants is different from each other.¹⁴ Continued changes to the environment, participants and technology are also difficult to calculate and control. This approach is best used when the main criteria and goals can be controlled. The best case scenario for an Engineered Systems approach is when developing an EIP from the absolute beginning when the EIP consists of only land. The land will be developed with industries, material/waste exchanges, and participants that fit within the specific EIP model set by the engineered criteria and goals.¹⁴ Since many EIP and possible EIP sites consists of pre-existing participants, the self-organized systems approach has been found to be the most successful systems approach. It is founded on the basis that each participant within the EIP will make their own connections and in turn, design their own solutions to problems they are presented with.¹⁵

3.0 Eco-Industrial Parks Around the Globe

The concept of EIP is fairly young, materializing only about three decades ago. However, the idea was well received and currently EIP are numbering at 12600 sites in different locations worldwide.¹⁶ Each site is unique and was designed and developed through collaboration of the industries and communities involved within the EIP. Many areas in developed countries along with remote areas in developing countries have encompassed the EIP concept in hopes of moving towards a sustainable future.⁹ The following sections below will describe the concept behind few of the EIP found globally.

3.1 Kalundborg Eco-Industrial Park

3.1.1 Kalundborg Eco-Industrial Flow Loop

The Kalundborg Eco-Industrial Park was the first successfully-functioning recycling network. Kalundborg is a small city in Denmark with a population of 20,000 residents.¹⁶ The Kalundborg EIP was conceptually designed when the five main industrial companies came together in the 1972 under the premises of reducing costs by creating methods of producing income from the unwanted by-products.¹⁷ Eventually, the industries and communities involved in the Kalundborg EIP began to incorporate an environmental agenda into the project, while only beginning to examine the environmental benefits created through the reduction of energy and waste outputs.¹⁷ The five core industrial participants include Asnaes Power Station which is Denmark's Largest coal-fired power plant; Europe's largest plasterboard manufacturer, Gyproc; Novo Nordisk pharmaceuticals plant which produces pharmaceuticals including 40% of the world's insulin supply; Denmark's largest oil refinery, Statoil; and lastly, the municipality of Kalundborg, which distributes heating, electricity and water to the local community.¹⁸ The main idea was that the by-products from one company can be reused as a form of low-cost product by another company, thereby exchanging materials and energy.¹⁷

The Kalundborg Eco-Industrial Park was designed to operate in the manner described by the flow diagram in **Figure 1** below. The Asnaes Power Station collects fresh water from Lake Tisso as an input and supplies residual steam to Statoil refinery.¹⁹ Asnaes, in exchange, gains waste refinery gas from Statoil Refinery, which it then burns to produce and generate electricity and steam for the company. The surplus electricity and steam is sent to the Kalundborg community which serves about 4500 homes, the local fish farm and the Novo Nordisk Plant. The Asnaes

Power Plant also produces other waste by-products such as 170,000 tonnes of fly ash per year which is received by a cement company or cement manufacturing and road building.¹⁹ 1.5 million cubic meters of excess sludge from Novo Nordisk pharmaceutical process and the fish farm is delivered to local farmers for use as fertilizer. Gyproc purchases 80,000 metric tons of Asnaes' excess fly ash at a large discount and uses it to create gypsum, a material used in the plasterboard manufacturing system, hence, meeting two-thirds of its gypsum requirement.¹⁹

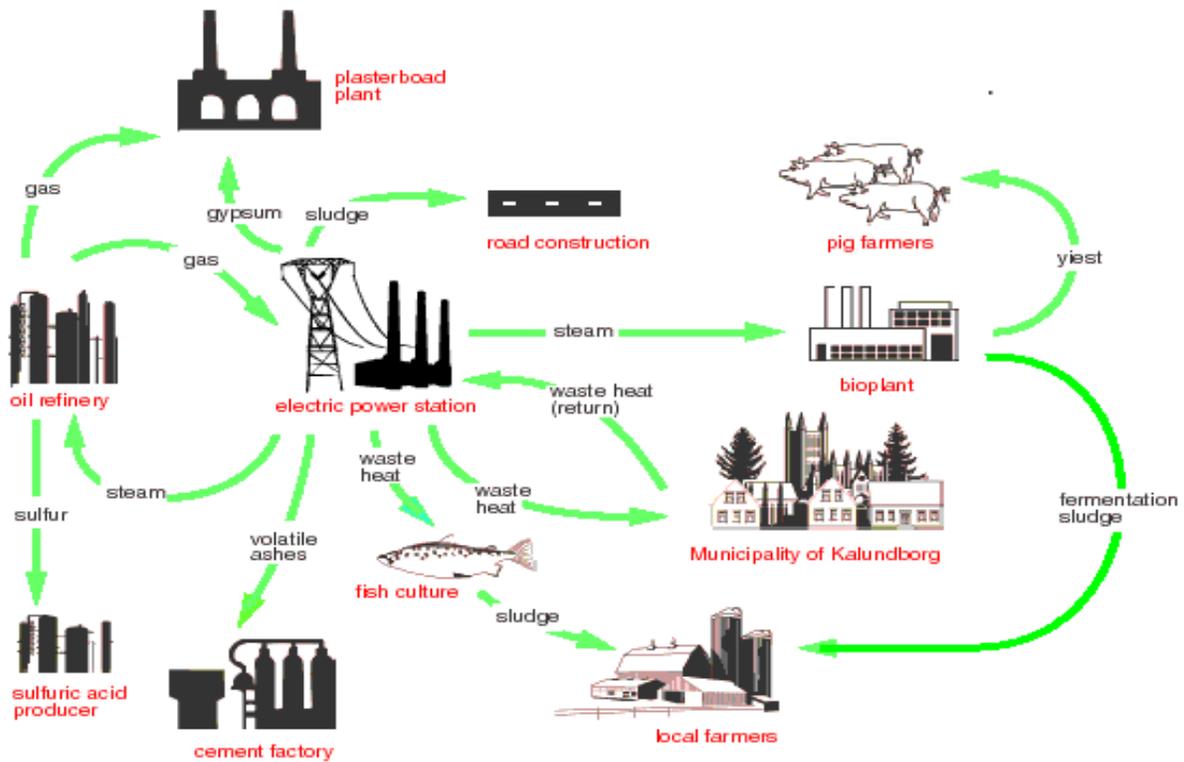


Figure 1 : Kalundborg Eco-Industrial Park¹⁹

3.1.2 Benefits

The economical and environmental benefits of the Kalundborg EIP project are abundant. The park allowed the participants to improve resource efficiency such as Gyproc experience with a reduction in its oil consumption by 90 to 95 percent when switching to the excess gas supplied

by Statoil Refinery.²⁰ 95 percent of the total supply of water to the Asnaes plant was due to water reuse and exchange within the EIP.²⁰ In 2004, it was calculated that the EIP has saved about 3 million m³ of water annually through reuse and recycling.²¹ 30,000 tons of straw is converted into 5.4 million liters of ethanol. A savings and reduction in the use of materials were also experienced including saving 150,000 tons of Gypsum.²¹ The area encompassing the Kalundborg EIP has also witnessed a significant decrease in pollution when compared to other industrial intensified cities in Europe. At the early stages of the EIP concept in 1995, about 3 million tonnes a year of material and energy were exchanged between the industries.²⁰ The participants experienced a total of \$15 million in savings annually along with continued investments which currently correlates to savings of about \$300 million dollars US and a revenue of approximately \$120 million dollars US per year.²⁰ From its inception in the late 1970s with the energy and material exchange between the five core participants, it has currently grown to over 30 exchanges between more than 18 small and large businesses in the Kalundborg area.¹⁹

3.1.3 Lessons from Kalundborg Eco-Industrial Park

Kalundborg's success has helped spark interest within the global industry about the economical, environmental and overall sustainable benefits of EIP.²¹ The executives behind the Kalundborg EIP have always argued against public planners critiquing that Kalundborg can be copied and improved upon. Kalundborg executives believe that others interested in developing EIPs should not look towards Kalundborg as a model in which they could replicate the exact industries and industrial exchanges and pipes fittings.²¹ Rather, they refer to it as model in how participants should collaborate together naturally to create a successful EIP that has a unique identity of its own. As explained previously, Kalundborg EIP was not originally created as a result of

environmental planning nor was it from the participant's interest in environmental protection.²²

Instead, it was meant to lower costs through accessing cheaper materials and energy and to reduce waste treatment and disposal costs.

Many do not realize that the Kalundborg EIP is not a cyclical closed loop system as described earlier but rather a *Type 2* loop system which is not fully self-sufficient.^{12,16} For example, the 200 tons of fish produced within the fish farm in Kalundborg are exported to French markets annually.¹⁶ Gyroc still imports a third of virgin gypsum, which is a significant amount, from distant countries such as Germany and Spain. Of the 1.2 million cubic meters of wastewater discharged, only 9000 cubic meters is reused at the Asneas Power Plant while the rest is still disposed.¹⁶ Kalundborg is continually improving their processes annually on the merits of lowering operational costs whilst subsequently improving environmental protection.²²

Experts have concluded that the success of Kalundborg lies upon its self-organized engineering approach which begins with the notion that all contracts are negotiated on a bilateral basis.²⁰ Kalundborg was created based on private conversations in the 1960s and 70s. Statoil needed fresh water for its process and therefore, it created an exchange (tube) connecting the company to Lake Tisso in 1961.¹⁷ In 1972, Statoil and Gyroc built an exchange between the two companies to transfer the surplus gas from Statoil's production. In the next year, Anseas Power Plant built exchanges between Lake Tisso and Statoil to address their water and wastewater needs.¹⁷ Slowly, Kalundborg Park kept growing. Each contract and exchange was the result from the conclusion between both participants involved, the main aim to create and expand this project was for economic reasons rather than how environmentally attractive it was.¹⁶ The government once tried to force the Kalundborg EIP to consider environmental

protection as a focal point in decision making and it resulted in a loss of revenue for the participants involved due to the strict environmental criteria set by the government. Each participant complies in hopes of minimizing the risks.¹⁶ Lastly, each company evaluates its own deals independently. Participants within the EIP do not to create a system-wide evaluation of performance nor does it impose standards for others because they believe it has been most successful and efficient when participants set their own standards and goals.¹⁶

3.2 Burnside Cleaner Production Centre

Based on the success of the Kalundborg Eco-Industrial Park, many developed countries began projects to implement the concept of EIP into their industrial sectors. The United States believed in benefits of EIPs and was quickly driven to implement concept within its industrial sectors.²¹ Currently, the United States has hundreds of EIP developed or in the stages of development. Canada has recently begun to adopt the idea of EIP into their sustainable agenda and have discovered 40 sites around Canada which would be suitable for this type of development.¹⁰ Canada has gained EIP success in a few sites such as Burnside Eco-Industrial Park in Nova Scotia as well as the Bruce Energy Centre in Trenton, Ontario and in Sarnia, Ontario.

With the help of the provincial and federal governments, the Burnside Cleaner Production Centre was created in 1995 to assist in establishing industrial ecological exchanges and linkages within an industrial park in Burnside, Nova Scotia. The role of the Cleaner Production Centre was to facilitate, promote, and assist 1,200 local businesses with the concept of sustainability.²³ The Centre included services such as assistance for searching for suitable technologies, energy and material conservation as well as improving resource use efficiency for participants in the Burnside EIP. Waste audits were used for facilitating reduction in packaging waste and lastly, in

order to assist in identifying energy and waste exchanges between companies.²³ The Burnside Cleaner Production Centre is a practical solution that has assisted in creating EIP linkages. A packaging firm was able to reuse the surplus of polystyrene from a computer company.

There are 25 printing firms located within the Burnside EIP and steps are being taken to create a silver recovery program for the printing industry through collaborative resource grouping.²⁴ A company within the park collects recycled corrugated cardboard and will send it to be processed into liner board. 19 firms in the Burnside EIP distribute, manufacture, or retail chemicals and thus, a chemical recycling program has been created between the firms. The Centre helped in creating a paint swap program between the 21 firms currently using paint in their processes in hopes of reducing the 5038 litres of paint discarded annually.²³ The Centre is in the process of identifying linkages to create a programs suited towards the reuse and recycling of toner cartridges, furniture refurbishing and the re-inking of ribbon.²³

The EIP in Sarnia, Ontario is an industrial exchange program between oil refineries, petrochemical companies, a synthetic rubber plant, and a steam electrical generation station. The Bruce Energy Centre in Ontario is a small eco-industrial park centered around a nuclear power station to use its waste heat and steam generation for processes such as distillation and dehydration.¹⁶

3.3 Hamilton's Airport Employment Growth District Eco-Industrial Park

The Airport Employment Growth District (AEGD) encompasses 1,340 hectares of land surrounding the John C. Munro Hamilton Airport.²⁵ It is a City led initiative to develop the employment opportunities within Hamilton and to support further population growth in accordance with the concept of an eco-industrial park.²⁵ The AEGD area was chosen due to

Growth Related Integrated Development Study (GRIDS) conducted in conjunction with the City of Hamilton Water and Waste Water Master Plan.²⁵ The study set out the population and employment targets and listed the major water and wastewater infrastructure throughout the City up to the year 2031. According to GRIDS one major area of employment growth was the existing agricultural lands surrounding the John C. Munro Hamilton Airport.²⁶ The report estimates that the AEGD site will provide approximately 27,700 jobs and about 660 net hectares of new employment land by 2031.²⁶

The AEGD project is adopting an engineered system approach in that it is encompassing a small area that has not been thoroughly developed thereby easily allowing the City to develop the EIP within the City's sustainable parameters and guidelines.^{14,25} For example in terms of water conservation it was calculated that for the expected employment criteria, the average water demand 260L/emp/day, the average daily water flow is 260L/emp/day and the overall water demand for the AEGD Secondary Plan Area is approximately 22ML/d.²⁵ The plan went to further calculate that the airport will passenger will see a flux of 9.5 Million Passengers/Year and the daily water consumption per passenger is 30-33L/passenger.²⁵ Developers will have to design methods in which to obtain specific sustainable water goals by using either water conserving technology such as low flush toilets, collecting and using rainwater, or creating a water exchange system.²⁵

The Master Plan further outlines more principles and criteria for other aspects of the EIP. For example, for industry within the AEGD, it will consist of light industry, warehousing, repair, wholesale trade, office, distribution, transportation, communications, and utilities.^{25,27} It will have minimum standards for urban design. Controlled outdoor storage, accessory uses such as

smaller offices and retail and ancillary support for commercial schools, health services, and financial establishments.²⁵ For airport related businesses, businesses must require airside access such as freight forwarders, regional integrator operations, and onsite custom brakes.^{25,27} Some urban park guidelines to follow are to integrate nature into public spaces by creating natural use as buffers, open space and trail systems. Provide a variety of public spaces and walkable places throughout the employment district that provide employees an opportunity to come together and to use native species in landscaping.^{25,27}

Another aspect of the AEGD Master Plan is to include elements of sustainability into the AEGD. Transportation networks must include public roads and lane designs that can reduce congestion, pedestrian/bicycle paths, carpool lots, green corridors, and future transit routes connecting to future rapid transit.²⁵ It must also require reduced parking areas with sustainable features such as permeable pavement and landscaping. The AEGD plan must incorporate a minimum of 25 % efficiency improvement over the Model National Energy Code for Buildings.²⁵ Water and wastewater management requirements include the use of drought resistant low-maintenance landscaping for 50% of site and the use of rain/moisture sensors, programmer irrigation sensors, and rain captures.²⁵ Some important suitable elements in regards to construction is that a minimum of 75% of all building materials made within 800 km of project site and a minimum of 10% of building materials must contain recycled content.²⁷ For economic sustainability, it is important to promote synergy between waste producers and waste users and promotion of the importance energy, water, utilities and material exchanges among business. As of 2013, the AEGD Master Plan has been completed and approved. In the next few decades, it will be interesting to witness the unique development of the AEGD Eco-Industrial Park.

4.0 Benefits and Barriers of Eco-Industrial Park

4.1 Benefits

The EIP began as a method of reducing costs related to material and output waste for industries. Gradually as EIP began to develop, it began to incorporate elements that were beneficial to environmental and societal sustainability. Table 1 below lists some of the benefits of EIP.

Table 1: Benefits of Eco-Industrial Parks

Community	Environment	Industry
Expanded local business opportunities	Larger tax base	Wide range of potential cost savings;
Larger tax base	Community pride	Revenue generation
Community pride	Reduced waste disposal costs	Promotional/marketing opportunities
Improved health for employees and community	Improved environmental Health	Improved opportunities for new investment
Improved environmental Health	Improved environment and Habitat	Costs savings through regulatory flexibility.
Improved environment and Habitat	Enhanced quality of life in areas near eco-industrial development	Improved environmental efficiency
Enhanced quality of life in areas near eco-industrial development	Improved aesthetics	Access to financing

4.2 Barriers of EIP

A general barrier experienced within the EIP structure is that it may prove to be an obstacle in furthering technological evolution and continued reliance on toxic chemicals.¹⁰ If companies are experiencing the same economical profits and environmental benefits with the outdated technology included in the process, there will not be any pressure to improve the technology or the technological standards in place.^{9,12} If companies within the EIP structure can easily discard

or exchange hazardous materials, avoiding deposit costs, the company may be reluctant to switch from hazardous to non-hazardous.

Inter-firm dependency is a barrier that can have a very negative effect upon the EIP structure.^{9,15}

As explained previously, participants are interconnected and rely on each other within an EIP therefore if one participant were to leave or closed down; those dependent upon that particular participant will be in risk of losing a critical supply or market.

Strict environmental regulations are creating many barriers in product exchanges. Once a product has a certain characteristics, it is classified as waste and is subjected to a number of restrictions and administration procedures.¹⁶ Therefore many find it difficult to reuse or recycle hazardous waste between companies due to strict regulations. Some municipalities, especially the City of Hamilton, have very strict zoning laws which hinder many proposed developmental projects. Regulation harmonization is rarely practised thereby making it difficult to exchange materials. Laws and regulation differ between municipalities; therefore one municipality may have less stringent laws and regulations than another, making it more difficult to carry over concepts from one EIP to another.¹⁶

In some municipalities development of energy related programs have been blocked by government-owned monopolies. There are steps being taken to deregulate the utility sector in Ontario which may result in new energy based EIP projects moving towards implementation.

5.0 Canadian Strategies and Policy Framework

The Canadian government must play a large role to successfully implement the concept of eco-industrial parks into Canada.¹⁰ Governments have the ability to push guide towards a desired

direction using both policy and technology. Governments in developed countries have currently been moving towards sustainable development due mostly to public outcry about rapid environmental degradation; therefore governments can create policies, laws, regulations and programs that can guide the residents towards a transition towards a sustainable future.⁹

Since the success of the Kalundborg EIP, the United States government has begun to adopt the EIP model into its societal framework through creating awareness and incentive programs, laws and policies that specifically target EIP development¹⁶ This has allowed for the implementation of over one hundred EIPs within the United States and been a large driving factor behind plans for many more.¹⁰ The Canadian government has begun to understand the importance of the sustainable benefits provided by EIP and have now taken steps to begin implementing EIP's into society. Currently Canada does not have any specific strategies and policies directed towards EIP but the existing sustainable strategies and policies can be adopted to suit the needs of EIP development.

5.1 Canadian Strategies

5.1.1 Securing Our Future Together

The government strategy, *Securing Our Future Together*, was focused on promoting innovation, improving science and technology, resource use efficiency, research on toxic substances, action on climate change, and investments in infrastructure.²⁷ The strategy was instrumental in providing funding towards research and development of sustainability and creating many sustainable programs.²⁷ The limitations of this plan, however, was that the sole responsibility and accountability of sustainable development was put upon the shoulders of departments and agencies where they took ownership of creating their own sustainable development strategies.²⁸

It was found there was lack of long-term focus due to an absence of an over-arching sustainable development strategy. The performance indicators created for the strategy were not accurate or comprehensive enough. The goals set by each department and agency had been too vague and unfocused, thereby failing to make any positive headway. Lastly, there was a lack of information on the progress of initiatives and programs due to the inadequate monitoring and development.²⁸

5.1.2 Federal Sustainable Development Strategy

Building upon past federal strategy failures, Parliament developed and passed the Federal Sustainable Development Act (FSDA) in 2008. The act required the Government of Canada to develop a Federal Sustainable Development Strategy (FSDS) that would create a framework to make environmental decisions more transparent to Parliament and also supports continuous improvements of the management of sustainable development. The FSDS framework has improved on established upon the following key elements:

- An integrated governmental venture incorporating the federal, provincial and municipal governments
- A link between sustainable development planning and reporting and the Government's core expenditure planning and reporting system,
- Create an effective compliance committee that can oversee and keep track of the progress of the strategy

Responding to past limitations the FSDA clearly states the Government's long term vision, targets, plans and goals for environmental sustainability which are categorized under four main priority themes: Reducing environmental footprint, Addressing climate change and clean air, protecting nature, and maintaining water quality and availability.²⁹

Under the FSDA the Government has also created the Canadian Environmental Sustainability Indicators (CESI) initiative, a program to monitor whether the FSDA is in compliance with its goals.^{29,30} The CESI chooses indicators based on the policy relevance represented by the FSDS goals and targets, whether the indicators meets the needs of the public and decision-makers, provides solid and consistent sound methodology and lastly data availability. The CESI is slated to measure the FSDS progress every three years.³⁰

Currently, the FSDS strategy has been successful in abiding by the goals and principles set by the strategy. Under the FSDS climate change goals for reducing greenhouse gas emission levels, it has developed a clean energy and climate change strategy that harmonizes with that of the United States.²⁹ Created new regulations requiring 5% of renewable content in gasoline and diesel fuel and frequent publishing of regulations for greenhouse gas emissions such that it aligns with the 2020 automobile emissions reductions targets of the United States.²⁹ The FSDS strategy is working on meeting its air pollution goal by moving forward with the Clean Air Regulatory Agenda, moving industry from voluntary compliance to regulations, and continuing to consult with provinces, territories, industries and Canadians to set and reach targets for reducing air pollutants and greenhouse gas emission.^{29,30}

5.1.3 Vision 2020 Hamilton

In 1992, the City of Hamilton adopted VISION 2020, a strategy which decided what the City of Hamilton would look like in the year 2020.³¹ Every five years, the VISION has been updated and the final goal of VISION 2020 was established which describes Hamilton as a fully functioning sustainable community. The VISION 2020 consists of goals, strategies, and compliance measurements that will help in shaping the sustainable future of Hamilton.³¹ VISION 2020

sustainable principles were built upon the following areas of focus such as ecological preservation, reducing and managing waste, reducing energy consumption, improving the quality of water resources, improving air quality, sustainable transportation, and community well-being.³¹ VISION 2020 went on to further state specific goals for the suggested areas of focus. For example, for the local economy of Hamilton, the VISION has set a goal to increase the number of non-polluting businesses and organization and those who produce sustainable products that reduce and prevent pollution.³² To improve the quality of water, the VISION has set a goal to identify and virtually eliminate all sources of potential chemical contamination.³² Another goal is to reduce the consumption of non-renewable energy and eliminate the excessive and wasteful use of energy. One of the principle goals of the VISION is to increase public awareness and participation to accomplish the outlined goals.³²

VISION 2020 has been the backdrop for the recent Airport Employment Growth District project, where goals such as reducing energy and water conservation, preserving natural areas and corridors, and improving the local economy correlate with many of the goals and principles of the VISION.^{25,32} VISION 2020 has been awarded numerous awards and accommodations such as the National Guide to Sustainable Municipal Infrastructure. The VISION has aided in the development of many sustainable projects and ventures and been the fundamental factor in championing Hamilton towards a sustainable future.²⁵

5.2 Governmental Sustainability and Incentive Programs

As mentioned previously, there are currently no programs that specifically support EIP development but the programs that are available can be adapted to suit the main primary

priorities of EIP. The federal, provincial and municipal governments provide the public with a variety of programs that will help in understanding and developing sustainability.

5.2.1 Infrastructure Programs

The Industrial Incubation Program in Nova Scotia provides rent subsidies to assist new manufacturing and processing companies.³³ Industrial mall managers can use this program to attract industries that use each other's by-products with the incentive of rent subsidies provided by the provincial department of Public Works and Transportation.

The NOHFC Community Infrastructure Capital Assistance Program dealing with infrastructure development provides a subsidy for costs relating to design, sight planning, engineering and construction costs for site improvement, materials, equipment, and labour.³⁴ This incentive program exists through partnerships of the private sector, other levels of government, non-profit education, municipal and other organizations.³⁴ EIPs could be created through the collaboration between the incentive programs and many partnerships associated with the program.

The City of Hamilton's Environmental Remediation and Site Enhancement (ERASE) plan is designed to encourage and promote Brownfield development.³⁵ The ERASE Study grant is available for Brownfield development. The City pays up to one-half the cost of a Phase II or Phase III Environmental Site Assessment. Maximum city allows is \$15000 per study period and \$20000 per property. The grant is calculated as 80% of the increase in the municipal portion of property taxes and is paid on annual basis for up to 10 years, commencing once the redevelopment is complete.³⁵

5.2.2 Energy and Waste Programs

The Government of Canada has provided many tax incentives and programs that encourages businesses to reduce energy, waste, and to use insurable energy. The Ontario provincial government provides rebate incentives on sustainable technology such as electric vehicle, energy efficient lighting, low-flush toilets, and energy/water conserving household appliances. The Ontario Ministry of Energy and Infrastructure provide the Home Energy Savings program where residents can sustainably upgrade their property to reduce their energy and waste consumption and a rebate of up to \$10,000 dollars may be provided. Large rebate and tax incentives are provided to industries that undergo a green retrofit to reduce energy and waste consumption. Therefore EIP concepts can be implemented in that processes where they could create energy exchanges between industries to meet the energy incentive requirements for the retrofit.

The Canadian Industry Program for Energy Conservation (CIPEC) along with a Partnership with Natural Resources Canada help organization cut costs, improve energy efficiency, and reduce greenhouse gases.³⁸ They have cost-shared assistance programs, of up to \$25000, available for implementation pilots, process integration studies and computational fluid dynamic studies. They have access to industry networking which includes fifty trade sectors.³⁸ The industry networking opportunity can be utilized to form exchanges and linkages between many industries in different sectors. Lastly, the CIPEC provides energy management workshops and technical information.³⁸

5.2.3 Environmental Programs

Recent policies and programs adopted by the federal and provincial governments can encourage the formation of EIPs. The environmental programs can help create an exchange between the natural environment and the community in order to foster community well-being.

Many projects are currently underway and are targeted at conserving the ecosystem within the City of Hamilton. The Dundas EcoPark Campaign is project that is trying to protect and restore the natural habitat encompassing 4,700 acres. It will protect over 1,500 species of birds, trees, and wildlife and help in restoring and maintaining meadows, healthy forests, waterways, and hiking trails.³⁹ The preservation and protection of the local natural environment can attract future residents and business as well as strengthening community well-being and pride.³⁹ Industries, businesses and the local community can include the natural environment within their EIP design, using the local environment as an aesthetic exchange.

The Province of Ontario recently included a recycling fee to electronic products in hopes of reducing electronic waste.⁴⁰ The fee would subsidize the cost of electronic recycling and the electronic waste would be sent to adequate recycling facilities where 98 % of the electronic waste is recycled.⁴⁰ The problem with the fee was that the public was unaware and were still discarding the electronic waste into municipal landfills. Therefore the Province could create an innovative solution that encompasses EIP concepts where they begin to promote the flow of material exchange of electronics between the community by promoting trade websites like Kijiji and Ebay. The consumers can sell and trade products online thereby promoting the reuse of electronics. Another idea is creating a material exchange loop between local companies that are

willing to collect the electronic waste from consumers for the reusable components within the electronics.

5.2.4 Research and Development Programs

Research and development programs are instrumental in developing new technologies and process. There is a wide range of federal and provincial programs available dealing with agriculture, energy water, waste by-products and manufacturing. Many small grants from \$15,000 to large loans of \$500,000 are available.

The Securing our Future Together Strategy, assisted in establishing the Canada Foundation for Innovation which was created to stimulate further research in industrial ecology. The Foundation was given \$800 million dollars to assist in research and development investments focusing their support towards research in Canadian universities and hospitals.⁴¹

Recently, a team of Environmental Studies university students completed a research project on the industrial ecological opportunities and barriers in Toronto's Portland District. The study was beneficial in discovering that a number of companies within the area were already engaging in EIP exchanges and linkages and the study concluded that there were unrealized potential industrial ecological linkages within the district. They team also found that some barriers in creating linkages were due to confidentiality issues were companies were hesitant in providing third parties with information about their inputs and outputs. The study found that there was a lack of mechanisms needed to promote information exchange about the benefits of EIP. The students found that promoting the economic benefits of the EIP concept was far more successful than appealing to the environmental benefits. Lastly, they found that there was a lack in knowledge among companies about the different types of businesses located in other areas of the

district and many were unaware of the possible linkages that existed. Similar research studies can be conducted where the results can be helpful in the development of future EIPs

6.0 Conclusion

The development of eco-industrial parks in the City of Hamilton is one important strategy to fulfill the Hamilton VISION 2020 in developing Hamilton into a fully sustainable community.³¹ EIP encompasses the principles of sustainability in that the final goal is to bring the park as close as possible to being closed-loop equilibrium between the economy, society and the natural environment.¹³ EIP do not work inside traditional sustainability parameters in that it usually does not focus on environmental stewardship as its fundamental goal. EIPs were originally developed for economical benefit due to high waste-byproduct disposal costs. As linkages were formed through exchanges of waste by-products, unknowingly environmental benefits were also experienced. EIP linkages usually begin with a sole purpose, but gradually each link will begin to encompass all three pillars of sustainability.

Developing an EIP in Hamilton may seem like a difficult task due to its enormous size and the large number of different industries, natural environments and communities. EIPs do not have to be large in size or contain numerous amounts of linkages. The Bruce Energy Centre in Ontario is a small eco-industrial park containing a few linkages that reuses the by-product outputs between the processes within the nuclear plant.⁴² Kalundborg Eco-Industrial Park consists of a maximum of 18 participants, 30 exchanges and covers a relatively small area.¹⁷ Hence, a possible EIP development idea for Hamilton could be to create smaller EIPs, like the Airport Employment Growth District Eco-Industrial Park, around the Hamilton area. Hamilton can adopt the self-organized systems approach used in the development of EIPs to ease the transition

into sustainability. The approach gives control to the participants within the EIP to develop their own linkages suited to meet their needs. Kalundborg EIP began with a single exchange between Statoil Refinery and Lake Tisso due to Statoil's need for a fresh water supply.¹⁷ Gradually, the EIP grew larger in size due to a growth in the number of linkages between the industries.¹⁸ By identifying and organizing possible linkages between industries in Hamilton, it has the possibility of gradually developing into an EIP overtime. An engineered systems approach can also be administered in Hamilton's many newly developing areas. The engineering systems approach is most successful in newly developing areas where detailed criteria is utilized to design the industries and communities within the EIP. For example, the AEGD Eco-Industrial Park was created using the engineering systems approach and followed the restrictions of the detailed criteria set by the developers, such as not allowing the development of large industries in order to allow the EIP to thrive.^{14,25}

Newly developing EIPs are beginning to build their parks upon social and environmental linkages as opposed to linkages driven by economic benefits. The Fugisawa Factory Eco-Industrial Park is built upon the concepts of environmental stewardship.⁴³ This EIP is located on the site of an old Panasonic Plant consisting of 1000 homes, a few stores, healthcare facilities and public green spaces.⁴³ Panasonic wanted to create a sustainable Smart Town where the primary goal of the EIP is to reduce CO2 emissions by 70% and cut household water usage by 30%.⁴⁴ To achieve these goals, the EIP is building the homes and commercial buildings that contain the latest energy conserving technology, where energy savings per home will be about 70% and 20% in public spaces in the town.⁴⁴ A sustainable transportation network will be created that will eliminate the need for vehicles inside the Park. To increase community well-

being, they have created nature trails connecting homes and the commercial district.⁴⁴ Similarly, EIP projects in Hamilton can be centered on environmental and social exchanges. Hamilton contains a vast amount of natural environment and respective projects like the Dundas EcoPark Campaign which can assist in creating links between the environment, the local community and industries that can benefit all involved while adhering to environmental stewardship.

Once linkages are identified and strengthened, the EIP has the ability to develop and flourish on its own. The difficulty lies in creating the linkages due to a lack of support tools available.

Information about EIP needs to be distributed to the Hamilton community in order to make the public aware of the benefits. An informed public can be a great driving force in support of EIP development in Hamilton. Strengthening existing partnerships with the government, private, public organizations and civil society groups for ideological and financial support is a valuable step that should continue to be prioritized in EIP development. Plausible steps must be taken to create a central figurehead that will look after and help with further EIP development similar to the role played by the Burnside Cleaner Production Centre located in Burnside Eco-Industrial Park.²³ The Centre's primary role is to promote and facilitate with EIP development through providing programs help the public in identifying and facilitating waste and energy linkages between firms. There needs to be municipal policies, strategies, and programs created specifically for EIP development as it continues to become more difficult for the public to innovatively adopt sustainable strategies and programs to suit EIP development. A good starting point for EIP development in Hamilton would be to include EIP development into the next review of VISION 2020. Although the government conducts both external and internal evaluation reports, key findings of these reports should be made available to the public to

demonstrate accountability and optimal use of resources. Evaluation mechanisms should include establishing baseline data, interim assessments as well as evaluations of specific policy and program outcomes. Feedback from community members and third-party should also be well-received. By undertaking both small and large scale in-depth longitudinal research projects, this municipal government can become better informed of local, context-specific conditions and base their practices and policies on evidence-based, cost-effective interventions. It will then be able to disseminate the information that it gains from the situational analysis to the local, national and international communities to identify the opportunities for improvement and gaps in services.

EIP is a viable method which can lead the City of Hamilton towards a sustainable future. It is one of the few methods that truly encompasses the sustainability motto of creating a synergy between the economy, society, and the natural ecosystem. EIP has proven to be very successful in the past as seen through the case examples. Lastly, it is the one of the very few methods available at this moment to handle the global crisis that is fast approaching.

7.0 References

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