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Title of Thesis/Project/Extended Essay
Strategic Analysis of Kouei Industries (Canada) Inc

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Date Aug 5, 2004
Abstract

The mainstream technologies utilized to divert waste from landfills by way of recycling and incineration is no longer sufficient in addressing ever-growing issues such as waste increase, escalating energy costs, and climate change. Newer, cleaner, and more promising technologies are emerging. Among them is pyrolysis – the use of heat in the absence of oxygen to break down carbon-based waste into carbon black, oil, and synthetic gas. Kouei Industries is a small start-up company that competes within this heavily fragmented pyrolysis market.

At the industry level, components that serve as catalysts to speed adoption of alternative waste-to-energy technologies include skyrocketing fossil fuel costs, strive towards energy independence, negative effects of climate change, and government intervention. Current key challenges are: (1) very few customers in the early market, (2) high cost of initial capital investment by customers, and (3) uncertainty of revenue streams through byproduct sales.

Prior to making attempts to engage these macro-level challenges, contenders must first assess whether essential components within the organization are in place. A closer examination of Kouei Industries reveals that these requirements are currently not met. Kouei must realize: (1) angel investors are a start-up’s first source of funding, (2) the importance of a sound strategy, (3) board of directors provides much
needed guidance, (4) new technology means slow initial adoption by customers, (5) keeping employees actively engaged results in higher productivity, and (6) how to improve communication/coordination by implementing an intranet and CRM solution.
Dedication

I would like to dedicate this final project to my parents. For their teachings about life and other valuable lessons.
Acknowledgments

Dr Jill Shepherd, thank you very much for your excellent guidance throughout my entire final project.

Thanks also go to CEO Jesse Klinkhamer of Kouei Industries (Canada) Inc and all the people I collaborated with during the course of my work. Pyrolysis is truly a remarkable emerging technology with tremendous potential. I’ve indeed learned so much about issues and technologies related to the environment.
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1 Introduction

This paper will conduct a strategic analysis of Kouei Industries Canada Inc, which competes in the emergent pyrolysis industry. Although the firm has an office in Japan and Canada as well as representatives around the world, the main focus of the analysis will be on the North American market. The rest of this chapter provides background on the industry, solution and the company. Chapter two will then provide a snapshot of the North American industry. Chapter three looks at the internal situation of Kouei Industries (Canada) Inc to assess its preparedness to compete. Chapter four covers the analysis and recommendations for Kouei. The paper concludes with a summary in chapter five.

The pyrolysis industry is directly categorized under waste management, one of the leading sub-sectors. Waste management, in turn, falls under a larger Environmental Technology Industry Sector umbrella. In British Columbia, this parent sector contributes more than $1.6B every year to the GDP.¹ For the most part, revenue is generated through exports to the US, Asia Pacific, Central/South America and

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various parts of Europe. Continued major growth is projected in the area of exports to developing nations.

Pyrolysis can be seen as the next generation of incinerators – equipment that utilizes waste to create energy. Whereas incinerators create heat energy used to convert water to steam and power generators, pyrolysis creates fuels that can be used in various ways. In the recent decades, waste has been classified as an abundant renewable resource along with wind, geothermal, solar, hydro, and biomass.

1.1 Greener Alternative Waste-To-Energy Solutions

The majority of "waste-to-energy" (WTE) systems currently operational in North America are based on mass-incineration of municipal solid waste (MSW) to produce steam for running generator turbines. In terms of environmental impact, this process creates large quantities of toxic emissions. Consequently, greener alternative WTE technologies – the next generation – are urgently being sought.

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The area of alternative waste-to-energy technology entails a wide range of thermal processes including (but not limited to): combustion, co-firing, and plasma gasification. However, the two predominant processes are gasification and pyrolysis. Pyrolysis is defined as being the thermal depolymerization of carbon-based waste – which includes petroleum-based and organic – in the absence of air (or with very little air) to create carbon black, oil, and synthetic gas (syngas) as byproducts. No combustion takes place because only a small amount of air is present. Gasification, on the other hand, involves maintaining a certain level of oxygen in the process. For the purpose of this project, the focus is on pyrolysis process technology.

1.1.1 Pyrolysis

Pyrolysis is the thermal-dissolution of chemical compounds into their original molecular components. The concept of pyrolysis "dates back to ancient Egyptian times, where tar for caulking boats and an embalming agent were made from pyrolysis." Nowadays, 3000 years later, over 150 companies worldwide are attempting to break the barrier.

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to develop commercial pyrolysis. The hurdles are many, but the enormous potential awaiting is understood by corporations, academia, non-government organizations (NGOs), and governments.

The model of pyrolysis for modern industrial and commercial applications first surfaced in the mid 1970s. Between 1980 and late 1990s, numerous companies entered into research and development and installed trial pilot facilities for demonstration purposes. Many of the same companies have since failed and those that currently remain possess commendable technologies that are ready for progressing into commercialization. However, this does not imply guaranteed ultimate success in the market. During commercialization, further elimination within the current group of contenders will occur as a result of discovering that some of the technologies are economically unfeasible in terms of setup, operational, or maintenance costs.
1.2 Kouei Industries (Hiroshima and Vancouver)

Kouei Industries Inc is an environmental solutions company with headquarters in Vancouver, Canada. The company is dedicated to solving municipal and industrial waste problems in a manner that is economically feasible and environmentally responsible. The current focus is on recycling billions of stockpiled scrap tires – a major environmental issue not only in North America, but in other parts of the world as well – and all types of plastics. Via Kouei’s patented ECOLUS™ SK-200 technology, these two types of feedstock are converted into carbon black, heavy oil, and synthetic gas (syngas).

1.2.1 Company Background

In Japan, around 1985, Mr Hiroyuki Matsubara, the president and CEO of Kouei Industries had recognized that massive quantities of off-cut fibre-reinforced polymer was being discarded as waste in his father’s shipyard and he felt this was an irresponsible method of doing business. He applied his chemistry and engineering background to solving this problem. After creating a machine that addressed this issue, Mr Hiroyuki Matsubara began research and development in 1993 to tackle the growing problem of scrap tire stockpiles. In 1996, pyrolysis tests were successfully completed on the new Dry Distillation Pyrolysis System™ and
in April 2000, the first ECOLUS™ SK plant was operational and began processing scrap tires.

Since 2000, Kouei Industries KK in Japan has been commercially offering for sale the patented ECOLUS™ SK-200 Carbon Waste Regenerator. This machine uses heat to break down polymers into: carbon black, heavy oil, and synthetic gas (syngas). Depending on the feedstock, the byproducts and their proportions vary. All of the syngas is used to fuel the boilers and a small portion of the oil is fed back into the system to power the process. The remainder of the byproducts are sold – current applications include fueling greenhouses.
1.2.2 Operational Plant Facilities

Currently, four operational ECOLUS™ plants exist. Their locations:

- Saitama (near Tokyo city), Saitama Prefecture, Honshu Island
- Chiyoda, Hiroshima, Hiroshima Prefecture, Honshu Island
- Onomichi, Hiroshima, Hiroshima Prefecture, Honshu Island
- Fukuoka, Fukuoka Prefecture, Kyushuu Island

Figure 1 - Current Kouei plant locations.
1.2.3 Product Offering – The ECOLUS™ SK-200

The ECOLUS™ SK-200 is a proprietary, medium-scale pyrolysis industrial plant with a simple design concept. Features that reflect its simplicity include construction from low-grade recycled steel, 3-person staffing requirement, batch processing (as opposed to automated or continuous feed), ease of operation, and speed of assembly/disassembly. The design helps to maintain low costs for production, transportation, and operation. Kouei plans to benefit the end-use customers in keeping margins low throughout the supply chain and under-cut the competition.

Figure 2 - SK-200 burners

©Kouei Industries (Canada) Inc, by permission.

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9 Photo ©Kouei Industries (Canada) Inc, by permission.
2 Industry Snapshot

A macro level understanding of the industry external to Kouei is necessary in order to assess whether the current strategy is appropriate. What follows is an examination of the external environment from different angles. First, we look at market drivers, incentives, and policies. Second, we look at the technology adoption life cycle and where the pyrolysis industry sits along the curve. Third, in terms of development, what has happened in the past, what is currently happening, and what can be expected in the future. Fourth, Porter’s Five Forces model will be used to describe the competitive nature of the industry. Then, an examination of the Wind Turbine Industry to help shed some light as to how the Pyrolysis Industry might unravel. Finally, key success factors will be covered.

2.1 Market Overview

In recent years, renewable green energy sources are gaining immense attention as concerns have surfaced regarding rising energy costs, dependence on foreign sources for energy, and most importantly, escalation of environmental issues. Industry, government, and the public are displaying greater preference toward renewable power technologies that can generate cleaner fuel from materials such as solid waste. Though many environmental alternative Waste-to-Energy (WTE)
technologies have cleared the research and development phase, they have yet to show evidence of their feasibility and cost-effectiveness for successful, sustainable commercialization.

### 2.2 Drivers, Incentives, and Policies

Climate change, human health, and government intervention make up a group of inter-related forces that push development not only in the area of pyrolysis, but also the environmental technology sector as a whole. Climate change is the abnormal increase in atmospheric greenhouse gases (GHGs) produced by human activity causing global temperature levels to rise. This, in turn, results in more frequent experiences in extreme weather patterns causing droughts and floods that will ultimately affect human health. The Kyoto Protocol represents international efforts to reduce GHGs and is currently ratified by countries including Canada and Mexico. However as with all other Kyoto developing nations, Mexico is currently not required to have emission reduction targets even though it contributes to the GHG problem. The US, on the other hand, has concluded that adopting the Kyoto Protocol is not in their

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best interest and therefore has introduced the Clear Skies initiative instead\(^\text{12}\).

From the industry business perspective, relying on external parties to supply energy has proven to be risky with the fluctuation of quantity, quality, and price. This leads to another market driver – the desire to be independent\(^\text{13}\). The combination of abundant renewable resources that are readily accessible and the availability of economical technology that converts these resources into energy make producing one’s own off-grid power a very appealing alternative. Renewable resources encompass solar, wind, geothermal, biomass and hydro energy. An additional source of abundant energy is municipal solid waste (MSW) feedstock utilized to fuel waste-to-energy (WTE) systems that produce electricity. As an alternative revenue stream, electrical energy produced can be sold to the grid.

Government policy and regulation has changed the focus from pollution management to pollution prevention with the burden being placed on industry businesses.\(^\text{14}\) Kyoto and Clear Skies both support and promote development of technologies that either: (1) steer away from fossil fuels towards renewable energy sources or (2) burn fossil fuels in a


cleaner way. Methods to ensure achievement of these goals include increasing the cost of fossil fuels and pollution penalties. These costs and penalties serve as strong incentives for industry members to seek new ways in becoming more efficient and environmentally responsible.

In certain parts of the US, government deregulation for generation, transmission, and distribution in the electrical power industry created a spike in demand and price. When deregulation was first announced, people were uncertain of what the industry’s future would hold. Therefore, investors chose instead to wait to see what the final cost structure would be holding back on the construction of new generator plants. Subsequently, demand grew as supply was held constant. To compound the problem, transmission infrastructure was inadequate and gave rise to bottlenecks – significant sections of the power grid designed to transfer electricity from different regions during emergencies were being used on a daily basis. In response to the chaos, the industry and consumers have cut back on energy usage, increased supply capacity, and found innovative ways to generate electricity.15

The Canadian and American governments both have tax credits and budgets put in place as incentives for developing environmental technology and renewable energy. However, Canada’s incentives are mainly for technologies in the R&D phase whereas initiatives in the US encompass more. For instance, the US has a corporate income tax

"production" credit of 1.5 cents per kWh and production tax credit (PTC) of 1.8 cents per kWh are offered to businesses that produce electricity via wind, closed-loop biomass, and poultry waste systems. In addition, besides conventional power, "green power" is offered as an option to consumers at a premium to cover the cost of environmental benefits from renewable resources.

Emissions trading under the Kyoto Protocol only involves carbon dioxide (CO₂) because it makes up more than 80% of GHGs in the atmosphere. The remainder of GHGs includes methane (10%), nitrous oxide (5%), and approximately 5% of others residual gases. Countries with CO₂ emission levels that are below their respective limits gain credits that can be sold. Buyers of these credits are countries that are unable to meet emission reduction targets through self-reductions.

The US not having adopted the Kyoto Protocol is ineligible to trade CO₂ credits with other participating Kyoto countries under the Clear Skies Act. There will only be sulfur dioxide and nitrous oxide allowance trading at the domestic level because US regulations do not consider CO₂ as a

17 Fred Sissine, CRS-5.
18 Fred Sissine, CRS-8.
Nevertheless, the key is to ultimately become compliant without relying on credits due to the fact that per credit price and penalties will dramatically increase in the future.

Significant irreversible damage to the environment has already been done as evidenced by a recent report from the United Nations. It states that by the year 2050, 2 billion people will be vulnerable to floods – up from the current number of 1 billion. These facts about threats to humanity’s well-being along with rising fossil fuel costs and government policy are the forces that drive adoption of environmental technologies. The present social pattern indicates that efforts in taking corrective measures will intensify.

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2.3 Technology Adoption Life Cycle

In assessing the progress of market penetration by pyrolysis competitors in general, Geoffrey A. Moore’s model of the Technology Adoption Life Cycle will be used. All potential customers can be categorized into one of five groups:\textsuperscript{23} Innovators, Early Adopters, Early Majority, Late Majority, or Laggards. The pyrolysis industry is currently in an early market with only Innovators and Early Adopters as customers. The necessary steps to clear this phase and the Chasm will also be covered. A brief look at each of the customer groups will now follow.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3.png}
\caption{Technology Adoption Life Cycle\textsuperscript{24}}
\end{figure}

\textsuperscript{24} Based on the Technology Adoption Life Cycle by Geoffrey A. Moore.
**Innovators** are those that aggressively seek out new technology due to a natural fascination for technological advancement. The unfortunate truth is that not many innovators exist which makes them difficult to find. Innovators are necessary because they can testify that the new technology works.

**Early Adopters** buy into new technology in and around initial release. They are not driven by fascination, but by being able to link their needs with the new product’s features and benefits. They make purchases based on instinct and do not require product testimonials. Early adopters are required to open up new markets.

The **Early Majority** also sees the connection between their needs and how the new product meets their needs. However, they are driven by practicality and will wait for testimonials as well as buy in from others prior to making their own purchase. This group makes up approximately one third of all customers.

The **Late Majority** is different from the Early Majority in only one way – they are not comfortable with their capability in using the new technology. Further, they usually wait until a dominant design emerges and prefer purchasing from reputable companies. This group makes up approximately one third of all customers. During this phase of the life cycle, diminishing returns begin taking effect and most (if not all) of the research and development costs have been recovered.
Laggards, simply stated, begin pedaling backwards upon seeing new technology. They are not worth any effort.

The small cracks and the major gap represent cliffs where companies can slip and fall off. The first crack between Innovators and Early Adopters arises when Early Adopters have trouble attributing the new benefits to the new technology. The second crack between the Early Majority and the Late Majority represents the issue of having to do with technological competence on the Late Majority’s side. Finally, there exists the huge gap between the Early Adopters and the Early Majority. The abyss-like Chasm is merciless. What’s worse is that it normally goes undetected.

The Chasm separates two customer groups both with significant and dissimilar views of what the new technology represents. The Early Adopters see an opportunity to get a head start on their competitors. They are ready to embrace the drastic discontinuity between the old and the new ways. On the contrary, members of the Early Majority seek technology that doesn’t replace, but augments the existing way of doing business. The Early Majority does not accept testimonials from the Early Adopter because of this fundamental difference. It is at this point that progress halts and becomes stuck in a gridlock – Early Majority purchasers will only accept testimonials from other fellow Early Majority purchasers and no Early Majority purchaser will buy in until testimonials have been obtained.
The pyrolysis industry is in the early stages of the adoption curve. Although the number of pyrolysis and gasification facility installations is increasing, incineration and other existing technologies to process solid waste are a long ways from becoming displaced. Juniper, a renowned pyrolysis consultancy based in the UK, conducted research to better understand governments, industry experts, potential customers, and equipment manufacturers around the world and their views towards pyrolysis and gasification. It was concluded that the majority of the decision makers are hesitant in adopting new technologies seen as being unproven and risky. This proves that the chasm in the technology adoption life cycle has yet to be crossed – even though it is anticipated that between 1999 and 2008, more than 200 new facilities (valued at USD$9B) will be constructed.

<table>
<thead>
<tr>
<th>Year</th>
<th>Facilities Constructed</th>
<th>Total Facilities</th>
</tr>
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<tbody>
<tr>
<td>1990</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>1991</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>1992</td>
<td>3</td>
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<td>1993</td>
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<td>1994</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>1995</td>
<td>12</td>
<td>42</td>
</tr>
<tr>
<td>1996</td>
<td>15</td>
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<td>1997</td>
<td>8</td>
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<tr>
<td>1998</td>
<td>11</td>
<td>76</td>
</tr>
<tr>
<td>1999</td>
<td>16</td>
<td>92</td>
</tr>
</tbody>
</table>

26 Data source: Juniper
In the early market portion of the adoption curve, the two most important things are: building the brand and building customer relationships. The few customers who are interested see an opportunity to one day establish an advantage over their competitors with the help of the new technology.\textsuperscript{27} However, they usually view the product as a prototype and are therefore only willing to enter into joint-venture agreements to share the risks and potentials.\textsuperscript{28} Being a prototype, the customers want to purchase \textit{at cost}.\textsuperscript{29} While these partnerships are forged, effort must also be placed on branding – advertising and publicizing the product and achievements. For here lies the opportunity to burn images into the minds of potential customers in preparation for mainstream mass adoption.

As previously mentioned, very few customers exist in the initial section of the adoption curve. According to Moore, once the early market has been saturated, we hit the Chasm. In this part of the graph, competing in the market will be equivalent to fighting a war of attrition. Most contenders will not make it. The sole objective becomes simple – survive. To successfully navigate through the Chasm, two things must occur: (a) market segmentation of mainstream customers and (b)

\textsuperscript{28} Geoffrey A. Moore, 36.
\textsuperscript{29} Geoffrey A. Moore, 32.
focused effort on dominating one small market segment at a time. This
seems overly simple. The key is to avoid the following two pitfalls:

(1) Spreading marketing resource efforts thin by not focusing on
one segment at a time. Avoid the tendency to spend time and money on
simultaneously broadcasting to multiple segments:

"Companies just starting out, as well as any marketing program
operating with scarce resources must operate in a tightly bound market to
be competitive. Otherwise their 'hot' marketing messages get diffused
too early, the chain reaction of word-of-mouth communication dies out,
and the sales force is back to selling 'cold'."\textsuperscript{30}

(2) Loss of focus due to distraction from the vast potential of the
mainstream market. Avoid the tendency to wander off from the chosen
niche segment being targeted by becoming sales-oriented as opposed to
market-oriented. Blindly pursuing sales can prove to be fatal at this
point:

"The sole goal of the company during this stage of market
development must be to secure a beachhead in a mainstream market –
that is, to create a pragmatist customer base that is referenceable, to
people who can, in turn, provide us access to other mainstream
prospects."\textsuperscript{31} Recall that the Early Majority will only reference others
from the Early Majority group – not Early Adopters.

\textsuperscript{30} Geoffrey A. Moore, 66.
\textsuperscript{31} Geoffrey A. Moore, 68.
2.4 Past, Present, and Future Developments

In the past, back in the mid-70s when the concept of pyrolysis materialized as an alternative waste-to-energy solution, systems were initially designed to provide high-capacity processing for specialized feedstock. In the recent years as more and more companies entered to compete, the market saw emergence of products that varied in size and hence capacity. In addition, products started to become flexible in that they could process multiple types of waste as feedstock. Applications are still geared towards industrial and commercial use. However, in the future, the technology will continue to evolve and become smaller for lower capacity processing – perhaps even for deployment in households. Dominant designs will appear as the market matures and more entry by new players is expected.

Ever since the early decades when commercial pyrolysis first surfaced, the majority of contenders placed effort in designing large-scale systems capable of waste processing upwards of 100 tonnes per day. This pattern emerged due to anticipation of exponential growth in waste stockpile. To date, a lot of markets demand such high-capacity systems. An example of one such market is the Mexican scrap tire problem. Mexico is desperately looking for solutions to process approximately 400
tonnes of solid waste per day. However, one must be aware that even if an order were placed to purchase a high-capacity system, the facility’s setup time may very well take several years due to the size and complexity in design.

A smaller group of pyrolysis contenders offer medium- and small-scale capacity systems. Small-scale systems include those that are literally mobile in that they can be towed from site to site with little setup and takedown times. JF BioEnergy of Abbotsford, Canada offers such a product. Kouei Industries’ SK-200 falls under the medium-capacity category with the ability to process up to 15 tonnes of waste per day. Order fulfillment of small- and medium-sized solutions takes between several months up to one year. It is very possible that medium-scale designs can compete with large-scale ones – multiple units can be quickly installed to build up capacity. This subsequently leads to the issue of operational costs and efficiencies where the large single unit is less flexible in adapting to fluctuations in processing demands.

Nowadays, systems are designed to process specific types of feedstock whether it be soil (for remediation purposes), biomass, tires, or medical waste. This gives rise to differences in feed mechanisms. Although most products on the market possess automated continuous feed mechanisms, manual batch processes also exist. The more complex

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32 Jesse Klinkhamer, email message, 3 April 2004.
designs may prove to require higher maintenance and initial costs than simpler systems. Finally, attempts have been and continue to be made to diversify into other markets by adapting systems to accept multiple types of feedstock.

Pyrolysis technology is presently geared towards installation in areas where waste builds up. These sites include transfer stations and other hubs that require logistics systems in place to transport in the feedstock. The next step in evolving the technology is to further reduce the physical size such that systems can be located at waste-generating sources. In the example of used tires, waste is generated at service stations, scrap yards, and other sites where worn tires are traded in or discarded. Small, easy-to-use, and economical pyrolysis systems with low processing capacity would fit this untapped market niche. This would also reduce and perhaps eliminate scrap tire transportation costs to designated higher-capacity processing facilities. Aside from industrial and commercial applications, pyrolysis has been envisioned to become adapted for household use.

Different niche markets exist with a reasonable amount of competition in each. A larger concentration of companies is fighting for the higher-capacity segments while fewer companies are pursuing the lower-capacity segments. Dominant designs have yet to emerge for each niche. Important factors determining emergence of the prevailing models include initial cost of capital, operating expenses, efficiency, and
reliability. When a dominant design emerges within a certain niche, players in that market segment will either design around existing patents to mimic the new established standard or simply license the technology.

Once indicators show that certain segments within the pyrolysis industry have crossed the chasm of technology adoption, those specific markets become lucrative and will attract investment. Consolidation between existing players will occur. Acquisition by companies within the environmental technology sector will also follow. For example, established players in the incineration and wind power areas may choose to further grow their product portfolio by entering the prospering pyrolysis business.
2.5 Industry Dynamics

The following five sections analyze the North American pyrolysis and gasification alternative waste-to-energy market and the implications for Kouei Industries in the context of the Porter’s Five Competitive Forces model.\textsuperscript{34}

\textbf{Figure 4 – Porter’s five forces}\textsuperscript{35}

\begin{itemize}
    \item Threat of New Entrants
    \item Threat of Substitutes
    \item Supplier Power
    \item Competitor Rivalry
    \item Buyer Power
    \item Threat of Substitutes
\end{itemize}


\textsuperscript{35} Based on Porter’s Five Forces Model
2.5.1 Rivalry Among Competitors

A few prominent factors contribute to the intensity of competition experienced by industry contenders – fragmentation, fixed costs, and differentiation. This section examines these three areas.

2.5.1.1 Diverse Competitors and Fixed Costs

Rivalry in the pyrolysis and gasification waste-to-energy industry is currently highly intensive due to high growth potential. This is caused by growing environmental concerns. Presently, there are more than 150 companies worldwide that claim to have a proven product. The bulk of the competition in the realm of pyrolysis and gasification is situated in North America, Europe, Asia, and Australasia with geographic distribution of 44%, 39%, 9%, and 8% respectively.\(^{36}\) In terms of maturity in technology development and adoption, Japan and Europe lead with North America trailing behind.

Rivals in the market vary in size from small to large firms. Large organizations with long histories hold an advantage in that they have sufficient financing and public exposure. Being publicized in press releases and by the media helps to build the brand. One drawback, however, comes with being large – high fixed asset costs. These fixed

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costs arise mainly because of horizontal integration. For example, establishing a global presence through sales offices in various geographical regions. Certain large competitors are experiencing the pain of being a giant and are folding back to cut down on their burn rates in adapting to the slow market adoption. Finally, in terms of manufacturing, vertical integration in a backward manner implies investment in capital.

Although smaller organizations tend to struggle in attempting to make their technology known, they are very effective at leveraging off of and focusing on their core capabilities – namely patented technologies from intensive research and development efforts. All other functions such as manufacturing, sales, and marketing are typically outsourced to a certain degree. Long-term outsource contracts serve as exit barriers.

No significant mergers and acquisitions have been observed as all competitors are jockeying for position in their own respective niche markets. They have no interest in compromising their current positions because of the enormous potential of what lies ahead. The objective is to either become the dominant industry design or to simply survive until mainstream adopters begin making purchases. The longer the competitors stay afloat, the more they build their brands. The better the brand, the greater the potential for sales.
2.5.1.2 Product Differentiation

More than 80 unique known processes exist that fall under the pyrolysis and gasification umbrella. Different technologies are unique in ways such as physical attributes, feedstock processing capabilities/capacities, and operational requirements to name a few. Ultimately, different customers give different weights to each of these dimensions.

For example, the ratio and quality of byproducts varies and hence may influence the price of the technology. Some customers value a system producing top quality oil, carbon black, and synthetic gas (syngas) more than one that produces a lower grade of oil, carbon black, or syngas. However, there are also customers that only demand the ability to process waste and do not place heavy emphasis on byproduct quality. In short, a diverse pool of products exist for a market with equally diverse needs.

Flexibility in terms of the type and quantity of accepted feedstock also affects the technology's perceived value. Government subsidies exist for the processing of certain types of waste. For instance, depending on geographic location, the processing of scrap tires generates additional revenues from government incentives. In British Columbia through the Financial Incentives for Recycling Scrap Tires (FIRST) Program, the

provincial government will pay up to $1.50 per scrap tire processed – this will mean millions in revenue dollars depending on the amount of annual processing. However, BC’s FIRST Program has yet to fully incorporate emerging pyrolysis technology – only transportation assistance for feedstock supply is disbursed. Additional types of feedstock include (but are not limited to): municipal solid waste (MSW), plastics, and biomass.

The following is a breakdown of novel processes as a percentage of all processes compared with conventional pyrolysis and gasification.

Table 2 - Pyrolysis & gasification technology combinations

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>Gasification</td>
</tr>
<tr>
<td>20</td>
<td>Pyrolysis</td>
</tr>
<tr>
<td>8</td>
<td>Thermal gasification</td>
</tr>
<tr>
<td>8</td>
<td>Pyrolysis + combustion</td>
</tr>
<tr>
<td>8</td>
<td>Gasification + combustion</td>
</tr>
<tr>
<td>7</td>
<td>Pyrolysis + gasification</td>
</tr>
<tr>
<td>3</td>
<td>Gasification + melting</td>
</tr>
<tr>
<td>2.7</td>
<td>Gasification + pyrolysis + combustion</td>
</tr>
<tr>
<td>2.7</td>
<td>Pyrolysis + melting</td>
</tr>
<tr>
<td>1.3</td>
<td>Gasification + combustion + melting</td>
</tr>
</tbody>
</table>

40 Data source: Juniper
2.5.2 Barriers to Entry

Mandatory initial investment and distribution channels serve to deter entry by new competitors. How these two factors do so will be discussed in this section. R&D efforts in the past have mainly focused on high-capacity processing – this leaves more opportunity in the medium- and low-capacity markets. Distribution channels remain largely available for contenders to take because the industry is in the early stages of development.

2.5.2.1 Initial Investment

Entry into the market with one’s own invention to compete involves immense research and development costs. With research and development spanning an average of 10 to 15 years, new entrants wishing to compete by creating their own unique, patented technology will be at a disadvantage – by the time they pull out of R&D, existing rivals with first-mover advantage would have already established strong brands. Brand strength is necessary to increase the chances of success in early and future stages of the adoption life cycle. In 15 years, a significant part of the early commercial and industrial market may have already been saturated due to the current urgency in reaching greener alternative waste-to-energy goals to meet fast-approaching environmental compliance deadlines.
Currently, more than 150 competitors worldwide have survived through natural selection and are poised for commercialization. Throughout the 1980s to the late 90s, industry shakeout took place for pure pyrolysis and gasification technologies. Aside from pure pyrolysis and gasification technologies, newer hybrid and other variations have emerged and continue to emerge. Therefore, further shakeout is anticipated because although they have illustrated feasibility in each of their technologies, economic viability has yet to be proven.

As time passes, the number of potentially feasible and economical processes that can be developed and patented will decrease due to the law of diminishing returns – a technology can be developed and improved upon only to a certain point. In order for new entrants to compete, the most likely tactic is to take advantage of proven and established technologies. This can be done either by acquisition of existing companies or by licensing existing technologies.

2.5.2.2 Distribution Channels

Whether it be for large-scale or smaller-scale products, reputation and large customer installation base are measures of quality and reliability. These will play a big role in fending off new competitors. This being the case, the first few installations in new markets are of particular importance. After this stage, exclusivity in distribution channels is reinforced due to the momentum build-up of additional secured customer relationships.
Different stages of the Technology Adoption Life Cycle call for different types of distribution channels. During the early and initial stages, channels that have a tight focus on delivering customized solutions through direct sales are appropriate. These channels demand a higher margin for their specialized services. For industrial products, this margin is typically 35% of the retail price.

Next in line are value-added resellers (VARs). They may already have relationships with customers that include mills, factories, and other large-scale industrial facilities. VARs are utilized to phase into the Early Market as pointed out by Geoffrey Moore: "the path into the pragmatist community is smoother if a smaller entrepreneurial vendor can develop an alliance with one of the already accepted vendors or if it can establish a value-added-reseller (VAR) sales base. VARs, if they truly specialize in the pragmatist's particular industry, and if they have a reputation for delivering quality work on time and within budget represent an extremely attractive type of solution to a pragmatist. They can provide a 'turnkey' answer to a problem, without impacting internal resources already overloaded with the burdens of ongoing system maintenance. What the

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pragmatist likes best about VARs is that they represent a single point of control, a single company to call if anything goes wrong.43

Existing manufacturers and distributors of large industrial machinery can be thought of as being the next type of distribution channel to be considered. Like VARs, they may already possess a network of established customers. Pyrolysis companies can take advantage of these networks through private label or licensing agreements where the channel partner can be responsible for manufacturing, sales, after-sales support and/or all three.

Table 3 - Channel attributes

<table>
<thead>
<tr>
<th></th>
<th>Manufacturing</th>
<th>Sales</th>
<th>After-sales Support</th>
<th>Brand Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAR</td>
<td>Channel Not Responsible</td>
<td>Channel Responsible</td>
<td>Channel Responsible</td>
<td>No</td>
</tr>
<tr>
<td>Private Label</td>
<td>Channel Not Responsible</td>
<td>Channel Responsible</td>
<td>Channel Responsible</td>
<td>Yes</td>
</tr>
<tr>
<td>Licensing</td>
<td>Channel Responsible</td>
<td>Channel Responsible</td>
<td>Channel Responsible</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note that private label and licensing agreements entail brand dilution whereas VAR agreements do not. This is important because of the chosen low-cost or differentiation strategy. Aside from helping to reach customers that are difficult to attain, all three types of agreements also allow the original firm to off-load varying degrees of risk and resource requirements to the VAR, manufacturer, or distributor.

2.5.3 Substitute Products

Substitute products are defined as alternative methods for processing scrap tires, plastics, and additional types of recyclable waste—the main objective being to divert waste from landfills. The majority of these substitutes fall under the following categories: incineration waste-to-energy, plastics recycling, and scrap tire recycling systems. With incineration, fly ash is created and usually still requires landfilling.

Current methods of recycling scrap tires involve burning them for use as fuel, integrating them into engineered applications, or creating final products with them. Note that these methods reuse tires, but do not recycle them back to the process of making new tires. Currently, this is what happens with certain plastic recycling methods as well. For example, some plastic containers are recycled to make new plastic containers. However, the majority is transformed into other plastic-based products such as carpets, polyester fleece, and park benches.

2.5.3.1 Incineration Waste-to-Energy Facilities

The term waste-to-energy was coined to describe plant facilities that simply incinerated municipal solid waste to produce steam, which in turn powered generator turbines.\textsuperscript{44} This option addresses the problem of landfilling because site space for dumping waste has become critically

\textsuperscript{44} “Waste-to-energy advances in Japan,” \textit{Power} 146, no. 3 (2002): 5.
scarce in North America. The early waste-to-energy facility systems, however, did not have any integrated pollution control mechanisms. This resulted in releasing massive quantities of toxic effluent.

Second generation waste-to-energy mass-incineration systems integrate additional processes that scrub effluents prior to release into the environment. This significantly reduces the amount of damage to the ecosystem. Unfortunately, only a handful of these more advanced incineration systems exist in North America – one of them being the $36M Waste-to-Energy Facility (WTEF) owned by the Greater Vancouver Regional District (GVRD) located in Burnaby.45

<table>
<thead>
<tr>
<th>Daily Input</th>
<th>Daily Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>720 tonnes of garbage</td>
<td>960 tonnes of steam (sold to Norampac)</td>
</tr>
<tr>
<td>6 tonnes of lime (to control acid gas emissions)</td>
<td>360 megawatt-hours of electricity (sold to BC Hydro power grid)</td>
</tr>
<tr>
<td>50 megawatt-hours of electricity</td>
<td>120 tonnes of bottom ash (used in road building and landfill cover)</td>
</tr>
<tr>
<td>270 kilograms of ammonia (to control NOx emissions)</td>
<td>25 tonnes of fly ash (disposed at landfill)</td>
</tr>
<tr>
<td>120 kilograms of activated carbon (to control mercury emissions)</td>
<td>20 tonnes of scrap metal (recycled into reinforcing steel)</td>
</tr>
<tr>
<td>1500 kilograms of phosphoric acid (added to stabilize leachable metals in the fly ash)</td>
<td></td>
</tr>
</tbody>
</table>

This facility first became operational in 1988 and added a generator component in 2003 to create electricity – which is fed into the BC Hydro power grid to generate revenue. Operated by Montenay Inc, the Burnaby

46 Data source: GVRD; Greater Vancouver Regional District, Solid Waste Facts, brochure, March 2004.
Incinerator was the second North American facility to become ISO 14001 certified – an international environmental management protocol that ensures continued compliance, monitoring, and improvement. Every year, it burns 250,000 tonnes of garbage (20% of all municipal waste from the Greater Vancouver Region).

In order to successfully operate an incineration-based waste-to-energy facility, economies of scale play a significant factor. If the facility is unable to sustain a certain level or rate of waste processing, then not enough electrical energy would be created to generate sufficient revenue for maintaining the costs of operation. This implies effort required for supplying feedstock, large capital costs associated with machinery and land, as well as other operational costs. Another issue is the landfilling of 25 tonnes of fly ash per day – it still amounts to landfilling (just less of it).

If the Burnaby Incinerator facility represents the best incineration technology the market has to offer, then all other more primitive systems incur higher operating costs in terms of monetary expense as well as damage to the environment.
2.5.3.2 Plastics Recycling

Seven different types of resins exist: (1) Polyethylene Terephthalate (PET/PETE), (2) High Density Polyethylene (HDPE), (3) Polyvinyl Chloride (PVC), (4) Low Density Polyethylene (LDPE), (5) Polypropylene (PP), (6) Polystyrene (PS), and (7) Other resins that are either made up of types 1 through 6 or types outside of those classified in codes 1 through 6. The first two, PET and HDPE, are the most recycled resins and they make up approximately 90% of all plastic bottle waste generated by households. \(^{47}\)

According to the Canadian Plastics Industry Association, there are around 1,400 recyclers and processors in North America that convert recyclable plastics into plastic-derived products. Currently, the capacity for PET and HDPE recycling far exceeds the supply. \(^{48}\) PET is commonly recycled to create new products including bottles, carpeting, and fleece while HDPE is used to create fencing, decking, and marine docks. \(^{49}\) Containers for beverages and other fluids are a major source of PET and HDPE for recycling.

\(^{48}\) "Recycling".
### Figure 5 - Resin codes (adapted from American Plastics Council)

<table>
<thead>
<tr>
<th>Code</th>
<th>Applications</th>
<th>Recycled Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bottles for: plastic soft drink, water, sports drink, beer, mouthwash, ketchup and salad dressing.</td>
<td>Fiber, tote bags, clothing, film and sheet, food and beverage containers, carpet, strapping, fleece wear, luggage and bottles.</td>
</tr>
<tr>
<td></td>
<td>Jars for: peanut butter, pickle, jelly, and jam.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ovenable film and ovenable prepared food trays.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yogurt and margarine tubs.</td>
<td>Pipe, buckets, crates, flower pots, garden edging, film and sheet, recycling bins, benches, dog houses, plastic lumber, floor tiles, picnic tables, fencing.</td>
</tr>
<tr>
<td></td>
<td>Cereal box liners.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grocery, trash and retail bags.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction products: pipes, fittings, siding, floor tiles, carpet backing, and window frames.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bags for: dry cleaning, bread and frozen food.</td>
<td>Shipping envelopes, garbage can liners, floor tile, furniture, film/sheet, compost bins, paneling, and trash cans</td>
</tr>
<tr>
<td></td>
<td>Squeeze bottles (honey, mustard).</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ketchup bottles, yogurt containers, margarine tubs, and medicine bottles.</td>
<td>Automobile battery cases, signal lights, battery cables, brooms, brushes, ice scrapers, oil funnels, bicycle racks, rakes, bins, pallets, sheeting, and trays.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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50 Data source: American Plastics Council; Disclaimer: APC makes no warranty, express or implied, respecting the accuracy or completeness of the information provided herein including but not limited to implied warranties of merchantability or fitness for a particular use or purpose. APC shall not be responsible for any direct, indirect, incidental or consequential damages, damages from loss of use or profits, or cost of procurement of substitute goods or services, in contract, tort or otherwise arising out of goods or in connection with the information contained herein. Recycling of plastics may not be available everywhere. Check to see if plastics recycling is available in your community.
Since its 1997 inception, British Columbia's Beverage Container Stewardship Program has held brand-owners and end-users of products that create Household Hazardous Waste (HHW) responsible for the residuals that are created.\textsuperscript{51} Brand-owners of beverage containers are required to establish province-wide return collection systems for used beverage containers under a deposit-refund system where they have control over the design and management of the recycling system.

Under the Beverage Container Stewardship, Encorp Pacific (Canada) – a non-profit, federally incorporated organization – is charged with the responsibility of developing and managing a consumer-friendly and cost-effective system for recovering non-alcoholic beverage containers to ensure that they are recycled as opposed to incinerated and landfilled. Encorp contracts out to independent private organizations that collect, handle, transport, and process containers. In 2003, over 232

\begin{table}[h]
\centering
\begin{tabular}{|c|p{10cm}|p{10cm}|}
\hline
\textbf{Code} & \textbf{Applications} & \textbf{Recycled Products} \\
\hline
6 & Compact disc jackets, food service applications, grocery store meat trays, egg cartons, aspirin bottles, cups, plates, cutlery. & Thermometers, light switch plates, thermal insulation, egg cartons, vents, desk trays, rulers, license plate frames, foam packing, foam plates, cups, and utensils. \\
\hline
7 & Three and five gallon reusable water bottles, some citrus juice and ketchup bottles. & Bottles, and plastic lumber applications. \\
\hline
\end{tabular}
\end{table}

million non-alcoholic, plastic beverage containers (more than 9 tonnes) were recycled and diverted from landfills.\textsuperscript{52}

| Table 5 - Plastic containers recycled in 2003 by Encorp\textsuperscript{53} |
|----------------|--------|--------|--------|--------|----------|
|                | Q1     | Q2     | Q3     | Q4     | Total    |
| Units          | 46,471,835 | 58,046,241 | 74,527,296 | 53,085,670 | 232,131,042 |
| Tonnes         | 1.930  | 2.348  | 2.942  | 2.129  | 9.349    |

Aside from beverage containers, recycling of discarded electronic products (TVs, computers, printers, mobile phones, etc) has recently emerged as a necessity. Environment Canada predicts that in 2005, more than 71,000 tonnes of electronic waste (e-waste) will be generated in Canada.\textsuperscript{54} More progress is needed to shift away from current practices of dumping e-waste overseas and incineration. In British Columbia, the e-Waste Product Stewardship will soon be enacted as a first step to solving this problem.\textsuperscript{55} It will model the successful Beverage Container Stewardship Program, which puts the onus on consumers and manufacturers.

Recycled plastics' value is related to its purity, which leads to a lot of effort in sorting that needs to take place prior to mechanical processing. In BC, plastic bottles are sorted immediately after being recovered from consumers and transferred to recycling processors in batches. They are then either: (1) shredded and turned into pellets for

\textsuperscript{53} Data source: Encorp Pacific
molding into new plastic containers, (2) melted into fine thread-like fibres that can be used to produce fabrics and carpeting or (3) processed and used to create other plastics-derived products.

2.5.3.3 Tire Recycling

Stockpiling of scrap tires is a major issue not only for North America, but for other parts of the world as well. In disposing scrap tires, there are currently two alternatives – tire derived fuel (TDF) and tire derived products (TDP). The TDF disposal method involves using tires, whole or processed, as a feedstock for heating kilns and boilers. TDF is commonly used by industries such as pulp & paper, cement, utilities, and other industrial processes.56 The use of scrap tires in whole or processed form to create products like artificial reefs, road-fill, and athletic tracks would best define the manufacture of TDP.

British Columbia’s Financial Incentives for Recycling Scrap Tires (FIRST) Program was established in 1991 to divert all scrap tires from entering landfills whereby a $3 levy on new tires is charged at the point of sale.57 The Ministry of Water, Land, and Air Protection manages the program and financial incentives funding.

The FIRST Program disburses a transportation fee for the transfer of scrap tires from the generating source (retailers and auto salvage yards) to the closest eligible processor.\textsuperscript{58} In addition, depending on the type of TDF use and the degree of TDP processing, payments reach up to $0.90/tire and $1.50/tire respectively.\textsuperscript{59} If sufficient revenue is generated from the final sale of TDPs, then financial assistance is deemed unnecessary. Currently, although TDF and TDP disbursements do not apply to operators of pyrolysis plants (the FIRST Program has yet to consider this emerging technology), transportation assistance is still provided to ensure a steady supply of scrap tire feedstock.

For 2002/2003, the total amount paid out for transportation, TDF, and TDP was $6,406,969. A total of 3,522,096 tires were transported and 3,276,510 tires were used as TDF and TDP in British Columbia. Refer to the following tables for details.\textsuperscript{60}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
\textbf{Transportation Credit (TC)} & \textbf{End-Use (EU) Credit} & \textbf{Total (TC+EU)} \\
\hline
\textbf{TDP} & \textbf{TDF} & \textbf{TC} & \textbf{Total} & \textbf{TDP} & \textbf{TDF} & \textbf{EU} & \textbf{Total} \\
\hline
$1,860,121$ & $98,586$ & $1,958,707$ & & $4,014,270$ & $433,992$ & $4,448,262$ & $6,406,969$ \\
\hline
\end{tabular}
\caption{FIRST 2002/2003 disbursements\textsuperscript{61}}
\end{table}

\textsuperscript{58} Financial Incentives for Recycling Scrap Tires. \textit{Schedule of Trucking Credits Per Kilometer Per Tonne}, schedule, 1 August 2001.
Table 7 - FIRST 2002/2003 transportation volumes

<table>
<thead>
<tr>
<th></th>
<th>TDP</th>
<th>TDF</th>
<th>Total (TDP+TDF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLT MT Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLT MT Total</td>
<td>1,844,680</td>
<td>1,163,864</td>
<td>3,008,544</td>
</tr>
<tr>
<td>n/a</td>
<td>513,552</td>
<td>513,552</td>
<td>3,522,096</td>
</tr>
</tbody>
</table>

* PLT = Passenger and Light-Truck / MT = Medium-Truck

Table 8 - FIRST 2002/2003 end use volumes

<table>
<thead>
<tr>
<th></th>
<th>TDP</th>
<th>TDF</th>
<th>Total (TDP+TDF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLT + MT combined</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLT MT Total</td>
<td>2,719,942</td>
<td>2,719,942</td>
<td>556,568</td>
</tr>
<tr>
<td>n/a</td>
<td>556,568</td>
<td>556,568</td>
<td>3,276,510</td>
</tr>
</tbody>
</table>

* PLT = Passenger and Light-Truck / MT = Medium-Truck

Over the decades, many have asked the question of whether the use or manufacture of TDF and TDP cause damage to the environment. Unfortunately, this question largely remains unanswered because various geographical regions have conducted tests with various conclusions. For example, in Japan and Europe, various studies have shown that TDF and TDP do in fact cause harm to the environment. In North America, however, not as many studies have been conducted. Furthermore, many of these tests and experiments are inconclusive. The following two sections give a better picture of what kind of impact TDF and TDP have on the environment.

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Tire Derived Fuels (TDFs)

Systems that burn TDF fall under three categories: (1) uncontrolled combustion, (2) ill-designed controlled combustion, and (3) well-designed controlled combustion. Relative to the other two, very little emissions data exists for ill-designed controlled combustion sources. These sources have poor combustion characteristics and include fireplaces, stoves, simple incinerators, and simple kilns. Uncontrolled combustion is no doubt the worst approach to utilize TDF because high levels of carbon monoxide, sulfur oxide, nitrogen oxide, and volatile organic compounds are released. The focus now turns to well-designed controlled combustion systems.

To better understand TDF combustion characteristics, the Environmental Protection Agency (EPA) conducted pilot-scale emissions testing on a rotary kiln incinerator simulator (RKIS). The RKIS was designed to exhibit features similar to that of bigger systems. However, emissions data should not be directly extrapolated to full-scale systems because of variation in features such as gas-phase mixing and other equipment-related details (for example, other combustion systems such as boilers). Instead, the study should only be used for exploring the basic phenomena of TDF combustion.

The results of this study indicate that TDF contains significant amounts of zinc, as this element is widely used in the production of tires. It was concluded that TDF-related emission characteristics should be similar to that of conventional fossil fuels\(^6\) – which heavily contribute to global warming. In addition, the integration of particulate control mechanisms may be required to scrub effluents prior to their release into the surrounding environment.

**Tire Derived Products (TDPs)**

In 2001, more than 88% of all scrap tires in British Columbia were used to create TDP\(^6\). TDP is the general umbrella that covers sub-operations dealing with the production of intermediary goods (such as crumb rubber) and final products (such as road-fill). Presently, crumb rubber is the chief TDP sold as a raw material and used as inputs further down the supply chain to create other viable products.

In general, most available studies specifically examine the effects of scrap tire use in whole or processed (shredded or chipped) form. They look at different structural applications including artificial reefs, road fill, embankments, and architectural projects. Several reports have concluded that shredded scrap tires can be toxic over the short-term with the probability of toxic chemical release being higher when newly

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\(^6\) Joel I. Reisman, 35.

discarded tires are used.\textsuperscript{67} The use of tires in building artificial reefs causes toxicity to aquatic organisms lasting up to several weeks.\textsuperscript{68} It is suggested that tires be used in whole form as opposed to shredded form because this prevents exposing and releasing of the metals.\textsuperscript{69}

After taking a closer look at some of the tests conducted in North America, it seems that they either fall short of pinpointing the root causes or are inconclusive. For instance, one study resulted in 100\% rainbow trout mortality from tire leachate – one tire was submerged into 300 litres of water\textsuperscript{70}. However, the same water was not lethal to three other species. Although the addition of activated carbon eliminated the lethal effects, the chemical cause or causes leading to trout mortality remain unidentified. Further testing was requested of the EPA. Unfortunately, these tests did not materialize due to a lack of funding.\textsuperscript{71}

In the study of leachate transfer from tires to soil, conclusions from various studies are inconsistent – some report observable detrimental effects while others do not. These inconsistencies arise from conducting tests either in an open environment (as opposed to one that is controlled) or in an overly isolated environment (inaccurate simulations that shouldn’t be extrapolated).

\textsuperscript{68} Grant Thornton, \textit{Assessment of the Benefits Associated with the Financial Incentives for Recycling Scrap Tires Program}, June 2001, 10.
\textsuperscript{69} Grant Thornton, 10.
\textsuperscript{71} Gulf States Marine Fisheries Commission, 30.
Reliable testing procedures tailored to examining harmful effects that TDPs pose on the environment have yet to be discovered. Best practices in this area are bound to appear in the future. Meanwhile, care must be taken when placing TDP in direct physical contact with the environment (specifically soil and water). Appropriate measures must be taken to ensure isolation of TDP to prevent leaching of toxic substances into the ecosystem.

2.5.4 Buyer Power

In early markets, buyers can be placed into two groups: (1) the end-users of the machinery, and (2) entities that are positioned between the pyrolysis manufacturer and end-users along the supply chain. The end-users include processors of scrap tires, plastics, and other types of recyclable waste. Entities that move the product to end-use customers include value added resellers (VARs), distributors, systems integrators, and manufacturers of heavy industrial equipment. They have established relationships with the target end-user market.

Being an emerging industry, the majority of the market favouring technology that is locally proven will not make purchases initially. This leaves a smaller customer segment to work with that is willing to initially venture into a partnership to provide proof of concept – a phase that
Kouei Canada is entering and that which Kouei Japan is going through. This smaller group of customers is one factor that enhances buyer power.

Since a large-scale sales effort is inappropriate for such a product in its initial stages of adoption, the aim is to directly target innovative, early adopting end-users. Channels that are geared towards mass distribution may not be interested in carrying products that have low sales volume.

The initial customer group is a wide spectrum ranging from small individual companies to enormous multinational organizations. Those prospects that are established and not looking for opportunities to expand, replace existing equipment, or improve on government environmental compliance, possess greater power because they already have high investment in current fixed assets. Any attempts to replace existing high-cost processing equipment will be scrutinized – high switching costs. “Cement manufacturing is a highly capital intensive and competitive industry. This fact combined with the long economic life of existing facilities will constrain the rate of upgrading exiting technology or adopting new technology”. 72 On the other hand, organizations that are looking to expand operations and grow in attempt to overtake bigger competitors within the same league are potential customers of the utmost

importance – hence their interest in newer technologies for preemptive strategic measures.\textsuperscript{73}

As previously mentioned, at the early stages of the Technology Adoption Life Cycle, the key is to establish partnerships with customers. Aside from emphasizing strategic advantages to adopting the new technology, it is also necessary to persuade them that pyrolysis is an essential value-added component that will create new revenue streams through byproduct sales and electricity generation. As well, pyrolysis is a solution for government environmental regulation compliance – a driver that pushes for alternative energy adoption. Tire dealers can process scrap tires to retrieve two of the original raw materials (carbon black and steel) for resale to manufacturers at the beginning of the tire supply chain cycle. With respect to composition by weight, carbon black makes up 28\% of a tire whereas steel makes up 14\% to 15\%.\textsuperscript{74} The byproducts are flexible in that they can serve not only as raw materials, but as a source of cleaner-burning fuel as well – this is a better alternative than continuing with current TDF practices, which involves burning scrap tires in whole or shredded form leading to higher levels of pollution. Processors of plastics and scrap tires can either resell these byproducts or

use them to fuel generators and become Independent Power Producers (IPPs), selling electricity to the power grid.

The current mainstream scrap tire and plastics recycling market earns low profits and significant costs are associated with processing operations. This is the reason why government financial assistance is offered (BC’s Beverage Container Stewardship, upcoming eWaste Stewardship, and FIRST Programs). The pyrolysis business model is potentially more profitable because the byproducts have a higher value than those of current recycling technologies.

2.5.5 Supplier Power

In manufacturing pyrolysis systems, the two key types of suppliers are steel manufacturers and heavy industrial machinery manufacturers. The two groups, however, can be seen as being virtually integrated because many steel manufacturers have integrated forward. Being a global industry, developing countries, as opposed to those that are industrialized, take on the bigger role of production. The latter sees steel as a declining industry whereas the former sees steel as a foundation for economic development. As developing countries become industrialized, they pass on the production role to new emerging players. This pattern will repeat itself well into the future.
Buyers of steel are free to obtain supply from any manufacturer in the world. From a global point of view, the steel industry is highly fragmented with buyers being able to play suppliers against each other – only to keep steel producers’ margins low. The same applies to heavy industrial machinery manufacturers. Furthermore, no significant switching costs exist if holders of patented pyrolysis technology sign flexible supplier contracts whereby outsourcing agreements can be taken elsewhere for production.

In Kouei Industries’ case, non-exclusivity agreements with Kobe Steel and Mitsui have been established – although Kobe Steel manufactures the final product, they can easily take up Mitsui’s role of sales and vice-versa. Since the cost of steel and manufacturing of pyrolysis systems are the main components of product cost, Kouei must continuously scan the market for better prices. However, differences in pricing between individual suppliers will be marginal because the steel market moves in unison.

In terms of the supplier’s ability to integrate forward into pyrolysis equipment, the task is difficult unless they are able to either internally come up with the patentable technology or acquire existing technology. As stated earlier, it takes on average 10 to 15 years of research and development to create a viable solution (assuming that one actually succeeds). Being a potentially lucrative industry, pyrolysis contenders
similar to Kouei will actively try to survive and emerge as one of the leading industry standards as opposed to being acquired.

The number of steel and machinery suppliers is vastly greater than the number of pyrolysis companies. Furthermore, pyrolysis is an industry that is recognized as being able to provide a viable green solution to the problem of waste management. Keeping this in mind, it is in the best interest of suppliers to establish and maintain good relationships with companies like Kouei. However, the one single most important factor that shifts power towards steel suppliers is demand – other immediate purchasers of steel pose a significant threat as outlined in the following section.

**Future Steel Prices Increasing**

Even though suppliers do not appear to have the upper hand, the price of steel still remains at the mercy of the market. China, with a population of 1.2 billion, has caused the skyrocketing of global steel prices in recent years due to overwhelming development.\(^75\) In December 2001, the price of scrap metal was at the USD$100 per ton mark. By January 2004, this figure had leaped up to $270 per ton.\(^76\)

In 2003, being the top global producer of steel, China manufactured 220.1 million tonnes – all for domestic consumption (Japan


finished second with 110.5 million tonnes). Domestic production continues to be insufficient to satisfy demand and China is aggressively pursuing supplies from abroad. Construction of Chinese steel production mills has reached countries such as Brazil where all outputs will be shipped back to China. Finally, the Chinese currency is expected to appreciate leading to additional imports because it is presently undervalued.

Table 9 - Top 5 steel-producing countries (millions of tonnes)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>2003</th>
<th>2002</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>220.1</td>
<td>181.1</td>
<td>+ 21.1</td>
</tr>
<tr>
<td>2</td>
<td>Japan</td>
<td>110.5</td>
<td>107.7</td>
<td>+ 2.6</td>
</tr>
<tr>
<td>3</td>
<td>USA</td>
<td>90.4</td>
<td>91.6</td>
<td>- 1.3</td>
</tr>
<tr>
<td>4</td>
<td>Russia</td>
<td>62.7</td>
<td>59.8</td>
<td>+ 4.8</td>
</tr>
<tr>
<td>5</td>
<td>South Korea</td>
<td>46.3</td>
<td>45.4</td>
<td>+ 2.0</td>
</tr>
</tbody>
</table>

79 Data source: International Iron and Steel Institute
2.5.6 Industry Summary

Overall, the industry will become more and more attractive although current industry forces pose major challenges – high barriers to entry, powerful suppliers, powerful buyers, intense competition, and established substitutes. For the time being, dynamics of the industry continue to ensure that the market is highly differentiated and remain extremely competitive. The following gives a summary of the pyrolysis industry.

The environmental technologies portfolio is promoted and supported by both the private and public sectors in North America. Pyrolysis falls in this portfolio and has the potential to realize the same achievements as other established environmental technologies. However, signs of success will appear through time because pyrolysis is in the early stages of growth. Results will be more apparent by the end of the current decade.

Unlike other parts of the world, such as Japan, North America has yet to provide the strong political support tailored specifically towards promoting pyrolysis. Nevertheless, progress of the Kyoto Protocol and amassing environmental awareness hint at a bright future for renewable energy technologies. The cost of ownership will decrease because R&D efforts to improve on current designs will continue. It is a matter of time
before government adoption incentives such as production tax credits become unnecessary.

As the market unfolds, rivalry will become increasingly intense due to efforts in global expansion by current players. Current efforts by Kouei and other contenders in foreign market entry evidence this. Furthermore, a significant number of other pyrolysis vendors have a handful of offices around the globe. Those who are able to quickly secure channels and build their brands will preempt other competitors and create effective entry barriers.

Pyrolysis attempts to replace incineration as well as augment current scrap tire processing and plastics recycling methods. Unfortunately, incentives in North America are not as strong as those that are found in Europe and Japan where government policy plays a big part in jump-starting adoption. However, this situation may change for the better as the public image of incineration becomes increasingly negative because of the inherent air pollution involved with operation. Furthermore, scrap tire disposal by means of producing TDF and TDP will remain inadequate as the rate at which scrap tires are generated continues to greatly outweigh processing capacity.
2.6 Wind Turbine Industry

In predicting how the pyrolysis industry might unfold, it is helpful to look at how similar environmental technologies have developed. One good example is the wind turbine industry. Similarities with respect to market adoption between these two technologies include market drivers, government policy, and other types of challenges associated with new technology adoption – namely, installation and operating costs. The following takes a closer look at market factors and challenges faced by the wind turbine companies. These are reasons why certain nations – specifically in Europe – have adopted faster than others.

Market drivers responsible for influencing the wind turbine adoption rate are: energy independence and greenhouse gas (GHG) emissions reduction. During the 70s and 80s, most nations saw how dependent they were on foreign oil. Countries that could take measures to become more independent did so to mitigate the impact should similar future crises arise. It is estimated that by 2006 to 2007, global oil production will peak and begin to decline due to exhaustion of fossil fuel resources. Therefore, the desire to become less dependent on non-renewable fuels will most likely grow stronger. Ratification of the Kyoto Protocol to

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combat global warming by reducing GHGs such as CO₂ also plays a major role in pushing for adoption of alternative energy.

Government policy comes in the form of R&D funding and demand incentive programs. R&D funding is mainly geared towards aiding companies that are developing and fine-tuning new technology in preparation for commercialization. Demand incentive programs play the role of aiding the actual commercialization process. Common demand incentive programs include tax policies, subsidies, and mandates. These are, in turn, made up of instruments such as Renewable Portfolio Standards (RPSs) and Production Tax Credits (PTCs). RPS mandates stipulate that a certain portion of total energy production must be generated by means of renewable energy and are enforced via monetary penalties. PTCs provided by the government help reduce the final cost to consumers – without PTCs, the price of electricity generated by wind heavily outweighs that of electricity generated by conventional means such as coal, gas, and hydro.

"In Europe, wind power is already a relatively easy sell. But in the United States, wind developers rely on federal tax credits to make a profit. These vital credits face chronic opposition from powerful oil and coal lobbies and often lapse. The wind power industry raced to plug in its turbines before these tax credits expired at the end of last year, then went dormant for the three months it took the U.S. Congress to renew them. Congress extended the credits through the end of next year,
initiating what is likely to be yet another start-and-stop development cycle. “81

The main factor that adoption relies on is cost – not government policy support and market drivers. 82 In terms of initial capital investment, although the price of equipment requirements has dropped significantly over the years, it is still too high and prevents adopters from making purchases. “On average, it costs about $1 million per megawatt to construct a wind turbine farm, compared to about $600,000 per megawatt for a conventional gas-fired power plant.” 83 However, it is only a matter of time before the price drops to an acceptable level because the design is continually evolving.

82 Peter Fairley, 45.
83 Peter Fairley, 42.
Three components that have an impact on the cost for any given wind power project are: site suitability, grid interconnection details, and solid buyer agreements. Grid interconnection examines the cost of setting up the transmission infrastructure – costs are lower if the site location is closer to existing infrastructure.

Site suitability involves assessment of wind availability as well as issues involving disruption of the local environment. This latter issue affects the granting of permits. Wind “may be free and widely accessible, but it is also frustratingly inconsistent... And this fickleness translates into intermittent power production. The more turbines get built, the more their intermittency will complicate the planning and management of large

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flows of power across regional and national power grids. Indeed, in west Texas, a recent boom in wind turbine construction is straining the region’s transmission lines – and also producing power out of sync with local needs: wind blows during cool nights and stalls on hot days when people most need electricity."86

Securing buyers of the electricity may be a concern if the price on wind power is considerably greater than that of electricity generated by other means. In parts of Europe, this is not an issue whereas in the US, it is. "Nations like Denmark and Germany are prepared to pay for wind power partly because fossil fuels are so much more costly in Europe, where higher taxes cover environmental and health costs associated with burning them. (About 20 percent of Denmark’s power comes from wind.) But for wind power to be truly cost competitive with fossil fuels in the United States, the technology must change."87

The following key points summarize the wind turbine industry:

- Although market drivers (such as reduction of emissions output and non-renewable energy use) and government policy (R&D funds and demand incentive programs) push for technology adoption, it all boils down to cost being the deciding factor
- The technology must be able to effectively adapt to and handle situational inconsistencies – wind ‘quality’ unpredictably fluctuates
- Buyers of the output – electricity – must be secured.

87 Peter Fairley, 43.
Market drivers, government policy, and challenges associated with the wind turbine industry have just been examined. Market drivers and government policy are very similar to that found in the pyrolysis industry. Attention should be directed towards the challenges – they can serve as lessons learned, extracted, and applied to the emerging pyrolysis industry. This will give us a better understanding of what the key success factors will be as the pyrolysis industry develops.
2.7 Key Success Factors

The pyrolysis, waste-to-energy industry has immense growth potential as it is in its early stages of development. Early adopters of this technology value comprehensive turnkey products. Therefore, successful organizations must be able to design and build systems that are immediately ready to operate. Other key success factors are: (1) cost of initial investment, (2) flexibility in handling feedstock, (3) value-added byproducts, and (4) the ability to match the product’s strengths with specific market niches. The first three are derived from that of the wind turbine industry mentioned in the previous section.

Initial Capital Investment

Subject to the geographical region, the initial capital cost of the systems is less of a concern, if there are demand incentive programs that make adoption attractive. These include government financial incentives for the disposal of scrap tires (excluding BC’s FIRST Program because it currently does not encompass pyrolysis). Dependant upon the processing method, revenues in the millions of dollars from financial incentives for scrap tire recycling will significantly shorten the time required to recover the initial cost of capital.

With more than 150 different pyrolysis contenders seeking to differentiate, the continual improvement of the technology is key in order
to compete. As the industry is in the early stage of the technology adoption life cycle, the dominant designs have yet to emerge, resulting in a persistent strive towards higher quality and efficiency. This trend calls for constant investment in capital-intensive research and development by organizations that wish to maintain or grow market share. Ultimately, the purchaser will benefit due to the continuous improvements that will drive down ownership costs.

**Feedstock Handling Flexibility**

The ability to adapt to fluctuations in feedstock supply remain a concern as evidenced by organizations whose operational facilities have not succeeded – a decrease in feedstock gave rise to insufficient generated revenue from byproducts. Manufacturers producing systems that are able to cope with fluctuations in processing needs will be at an advantage. The physical size of the system is tied in with its operating costs – the bigger the plant, the more resources necessary to operate.

**Value-Added Byproducts**

It is important to be able to: (1) produce valuable byproducts that can be sold back into the market with minimal processing or (2) have the byproducts distributed in such a way as to create other forms of value. The former entails finding buyers and their channels as well as setting up shipping logistics for raw byproducts. Methods to process the byproducts include grinding up or activating the carbon black or refining the oil. As
pyrolysis is an emerging technology, a relatively small number of buyers exist for the byproducts. This means that great effort is still required to educate potential byproduct customers.

Systems that are able to generate off-the-grid power with ease to become self-sufficient or supply the grid as an Independent Power Producer (IPP) to generate value in the form of revenue have an advantage. Integrated complementary technologies such as turbines and generators allow the system to achieve this. In addition, the ability to produce byproduct fuels that can be looped back and used to sustain operations also adds to the system’s attractiveness.

**Target Appropriate Niches**

The final primary success factor that ties all of the above together is the ability to identify differentiated strengths of the product and match these with specific market segment needs. Normally, the market is first analyzed to identify niche opportunities before products are manufactured. In the case of Kouei Industries, tremendous effort was first put into creating the unique product. The challenge is now to find the markets that the existing SK-200 is able to fit into and secure solid partnerships.
2.8 Future Outlook

Widespread changes to promote growth are forecasted in the alternate waste-to-energy markets with the conception of tax incentives for waste-to-energy facilities and the ratification of the Kyoto protocol. Other factors such as renewable portfolio standards, strict greenhouse gas emission standards, and "Clean Air Act" standards are also expected to result in constructive influence upon these markets. All these elements together will force changes in organizations within certain existing industries. For example, cement manufacturers that currently burn scrap tires will need to adopt greener waste-fuel management technologies.

In the face of high initial investments and obstacles in securing financing, waste-to-energy plants are projected to grow by up to 26 percent in the next ten years. As this is a heavily fragmented industry in its early stages, the main objective of market participants will be to obtain their initial commercial installation and demonstrate reliability. Next, various technologies will strive for acceptance and entrenchment in the market. Companies offering full-packaged solutions – encompassing the design phase, construction, and maintenance – possess an advantage and will be better able to capture a significant part of the market.

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89 "North American Biomass and Waste-to-Energy Markets".
3 Current Snapshot of Company

This chapter focuses on the current situation at Kouei Industries Canada. Areas to be covered include the organization structure, management team, internal communications/coordination, corporate culture, strategy, product in detail, market, and prospective customers. Upon examination, an assessment can then be made to see whether Kouei is in a good position to compete in the pyrolysis market by working towards achieving the key success factors as outlined in the previous section.

3.1 Organization Structure

In recent years, plans for global expansion unraveled and are now being executed. Initial division of labour, with respect to main activities and functions, has emerged resulting in a functional structure with defined organizational boundaries. The Kouei Hiroshima office is currently responsible for research and development as well as final assembly of all plants. The Kouei Vancouver office, which has been given exclusive rights to license, manufacture, and distribute the patented ECOLUS™ SK-200, has been charged with the responsibility of sales and marketing outside of Japan – within Japan, Mitsui & Co., Ltd. is responsible. Manufacturing of prefabricated components is currently outsourced to Kobe Steel (situated in Japan).
The current organizational structure within Kouei (both Hiroshima and Vancouver) is operating on a skeleton crew. Further growth within the functional activity areas will occur as the company develops. The Hiroshima office will hire more engineers because it is the centre of research and development. The Vancouver office will hire more staff members relating to areas of administration, finance, and business development. Each function will vertically coordinate internal activities by establishing a hierarchical infrastructure that supports supervision, rules, and plans. Employees will be focused on reaching goals of their particular functional departments resulting in differentiation and adoption of similar values and orientations.
3.1.1 Mitsui & Co., Ltd.

Mitsui, a publicly-traded company with 2003 revenues in excess of USD$4.8B and assets totaling USD$55.4Mt, has a heavily diversified portfolio of business units spanning various different industries. In regards to steel and iron, they are vertically integrated to cover a significant portion of the upstream supply chain functions such as production of raw materials and manufacturing of products that utilize these raw materials. Aside from selling Kouei’s SK-200, they also manufacture and sell their own large-scale R21 pyrolysis system. Their first 70,000 ton/year facility has been operating for four years. The total dioxin release is approximately 0.26 g TEQ per ton of municipal solid waste (MSW) – less than 10% of the Japanese government allowable limit. Another R21 facility is currently being constructed with a capacity of processing 150,000 tons/year of MSW.

Table 12 - Mitsui & Co., Ltd. Business Units

<table>
<thead>
<tr>
<th>Business Units</th>
<th>Plastics &amp; Inorganic Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron &amp; Steel Raw Materials and Non-ferrous Metals</td>
<td>Energy</td>
</tr>
<tr>
<td>Iron &amp; Steel Products</td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>Foods &amp; Retails</td>
</tr>
<tr>
<td>Power, Transportation &amp; Plant Projects</td>
<td>Lifestyle</td>
</tr>
<tr>
<td>Transportation Logistics</td>
<td>Consumer Service</td>
</tr>
<tr>
<td>Information, Electronics and Telecommunications</td>
<td>Financial Markets</td>
</tr>
<tr>
<td>Organic Chemicals</td>
<td></td>
</tr>
</tbody>
</table>

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93 Data source: Mitsui & Co., Ltd.
3.1.2 Kobe Steel

Kobe Steel produces a wide range of metal products, machinery, and electronic equipment while supplying engineering and infrastructure services that include chemical plant construction. In the iron and steel area, Kobe is vertically integrated. Being a publicly traded company with revenues of over USD$10B and assets totaling USD$15.8B, Kobe is currently in a joint venture agreement with Solvay S.A. where they will construct two PVC recycling plants in Japan. The agreement also gives Kobe Steel exclusive rights to supply Japan with Solvay’s PVC recycling technology. Each facility will be able to process 20,000 tonnes of PVC annually.

Table 13 - Kobe Steel Business Units

<table>
<thead>
<tr>
<th>Business Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron and Steel</td>
</tr>
<tr>
<td>Welding</td>
</tr>
<tr>
<td>Aluminum and Copper</td>
</tr>
<tr>
<td>Engineering</td>
</tr>
<tr>
<td>Machinery</td>
</tr>
<tr>
<td>Real Estate</td>
</tr>
<tr>
<td>Infrastructure and Plant Engineering</td>
</tr>
<tr>
<td>Other Businesses</td>
</tr>
</tbody>
</table>

97 Stephen Moore & Ian Young, 17.
98 Data source: Kobe Steel
3.2 Management Team

3.2.1 Kouei Industries KK (Hiroshima, Japan)

**Hiroyuki Matsubara – President and Chief Executive Officer**

- PhD Engineering
- Dry Distillation Pyrolysis System™ and ECOLUS™ SK-200 inventor
- First class environmental manager
- Vessel Engineering Graduate from Oita Industrial University
- Recipient of Ship Building Society Award for Structure Dynamics
- Registered Shipbuilding Chief Engineer at Ministry of Transport
- Member of Industrial Waste Society

**Toshio Muratani – Technical Advisor**

- PhD Engineering
- Guest professor at Oita University
- Registered consulting engineer at the Science and Technology Agency
- Registered environmental counselor at the Environment Agency

**Yuukichi Takashi – Technical Advisor**

- PhD Science
- Engineering Department Guest professor at Nippon Bunri University
- Applied Science graduate at Osaka University
- Member of Oita City Environmental Council
- Member of Japan Chemical Society Macromolecule Society
- Research & Development at Asahi Kasei Corporation
3.2.2 Kouei Industries Ltd (Vancouver, Canada)

Jesse Klinkhamer – Chief Executive Officer

- Previous CEO of Solid State Investments
- Managed and raised funds for various public companies
- Former CEO of the largest online portal for boating membership rewards program on the west coast of North America
- Instrumental in the development of funding for marine charities
- Accumulated international network of high-profile contacts during management career
- Environmental and humanitarian awareness

Patrick Brown – Chief Financial Officer

- Professional accountant for 9 years
- Held several key senior finance roles both in public and private companies, all of which have been huge successes
- Strategic thinker and long-range planner with an entrepreneurial spirit
- Most recently worked in the public sector and on the financial side of the entertainment industry

Scott Carley – Chief Operations Officer

- Former CFO of Next Level Communications Inc
- Key business development representative for multimillion dollar internet company
- Provided initial start-up capital for Kouei
- Exceptional understanding of business realities and pitfalls
Hiro Tanaka – Director of Communications

- Publisher of the Planet Newspaper in Tokyo, Japan
- Has been involved in changing the world through media and education
- Has many charitable achievements to his name
- Has been involved in sales for over 20 years
- Formerly part of Kyocera’s sales team in Japan

Kouei Canada’s management team is a dynamic and hands-on group that takes an integrated analytical approach. No formal planning seems to take place because strategies change on the fly as new information is collected from the environment – for example, from meetings with representatives from other organizations. Members have a strong entrepreneurial spirit. They are actively engaged in day-to-day activities, interacting with investors, potential customers, and potential partners. No board of directors, formal or informal, exists.

3.3 Communication and Coordination

Although inter-organizational communication and coordination currently exists at a minimal level, management understands that a strong infrastructure is necessary and gradual progress is being made in reaching this goal. A large part of all efforts is spent with parties outside of the organization on business development. There is no set schedule for formal face-to-face company meetings, which are held approximately once every couple of months. Management attempts to increase the
frequency of such meetings to keep everyone abreast of current on-
goings. However, this is proving to be difficult as new contacts are made and more time must be spent with external parties. Kouei Canada updates Kouei Japan on progress once per month to meet contract obligations. As for the company website, the CEO is tech savvy and makes web content updates by himself from time to time.

3.4 Corporate Culture

An important aspect of the culture originates from the founder of Kouei and inventor of the ground-breaking pyrolysis product - Mr Hiroyuki Matsubara. He believes in the vision that one day, problematic stockpiles of garbage will cease to exist and that he must put tremendous effort in helping society realize this goal. Mankind has created many problems and Kouei will play a part in correcting them. All management team members of the Hiroshima and Vancouver office share this vision.

Toxic electronics waste is currently being shipped to and dumped in developing nations. These nations have non-existent or non-enforced worker safety, child protection, and environmental standards. Tourist attractions located in developing countries such as Cambodia continue to be littered with consumer waste. One of Kouei’s objectives is to

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eventually donate SK-200s to places in need that can’t afford the initial high capital costs. This allows locals to operate their own waste-to-energy facilities and generate revenue by selling the fuel byproducts – this will in due course also improve economic and living conditions in the operators’ geographical areas.

3.5 Current Strategy

The North American pyrolysis market lags behind Europe and Japan in terms of adoption due to differences in government intervention efforts. For example, in Japan, aggressive laws have been enacted to speed market acceptance of recycling technologies. Further, to reduce incinerator emissions of dioxin, pyrolysis furnaces are heavily promoted. Kouei Industries believes that in order to compensate for the less stringent North American laws, more promotional efforts are required from pyrolysis companies. This has led to Kouei’s current strategy of emphasizing low cost to quickly gain market share.

Entering at a low price point is possible because costs are kept down by simple product design, usage of low grade recycled steel in the manufacturing process, smaller product size, and lower processing capacity. A smaller product also translates into faster delivery and setup times as well as reduced transportation costs. Manufacturing is currently outsourced to Kobe Steel at a fixed price per unit regardless of volume.
This means that as volume increases, Kobe Steel will enjoy a higher margin due to economies of scale.

Kouei Industries only offers the SK-200 and the most important goal is to set up one facility in North America (preferably in British Columbia, Canada) to demonstrate the technology. The initial capital investment required amounts to USD$3.6M which includes a warehouse, the SK-200 demonstration machine, forklift, crane, and other necessary equipment. Operating expenses for three years total USD$9M. Kouei Canada plans to obtain the total amount of USD$12.6M from investors in two rounds. They believe the first round of USD$5M can be easily obtained from venture capitalists – there have been meetings with representatives from Canaccord Capital.

3.6 The Product In More Detail

Kouei Industries’ ECOLUS™ SK-200 machine is a system that consists of the following main components: two dry distillation furnaces, first-stage/second-stage coolers, filtration/containment units (for gas and oil), silo cartridge cooling platform, and eight sealable air-tight silo cartridges. Feedstock is first placed into the cartridges, sealed, and hoisted into the burners for heating. The heating process for tires and plastics lasts three hours during which vapour (made up of oil, syngas, and other constituents) pass out of the cartridge and through the first-stage/second-stage coolers. The oil undergoes a filtration process and is
captured – 18% of the oil is rerouted back into the system’s furnaces to continue the process. All of the syngas is used by the hot water heater for cooling the system. What remains inside the cartridge after the 3-hour cycle is high-tension steel (if tires are used as feedstock) and carbon black.

During the initial half-hour start-up of the very first cycle subsequent to commissioning, the SK-200 uses natural gas to fire the burners, run the water heater, and ramp up. Once ramped up, usage of natural gas ceases and the system commences utilizing a small portion of it’s own oil byproduct and all of its syngas as fuel. From this point forward, if the processing cycle is repeatedly unbroken, then the system requires in effect no external sources of energy – only feedstock and operators.

Figure 6 - SK-200 top-level process model
Throughout the 3-hour cycle, vapour (consisting of the oil, syngas and moisture) from the feedstock within the cartridge moves to the first-stage cooler. At this phase, all water content is separated out as steam. What remains in the vapour is oil and syngas, which now enters the second-stage cooler for further separation. The heavy oil and syngas now individually go through a filtration process. After which all of the syngas directly feeds the water heater and most of the heavy oil is stored (a small portion of it is used to fuel the burners). Each of the two burners undergo 8 cycles per day amounting to a total of 16 combined cycles.

The SK-200 unit itself has a footprint of approximately 3,500 ft² and can be easily assembled/disassembled – being able to fit into three containers for transport when disassembled. A warehouse of at least 10,000 ft² (preferably 20,000 ft²) with a ceiling of 40 ft is required to accommodate the SK-200, feedstock, forklift, crane, and crew of three. Several units can be installed within one warehouse facility to expand processing capacity – each unit is capable of processing between 10 to 15 tonnes of waste per day.

The raw byproducts from scrap tires and plastics are carbon black, heavy oil, syngas, and steel. The only option Kouei has for the steel is resell it to steel recyclers. The carbon can be sold as is or pressed into briquettes to be used as a substitute for coal and other solid fuels. The oil can be used as is, further refined, or directly placed into generators to produce off-grid electricity. Aside from being used in the water heater,
the syngas – made up of benzene (70%), propane (10%), propylene (10%), and ethane (10%) – can also be used to fuel generators or be resold.

**3.7 The Market**

Kouei describes the market as being immense to the point of being “un-measurable”. Therefore, no quantitative estimation on its size and on Kouei’s predicted market capture is provided. Two general categories of customers/partners have been identified: (1) large commercial consumers of tire and plastic waste as fuel and (2) government and local organizations focused on landfill waste disposal issues. Although Kouei Canada has conducted preliminary research into these two groups, a more in-depth understanding is needed to identify unmet market needs that can be capitalized on. The emphasis should be on conducting primary research as opposed to secondary research. Primary research is obtaining tailored information about the target market through interviews, surveys, focus groups, and other direct means. Secondary research involves utilizing readily available sources of information about the target market – for example, third party research reports and studies.
3.8 Prospective End-Use Customers

To date, Kouei carries ongoing discussions with potential customers including Lehigh (owned by Heidelberger Zement AG in Germany), Lafarge, Mexican government officials, and Fountain Tire. These parties represent three market segments: cement manufacturers, tire stockpile sites, and tire dealerships. In addition, they are points located along the scrap tire supply chain where the product moves from generation source to temporary holding station to TDF end-user. The following gives some insight as to what the situation is for each of these segments. A more thorough assessment should be conducted that examines the value created by Kouei’s SK-200 and the target customers’ demands.

3.8.1 Cement and Concrete Manufacturers

Two recent studies have been conducted that examined power consumption and emissions related to Canadian and US operations in cement and concrete manufacturing. A summary of the relevant highlights from the studies will now be presented.

"The industry is diverse, involving 39 companies with no single company controlling more than 13.1% of the market based on tonnes produced. The five largest companies control nearly 50% of the market. Roughly 80% of the cement production capacity in the United States has foreign ownership or affiliation. Based on plant capacity, the top six
Figure 7 - Cement manufacturing (© US DOE, by permission)

[Diagram of cement manufacturing process]
countries with U.S. plant ownership are France (14.5%), Mexico (14.4%), Switzerland (14.3%), Germany (13.8%), Italy (9.6%), and Japan (5.4%). These countries each have two corporations present in the United States, except for Switzerland, which has only one. The top six companies in terms of U.S. capacity are Holcim, Ltd. (Switzerland - 13.1%), Lafarge Coppee (France - 12.7%), CEMEX S.A. de C.V. (Mexico - 12.2%), Heidelberger Zement AG (Germany - 8.25%), Ash Grove Cement Co. (United States - 6.5%), and Buzzi UNICEM SpA (Italy - 4.4%)."\(^{100}\)

There are 17 cement plants in Canada\(^{101}\) and 118 in the US\(^{102}\). During 2001, cement output in Canada and the US were 13.7 and 88.9 million tonnes utilizing 58.7 and 442.9 trillion BTU respectively. A tremendous amount of this energy is lost because the cement and concrete production industry operates at less than 40% efficiency. Out of the quarrying, cement and subsequent concrete manufacturing, the pyroprocessing within cement production utilizes the most amount of energy percentage-wise at 74%. This is because a rotary kiln must operate at a temperature of 1,500°C to chemically change raw materials into clinker, which is then ground into cement. For every tonne of cement produced, 0.97 tonnes of CO\(_2\) is released – this estimate excludes quarrying and concrete production. For 2001, this translates into the

\(^{102}\) William T. Choate, 6.
release of 99.5 million tonnes of CO₂ into the atmosphere by Canadian and US operations.

The biggest room for improvement on cutting energy consumption and emissions is within pyroprocessing. Currently, coal (60%), petroleum coke (15%), and natural gas (5%) make up 80% of the fuels used to power the cement manufacturing phase. Between approximately 1970 and 2000, the mixture of fuel sources changed to include more alternative/waste fuels and less conventional fuels. This newer type of fuel is better suited for pyroprocessing because of a more complete combustion from high temperature and longer residence time. Further R&D in creating equipment that is geared towards accepting alternate fuels would result in more energy efficient operations and reduced emissions.

“Cement manufacturing is a highly capital-intensive industry requiring large-scale equipment to be economically competitive. The capital investment per worker in the cement industry is among the highest in all industries. The high capital intensity limits the financial incentive to build new plants or update old plants.”¹⁰³ Cement producers are always looking for ways to reduce costs because of the low-margin nature of this business. Alternative fuels generated by Kouei’s SK-200 at an overall cost that is lower than that of conventional fuel types stand to benefit the cement and concrete industry.

¹⁰³ William T. Choate, 6.
3.8.2 Mexico-US Border Scrap Tire Stockpile

Paso del Norte - made up of Ciudad Juárez, Chihuahua, and El Paso, Texas - is the second-largest metropolis located along the Mexico-US border. During the past ten years, population hyper growth and demand for used tires from the US has given rise to scrap tire build-up along the border region. Two high-priority problems are associated with this stockpiling: fire hazard and limited landfill space. Local governments are desperately trying to address these problems through projects with the objective of reducing the size of the stockpiles. Help from state, federal, and international authorities is being sought.

Figure 8 - Paso del Norte (Mexico and US border)
The US alone generates approximately 273 million scrap tires each year – calculated using a rule of thumb where the number of scarp tires generated per year is equal to the population. Disposal of scrap tires currently does not keep up with its generation. It is estimated that in 2001, 300 million scrap tires existed in accumulation facilities across the US. “American scrap tires are often used in Mexico until the tread is completely worn; they are then discarded.”104 This leads to the influx of used tires from the US into Mexico.

Amassing of scrap tires along the border is an ever-growing problem. “Most of the cross-border trade in used tires is illegal and informal, since importing such tires into Mexican border states (except Baja California) is prohibited under Mexican law.”105 To compound the problem, appropriate industrial facilities to simply use tires as TDF are located too far away.

In terms of tire pile fires, they are extremely dangerous. “Partly because of their high energy content – 14,000 to 15,000 BTUs per pound versus 8,000 to 12,000 BTUs per pound for coal – tire piles burn intensely and are extremely difficult to extinguish.”106 In certain situations, it is suggested that the tire fire be left alone until it burns out. For this reason, such fires have known to last months and sometimes years. “Tire

105 Allen Blackman & Alejandra Palma, 2.
106 Allen Blackman & Alejandra Palma, 12.
fire emissions are estimated to be 16 times more mutagenic (toxic) than emissions from residential wood-burning fireplaces, and 13,000 times more mutagenic than emissions from coal-fired utilities with good efficiencies and add-on pollution controls (U.S. EPA 1997)." Hence stakeholders place scrap tire stockpiling high on the list of high-risk priorities.

Table 14 - Tire fire air pollutants

<table>
<thead>
<tr>
<th>Conventional</th>
<th>Hazardous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulates</td>
<td>Polynuclear aromatic hydrocarbons (PAHs)</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Dioxins</td>
</tr>
<tr>
<td>Sulfur oxides</td>
<td>Furans</td>
</tr>
<tr>
<td>Nitrogen oxides</td>
<td>Hydrogen chloride</td>
</tr>
<tr>
<td>Volatile organic compounds</td>
<td>Benzene</td>
</tr>
<tr>
<td></td>
<td>Polychlorinated biphenyles (PCBs)</td>
</tr>
<tr>
<td></td>
<td>Heavy metals (e.g., lead, arsenic)</td>
</tr>
</tbody>
</table>

107 Allen Blackman & Alejandra Palma, 12.
108 Data source: Allen Blackman & Alejandra Palma, 12.
3.8.3 Tire Dealers/Retailers

Small- to medium-sized enterprises (SMEs) dominate the tire dealer industry in Canada. The top five provinces (Manitoba and Saskatchewan combined) with the highest number of dealers are: Ontario, Quebec, British Columbia, Alberta, and Manitoba/Saskatchewan with 27.9%, 19.1%, 17.6%, 16.5%, and 11.3% respectively. Together, they hold a little over 87% of the total number of dealers in the Canadian market. Between 2000 and 2003, the number of tire dealers has been steadily increasing.

Table 15 - Breakdown of tire dealers in Canada (2003)\textsuperscript{110}

<table>
<thead>
<tr>
<th>Canada</th>
<th>Total</th>
<th>1 - 4</th>
<th>5 - 9</th>
<th>10 - 19</th>
<th>20 - 49</th>
<th>50 - 199</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF</td>
<td>17</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PE</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>NS</td>
<td>50</td>
<td>15</td>
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<tr>
<td>NB</td>
<td>44</td>
<td>8</td>
<td>19</td>
<td>11</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>PQ</td>
<td>279</td>
<td>102</td>
<td>84</td>
<td>58</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>ON</td>
<td>384</td>
<td>113</td>
<td>106</td>
<td>108</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>MB</td>
<td>68</td>
<td>23</td>
<td>25</td>
<td>17</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>SK</td>
<td>116</td>
<td>55</td>
<td>34</td>
<td>22</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>AB</td>
<td>268</td>
<td>71</td>
<td>102</td>
<td>67</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>BC</td>
<td>281</td>
<td>80</td>
<td>118</td>
<td>57</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>YK</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
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<td>2</td>
<td>0</td>
<td>1</td>
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<tr>
<td>NU</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

\textsuperscript{110} Data source: GD Sourcing; GD Sourcing - Research Retrieval, 3.
Retailers offer tires for not only consumer vehicles, but also for farm, off-the-road (OTR), mining, industrial, and commercial vehicles. They are currently not responsible for the actual recycling of scrap tires. Instead, contractors pick up and transport the used tires to processors. Tire recycling programs that exist mainly accommodate passenger tires. Other types are too “huge and heavy and pose significant challenges with respect to processing and recycling.”

Operation of pyrolysis equipment currently requires significant upfront capital asset investment. According to the tire retail industry profile, the majority of the potential customers are small businesses with less than 20 employees and limited financial resources. Furthermore, most individual businesses may not be able to generate enough scrap tires to feed a medium-capacity pyrolysis machine. Therefore, owning and operating an expensive pyrolysis system themselves is not warranted. Attention should be focused towards entities further downstream in the scrap tire supply chain. These parties include marshalling yards, transfer stations, and processors.

3.9 Assessment of Current Situation

Aside from having a good business idea, the right people in management positions, and enough money to get started, a start-up company needs other essential building blocks as well to increase the chances for success. These universally recommended fundamental building blocks were not found within Kouei. They have an impact on the following vital issues:

- Board members for management team guidance
- Sufficient communication/coordination structure
- Focused overall corporate and product strategy
- Knowledge in alternative financing options
- Understanding of the slow initial adoption of new technology
- Market segmentation and competitor analysis for strategic positioning

An organization without having covered the above basics before entering to compete will be at a disadvantage – strong competitors will most likely have these issues sorted out already. It is therefore imperative that each of these areas be more closely examined. The next chapter provides analyses and recommendations that relate to these issues.
4 Analysis and Recommendations

Urgent issues mentioned in the previous section that Kouei Industries is facing need to be addressed as soon as possible because they ultimately affect morale and productivity. However, the option of continuing as is still exists. If this is the chosen course of action, then the very fabric of the company will remain flawed and significant problems are guaranteed to arise later in the future. Instead, it is recommended that what follows be taken into account.

4.1 Fundamental Start-Up Essentials & Expectations

The following are some of the basic building blocks required to successfully build a new business. If these elements are in place, they form a strong foundation and a company can reliably base its growth on them. At which point, the start-up can then proceed and enter to compete in the market.

4.1.1 Raising Money

Obtaining funds to fuel a start-up can be frustrating for those who don’t fully understand the different sources that are available. These different sources are tailored to businesses that are at specific stages of development. Entrepreneurs who are not aware of these sources are
likely to pursue financing from the wrong parties and will more than likely fail to obtain funding.\textsuperscript{112} This results in wasted effort and perhaps even complete failure of a sound business venture. Kouei Canada to date has been maintaining operations with investment from founders. The current state immediately calls for funding from founders and angels. The following explains why. First, a brief description of the available sources is provided.

Newly established companies normally tap into the following sources (in order): founders, angel investors, venture capitalists, and banks.\textsuperscript{113} These elements are accessed in that specific sequence because they serve as building blocks for one another. It is difficult to obtain funding from venture capitalists and banks without prior angel support. Angels may not provide funding if the founders themselves have made no investment into the venture.

Founders put in money to acquire necessities needed to set the business in motion. This shows their confidence in the business because they have made a significant financial commitment. Angels are usually successful entrepreneurs with money to invest and can fund new ventures with tens of thousands of dollars, but rarely, a couple million. Venture capitalists are professionals that invest other people’s money typically giving upwards of several million dollars with the objective of achieving at

\textsuperscript{113} Ian Hand, email message, 22 June 2004.
least a 10-fold return. They are not as interested in a $5M or $10M market opportunity as they typically look for $100M market opportunities. Risk-averse banks look for companies with established customers or other assets – money is lent only to those that are able to repay loans.

Initial funding from founders is rarely sufficient. Immediately beyond this source, individual angel investors should be targeted. The objective is not only to obtain cash, but also to build solid relations with prominent angels. These relations are key to other windows of opportunity in terms of funds because most of the time, even angel funds are insufficient in maintaining the growth of a new business.\(^\text{114}\) Venture capitalists have made their fair share of returns from formerly investing in angels. The latter are seen as seasoned professionals in their own individual lines of business having experience and sound judgment. From a sea of start-ups, they can recognize and handpick the best ventures that are a cut above the rest. Therefore, obtaining support from one or several angels gives a lot of credibility, if in the future, funding from venture capitalists and banks are needed.

4.1.2 Solid Strategy Formulation

A sound business strategy is necessary because it allows an organization to understand the industry and formulate a plan of action to exploit opportunities. This basically involves analyzing the industry's competitors, their products, buyers, and suppliers. After doing so, an appropriate strategy is then chosen, developed, and documented in the form of a business plan. Low-cost, differentiation, and focus are the three generic strategies outlined in Competitive Strategy by Michael E Porter.

A low-cost strategy centres around "aggressive construction of efficient-scale facilities, vigorous pursuit of cost reductions from experience, tight cost and overhead control, avoidance of marginal customer accounts, and cost minimization in areas like R&D, service, sales force, advertising, and so on."\textsuperscript{115} A significant margin can be created with per unit manufacturing cost being minimized. This margin acts as a defence mechanism to respond to supplier/buyer power as well as competitors. Should strong suppliers increase the cost of raw materials, the margin is sufficient enough such that the final price to the buyer can still remain fixed. Should strong buyers demand a better deal, the price can be driven down to approximately the same level as the next best competitor without completing the transaction at a loss. One

drawback of this strategy, however, is that it tends to result in price
battles with other low-cost producers and hence significantly reduces
margins for all competitors within the segment.

A differentiation strategy stresses that the product being offered is
unique on an industry-wide basis. This uniqueness can result from one
or, ideally, a combination of different dimensions – product reliability,
customer service, leading-edge technology, design, etc. Although cost
minimization is not emphasized, it is also not completely ignored.
“Differentiation provides insulation against competitive rivalry because of
brand loyalty by customers and resulting lower sensitivity to price. It also
increases margins, which avoids the need for a low-cost position. The
resulting customer loyalty and the need for a competitor to overcome
uniqueness provide entry barriers. Differentiation yields higher margins
with which to deal with supplier power, and it clearly mitigates buyer
power, since buyers lack comparable alternatives and are thereby less
price sensitive.”\textsuperscript{116} However, maintaining or improving unique
characteristics of the product offerings mean that costs associated with
production are or will be high. Some customers may not be willing or
able to pay such high prices.

A focus strategy concentrates effort on a “particular buyer group,
segment of the product line, or geographic market; as with

differentiation, focus may take many forms. Although the low cost and differentiation strategies are aimed at achieving their objectives industry-wide, the entire focus strategy is built around serving a particular target very well, and each functional policy is developed with this in mind. The strategy rests on the premise that the firm is thus able to serve its narrow strategic target more effectively or efficiently than competitors who are competing more broadly.\textsuperscript{117} This results in achieving a strategy that is of either differentiation or low cost or a combination of both within a particular niche market segment – not within the entire market or industry as a whole.

In the case of start-up firms, undertaking a strategy that is used for industry-wide application would mean spreading limited resources too thin. Therefore, adopting a focus strategy is more appropriate. The question then becomes whether to adopt a focus strategy that leans toward low-cost or one that leans toward differentiation. Although Kouei Industries believes otherwise, they possess elements allowing them to be in good position for adoption of a focus-differentiation strategy. These elements include: targeted specific customer niches, low priority given to production cost reduction, unwillingness to discount the price, and brand-building activities. The main reason why Kouei believes they are pursuing a low-cost strategy is because the product happens to be low in cost and

can be sold to customers at a price lower than that of competitors – while maintaining a healthy margin.

Table 16 - Risks associated with each strategy

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Risks</th>
</tr>
</thead>
</table>
| Low Cost  | • Technological change that nullifies past investments or learning  
• Low-cost learning by industry newcomers or followers, through imitation or through their ability to invest in state-of-the-art facilities  
• Inability to see required product or marketing change because of attention placed on cost  
• Inflation in costs that narrow the firm's ability to maintain enough of a price differential to offset competitors' brand images or other approaches to differentiation |
| Differentiation | • The cost differential between low-cost competitors and the differentiated firm becomes too great for differentiation to hold brand loyalty. Buyers thus sacrifice some of the features, services, or image possessed by the differentiated firm for large cost savings  
• Buyers' need for the differentiating factor falls. This can occur as buyers become more sophisticated  
• Imitation narrows perceived differentiation, a common occurrence as industries mature |
| Focus    | • The cost differential between broad-ranged competitors and the focused firm widens to eliminate the cost advantages of serving a narrow target or to offset the differentiation achieved by focus  
• The differences in desired products or services between the strategic target and the market as a whole narrows  
• Competitors find sub-markets within the strategic target and out-focus the focuser |

A company's strategy consists of three general groups that determine and define specifications: (1) product market and level of investment, (2) functional areas and (3) competencies providing the sustainable competitive advantage. Product market and level of investment details the product offering, target market, competitors,

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extent of vertical integration, and investment objectives (to grow, sustain, or reduce market share). Functional areas illustrate how the company competes – details strategy for product, price, promotion, distribution, etc. Core competencies are what a business does very well and include, but are not limited to, unique resources, brands, and other assets. These areas should be addressed in the company’s business plan.

Table 17 - Each strategy’s skill, resource, and organizational needs

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Skill and Resource Needs</th>
<th>Organizational Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost</td>
<td>• Sustained capital investment and access to capital&lt;br&gt;• Process engineering skills&lt;br&gt;• Intense supervision of labour&lt;br&gt;• Products designed for ease in manufacture&lt;br&gt;• Low-cost distribution system</td>
<td>• Tight cost control&lt;br&gt;• Frequent, detailed control reports&lt;br&gt;• Structured organization and responsibilities&lt;br&gt;• Incentives based on meeting strict qualitative targets</td>
</tr>
<tr>
<td>Differentiation</td>
<td>• Strong marketing abilities&lt;br&gt;• Product engineering&lt;br&gt;• Creative flair&lt;br&gt;• Strong capability in basic research&lt;br&gt;• Corporate reputation for quality or technological cost leadership&lt;br&gt;• Long tradition in the industry or unique combination of skills drawn from other businesses&lt;br&gt;• Strong co-operation from channels</td>
<td>• Strong coordination among functions in R&amp;D, product development, and marketing&lt;br&gt;• Subjective measurement and incentives instead of quantitative measures&lt;br&gt;• Amenities to attract highly skilled labour, scientists, or creative people</td>
</tr>
<tr>
<td>Focus</td>
<td>• Combination of the above polices directed at the particular strategic target</td>
<td>• Combination of the above polices directed at the particular strategic target</td>
</tr>
</tbody>
</table>

The core competency of Kouei Industries is innovative research and development. It would make sense to keep this functional area in-house and centralized under the authority of Mr

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Hiroyuki Matsubara – the inventor of the ECOLUSTM patented technology. Ultimately after the Vancouver office has established a foothold in North America, all other parts of the company – sales, marketing, and production – can be duplicated or outsourced and grouped into strategic business units that are located around the world. This leads to a hybrid organizational structure consisting of a cross between functional and divisional.

### 4.1.2.1 Market Segmentation

Determining within the entire market what the customers value, dividing this large group into smaller sub-groups with common values, and profiling them are several of the initial steps required to formulate a sound strategy. Effort should be placed on market segments whose values match those provided by Kouei’s product. This will ensure that Kouei can command the highest possible price. The objective is to completely satisfy the targeted segments **one at a time**. Start-up companies with limited internal resources that attempt to please multiple customer segments simultaneously will end up satisfying them partially at best. Furthermore, each segment differs in terms of profitability and this should be taken into account to maximize return on efforts.

Each segment has its own unique business model. A sufficient amount of time must be allocated to analyze how the SK-200 would fit into existing operations and how profit might be maximized. For
emerging markets, this is painfully challenging because a whole new scenario must be created. Past product installations in Japan can only be used as a guideline due to geographical and associated differences.

Different segments lead to differences in value perceived and in turn, different marketing mixes. For example, in terms of the product, a basic core design exists. Modifying the product may mean simple aesthetics changes. It can also mean design changes in terms of functionality, which requires more R&D efforts. Segments that demand a lower price can still be profitable for Kouei – outsourcing to lower cost manufacturers in China and paring down service agreements can be considered, if margins are to be kept constant.

More understanding of the different customer types is required. Finding industry experts within identified segments will definitely speed this process up. They would be able to give a lot of insight regarding each segment’s profile. This, in turn, can be used to prioritize customer groups. Finally, if these industry experts can be convinced to buy into the SK-200, they would make valuable channel managers.
4.1.2.2 Competitor Analysis

The third fundamental component to an external analysis is an examination of the competitors. Ever since the late 80s and early 90s, there has been an increase in competitor analysis effort by companies. "Considering this new trend, firms that hold analyzing the competition low on the list of marketing priorities are operating at a great disadvantage." Information gathered from analyzing competitors is used in formulating the strategy.

The process itself involves looking at competitors’ past, present, and (most importantly) anticipated future. Foremost, an understanding and mapping of competitor products, capabilities, and strategies to assess how industry players compare in relationship to each other is required. After identifying their assumptions, goals, strengths, and weaknesses, one can decide who to compete with and whether to compete directly or indirectly. For example, those choosing to avoid costly turf battles in the early stages first survey where other competitors have claims staked and then avoid intruding on another’s territory. Markets that no existing competitors serve can also be revealed and capitalized upon.

Such past and present information is important. However, at best, it is focused on the near-term. This shortsighted analysis “feeds the

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temptation to match and counter... move for move."\(^{121}\) The true value in analyzing competitors is realized when their future moves can be accurately anticipated.

Finally, given that strategies and capabilities of competitors are dynamic elements, care must be taken to avoid putting too much effort on capturing too much information that will become obsolete in the near term. Instead, quick and general snapshots should be frequently taken.\(^{122}\) This will free up enough resources to broaden the scope allowing the monitoring of more than a few close competitors. The more competitors one can keep an eye on, the lower the chances of incurring a blindsided surprise attack.

4.1.3 Board of Directors

Every employee in the company looks up to and toward the CEO for direction and guidance. However, nowadays, a lot of times the CEO is also in need of direction and guidance:

"Today’s chief executives face a bewildering mosaic of fast change, uncertainty, and stiff competition in a world of unprecedented opportunity for growth. Many are wrestling with fundamental and profound questions about how to reposition their businesses. The best and brightest do not always have the answers. But no wonder. Industries consolidate, converge, and diverge at mach speed (witness telecommunications, health care, entertainment), and powerhouses arise from the dust (think Microsoft). The most basic assumptions can become obsolete overnight."\(^{123}\)

In such complex environments, especially in technology-based industries that strive on innovation, the executive team needs to tap into all the relevant knowledge and experience it can get to ensure a higher rate of success. Having an actively contributing Board of Directors is important. Boards serve to "identify blind spots and overlooked opportunities, offer multiple perspectives and insights into the external environment, and provide an objective view of the industry landscape and

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alternative views on people. In general, they provide the reality-checking every CEO needs.\textsuperscript{124}

For small start-ups, as opposed to creating a full-blown Board of Directors with 10 to 12 members, a smaller and less formal group of seven would be more appropriate because of easier relationship management. Normally, a board represents shareholders and has the power to hire and fire the CEO. However, depending on who the majority shareholder is, this situation may be different. For example, the board cannot fire a CEO who holds a majority of shares. On the contrary, if this were the case, the CEO is the one who would appoint, elect or re-elect directors\textsuperscript{125}. Finally, as previously mentioned, angels make excellent board members because they are successful entrepreneurs.

\begin{table}[h]
\centering
\begin{tabular}{|l|l|}
\hline
\textbf{Areas of expertise} & \textbf{Mentorship} \\
\hline
Academic / research experience & Regulatory experience \\
\hline
Angel investment & Political / lobbying contacts \\
\hline
Customer contacts & Sales expertise \\
\hline
Finance expertise & Scientific background \\
\hline
Fund raising & Strategic partnership contacts \\
\hline
Industry contacts & Technical expertise \\
\hline
International experience & Venture capital contacts \\
\hline
Investment banking contacts & \\
\hline
Marketing experience & \\
\hline
\end{tabular}
\caption{Advisory areas of coverage\textsuperscript{126}}
\end{table}

\textsuperscript{125} Ian Hand, email message, 22 June 2004.
4.1.4 Slow Adoption Rate

New technology that has yet to enter the widespread adoption phase requires unreasonable amounts of time and effort in order to achieve minimal results – as explained by the technology adoption life cycle. The pyrolysis industry is no exception. Prior to crossing the chasm, there exists customers who are willing to invest in the revolutionary product. However, these customers represent only, at most, 15% of the entire market. Due to the high risks – namely the significant cost of capital the initial innovators and early adopters will bear, they should consider all matters very carefully before reaching a decision. Furthermore, there may very well be a long wait between the point when the decision to purchase is made and when the actual deposit and order are placed. Juniper confirms this reality:

"After more than a year of detailed research, during which the company talked to governments, industry experts, potential customers and equipment makers across the world, Juniper has concluded that, while these processes will play an increasingly important role in recovering value from waste, their analysis also shows that many decision makers remain cautious about adopting such systems. Customers still regard many of the new processes currently being marketed as relatively unproven – and therefore risky. For this reason, Juniper's conclusion from its research is that while these new
technologies will gain market share, the majority of thermal treatment facilities ordered will still utilize conventional incineration technology...”

4.1.5 Employee Engagement

The Gallup Organization is a prominent research group that conducts studies on human nature and behaviour. With over 70 years of experience, Gallup helps organizations and individuals maximize performance. They emphasize that the key to maximizing employee productivity is through engagement. Employees that: understand what is expected of them, create strong relationships with colleagues and superiors, or experience meaning in their work, are deemed as being engaged. Being disengaged, on the other hand, entails weakening the connection between the employee with work roles and responsibilities resulting in lack of: social interaction, autonomy, and importance in the workplace.

Engagement leads to satisfaction, which results in the engaged to go above and beyond. Statistics indicate that the average company has only 25% of its workforce fully engaged. The remaining 75% are made

up of employees who either put in the minimum amount of effort every
day just to fulfill their duties or those who are completely disengaged to
the point where they are simply dead weight. Efforts by companies to
build and maintain engagement are costly. However, the opportunity
cost of not addressing this issue is far higher.

In determining the extent of employee engagement or
disengagement, Gallup recommends asking employees the following 12
questions\textsuperscript{130}:

\begin{table}[h]
\centering
\begin{tabular}{|l|}
\hline
\textbf{Questions}  \\
\hline
Do you know what is expected of you at work?  \\
Do you have the materials and equipment you need to do your work right?  \\
At work, do you have the opportunity to do what you do best every day?  \\
In the last seven days, have you received recognition or praise for doing good work?  \\
Does your supervisor, or someone at work, seem to care about you as a person?  \\
Is there someone at work who encourages your development?  \\
At work, do your opinions seem to count?  \\
Does the mission/purpose of your company make you feel your job is important?  \\
Are your associates (fellow employees) committed to doing quality work?  \\
Do you have a best friend at work?  \\
In the last six months, has someone at work talked to you about your progress?  \\
In the last year, have you had opportunities at work to learn and grow?  \\
\hline
\end{tabular}
\caption{Employee engagement assessment survey\textsuperscript{131}}
\end{table}


4.1.6 Augmenting Communication/Coordination

Recall that Kouei Industries as a whole will further develop into a functional organizational structure. This results in high specialization by the different departments. Employees within each department share similar goals, values, and orientations. Hence collaboration, efficiency, and quality is encouraged within the function. A major drawback, however, is that coordination, cooperation, and integration between departments will become more difficult – especially when functional departments are on opposite sides of the globe. Establishing sound procedures and infrastructure to cut across functional departments is key.

One affordable and readily available way is to leverage off internet technologies. Since the current objective is on establishing customers as well as enhancing internal communications, customer relationship management (CRM) and intranet applications are the focus. These two terms are defined as follows:

"CRM (customer relationship management) is an information industry term for methodologies, software, and usually internet capabilities that help an enterprise manage customer relationships in an organized way. For example, an enterprise might build a database about its customers that described relationships in sufficient detail so that management, salespeople, people providing service, and perhaps the customer directly could access information, match customer needs with
product plans and offerings, remind customers of service requirements, know what other products a customer had purchased, and so forth."132

"An intranet is a network within an organization that uses internet technologies to enable users to find, use, and share documents and web pages. Corporations use intranets to communicate with employees. In some large companies intranets are used as the primary way for employees to obtain and share work-related documents, share knowledge, collaborate on designs, access e-learning and learn about company news."133

Table 20 - How CRMs add value134

<table>
<thead>
<tr>
<th>What a CRM solution can do</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Help an enterprise to enable its marketing departments to identify and target their best customers, manage marketing campaigns with clear goals and objectives, and generate quality leads for the sales team.</td>
<td></td>
</tr>
<tr>
<td>Assist the organization to improve telesales, account, and sales management by optimizing information shared by multiple employees, and streamlining existing processes.</td>
<td></td>
</tr>
<tr>
<td>Allow the formation of individualized relationships with customers, with the aim of improving customer satisfaction and maximizing profits; identifying the most profitable customers and providing them the highest level of service.</td>
<td></td>
</tr>
<tr>
<td>Provide employees with the information and processes necessary to know their customers, understand their needs, and effectively build relationships between the company, its customer base, and distribution partners.</td>
<td></td>
</tr>
</tbody>
</table>

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Table 21 - How intrants add value

<table>
<thead>
<tr>
<th>What an intranet solution can do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share documents with anyone you authorize.</td>
</tr>
<tr>
<td>Schedule meetings and share calendars with colleagues and remote workers.</td>
</tr>
<tr>
<td>Conduct discussions on everything from product ideas to employee suggestions</td>
</tr>
<tr>
<td>Create and share access to information databases, or build database-driven applications</td>
</tr>
<tr>
<td>Manage and delegate action items and project tasks</td>
</tr>
<tr>
<td>Maintain standard contact directories of all employees, suppliers, and customers</td>
</tr>
<tr>
<td>Conduct opinion polls among employees</td>
</tr>
<tr>
<td>Post announcements and share web links among all colleagues</td>
</tr>
</tbody>
</table>

For organizations with tight budget constraints, such powerful systems for enhancing productivity are affordable through application service providers ASPs. An ASP is “a company that offers individuals or enterprises access over the Internet to applications and related services that would otherwise have to be located in their own personal or enterprise computers.” Instead of incurring the high cost of acquiring the software, infrastructure, and people to set up and maintain CRM and intranet solutions, they can simply be rented on a monthly or annual basis for a fraction of the acquisition price.

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5 Summary

This paper has examined the emerging pyrolysis industry in North America and Kouei Industries (Canada) Inc. The analysis indicates that Kouei has a good opportunity to reap high profits provided that pieces on the chessboard are properly in place. The paper is summarized as follows.

At the industry level, components that serve as catalysts to speed adoption of alternative waste-to-energy technologies include skyrocketing fossil fuel costs, strive towards energy independence, negative effects of climate change, and government intervention. The same drivers in Europe and Japan are more intense. Nevertheless, progress in North America will move forward although at a slower pace.

In the early stages of adoption, the majority of all customers are skeptical of the new, unproven technology. This is especially the case for high-cost industrial products. Effectively building one’s brand through differentiation and establishing solid customer partnerships are key initial steps. Careful, sustained focus ensures efficient and effective use of limited resources.

Pyrolysis intends to ultimately replace incineration and other methods of processing/recycling carbon-based waste. Scrap tire disposal by means of producing TDF and TDP will remain inadequate as the rate at which scrap tires are generated continues to greatly outweigh processing
capacity. However, the North American capacity to recycle plastics is far from being reached.

In order to effectively compete inside the pyrolysis market, the following Key Success Factors must be achieved.

- Ability to offer turnkey systems
- Lower cost of initial capital investment
- Flexibility in handling feedstock fluctuations
- Generation of high-value byproducts
- Ability to bring together product strengths with market niches

Kouei Industries has been competing in the pyrolysis industry since 2000 and is still considered a new contender. As with any new company, there is much room for growth and development. In Kouei’s case, an opportunity exists to set in place essential building blocks that form a solid foundation. These building blocks are as follows.

- build strong relationships with angel investors
- take time to decide on and develop the strategy incorporating thorough market segmentation and competitor analysis
- establish an active board of directors for guidance and mentorship
- extremely slow uptake is associated with new technology adoption
- obtain high productivity by keeping employees engaged
- implement web-based intranet and CRM to improve internal communication/coordination

It is highly recommended that the above essential ingredients that allow for a greater chance of success be implemented. However, the option of continuing as is still remains. Should Kouei choose to stay with how business has been done, the rate of progress will continue to be slow. Amidst a highly competitive industry, slow progress is extremely costly and sometimes fatal. On the other hand, once the recommended pieces are in place, they help to increase the chances of both continued survival and ultimate success.
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Personal Communications


