THE VALUE PROPOSITION OF 'TECK COKE LIMITED'

SHOULD TECK ENTER THE COKE TRADE?

by

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PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF BUSINESS ADMINISTRATION

In the Simon Fraser University (Learning Strategies Group) Program
of the
Faculty
of Business Administration

SIMON FRASER UNIVERSITY

Spring 2011

Approval

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Degree: **Executive Master of Business Administration**

Title of Project: **THE VALUE PROPOSITION OF 'TECK COKE LIMITED'**

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Abstract

This paper will review the business case for Teck to enter the metallurgical coke market for the steel industry. The trend impacting investment is the growing demand for steel. There are two coke battery technologies to choose from; environmental concerns make the heat recovery oven the preferred technology. Four countries were considered in which to build the coke plant; Teck's relationship with Chile and Chile's desire for foreign investment makes it the best choice. Market size was estimated using the Demand Estimation Model. The forces that determine the 'total market' are a net positive on demand. 'Marketing plan' forces do not have an impact on the size of the market. Profitability is dependent upon the premium paid for coke over its input hard coking coal. With steel demand expected to increase and little additional coke supply coming online, Teck should invest in a coke oven alone or in a JV.

Executive Summary

Teck Resources Limited is Canada's largest diversified mining company. It is one of the world's largest zinc miners and it has a zinc smelter in Trail; it is forward integrated in the zinc industry. In 2008, Teck Resources Limited made a US$14 billion investment to ensure its place in the steel industry for years to come. Teck is now the second largest producer of metallurgical coal for the steel industry selling its coal products to steel mills and merchant coke makers around the globe. Like its zinc counterpart, should Teck's coal business unit forward integrate in the steel industry and produce coke? Coke is used directly in the process to make hot metal in the blast furnace and there is no indication that the blast furnace will be made obsolete any time in the next 30 years. The most convincing argument to enter the coke trade is that steel demand is going to increase for a number of years to come. The BRIC nations are going to urbanize 500 million people; steel is going to be a necessity, as it serves as the foundation for infrastructure, automobiles, and home goods. Although steel demand is expected to increase significantly, there is little additional coke supply coming online. Ultimately, the world is short coke. Some reasons for this are that the investment required for coke production is considerable (US$500 million to US$2 billion), the raw material to create coke is hard coking coal and prices are the highest ever (margins are tight), and environmental forces are at play.

When coke battery technologies are compared, the heat-recovery technology appears to be the logical choice in order to deal with the environmental concerns that all nations have. This technology would not force Teck to compromise its social license to operate. In combination with the choice of technology is finding a suitable location to accommodate the large footprint of a coke battery facility. Teck's current operations are mainly in the Americas, so the potential locations were limited to North and South America. Four potential countries were compared, all of which had the space available for the facility. In the end, a country in South America was a better candidate than trying

to permit a coke plant in Canada or the U.S. When Teck's current relationship with the Chilean government is taken into account, Chile is the best location for a coke plant investment.

With the coke plant technology and the location determined, a fulsome review of the coke market is required to determine if there is room for additional investment. To complete this, the Demand Estimation Model was used, which includes a review of the total market, marketing plan forces, and a financial analysis. The total market analyzes the environment, temporal parameters, cannibalization, and market complementarity. These forces all had a positive impact on the size of the coke market. Marketing plan forces include the impact of direct and indirect substitutes on the size of the market and understanding how the new product fits into the existing product suite. These had a nil effect on the size of the market. A financial analysis was also completed and it showed that the premium received for coke over the price of coal is the most critical factor between a positive and a negative NPV. A coke premium of 2.5 times the price of coal results in a project with a 14 percent IRR and a positive NPV of over US$100 million (over 20 years with a 10 percent hurdle rate). A premium of this magnitude has existed in the past and if demand for steel grows as expected, there is no reason to presume it will not happen again. This is especially true if steel producers limit their investment in coke production, because they are the ones currently being squeezed by the raw material producers (coal and iron ore) and the automotive industry. Steel producers might very well sit back and wait for steel prices to rise, rather than risking investment while margins are tight.

How a coke plant fits into Teck's strategy is important. For strategic purposes, forward integration is critical. To have a coke plant at its disposal will be vital in showing customers how Quintette coal cokes. Quintette is an old mine that Teck is re-opening and it is known that the quality is not as impressive as the rest of Teck's coals. Teck will mine 3.5 million metric tonnes of coal per annum at Quintette and will invest nearly US$425 million in the restart. An inability to properly market the coal could cost the company in the range of US$10 to US$20 per tonne, as that is price differential for poorer coals in the most recent quarterly negotiations. US$30 to US$60 million per annum in revenue could easily be lost jeopardizing the viability of the project.

When all factors are considered, an investment of US$500 – US$750 million is warranted. The potential financial gains, the product knowledge enhancement that could prevent price differentials, and the added benefit of moving some of Teck's coal products out of Canada are all reasons why the investment should be made. Moving product out of Canada is important, because product gets trapped at the coal mines from time to time and revenue opportunities are lost. Moreover, if too much coal is in inventory at the mines, the processing plants are shut down (storage space is limited). Production is lost that can never be regained. Logistical constraints are to blame. The western rail corridor is a busy section of track that is over 1,200 kilometres long and traverses three (3) mountain passes. It is a challenge at the best of times and more so when it becomes impassable due to avalanches. In addition, the Vancouver area port capacity is limited.

If the environmental risks are too high and there is uncertainty in how high coke prices will go, Teck should at the very least engage a partner in a joint venture project. In Chile, this would be steel producer CAP. In a joint venture, Teck would still gain from all of the factors mentioned, while securing a buyer for the coke and adding industry knowledge. In either case, it becomes clear that an investment in a coke plant would be a benefit to Teck.

Dedication

I dedicate the work involved in completing my MBA and this paper to my family and those closest to me at Teck.

Joanne, my loving wife, without your support I would have found it very difficult to complete the program. You took care of everything when I was gone and when I was most busy with studying. Add to that my time away for business and there were many days you were left alone and for that I ask your forgiveness. I will love you always.

Kyler and Brady, my two boys, were very patient with me when I locked myself in the den for hours on end. They may not know it, but their efforts in school and in life pushed me along the way. Boys, I love you both dearly and I will make it up to you!

To my parents - I still love you guys, even though you are 68. I am proud to say that my mother checked up on my schoolwork to the bitter end. She even phoned me as I was writing this page. I guess one never lets go!

I also dedicate this paper to Jim Jones, the mentor who not only pushed me to enter the program, but who also hired me in the very beginning. I have often said that I never dreamed I would be selling coal to the farthest reaches of the world when I first met you. You truly changed my life.

Finally, I dedicate this paper to the one man whose enjoyment and love of coal (if one can truly love coal!) inspired me to learn more about coal quality and coke making. I know I took a lot of your time down the stretch, but you helped me relentlessly and with a smile, even when things were not going so well and work was mounting. "Teşekkür ederim Tayfun Zehir.

I LOVE YOU ALL and I became who I am because of all of you.

Acknowledgements

Thank you to those who have supported and encouraged me. At Teck, Jim Brown and Mark Gow, your belief in me drove me further than I thought I could go. At Computershare, Craig Fisher and Steve Bandola, we pushed each other and pushed the system. Mike McLeod, you had the chance not to hire me way back, yet you saw something in me and gave me the opportunity to start down the road that has taken me to where I am today. We learned much together. At SFU, Team Revolution was vital to me in finishing the program. Tammy Salway, Brandon 'PEng' Scott, and Mike Harrington – I will never forget you guys and I will never forget the enjoyment I got out of all the work we did. The routine was a necessity. Who could forget, "I wonder which group got the highest mark on that paper?" Dean Winsor – although not formerly a member of Team Revolution, I will call you an honorary member and I thank you for all the time we spent together battling through online classes, final exams while out of the country, and 'you had me at bacon'.

Last but not least, I would like to thank those that assisted me directly with this paper. Paul Armstrong, Cornelis Kolijn, Bernhard Luemmen, Edwin Shadeo, Corey Caville, and Tayfun Zehir, your inputs were critical. At SFU, to my readers, Dr. Mark Selman and Dr. Ian McCarthy, I am not sure how much time you took reading all of our papers, but you found the time to help us all. For the help you provided to me – thanks so much!

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Glossary

BHP	BHP Billiton and together with Mitubishi form BMA – the largest supplier of seaborne coking coal
BRIC Nations	The emerging nations of Brazil, Russia, India, and China
CAP	Compania Siderurgica Huachipato – A Chilean steel producer
CAPEX	Capital Expenditure
CASP	Carbon Alloy Synthesis Process
CCRA	Canadian Carbonization Research Association
CESL	Teck's CESL Limited – has developed proven technologies for processing copper, nickel, gold, and silver
CI	Community Investment
CIM	Canadian Institute of Mining
CSR	Coke Strength After Reaction – a measure of coke quality
Coking Coal	Type of coal used in the steel making process. When heated in a coke oven in the absence of oxygen, coking coal becomes coke.
Coke	The product that remains in the coke oven after the volatile matter is burned off the coal. It is a porous substance made of almost pure carbon.
COI	Community of Interest
CONAMA	National Environmental Commission (Brazil)
COREMA	Regional Environmental Commission (Brazil)
CORFO	Development Promotion Agency (Chile)

Demand Estimation Model	Model as presented by Dr. Lindsay Meredith. It is used to determine the size of a current market and whether room exists for new entrants.
DJSI	Dow Jones Sustainability Index
EAF	Electric Arc Furnace
EVC	Economic Value to the Customer
Fording	Fording Canadian Coal Trust
GFC	Global Financial Crisis of 2008 and 2009
Heat Recovery Oven	A particular coke oven technology also known as a non-recovery oven
ICSID	International Council for Settlements of Investment Disputes
IRR	Internal Rate of Return
JV	Joint Venture
LME	London Metals Exchange
MACT Standards	Maximum Achievable Control Technology Standards
Metallurgical Coal	See 'Coking Coal'
MT	Metric Tonne
MMT	Million Metric Tonnes
n/a	Not Applicable or having no effect one way or the other
NPV	Net Present Value
OAS	Organization of American States
OECD	Organization for Economic Cooperation and Development
PCI	Pulverized Coal for Injection
PDAC	Prospectors and Developers Association of Canada

POSCO	Pohang Iron and Steel Company (Korea) – one of the world's largest steel producers and a customer of Teck
PPI	Policy Potential Index
Rank	A specific measure that indicates a coal's degree of 'coalification' or the increase in organic carbon content attained by burial and metamorphism
RVG	RVG Geschaftshuhrung / Evonic Industries – A German coke producer
Slot Oven	A particular coke oven technology also know as a by-product oven
TKS	Thyssenkrupp Steel Europe AG – a German steel producer
Ton	Imperial measurement being 2,000 lbs
Tonne (or 't' in Appendix charts)	A metric ton being 1,000 Kg or 2,204 lbs
U.K.	United Kingdom
U.S.	United States of America
US$	U.S. Dollars – all figures in the paper are US$, unless otherwise noted.
Vale	Vale S.A. – A Brazilian mining company
VAT	Value Added Tax
WBIFC	World Bank's International Finance Corporation

Introduction

Neil Armstrong's most famous quote, "one small step for man, one giant step for mankind", was made from the metal steps of a metal rocket, which was launched from a metal platform after being moved there from a metal mechanical bay on a metal transport. Steel is a fabric of life that shapes and changes our world. Whether you are in the far reaches of China or downtown Manhattan, steel is everywhere. Without steel, many of the things people take for granted would not be available and those in developing countries would not have the tools necessary to continue the struggle to urbanize and move up to middle class. For the immediate future, and likely for at least the next 20 years, steel will be produced from molten iron created in blast furnaces around the globe. Although various technologies have been developed in an attempt to displace the blast furnace as the primary source for molten iron, none of them has been seen as economically viable. Critics will say that a technology must be on the horizon, but there is no indication whatsoever that blast furnace steel making can be replaced in any substantial fashion in the near future. As long as the blast furnace is the primary source of molten iron, metallurgical coke will be required. As developing countries like China, India, and Brazil continue their rapid growth and push to urbanize their citizens, steel will be required and more metallurgical coke will be needed. The world is coke short in many regions and this shortage will grow, as more and more coke is required to create steel. China is still 40 years behind Japan and 20 years behind Korea in its development. The amount of steel needed in China alone over the next 40 years is astounding, as the nation is building 'a Canada' per year. Imagine how many airports, buildings, bridges, and subway / rail systems are required to do that. All of that infrastructure requires massive amounts of steel. Clearly, additional coke production will be required to make that steel. China's steel production will consume more coke than they are able to produce, forcing coke production to grow elsewhere. Even if domestic coke production can hold up, the rest of the world's steel mills will need to look

elsewhere for coke. Those mills have been fortunate enough to purchase coke from China over the past 30 years to fill their own lack of coke production, but this buying pattern will need to change.

This paper will attempt to determine if Teck Resources Limited should invest approximately US$500 to US$750 million to construct a coke battery and enter into the merchant coke business. A four-step plan will be used to get to a decision. To begin, a complete review of the different coke making technologies is presented and a choice made on which technology Teck should use. The environmental profiles of the alternative technologies will be a significant focus because emissions will be a critical factor when applying for permits in most jurisdictions around the world, as many governments are wishing to cap emissions and implement some sort of carbon tax. Next is a review of potential locations. If a suitable location does not exist, there is no need to go any further in the analysis. For the purposes of this paper, Chile, Brazil, the U.S., and Canada will be studied.

If a suitable location exists, the next step is to determine if a sufficient market for coke exists to allow a new entrant to profit. Since the attractiveness for Teck to add a new product to its existing portfolio is being reviewed, it is reasonable to use the Demand Estimation Model as presented by Dr. Lindsay Meredith as the framework for this part of the analysis. First, a complete market evaluation will be conducted. An analysis of the competition and a review of the congruency of coke in Teck's portfolio will follow. A financial analysis will also be completed, in order to consider the financial impact on Teck, as few coal miners are in the coke production business, which begs the question if forward integration for a coal miner is viable. Perhaps the economics favour the steel mills owning the coke production facilities; however, true merchant coke makers exist and are profitable, so the numbers can work. Although there are many positives that suggest that Teck should invest in a coke battery, if financial returns are not one of them, the risks associated with such a large capital expenditure will prevent Teck from making the investment. If that is the case, different potential ownership structures, such as joint ventures (JV) should be considered.

Finally, strategy is considered and how a coke plant fits into the greater Teck. Strategic principles, such as Porter's Five Forces, Game Theory, and forward integration will be investigated to understand the benefits of adding coke production to the company's portfolio.

Along the way, this paper will:

- describe Teck and the processes involved in the production of coal, coke, and steel;
- review the legal and political ramifications of owning and operating a coke battery;
- consider the implications of operating a coke battery on Teck's quest to be a sustainable organization;
- summarize how a coke battery will assist Teck's technical marketing efforts, since it is critical to dispel myths that exist in the market about Teck's coals that are the result of tests conducted in small one (1) kilogram test ovens;
- consider the positive impact of coke production on Teck's coal storage issues and logistical constraints; and
- determine the financial impact of cannibalizing coal sales.

When the analysis is complete, it will become clear if coke has a place in Teck's asset mix and a final decision will be made as to whether Teck's Senior Management should approach the Board and request US$500 to US$750 million for the capital expenditure. If so, in three years Teck will enter the coke trade, a business that has existed for over 100 years.

1: Background

1.1 Teck Resources Limited

Teck Resources Limited (Teck) is Canada's largest diversified mining company concentrating its assets on metallurgical coal, copper, zinc, and oil sands. With its head office in Vancouver, British Columbia, Teck manages operations in North and South America. Teck is the world's third largest producer of zinc, is a top ten producer of copper, has a significant lease foothold in the Alberta oil sands, and is the second largest producer of coking coal for the seaborne market.

Teck's Class A and Class B shares trade on the Toronto Stock Exchange and the New York Stock Exchange and as at January 31, 2011, its market capitalization exceeded $35 billion. Teck's coal division consists of six operating metallurgical coal mines with five in south eastern B.C. and the sixth in the west central region of Alberta. Full ownership in the six mines was the result of Teck purchasing the assets of the Fording Canadian Coal Trust (Fording). Fording and Teck were previously partners in the Elk Valley Coal Partnership, the first ownership structure that combined all of the Canadian metallurgical coal assets under one umbrella. In 2008, when the economy was super-heated and metallurgical coal prices soared to $300 per tonne, Teck invested US$14.5 billion to purchase Fording. With US$9.5 billion of the US$14.5 billion being debt, the takeover was risky and required the newly purchased coal assets to bring in significant revenues to meet looming bank covenants. During the summer of 2008, the unthinkable happened and the world plunged into the Global Financial Crisis (GFC). Revenues Teck expected from coal dried up nearly crippling it. In response to the economic challenge, Teck's management team implemented and completed a ten-step plan saving the company from bankruptcy, as the world's economy continued to implode. Today the coal division accounts for over US$5 billion in revenue and the future is promising with metallurgical coal being in short supply globally and prices returning to the US$300 plus levels.

All six mines produce metallurgical coal making Teck the second largest producer in the world. Teck's coal is 90 percent high quality hard coking coal and about 10 percent of it used as pulverized coal for injection (PCI) or thermal coal used in the production of electricity. In total, Teck will mine about 25 million metric tonnes ("MMT") of coal in 2011 and has capacity to mine over 30 MMT per annum, a target Teck has set for 2015. Perhaps the most exciting statistic, however, is that Teck Coal has proven, economically viable coal reserves of 750 MMT, or enough to mine for the next 25 years. In addition to that, Teck Coal has another 6 billion MT of coal classified as indicative resources meaning that Teck can mine for generations to come (Teck Investor Presentation - 2011).

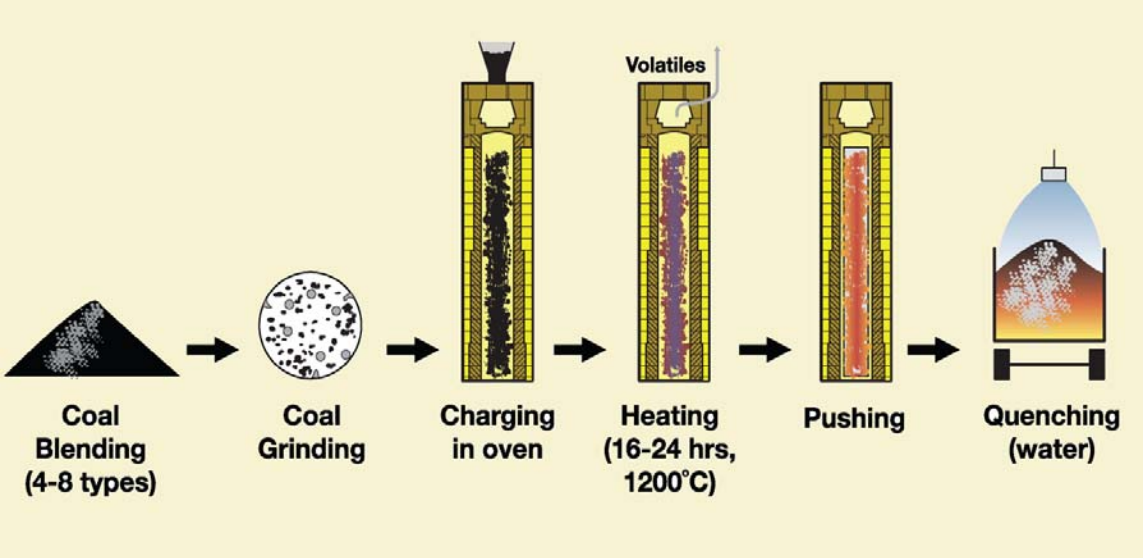
1.2 Coal, Coke, and Steel Production

Teck mines coking coal using truck and shovel methods in all of its open pit operations. Teck releases raw coal from the various seams that exist in the mountain ranges it mines and blends them in raw coal stockpiles in order to meet certain specifications. It then washes the coal in preparation plants to reduce the ash that is inherent in the coal seams as well as the dilution from the mining process and then dries the coal in order to reduce the moisture. Teck stores the coal or immediately loads it onto rail cars in its clean coal state. Teck separates the clean coal into products consisting of Elkview Standard, Standard, Premium, Eagle, and Cheviot differentiated by certain characteristics. The major differentiating characteristic is rank, a specific measure that indicates a coal's degree of coalification (increase in organic carbon content attained by burial and metamorphism) or quality and the amount of volatile matter that one can likely expect in the coal (Tayfun Zehir and Cornelis Kolijn, March 2011). The lower the carbon content (or the larger the percentage of volatile matter) the lower the coke yield, so rank is a function of cost for the coke producer. Teck transports the various coal products to the coast by rail and the coal is loaded onto ships. Large vessels deliver Teck's coal to customers around the globe. In addition, Teck does have some domestic customers accessible via direct rail or via vessels across the Great Lakes.

When the coal reaches the integrated steel mill or merchant coke maker, it is stockpiled prior to being prepared for the coke oven. Coal preparation includes blending

various coals and pulverizing them, before charging them into the coke oven. In the battery, the coal blend is heated in the absence of oxygen for a period of time (16- 24 hours) at temperatures exceeding 1200°C. The heating process drives off volatile matter in the coal and then melts the coal, which then re-solidifies to produce coke. Coke is a porous substance that is nearly pure carbon. The steel producer pushes super hot coke from the oven into rail cars, quenches it in a water bath, and transports it to storage. Figure 1 illustrates the coke making process. There are two types of coke ovens, the traditional by-product oven or 'slot oven' and the newer non-recovery coke oven. A fulsome review of both technologies follows later.

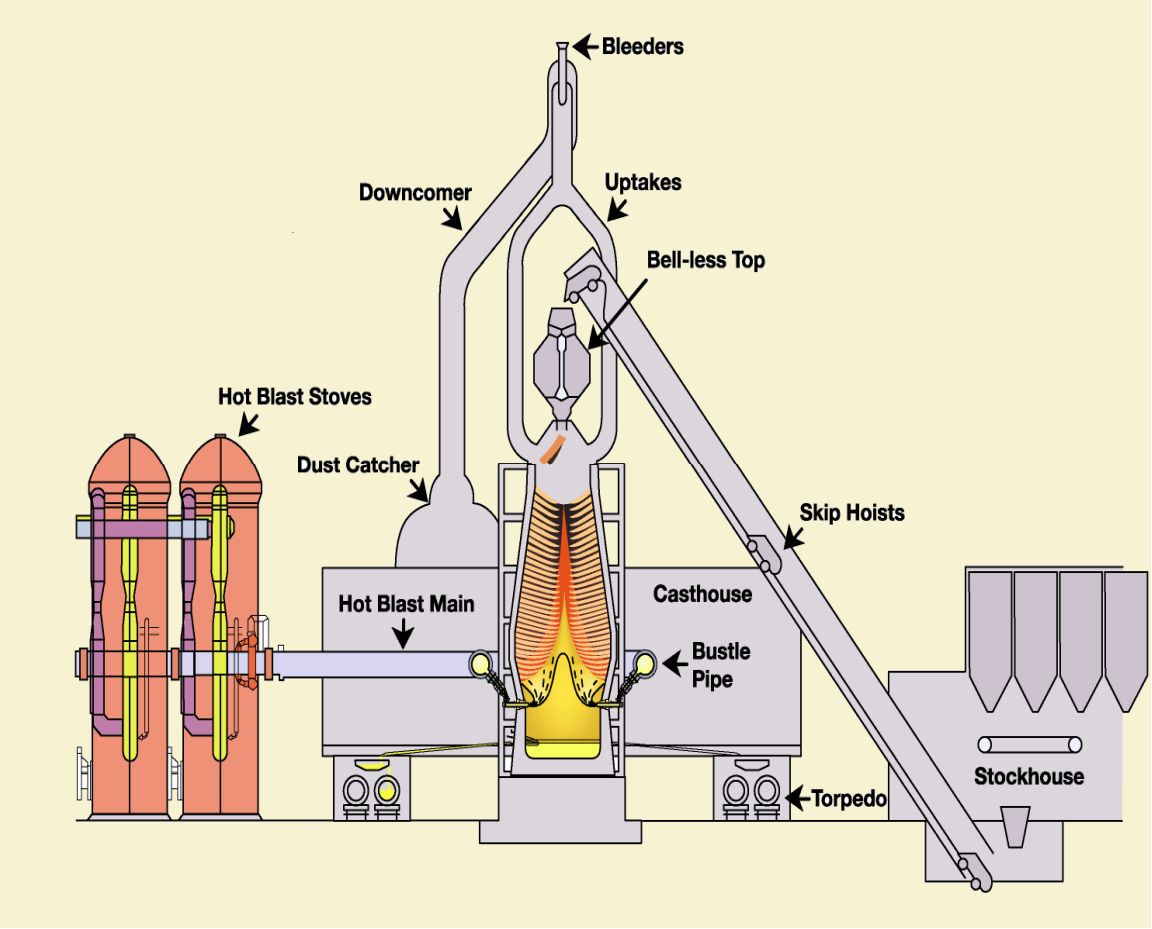
Figure 1 - The traditional by-product oven coke making process (www.teck.com)



At the blast furnace, the two main ingredients are coke and iron ore. The iron ore is processed into sinter by combusting the sulphur in the ore to form iron oxide pellets about one inch in diameter. The system dumps alternating layers of coke and sinter into the top of the blast furnace from skip hoists. As they float down through the furnace, they meet super heated air from below blown in from the hot blast stoves, as seen in the Figure 2. Blast furnace productivity requires the use of strong coke, as its purpose in the blast furnace is four-fold. One, it supplies heat. Two, it supplies the carbon content and the gases that chemically reduces the iron oxide to molten (pig) iron. Three, it supports the massive burden of the raw materials in the blast furnace in such a way as to create the

environment for the reduction to occur. Four, it remains strong enough at elevated blast furnace temperatures to provide vertical permeability for the gases and molten iron to travel through. Good quality coke requires good quality coal, so coal's importance in the steel making process is evident. The relationship is 1.5 MT of coal produces one (1) MT of coke and one (1) MT of coke produces two to three (2 to 3) MT of molten or pig iron (Tayfun Zehir and Cornelis Kolijn, March 2011). Molten iron is also known as pig iron, because it was sold to customers in pig shaped moulds. In the final stage, the molten iron drips out the bottom of the furnace and is delivered to the basic oxygen furnace for further processing into molten steel and then into the various steel products that are used around the world today.

Figure 2 - A commercial scale blast furnace operation (www.teck.com)



2: Coke Battery Technology

Before any work with respect to location, demand estimation, or financial impact is completed, Teck should determine the coking technology it needs to invest in. This is important because an understanding of the environmental issues, the capital investment needed, and the actual footprint of the plant are all required. The coke trade employs two different technologies, the chemical by-product or slot oven technology and the non-recovery technology, with the differentiating factor being how the oven deals with coke oven gas.

2.1 Slot Oven Technology

A typical slot oven is six meters high, about a meter wide, and lined with ceramic bricks. The picture following shows a series of slot ovens; it is easy to see their magnitude. The battery system charges the ovens individually with coal and the heating process begins. Combustion of fuel gas in the flues flanking both sides of the oven produces the heat for coking. As a result, the heating process is indirect. As coking begins, gases from the coal evolve. In integrated steel mills, these 'by-products' are captured and processed for reuse downstream in the steel making process as chemical feedstock for industrial purposes. Reuse or sale requires purification of the tar and oil. Accordingly, a slot oven battery requires a functioning by-product plant that requires considerable additional capital expenditure, nearly equal to that of the coke plant itself.

Figure 3- A commercial scale by-product coking oven (Cornelis Kolijn)

The slot oven, also known as a 'positive pressure oven', is technology that has been in existence since the early 1900s. The fact that the technology is still in use today and that integrated steel producers still choose the technology for new plants or for existing plant expansions is proof that the technology is still viable. In fact, Usiminas in Brazil just commissioned a new slot oven battery in 2010 and ThyssenKrupp has received approval from its Board of Directors to add a slot oven battery to its existing HKM works in Germany (Bernhard Luemmen – March 2011).

A major advantage of the slot oven is its ability to withstand coke blend changes and still produce good coke. Since charging of the ovens occurs from the top, the bulk density of the charged coal, especially at the bottom of the oven, is higher than that found in the non-recovery oven. The bulk density assists in better coking of the coal. Moreover, slot ovens can be 'stamp charged', or packed, to further increase the bulk density and further improve coke strength properties. Another benefit of the upright oven is its heating efficiency. While the non-recovery process requires technology to ensure heat envelopes the coal, the heating of the slot oven walls ensures uniform heating. This increases the effectiveness of the coking environment (Tayfun Zehir – March 2011).

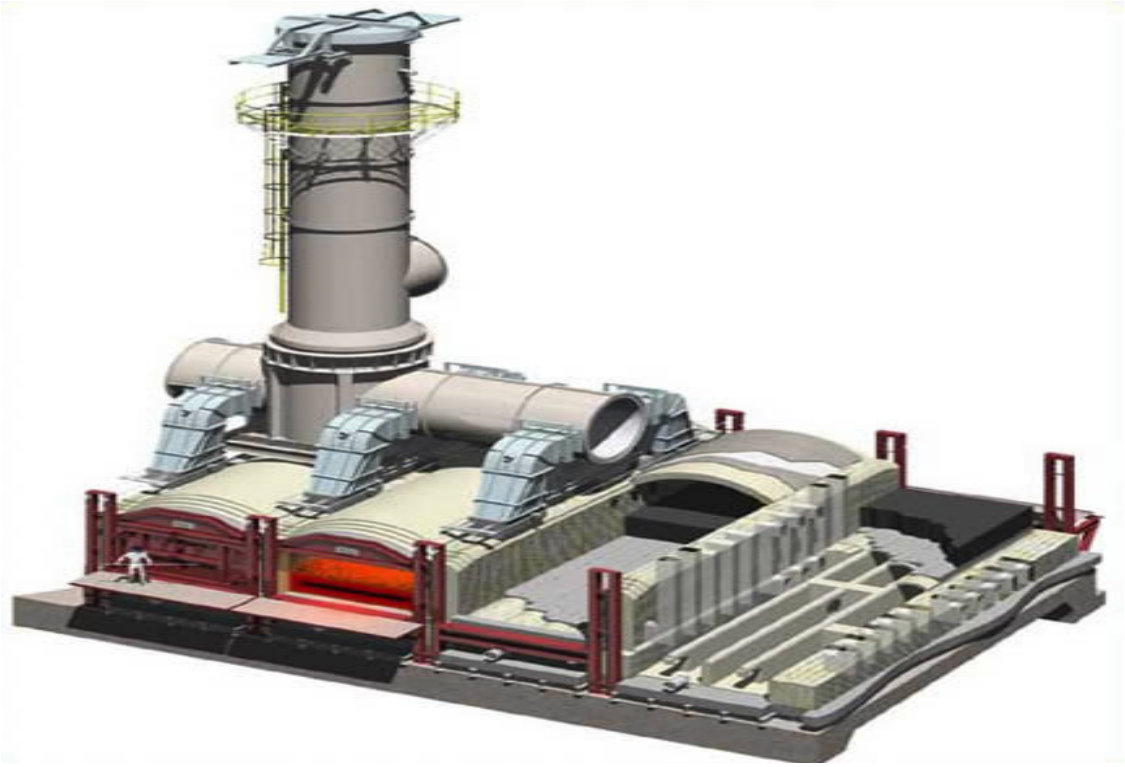
A disadvantage of the slot oven is its propensity for 'stickers'. Stickers occur when the coal blend used does not shrink sufficiently upon carbonization or because coke created after carbonization is so weak it slumps within the oven preventing an easy exit.

When the pusher tries to move the coke out of the oven into the quenching cart, a sticker does as its name suggests and the coke sticks in the oven. This adds to costs and maintenance for the oven owner and can result in severe damage to the brick walls. Slot ovens are much more sensitive to expanding coals, because of the slim nature of the ovens (Tayfun Zehir – March 2011).

2.2 Non-Recovery Technology

The 'negative-pressure' or 'non-recovery' oven is SunCoke Energy Inc.'s attempt to improve the coking process. Coal is charged one (1) meter deep, four (4) meters wide, and 14 meters long into the side of the ovens. The picture below illustrates what the oven system looks like.

Figure 4 - A SunCoke non-recovery coking oven (www.suncoke.com)



The coal bed immediately begins absorbing heat from the refractory and volatile matter is released and burned off. The negative pressure system pulls air into the oven through airports on each oven door and sole flue. The movement of air through the oven

maximizes temperature. Combustion transfers heat back into the system. This makes the system self-sustaining, so that no auxiliary fuel is required. The oven system establishes direct equal heating above and below the coal bed allowing carbonization to occur relatively evenly (www.SunCoke.com).

Carbonization times, or the time it takes coal to turn into coke, average 48 hours in the self-sustaining process. While there is an obvious cost advantage to any self sustaining process, the additional time spent coking means that less coke can be produced per annum. On the positive side, SunCoke states that the longer coking times prevent undue door wear, lower operating and maintenance costs, and will prolong oven life.

Ten generations of improvements have occurred since the inception of the non-recovery oven in 1962 allowing SunCoke to boast that its coking ovens consistently produce higher CSR (coke strength after reaction), larger coke size, and greater coke cold strength, providing for greater efficiencies in the blast furnace. Tests run by SunCoke show that the average CSR is four (4) to six (6) points higher for coke produced in its ovens and that stability ratings are two (2) to four (4) points higher than other systems. While it is important to consider the findings of SunCoke, industry experts will argue that the success of non-recovery ovens is highly dependent on the coal blend used. They suggest that using specific coals is necessary in achieving higher coke ratings. Altering the blends is likely to result in coke that is not as good, while slot ovens are more forgiving with alterations in the coal blend, due to the better bulk density-coking environment (Tayfun Zehir, March 2011). However, while the coke blend might ultimately be responsible for a certain level of CSR, the non-recovery oven does provide an advantage. The larger size of each oven cavern is a suitable environment for coking coals with expansion characteristics.

The non-recovery oven operates on a regenerative principle that, while separating coal into carbon, transforms volatile matter into gases and thermally destroys them. Destruction of organic compounds occurs because sole flues and hot gas ducts provide sufficient time and temperature to create hot inert gasses (www.SunCoke.com). Therefore, emissions are very low. SunCoke states that the carbon monoxide concentrations around its heat-recovery stack measured over a two day period is half that

of the concentrations found in rural ambient air. Furthermore, reduction of most ambient air emissions occurs at the battery site. The combined impact of the reduced emissions resulted in the 1990 Amendment to the U.S. Clean Air Act naming SunCoke technology as the Maximum Achievable Control Technology (MACT) for U.S. coke making. All new coke plants built in the United States must comply with those MACT standards. SunCoke suggests that the older positive-pressure slot oven coke making technology fails to comply.

Aside from the obvious air emission benefits, there are no wastewater discharges from a heat recovery plant and there are no hazardous solid wastes. The plant is a net water consumer and the only solid wastes are non-hazardous calcium sulphate and calcium sulphite from the spray dryer 'flue gas desulfurization system'. These solid wastes can be recycled to other industries, used as fertilizers for certain crops, or land filled. SunCoke states that their plant requires fewer staff and has a much simpler brick design. Non-recovery ovens use 23 brick shapes while a typical slot oven has over 1,000 (www.SunCoke.com).

From a cost perspective, since the non-recovery oven battery has fewer brick shapes, is simpler to build and does not require a by-product plant, it is cheaper to build than a slot oven battery. An estimation of the costs for an 830,000 MT per year coke plant would cost approximately $500 million versus US$1 to US$1.5 billion for a slot oven battery of the same capacity.

A very important benefit to consider is that the system converts excess heat into steam to generate electricity through its steam generators and steam turbines. A one million ton-per-year coke facility can generate approximately 100MW of electricity (www.SunCoke.com). The electricity generated can supply the plant with all the power it needs and any excess is sold into the power grid. When attempting to secure a permit to build a coke battery, this sustaining benefit could be the difference between receiving the permit and having the permit rejected. Certainly, green power and recycling are of importance around the world. The ability to provide power to areas of need, while limiting emissions, is a distinct advantage. This should help in the process of obtaining necessary permits.

A disadvantage of the heat-recovery oven is that its footprint is far larger than that of the slimmer slot oven. The slot oven uses vertical space for each oven versus spreading the ovens out in a horizontal fashion. In today's more environmentally sensitive economy, this is an important factor to consider (Paul Armstrong - March 2011).

2.3 Decision Point 1 – Preferred Technology

Hatch Ltd. of Mississauga, Canada, completed a rigorous study to attempt to provide assistance in choosing the best technology for a given investor. Their study was largely inconclusive, as two different scenarios resulted in each technology being the best option. This study included a financial analysis and assumed that the coke battery was part of an integrated mill. The determining factor was the return on investment, which depended on how the coke plant was integrated into the steel mill and what external energy sources were available to the plant. In remote regions where energy is hard to come by, the heat-recovery had a better return on investment because it could provide the necessary power the plant needed instead of relying on expensive alternative fuels that had to be transported 14.2 percent IRR vs. 13.6 percent). When the mill was established in a larger centre with access to the grid and cheaper fuel, the by-product oven had a better return (12.8 percent IRR vs. 12.4 percent) (Hatch Study - 2010). Evidently, a decision on technology must be made on a case-by-case basis and even then, the rates are so similar that extraneous factors will likely be the difference. One such extraneous factor is the environment. From an environmental perspective, Hatch states that the heat-recovery oven has an overall smaller carbon footprint, particulate release is lower, and the negative pressure is less susceptible to toxic gas release (Towsey, Cameron, and Gordon, Hatch Study, 2010).

A chart comparing the rival technologies follows:

Table 1- Oven Technology Comparison

Comparator	**Non-Recovery**	**Slot Oven**
Coking Time (coke production per annum)		√
Emissions Control	√	
Capital Outlay	√	
Staffing Requirements	√	
Coal Blend Flexibility		√
Plant Footprint		√
Operational / Maintenance Costs	√	
Coke Quality		√
Plant value add to the region	√	
Ability to use expanding coals	√*	
Design Simplicity (construction time)	√	
Can be switched off in slow market	√	

It becomes clear that the SunCoke technology has some advantages over the traditional slot oven. With respect to coal expansion (*) during the coking process, Teck's coals are non-expanding, hence that comparator is not as valuable in the decision for Teck. Even if Teck wishes to use blends that contain coals that have expanding characteristics, such as some U.S. Appalachian coals, the issue is moot. This is true because industry experts confirm that Western Canadian coals are excellent counterparts to expanding coals, as the non-expanding Canadian coals offset the expansion of the U.S. coals, even in slot ovens (Tayfun Zehir, March 2011). When all of the points are considered, a critical factor for Teck is using technology that is consistent with its desire to be a sustainable organization. Teck has invested much time and effort to show stakeholders that it is a conscious corporate citizen and a sustainable organization. This effort has resulted in Teck appearing on the Dow Jones Sustainability Index (DJSI), an achievement that is recognized worldwide. Even if all else was equal, in order to maintain its sustainable advantage, Teck should invest in the SunCoke technology if the decision is made to invest in a coke battery.

3: Location

'Location , location, location.' That phrase has been a marketing mantra for decades. Whether it was Wendy's decision to place restaurants right beside a McDonald's, or Toys R' Us and other big box stores deciding to separate from shopping malls, location is critical to a successful business. This also applies to a coke plant, as a suitable location will be necessary if Teck is to profit. From a country standpoint, there are a number of factors to consider for suitability.

1. Most importantly, a suitable country will have a fair political regime that is open to foreign investment and not influenced by corruption. In Teck's quest to be a sustaining organization, it has publically stated that it will not operate in jurisdictions that are corrupt or politically unstable.
2. The current relationship between the government and the company is critical. An existing relationship gives a company an advantage in making its way through the bureaucracy.
3. A good location will also have a fair permitting system. If there is any chance of a coke plant to be permitted in this 'green' age, the country's permitting system will have to review not only the negatives, but the positives as well, in order to make a fair and thoughtful decision.
4. Economic growth and steel consumption per capita are important indicators, as they will determine the future demand for steel. If a country expects its steel demand to grow, coke capacity will be needed.
5. Population is important because the size of the footprint of the coke plant is considerable, so the population per square kilometre can be an issue, as a country that is overcrowded such as Japan will have little room for a large-scale facility.
6. A good location requires sufficient infrastructure. The infrastructure must be advanced enough to allow for easy transportation of both the raw material (coal) and

the product (coke) and for Teck's people to be able to navigate around the country. In addition, banking and communications are important to allow business to transact efficiently. Stock trading, lending of capital, cell phone usage, and internet penetration are all good indicators to determine if the 'business' infrastructure is suitable.

7. The size of the existing steel industry and expected growth help determine where additional coke capacity will be required. Since steel production depends on mining of coal and iron ore, understanding the mining sector in a given country will assist.

At the end of this chapter, each of the potential countries will be ranked on factors related to each of these seven categories to help determine the most suitable location.

For the purposes of this paper, a limit is required on how many countries can be reviewed. Because Teck's coal mines and head office are in Canada, it should be considered. Certainly, a cost saving exists in not having to transport the coal before it is coked; however, the environmental issues must not be overlooked. This paper will also evaluate the United States, Chile and Brazil. The U.S. is interesting because it has been historically coke short when all of the blast furnaces in the country are operational; consequently, demand is inherent there. On the other hand, the same environmental concerns that will affect a coke plant investment in Canada will be the case in the U.S. With respect to Chile, Teck already has a presence there and it has forged a relationship with its government, making it a good foreign jurisdiction to evaluate. Brazil is one of the BRIC countries with a large population that is traditionally coke short. It is also one of the few nations around the world showing the willingness to permit a coke battery. Brazil commissioned a brand new battery in 2010 for ThyssenKrupp and Usiminas has the required approvals to build extra coke capacity at its steel works.

3.1 Chile

Chile has a population of 16,970,265 (World Bank 2009), which is growing at a rate of about 1.7 percent per annum. According to the Population Reference Bureau, the population should reach 20 million by the year 2025. Chile has an area of 756,950 square kilometres (Nations Encyclodedia.com), meaning that there are just 23 people per square

kilometre. Sufficient space exists in the country to consider a coke plant investment. Even with the expected population growth, only 26 people will populate each square kilometre in 2025.

Chile's average economic growth rate reached 5.5 percent between 1985 and 2009 and this growth is expected to rise (World Bank), especially in the near term as the country completes the necessary repairs needed after last year's devastating earthquake. In 2008, steel consumption per capita was 176 kilograms per year, which makes it the largest steel consuming country in Latin America, according to the Chilean Steel Institute (ICHA). Market participants in Chile are optimistic that consumption levels of steel will grow. These comments followed the announcement of a free trade agreement between Chile and Turkey, which is likely to result in an influx of Turkish steel into Chile (Steel Business Briefing – March 7, 2011). According to Chilean traders, the limited steel production in Chile means that there is room for increased imports. After last year's earthquake, steel production slowed and a requirement for imports resulted; however, market sources believe the increased steel demand is not a short-term phenomenon linked to the earthquake recovery. Consumption is rapidly increasing and the market is currently booming. Chile definitely appears to require additional domestic steel production.

3.1.1 Teck's Relationship with Chile

Before making any investment, potential projects must pass through the 'stage-gate' process, Teck's internal decision aid. This process identifies certain business processes that must be completed and outlines certain hurdles when the project is given a 'go' or 'no go'. This process scrutinized projects in Chile and reviewed among other aspects the following (Teck state-gate process outline): In each case, Chile passed the test and now Teck is involved in three major projects (Quebrada Blanca, Relincho, and Carmen de Andacollo – discussed in more detail below). This suggests that Chile is a location in which Teck prefers to do business.

Table 2 - Teck's stage-gate process (jurisdiction review parameters)

Socioeconomic Policy	Site specific
Political environment/risk	Country, regional & community dynamics
Government Engagement	Engaged - assess governance capacity
Community Engagement	Preliminary engagement (Socioec team)

Beyond the stage-gate process, Teck's corporate vision values positive foreign investment. Community Investment (CI) programs for Teck intend to go beyond the scope of normal business in an attempt to benefit local communities. In order to ensure benefits exist, Teck aligns its CI with its three-pillar philosophy. Pillar 1 suggests that CI is directly linked to fundamental business needs such as obtaining and maintaining a social license to operate, managing social risks, and improving reputation and project legacy. Pillar 2 mitigates social risks faced by the project. Pillar 3 strategically empowers Communities of Interest (COIs) to achieve their long-term development goals (Teck 2009 Sustainability Report). This is currently taking place in Chile as Teck continues to work with Chilean firms and communicates regularly with the Chilean government. Many challenges have been overcome, as the success of Quebrada Blanca (Chilean firms hold a 23.5 percent working interest), Relincho, and Carmen de Andacollo (a Chilean firm holds a 10 percent working interest), did not come easily. As an example, when Teck took over the Carmen de Andacollo project, it inherited a water usage problem. The Chilean government made a decision that the project would use water from a strained aquifer. The COIs in the area were irate and it was noted that up to 30,000 inhabitants of the region could feel the impact of a water shortage, if the project continued to take water from the aquifer. Realizing that a major issue existed, Teck immediately consulted the government and the COIs and an alternative water source was discovered. Accessing a less used aquifer required Teck to make an additional investment and build a pipeline. In addition to lessening the strain on the aquifer and giving it a chance to recharge, the pipeline project resulted in higher quality drinking water for the entire community (Teck's 2009 Sustainability Report).

Clearly, Teck learned some valuable lessons during this water issue and the community recognized the professional and innovative way Teck solved the problem, thus elevating its stature within the community. This elevated status has allowed Teck to gain a much better understanding of Chile's legal, political, and foreign investment environment. Today, Chile considers Teck a preferred company to do business with creating a tremendous competitive advantage for Teck within Chile. For this reason, Chile is one of the best locations to invest capital on any type of project, including a coke battery. With the electrical challenges that are set out later in this paper, a non-recovery oven may very well be an important investment for the Chilean government to consider.

3.1.2 Chile's Infrastructure

Coal and coke movements will require adequate port capacity. A total of 95 percent of Chilean exports and 87 percent of international trade move through port facilities. Since 1999, Chile has had 36 operational ports, with ten being state-owned and offering public services. The other 26 ports are privately owned, of which only 15 offer services to the public (U.S. Department of State). Chile's growth, and the growth of international trade, overwhelmed the port infrastructure in Chile. This resulted in the Chilean government approving a Port Law in 1997 intended to improve the operational ability of the state-owned ports. Chile's goal today is to reach maximum capacity of its ports by 2014 to aid the country's economic growth (Dredging Today Oct 19th 2010). While the port capacity is still insufficient for more coal and coke movement than is occurring today (Tayfun Zehir – March 31, 2011), the government's plans for additional capacity by 2014 coincide with a coke plant start-up.

Any investment in Chile has to consider the capacity of the country's power grid to ensure that blackouts and other power outages do not impact the business. Although private companies have been responsible for electricity in Chile for years, the Chilean government had to levy fines on ten (10) companies in 1999, as daily blackouts were occurring (U.S. Department of State). Disruptions of this nature would be a challenge for any type of operation, let alone a coke plant. Since 1999, electrical capacity has grown faster than the country's economy. With the introduction of natural gas supplies into the energy matrix in the mid 2000's, capacity has grown at 7.2 percent per year, but it is still

falling short of the 8.4 percent increase in electricity demand. Chile's copper cathode production requires significant amounts of power. Power consumption is expected to grow by 77 percent through 2019, but with some natural gas supplies being cut, production costs for electricity will increase as more expensive diesel replaces natural gas. Coal fired power plants are helping cost pressures, but with carbon footprint being a global concern, it is clear that electrical capacity will continue to be a challenge for Chile into the future (U.S. Department of State).

While electrical capacity has been a challenge over the years in Chile, telecommunications has thrived. This is important to an investment in Chile, as the team would need to be fully connected to Teck's headquarters in Vancouver. The Internet has become efficient in Chile due to heavy U.S. investment, but penetration is still limited due to expensive local access charges and lack of hardware in some of the more isolated regions. Nevertheless, Chile has the most developed telecommunications infrastructure in Latin America and the government continues developing its Internet infrastructure through private investment in order to become the preferred country for Internet investments (U.S Department of State).

Air transportation is sufficient. The country has numerous airports with 48 having paved runways. Santiago hosts the country's international airport that is serviced by two (2) national airlines and 18 international airlines (www.nationsencylcopedia.com).

As noted previously, the banking system is a good proxy for the country's ability to facilitate business. A well functioning banking system is also critical to foreign investment. Accordingly, with Chile's desire for foreign investment, it has ensured that the Chilean banking system is efficient and competitive. Currently there are 26 banks, of which 12 are foreign-owned. There are 31 representative offices of foreign banks in Chile and a few 'loan and savings' companies as well. Not surprisingly, for a relatively small economy, there is one state-owned bank and it is the nation's third largest bank in terms of assets; however, private banks manage most of the corporate business that has developed in Chile (U.S. Department of State).

Chile does not have domestic fossil fuel mining. As a result, access to fuel and energy alternatives is a critical factor to consider when investing in Chile, especially for a

coke plant. Because of the relatively high transportation costs that are a result of Chile's location, energy and fuel alternatives need to be developed and available for an effective investment (Tayfun Zehir, March 2011). Many existing operations are looking at or have already developed sources of renewable energy such as wind and solar power. There appears to be enough fuel supply to run an operation in Chile for many years, as long as surging fuel costs do not render a business in Chile uncompetitive compared to ones in other jurisdictions. In Chile, fuel costs in the mining sector increased by 15 percent (or by US$2 billion) from 2007 to 2008. The valuation of a project could be impacted, but for a coke plant, the fuel costs are not the most critical issue. At approximately US$40 to US$60 million per year, fuel costs are $48 per tonne of coke, which is far less than the $300 per tonne the plant will pay for coal.

It is critical to mention the growing global carbon footprint worry. Existing companies and those looking to add new investment in Chile will see 'green' pressure increase. Understanding and being able to deal with that pressure is of paramount importance for a successful coke battery investment. What could help matters is if the power generated by the non-recovery plant is considered alternative energy or if the plant can prove that there will be no additional burden on the country's power grid.

3.1.3 Chile's Political Stability and Access to Foreign Investment

At the 2011 Prospectors and Developers Association of Canada (PDAC) conference, a major theme was the 'Return of Chile' after an absence from the Conference for two years. Mining Minister Golborne stated that "Mining is Chile's economic engine. Through State policies with a long term vision that promotes expansion and development, we want to transform mining in the heart of our country." Following his opening address, Matías Mori, Executive Vice-president of the Foreign Investment Committee presented a very thorough case for the Chilean mining industry. The presentation included a history of how Chile became a mining world power and a case for why major companies are investing in Chile. With such a commitment to mining, an understanding of the openness for other investments is crucial. Mr. Mori made it clear to the conference that Chile is attractive for any foreign investment because of four pillars: political and economic stability, a wide network of international trade agreements, the

legal security and stability it offers and its high-standard transport and communication services. He confirmed that foreign direct investment has been running at 6.5 percent of GDP and is demonstrated in the operations of over 5,000 companies from over 60 countries (www.pdac.com and www.ibtimes.com).

Chile's political and business climate has been viewed globally as inviting, which has been the country's goal for the last three decades. During that period, Chile made foreign investment an essential part of its national development strategy. Today, Chile's governmental policies are sound and market-oriented, creating significant opportunities for foreign capital to participate in the country's economic growth. Foreign investors receive assistance from the government in nearly all sectors, but there are no special exemptions or incentives to attract foreign investment. Chile's desire and willingness to promote foreign investment is set out in the country's foreign investment statute, known as Decree Law 600 (U.S. Department of State). Under it, a foreign investor may sign a contract with the Chilean State that is typically approved within a matter of days. In fact, the potential to reject a foreign investment is severely limited by the Chilean Constitution. Evidently, there is a push to have foreign investment in Chile. A positive tax regime is also beneficial for attracting investment. Chile has a corporate tax rate of 17 percent, one of the lowest business tax rates worldwide. Because of the massive earthquake in 2010, that will cost the country some $30 billion, the tax rate will increase to a maximum of 20 percent before returning to its usual rate after 2012 (U.S. Department of State and Edwin Shadeo, April 2011). The increased tax rate will fund necessary reconstruction. As proof of the positive investment climate, the Chilean economy has attracted large inflows of foreign capital since the 1990s, especially in the mining sector. The United Nations Conference on Trade and Development's 2006 World Investment Report stated that foreign investment in Chile reached 64.6 percent of Gross National Product in 2005, while the average world figure for 2005 was 22.7 percent. The Organization for Economic Co-operation and Development (OECD) recently recognized Chile as the first South American member and only the second in Latin America. Chile now sits as the 31st member of the organization that plays an integral role creating and changing economic and social policy making internationally.

There are other internationally recognized measures of a country's propensity for foreign investment. The PPI (Policy Potential Index) is a rating that is given to countries to measure the effects of public policy on the economy and foreign investment. Although the measure is used largely in relation to mining, it still is a valuable measure of foreign investment climate. Chile is the only country outside North America that has consistently ranked in the top ten. Last year Chile ranked 3rd in the world with a score of 87 out of 100 (www.mineweb.com, Feb 6), but since the accident that occurred where Chilean miners were trapped in an underground mine, the ranking has dropped to 27th with a score of 64. Worrisome to Chile's government is that of the 12 policy areas examined, the biggest declines were in the area of political stability and security. Still, the positive environment the government is trying to maintain for foreign investment needs to be recognized. Investors should also note that Columbia and Peru are emerging economies accessible through investments in Chile. Chile is also ranked in first place in Latin America according to the 2010-2011 Competitiveness Ranking and in the 30th position out of 139 countries worldwide (World Economic Forum – Feb 6). The Competitiveness Ranking sets out a country's ability to provide high levels of prosperity to its citizens by measuring how productive a country utilizes its available resources. Finally, Chile's economic stability and monetary discipline have positioned Chile as the country with the lowest investment risk in Latin America.

Understanding which governmental bodies would be involved in permitting a project is valuable because research can be done to identify the priorities and habits of the departments and the likelihood of success. A coke plant would probably not fall under the auspices of any specific investment governing body that exists in Chile, like the Copper Commission or the Under-Secretariat of Fishing, but foreign investment in a project with a potential environmental impact will require authorization from the National Environmental Commission (CONAMA) and/or the Regional Environmental Commission (COREMA). Most recently, a Brazilian company was looking to invest over $4 billion to construct a coal fired power plant in the northern area of Chile and when an official involved in the permitting process changed the application from one with a 'polluting' impact to one that was 'bothersome', the courts intervened. The status of the project is now unknown. It is evident that environmental impact is a major

concern in the country and one that Teck will need to fully understand. Moreover, a thermoelectric power plant that was to be located near a Humboldt Penguin Reserve was approved by COREMA, yet the environmental community and many national celebrities challenged the bill; eventually it was overturned in September of 2010 (Huffington Post September 18, 201 and Feb 6, 2011). Even with COREMA approval, a project may still be in question. An understanding of all the nuances of a potential site location will be required to minimize the environmental impact.

To assist in the permitting process, Teck should specifically look to Chile's Development Promotion Agency (CORFO). The agency implemented the "Chile Invests" plan focusing on providing support and promoting investment outside of Santiago in key sectors. The coke battery will need access to a port, but perhaps an opportunity exists to choose a port in one of the specified areas of the plan. An important objective of Chile Invests is to encourage investments in non-traditional business sectors that add value to Chile's natural resources. Sectors of note to Teck are 'engineering processes' and 'new production techniques'. Since iron-ore is a Chilean natural resource and the SunCoke technology can be considered a new production technique, a coke plant should add value. Iron-ore and coke are market compliments and prime ingredients for Chile's steel making industry.

When the entire permitting process and the overall business environment is considered, the World Bank's International Finance Corporation (WBIFC) ranks Chile as the 43rd country (out of 183 – benchmarked to June 2010) in its Ease to do Business 2011 ranking (up from 53 in 2010). A ranking of 28th in the world for protecting investors heavily influences this ranking. The time to start a business in Chile is a matter of weeks and places Chile at 62nd in this category - up from 70 in 2010. This is a benefit for Teck when starting a new business.

Besides a country's views on foreign investment, the political environment generally impacts investment due to the potential for expropriation, political unrest and a country's inability to deal with corruption. In Chile, since 1973 and the nationalization of the mining firms, the military regime did not expropriate any assets. Since 1990, the four democratically elected governments have continued to leave investments in the hands of

the investors and there is nothing to suggest that this policy will change. To add credence to this positive stance on foreign investment, Chile joined the International Centre for Settlement of Investment Disputes (ICSID) in 1991.

Corruption can be another major issue. In Chile, corruption is not prevalent, but incidents of bribery of government officials do occur. This culminated in late 2006 when a major scandal erupted over the misuse of state funds by ChileDeportes, the political body that organizes local-level sport activities for political campaigns. The government was very embarrassed by the scandal because it believed there would be serious repercussions on Chile's positive image overseas. In response, Chile vowed to improve its institutional framework and accordingly introduced 30 anti-corruption measures. Moreover, the government signed into the Organization of American States (OAS) Convention against Corruption and the OECD Convention on Combating Bribery. A shortfall is that Chilean law still does not consider bribing a foreign official to be a criminal act. More acts are punishable, but additional law reform is necessary. Even in the current state, Transparency International ranked it 22nd on its corruption perceptions index and first in Latin America. It is evident that corruption is not a major deterrent to investing in the country. For Teck this is vital, as it will not invest if it is pressured to bribe or engage in other types of corruption. The fact that Teck has three ongoing investments in Chile indicated that corruption is not an issue.

Chile is a low threat - political unrest regime. Over the past ten years there have been next to zero politically motivated attacks on projects or infrastructure. Acts of terrorism are rare and there have been no incidents involving international terrorist groups in Chile. Since 2007, some notable acts garnered attention; however, they involved only small-scale bombings targeting local service providers, banks, a police station, and the U.K. Embassy. In addition, there were some acts of violence in southern forestry plantations related to the land claims of the area's indigenous peoples. Chile has made it a priority to ensure that violence and acts of political unrest do not upset the direction the country is moving.

A challenge is Chile's labour regulations. According to the World Competitiveness Report, labour regulations were by far the worst issue to deal with when

doing business in Chile. Evidence of the labour difficulties is a score of 111 (out of 139) on hiring and firing practices and 110 on female participation in the Chilean workforce. IPS News reported that only 35 percent of Chile's workforce is made up of women. This is one of the lowest proportions in Latin America. In addition, wages for women are on average 20 to 50 percent lower than for men. As far as hiring practices go, the main issue is one of exclusion. Whether it is excluding females, or excluding members of a social class, international companies leaving their hiring practices to locals need to understand what could be happening. While the number of female workers in the workforce may not necessarily impact the operation of a coke plant (typically coke plant operators are male), Teck must be mindful of its reputation. If Teck needs to hire employees in Chile and employs these sub-standard hiring practices, many will question Teck's social license to operate. In Chile, there may be pressure for Teck to adhere to local practices, but Teck must do what is right. A minor point to consider is that exclusionism, from a strategic perspective, limits the pool of potential employees. Teck will want to maximize the pool from which to choose good employees, because a coke plant is a complicated environment in which to work.

3.1.4 Chile's Mining and Steel Industry

The Chilean economy is dependent on copper production. The copper industry and mining in general employs more than 1.5 percent of the population, or 250,000 people (MercoPress – March 31, 2011). Chile is the world's largest producer of copper, constituting 28 percent of the world's reserves and 35 percent of global production (ICHA). According to the International Monetary Fund (IMF), in 1997 copper accounted for 42 percent of exports and 8 percent of Chile's GDP. In 2010, the value of copper exports increased by 43 percent, earning US$11.8 billion (MercoPress- March 31, 2011). However, there was a rocky start to foreign investment in mining. In 1971, the government nationalized all mining companies; foreign investment all but stopped. Fortunately, foreign private investment started growing again in Chile. Today, about half of the foreign investment in Chile is directed at the mining sector, more specifically copper, as the world's demand for the ore is growing. On February 2, 2011, copper was

about to breach the US$10,000 per MT mark, a historical high. This is largely attributable to China, as its demand seems to be insatiable.

More closely related to the production of coke and steel, Chile boasts significant deposits of high-grade iron-ore. Most of this ore is exported, as domestic steel production is not significant enough to consume all of the iron-ore.

Steel manufacturing is growing in Chile and remains competitive on the world stage because of accessible domestic iron-ore, technological innovation, and a healthy abundance of skilled workers, especially engineers. There are over 2,000 metal manufacturing companies in Chile producing steel products from the 1.1 MMT of hot metal produced each year by Compania Siderurgica Huachipato (CAP). Most of these metal manufacturing companies are located in central and southern Chile. The sector employs about 20 percent of the total industry workforce and many of the steel making companies are at least partly foreign-owned, keeping in tune with Chile's desire to attract foreign direct investment (U.S. Department of State). With the GFC behind it, the expectation is that the consumption of steel in the country will continue to grow. To appease the expected demand growth, CAP has made plans to invest US$2 billion to increase its hot metal production to three (3) MMT. There is a delay in the investment due to the impacts of the 8.8 magnitude earthquake that occurred in February 2010 (Automated Trader – July 13, 2010).

Chile currently produces about 500,000 MT of coke per year, or just enough to satisfy CAP's demand in producing 1.1 MMT of hot metal. If CAP does increase its production to three (3) MMT of hot metal, an additional one (1) MMT of coke will be required just to satisfy its demand. Since CAP's coke batteries are able to produce only 500,000 MT per annum, there is certainly room for another 500,000 MT to one (1) MMT coke battery in Chile (Tayfun Zehir – 2011 and CAP Investor Presentation).

3.2 Brazil

Brazil is another nation to consider for a number of reasons, not the least of which is that it is one of the world's emerging markets. Accordingly, it will need steel for many years to come. At 8.4 million square kilometres, it covers nearly half of South America

and borders nearly all of the countries (all but Chile and Ecuador) (Brazil – infoplease.com – March 1, 2011). The country has a population of over 201 million (World Bank 2009), which means that there are roughly 24 people per square kilometer; room exists for a coke plant. According to the Population Reference Bureau, the population is expected to reach 212 million, which has little impact on the population per square kilometer. The population of Brazil is highly urbanized with 86 percent of the population residing in urban areas, similar to Chile. Brazil's average economic growth rate reached 5.5 percent between 1985 and 2009 and this growth will rise, especially in the near term as the country prepares for the World Cup in 2014 and the Summer Olympics in 2016. In 2008, steel consumption per capita was 124 kilograms per year, which puts it 50 kilograms per capita behind Chile, but this number is expected to rise. The President of the U.S. supports this belief. On March 19, 2011, President Obama and President Rousseff gave a press conference after signing trade agreements and agreed to establish a Commission for Economic Affairs. The U.S. President stated that he supports Brazil's economic growth and that the U.S. will be a big customer when Brazil starts selling (Wall Street Journal, March 19, 2011). Brazil is going to be hosting the world in the years to come and will certainly require additional domestic steel production to do it right.

3.2.1 Teck's Relationship with Brazil

Teck's presence in Brazil is not significant at this time. It announced in the summer of 2010 a deal it struck with Brazilian company Horizonte Minerals to acquire half the company in exchange for another Brazilian company Teck owned. The transaction was to result in one of the largest nickel projects in Brazil that would produce the ore from its100 million tons of high-grade reserves. The transaction effectively took Teck out of Brazil as far as operations are concerned. The only other project that Teck has interest in is Vale's Sossego mine in the Carajas region of northern Brazil, which incorporates Teck's CESL process for producing copper cathodes from copper sulphide concentrates. As a result, Teck's relationship and understanding of the business landscape in Brazil is not nearly what it is in Chile.

3.2.2 Brazil's Infrastructure

Reuters reported on November 24, 2010, that although Brazil may be one of the world's hottest emerging markets, there is at least one area in which it is struggling - infrastructure. Reuters claimed that Brazilian business leaders concluded that President Rousseff would have to make vast regulatory improvements and boost incentives for private-sector investment in roads, ports, and airports if Brazil is to sustain the commodities-driven growth of recent years. Luciano Coutinho, president of state-run development bank BNDES, stated publically that, "The current bottlenecks punish the competitiveness of Brazilian companies. One of the most important things to be done is to improve economic efficiency by investing in infrastructure." Fields in Brazil produce grain twice as fast as the rest of the world, yet transportation problems result in those crops losing half their value by the time they reach the market. In the minerals sector, deposits lie untouched due to lack of rail. The country's infrastructure problems will be under the microscope as it prepares for the two significant world events already mentioned.

Many Brazilians hope that the microscope forces an acceleration of infrastructure improvements. A $1 trillion investment is planned to bring Brazil's infrastructure in line with the other BRIC nations. The problem will be financing the improvements, as it is unknown whether the public sector has the capacity to do it. It is likely that the government will need to search out significant private help. Airports are likely at the top of the list for improvements. Currently, it is difficult to find standing space while waiting for flights and flight delays are inevitable. Brazil does have 48 main airports of which 21 are international. As far as track, Brazil's rail system is extremely limited (www.nationsencyclopedia.com, March 10, 2011). Even trip advisor websites suggest that travel by rail is not viable. Change may be coming. Investments in rail were made early in 2010 to begin the improvement process as various companies from a number of countries bid on the $20 billion contract to connect Rio de Janeiro and Campinas via Sao Paulo (Korean Times – Jan 8, 2010). Steel demand will rise as these projects proceed, but in terms of transportation efficiency related to a coke plant investment, Brazil is not currently the best choice.

On the other hand, the banking and financial sector in Brazil is large and sophisticated. The two (2) largest banks by assets are state owned and the ten (10) largest banks hold some $1.5 trillion in assets. The financial sector challenge is the lending rate that is extremely high due to high risk of loan default, mandatory reserve requirements, unenforceable contracts, and high taxation. High taxation is a burden that impacts the entire society. The World Bank - Doing Business Report mentioned that the administrative burden on a medium sized company of tax payments in Brazil was 2,600 hours versus 194 in high-income OECD economies. The government tabled a proposal to streamline tax collection to reduce the administrative burden and improve competitiveness, but the proposal has been stalled. Moreover, the total tax rate is 69.2 percent of profits. While banking infrastructure allows business to be transacted efficiently, the administrative burden and tax rate are significant enough to deter foreign investment. Teck should carefully consider this.

While supply usually runs a bit short of demand for electricity, Brazil has a power grid that reaches 50 million customers or more than 97 percent of households that actually have access to electricity. Brazil is fortunate enough to have a hydroelectric system that accounts for nearly 80 percent of its electricity generation and an incredible 70 percent of the available hydroelectric capacity is still untapped. With the country looking at promising potential for solar and wind power (140 GW for wind alone) the electricity demands should not be taxing on the system. Electricity becomes a problem in Brazil when there is a drought. This is what caused the energy crisis of 2001 – 2002 (World Bank), but for the most part, electricity should not be an issue for a coke plant.

Brazil is 7th in the world with regard to the number of people who use the internet, representing approximately 34 percent of Brazilians (Internet World Stats, March 10, 2011). Over half of the population had a cell phone in 2008 and now almost 94 cell phones exist for every 100 people (Latin America Herald Tribune – March 11, 2011). This means that telecommunications has proved to be accessible to all classes and connectivity for Teck in Brazil would not pose any difficulties.

Brazil is next to free from imported oil as it produces a cheaper alternative to gasoline: sugarcane ethanol. According to the World Bank, Brazil's ethanol is about 30 percent less expensive than gasoline and although ethanol gets slightly less mileage, it is

still cheaper on a per-mile-driven basis. A sufficient fuel source for the coke plant exists and there is potential that fuels costs would be lower in Brazil than in Chile. A radical move several years ago to ensure that all cars sold in Brazil could operate at any level of ethanol has also paid off with fewer greenhouse gas emissions. Ethanol has been in use in Brazil since the 1970's, when the Proálcool program was rolled-out. This program was the biggest renewable fuel usage program ever deployed in the world (www.petrobras.com, March 10, 2011). Brazil is also home to the eighth largest company in the world in Petrobras, which produces nearly two million barrels of oil and almost 500,000 barrels of natural gas per day. The government holds the majority of shares in Petrobras. Should Brazil need additional fossil fuel in the future, options do exist.

3.2.3 Brazil's Political Stability and Access to Foreign Investment

Brazil fell victim to the Asian crisis in 1999 and faced an energy crisis. In the early 2000s, the IMF agreed to lend Brazil some $30 billion to ensure that it would not fall prey to the catastrophic economic problems that haunted Argentina.

As previously set out, the PPI is a rating given to countries to measure the effects of public policy on the economy and foreign investment. With respect to attractiveness to miners, in 2001 Brazil ranked seventh in the world with a score of 71 out of 100 (Fraser Institute – Survey of Mining Companies) and seventh as far as investment attractiveness (74 out of 100), but since then, the ranking dropped to 27th with a score of 64.

Brazil ranked in 58th place in the 2010-2011 Competitiveness Ranking out of 139 countries worldwide (World Economic Forum – Feb 6). As stated prior, the Competitiveness Ranking sets out a country's ability to provide high levels of prosperity to its citizens by measuring how productive a country utilizes its available resources. Brazil's 86th position in 'Basic Requirements' (institutions, infrastructure, macroeconomic environment, and health and primary education) is a major reason for it being rated far below Chile, as well as it being considered only a 'Stage 2' economy (efficiency driven with per capita GDP of US$3,000 to $9,000). Meanwhile, Chile is

transitioning to 'Stage 3' (moving toward innovation with per capita GDP of US$9,000 to $17,000). Stage 3 economies have over US$17,000 per capita GDP (The Global Competitiveness Report – 2010/2011 – World Economic Forum).

Although Brazil is only in the middle of the global pack and has some very poor ratings on a number of indices, it is making strides by increasing the average wealth of its citizens and providing a much friendlier business environment for foreign investment. Accordingly, Brazil ranks tops in the world by investment dollars since 1999 with more than US$270 billion having been invested and Brazil is second in the number of projects at 467 over the same period, topped only by China at 931. Chile ranked eighth with 117 projects. Furthermore, during the GFC, Brazil's GDP only contracted slightly and is now growing at a rate of 5.5 percent per annum. Without question, the sheer size of the Brazilian market is a significant advantage; its market is the 10th largest in the world. Challenging Brazil is its macroeconomic environment, where it is 101st out of 139 countries and its interest rate spread of 35.4 percent is almost the worst in the world. To complicate matters further is a relatively high public indebtedness, a severe lack of trust in politicians, and labour market inefficiencies.

Hindering the labour market is the involvement of unions. The impact unions have is a significant hurdle that may ultimately influence a corporation's desire to invest in a foreign municipality. Brazil ranked 96th in labour market efficiency in relation to the Competiveness Report and restrictive labour regulations was the fourth most problematic factor for doing business in Brazil, behind tax policy and infrastructure (Global Competiveness Report). Over 16,000 labour unions exist in Brazil, strikes are frequent, and many unions have political ties. The labour unions in the metalworking and banking sectors are the best organized and are aggressive in defending wages and working conditions (US Department of State, March 9, 2011). When asked about the impact of the labour militancy and work disruptions, 50 percent of respondents stated that they were a mild deterrent to investment while another 10 percent suggested that it was a strong deterrent (Fraser Institute – Survey of Mining Companies). In addition, employer federations supported by mandatory fees on payroll, play a significant role in labour relations. In the process to permit a new business, the time associated with registering with the associated union(s) accounts for approximately five (5) days and involves an

annual fee. Pursuant to labour laws, registration with a union is mandatory to ensure the company is obeying employee labour rights. Each municipality and state must have unions that represent the activities performed by the company (www.doingbuisness.org - March 9, 2011).

The system to permit a new business is very bureaucratic in Brazil and the timeliness poor. The government is trying to make it simpler and shorter. Currently the time it takes to permit a new venture is some 120 days, of which 90 days are required for the operations permit. From an operational permit perceptive, the government is moving to an electronic system. As of May 2009, eight out of the 31 districts in Sao Paolo were operating under the new electronic operational permit system. By the end of the first quarter of 2011, it is expected that all districts will be using the system where applicants can apply and receive the approval for an operational license online instantaneously.

When the entire permitting process and the overall business environment is considered the WBIFC ranks Brazil as the 127th country (out of 183 – benchmarked to June 2010) in its Ease to do Business 2011 ranking (down from 124 in 2010). What most influenced its position was a ranking of 152nd with respect to taxes and 128th with respect to starting a business, even with the new online system. Even trading across borders has become more challenging as suggested by the rank falling from 98 to 114 year over year in that category.

The Ministry of the Environment holds the environmental responsibilities in Brazil. One of its associated institutions is Ibama, the Brazilian Institute for the Environment and Renewable Natural Resources. It is in charge of executing the environmental policies dictated by the Ministry regarding, among other things, environmental licensing and environmental quality control. Brazil's heavy bureaucracy and slow environmental licensing will make it difficult to permit any project seen as potentially impacting the environment. An example of the challenge was the rejection of a Vale project in Maranhao in 2008-2009 on environmental grounds. The steel mill investment would have exceeded US$3.2 billion for the local economy. Even after the land department gave Vale a land grant near the port of Tubarao, Brazil’s environmental agency again did not approve the project. Fortunately, Brazil is not completely averse to

permitting coke batteries (Harvard Business School, June 30, 2010). Most recently permitted is the ThyssenKrupp investment in the state of Rio de Janeiro. The $5.2 billion integrated steel mill, the first such investment in Brazil since the early 1980s, houses three coke batteries. What made the permit obtainable was the decision to build Chinese non-recovery coke ovens, which is similar technology to SunCoke. In addition, process gas from the batteries will be used in a power plant that will produce all the electricity that the integrated mill will need and will add nearly 300MW to the Brazilian power grid.

Although the project was successfully permitted, the environmental challenges are far from over. ThyssenKrupp CSA has already been fined twice for air pollution. The combined fines were greater than US$1 million. In addition to the fines, the company was asked to start a bursary of US$8 million to aid the quality of life for patrons of nearby Santa Cruz (Metal Bulletin – Jan 6, 2011). The Steel Guru on January 9, 2011, reported that residents of Santa Cruz complained in December of graphite dust emissions that can occur after pouring pig iron into an open-air container to cool. While these fines are not related to the company's coke plant, environmental concerns are clearly significant. The Brazilian environmental agency asked ThyssenKrupp CSA to install video cameras around the facility so that it could keep its 'green eye' on them.

Corruption is a challenge in Brazil and scandals are frequent, ranging from vote buying and illegal rebates to senate presidents having to step down because of ethics violations. In 2009 Brazil ranked 75th of 180 countries in Transparency International's Corruption Perception Index. In South America, it ranked below Chile (22nd) and Uruguay. Brazil was merely tied with Columbia, a country with an infamous reputation associated with corruption and drugs. Teck's integrity could be at risk dealing in Brazil. Knowing that corruption does impact foreign investment, Brazil has signed the OECD's Anti-Bribery Convention and created new laws in an attempt to combat corruption, but their effectiveness is still in question. This is especially true at the local level, since it is widely known that most business dealings are subject to corruption of some sort.

Terrorism and political unrest is not a major issue in Brazil. It ranks very high (15th) in the business cost of terrorism, in that the costs of terrorism do not affect companies significantly in Brazil (Competitiveness Report). The U.S. Department of State suggests that Columbian terrorist groups have operated in bordering countries and

some small-armed incursions have occurred, but there is no specific threat against Brazil and no specific threats against ex-pats (from US or Canada) at this time. A Canadian company operating in Brazil should not be overly concerned with acts of terrorism. Political demonstrations are known to occur in urban areas and can cause temporary disruptions to public transportation, but these protests are no worse than those seen anywhere in the world.

The political environment can also influence businesses by its willingness to expropriate investments. In Brazil, there have been no expropriation activities in the recent past and the government has not shown any signs of changing its stance. A point of caution: in 2009, Vale, the world's largest iron ore producer, was finding itself under intense pressure from former President Luiz (Lula) Inacio da Silva, who was a former union leader. He was stating that Vale's recent layoffs and international diversification strategy was affecting Vale's investments in Brazil. In Lula's eyes, Vale was not investing in the Brazilian steel industry (Harvard Business School Jun 30, 2010). This issue continues to trouble Vale; Bloomberg reported on March 25, 2011, that certain controlling shareholders of Vale may attempt to replace CEO Roger Agnelli with an executive from within the company. The Brazilian government is one of those controlling shareholders and has stated that the pace of the company's investments in Brazil is inadequate. Rio de Janeiro-based newspaper columnist Ancelmo Gois reported that Agnelli will leave Vale, but the company declined to comment on the report. Vale's troubles do not end there. It announced on March 29th that the federal regional court had ruled against the company regarding the alleged failure to pay the full amount of certain mining royalties. A Bank of Montreal analyst noted that this dispute first surfaced in March 2006, with a total amount under claim of US$2.8 Billion, based on Vale's 2009 disclosure documents. Vale has publically stated that it intends to pursue the case with the Supreme Court. Clearly, while expropriation might not occur, the government certainly can change its stance from one of conservative market-friendliness to one of explicit intervention.

3.2.4 Brazil's Mining and Steel Industry

If the investment required for improving Brazil's infrastructure in time for the World Cup and the Olympics happens, massive investments are necessary and much of that investment will require steel. In addition, the huge "pre-salt' off-shore oil fields that Petrobras and others are analyzing would also require significant investment and large amounts of steel. Currently, the country is producing at about 80 percent of capacity producing about 35 million tonnes of hot metal (Teck Coal Marketing Analysis), which is not sufficient for the population growth and infrastructure additions that need to take place.

Brazil has substantial reserves of iron ore, which is a market compliment to coke. Approximately 300 MMT of iron ore was mined in 2009 / 2010 in Brazil. Vale is the world's largest iron ore producer and one of three companies that control 35 percent of the production and 60 percent of the seaborne trade of iron ore. Iron ore availability in Brazil is significant and is important to the ability to procure it for the production of steel (The Iron Ore Market – June 2010).

Brazil produces about nine (9) MMT of coke per year. This provides for approximately 18 to 24 MMT of steel production. With Brazil currently producing in the range of 35 MMT of crude iron, there is a coke shortfall in the range of four (4) to five (5) MMT. Even with the extra capacity available from the two new CSA ovens, Brazil will still be coke short (Tayfun Zehir – 2011).

3.3 Canada

This paper will not provide the same depth analysis as was done for Chile and Brazil, as Canada consistently ranks as one of the best jurisdictions in which to do business. Canada ranks tenth in the world in the Global Competitiveness report due to its efficient market and substantial institutions. Alberta ranked first in the PPI index last year and has been in the top five since 2006. Infrastructure is sound, government stability is about as good as you could hope for, and corruption is non-existent. Negatives include B.C.'s PPI ranking of 36 resulting from its war on carbon and its unwillingness to approve anything related to burning coal. Furthermore, if the coke plant

needed to be set east of B.C., transportation limitations would affect the investment, as only two major railways exist. Coke production would actually be cannibalizing rail capacity from coal production, which is currently fighting for coal capacity westbound. This is true because most of the coke traffic would have to be sent through the western corridor to access west coast ports and the seaborne coke market. Eastern rail shipments in Canada might occur, but would only represent a portion of sales; those destined for Hamilton or the U.S. No seaborne coke would be railed east.

Canada's domestic steel industry has not grown in some time. In fact, certain acquisitions and subsequent shutdowns of some Canadian steel producers have left the industry in a declining state. Canada's hot metal production wavers between seven (7) and ten (10) MMT and there is no sign that this will change. With virtually no investment on the horizon and no desire to erect an integrated steel mill within Canada's borders, steel production is a dying industry. Canada domestically produces only in the range of two (2) MMT of coke per annum. Currently, the sole source of metallurgical coke in Canada is the conventional slot oven. Today, Canadian coke making facilities are on average 41 years old. In total, 64 percent of Canadian coke making capacity is 35 years or older. This is problematic because coke oven life is limited. To continue to maintain these assets requires huge capital investment due to the high level of maintenance and repair to both the ovens and associated by-product plants. Canadian coke plants are known to be one of the major emitters and sources of Hazardous Air Pollutants including Polycyclic Aromatic Hydrocarbons, Volatile Organic Compounds and Particulate Matter in its industrial sector (Cornelis Kolijn, CCRA Committee, November 3, 1010). If production of hot metal continues in Canada at present rates and coke plants continue to age and are not replaced, a coke requirement will exist in the future. All of the Canadian mills are situated on the Great lakes and much trade occurs on the lakes between the U.S. and Canada. With rail infrastructure available for eastbound movements and a viable port at Thunder Bay, moving coke to the mills on the Great Lakes is easy, if coke is produced in Western Canada.

3.4 U.S.A

As in the section for Canada, an in-depth review of the U.S. will not be provided. The U.S. ranked fourth in the world in the Global Competitiveness Report and many states run very high on the PPI index. The U.S. is still a good jurisdiction in which to do business and the EPA has already demonstrated its willingness to permit the SunCoke technology. The U.S. is still an enormous market place. A major issue in the U.S. is the current state of the economy. The U.S. is also far along in its lifecycle, so dramatic growth in the future is unlikely compared to the emerging markets. As far as the current economy is concerned, the industries that are reliant on steel are not faring well and many believe that the U.S. market place will never return to its perch atop the world market, with China demanding so much in terms of raw materials and India and Brazil not being too far behind. U.S. steel production is still below 80 percent. Even at that level, production is sufficient to meet demand. A major factor is that infrastructure improvement is not yet receiving the stimulus money it had been promised. If this does not change, steel demand will probably suffer for some time.

What is important to review is the hot metal and coke market in the U.S. A critical factor is that the U.S. has been typically coke short in the past and has even imported coke from as far away as China and Japan. In 2004, the U.S. produced over 40 MMT of hot metal, while only producing 15 MMT of coke. Recall that one part coke produces 2.5 parts steel and it is clear that a shortfall existed. Currently, in the wake of the GFC, coke production is sufficient to meet internal demand. In 2010, the U.S. produced 26 MMT of hot metal along with 12 MMT of coke. Supply and demand were in balance. The issue is whether hot metal and coke demand will grow beyond the current state. If not, can a coke plant in the U.S. access other market areas easily enough? The U.S. will produce in the neighbourhood of 30 MMT of hot metal in 2011 and this will only grow modestly into the near future. Current coke production is 13 MMT with capacity to increase back to the 15 MMT level. Coke production in the U.S. will be sufficient to meet internal demand until hot metal production increases beyond 35 MMT, which will not occur until 2014 and even then, it will be growing at a slow rate.

3.5 Decision Point 2 – Preferred Location

A chart comparing the potential countries follows based on comparators found within the environmental scan of the Demand Estimation Model. The scoring system utilizes the following rankings:

1 – Very Poor
2 – Poor
3 – Average
4 – Good
5 – Very Good

Table 3 - Jurisdiction Comparison

Comparator	**Can**	**U.S.A.**	**Chile**	**Brazil**
Socio-Cultural (supports foreign investment)	5	5	5	3
Political / Legal Trends (Stability of government)	4	4	5	2
Technology Trends (Green Power)	1	1	3	2
Taxation	3	5	4	2
Corruption	5	5	4	2
Demographics	2	4	2	5
Current Economy	5	2	4	2
Uncertainty concerning admin/enforce (SoM)	4	3	5	2
Steel Market Size	2	3	1	5
Steel Production	3	4	1	5
Internal Coke Requirements	2	4	4	5
Access to Coke Demand	2	3	4	5
Coal Availability	5	4	1	1
Infrastructure	5	5	4	2
Transportation	5	5	4	2
Teck's Relationship and History	5	3	5	2
Environmental Permit Likelihood	1	2	5	3
Bureaucracy (Timing to Start New Business)	1	1	5	2
Total	**60**	**63**	**66**	**52**

This paper did not evaluate any other nations, as Teck is committed to the Americas and jurisdictions that are in alignment with its ethical approach. The nations reviewed are the ones that meet those criteria and that require additional coke capacity. Based on the evidence provided, Chile and the U.S. are the front-runners. What separates Chile from all of the other nations is the relationship Teck has with its government officials. The trust that exists today due to Teck's CI program and Chile's willingness to permit Teck's projects makes Chile the favourite location to consider for the coke plant. In addition, emerging markets like those of Peru and Argentina are sitting right next door to Chile and not too far off is Brazil, so markets for coke are readily available to a coke plant located in Chile. Transportation options will exist, as port capacity is set to grow and sufficient rail infrastructure is in place to access these markets. With respect to rail, Teck would be wise to review the success of the Polish company CokeinContainers, part of the Weglohut Group, who has been railing and shipping coke in cars for some time. Furthermore, 50 percent of the Chinese domestic coke market rails its coke to integrated mills around China, so the prospects of delivering coke to various markets are good (Paul Armstrong March 2, 2011).

4: Demand Estimation Model

With the decisions made to consider building a heat-recovery oven in Chile, it is now appropriate to consider the Demand Estimation Model. The model will help provide a better understanding of whether a sufficient market exists for coke to make the investment worthwhile. The model will consider the coke market in Chile and then the broader global market, since coal, coke and, steel are global in reach.

4.1 Total Market

The total market for coke in Chile is comprised of domestic production, imports, and exports. Exports are considered a negative in assessing market size because goods destined for other markets should not be included in determining market size. Including them would artificially increase the size of the market (Meredith Pg 433). Domestic production of coke in Chile stands at about 500,000 MT per annum. Very little is imported and none is exported. Every gram of domestic production is needed to satisfy internal demand, since CAP requires it to produce its 1.1 MT of pig iron per annum. Currently, the market in Chile is in balance. This in isolation would be a significant negative factor on estimating the size of the coke market. Fortunately, there are two other factors to consider. CAP is growing its steel production, so Chile's internal demand for coke will grow in the near future. In addition, the market cannot be limited to just Chile. Coke is transportable (although you need to ensure limited breakage) to other parts of the world where there is a shortage of coke like Brazil. The chart below shows expected crude steel, hot metal, and coke output increases through 2019. The total market is definitely growing. It is for these reasons the total market is a positive factor in estimating coke demand.

Table 4 - Global crude steel, hot metal, and coke production (Source: CRU Analysis–Teck Subscription)

Product ('000 MT)	2010	2011	2012	2013	2019
Crude Steel	1,316,000	1,438,000	1,540,000	1,623,000	1,838,000
Hot metal	955,000	1,033,000	1,099,000	1,155,000	1,288,000
Coke	550,000	586,000	620,000	649,000	714,000

In addition, the total market for coke is not limited to the steel industry. Coke is also used in other sectors, including the sugar industry, the metals processing industry, and the cement industry, just to name a few. Producers sell coke in these sectors at market prices; consequently, any of these industries would be a viable customer for coke.

4.2 Environmental Scan

4.2.1 Macro-determinants

The analysis of Chile in Section 3 provided many insights into the environmental scan and more specifically into macro-determinants. The political and legal trend in Chile is sound. In fact, Chile's goal is to invite foreign investment in to help it develop. Demographics, while not a major positive for Chile, suggest that skilled labour is available to operate the plant and that there will be more individuals consuming steel in the years to come. A larger middle class is developing and that class will be looking for goods and services that in part will be steel intensive. In South America as a whole, a population growth story is unwinding. Economic determinants are perhaps the most notable macro-determinant. The cost of labour in Chile is still relatively inexpensive. As Chile grows on the heels of the mining sector, more and more steel will be required. CAP has already disclosed its intention to double steel output. Brazil will need incredible amounts of additional steel as it prepares for the Olympics in 2016 and the World Cup in 2014. On the world stage, a mega-trend to consider is that from 2010 to 2019, the urbanization of nearly 500 million people will occur around the globe and this move will require immense amounts of steel (CAP investor presentation June 8, 2010).

Socio-cultural impacts are not as positive. Chile's attitude toward protecting the environment is evident. Chile is a beautiful country and its residents are not going to allow it to be disturbed much. Some of the most unique landscapes in the world exist there, so any new investor must tread lightly. Innovation at some point in the future will alter the steel making industry, but history has shown that innovation of the scale required to displace the blast furnace is still some time away. An investment today would likely not be impacted.

4.2.2 Industry Determinants

4.2.2.1 Market Size and Market Growth

The market for coke in Chile is currently 500,000 MT into a hot metal market of approximately 1.5 MMT (CAP investor presentation June 8, 2010). There is almost a balance; however, the market size in two years is more important, as it will take at least two to three years for permitting and construction of a coke battery. In a couple of years, CAP will have doubled its hot metal production to three (3) MMT per annum. This will leave Chile coke short some 500,000 to one (1) MMT. In addition, the coke market in neighbouring South American countries will be growing. Most notably is the market in Brazil, which will likely be at least five (5) MMT short of coke in the near future. Some evidence is that ArcelorMittal's Belgo steel mill has plans to double its steel production by 2013. This mill has no coke production, so it will be in the coke market for 200,000 MT. Moreover, Usiminas has plans to increase its production by 2013 requiring an additional 500,000 MT of a coke. Usiminas does have coke making capacity, but not for the entire increase in demand. Argentina will be coke short by 2019 even with no expansion in hot metal production. Columbia currently has excess coke capacity, but Chile's proximity to Argentina will give it a competitive advantage in delivering coke to that market. The growth in neighbouring Latin American countries is a very important point to consider, as CAP believes it may need to consider collaborating with other steel producers in the region to satisfy the growing demand (CRU Analysis).

The next market of importance is that of the U.S. due to its relative short shipping distance from Chile. The U.S. will become coke short once again if hot metal production

increases. Unfortunately, as a result of the GFC's impact on the U.S. economy, this is not likely to happen for several years. A decision to construct a coke battery should not rely on American consumption. As a last resort, Chile has relatively good shipping access to the enormous market of China. In fact, many of Chile's exports are destined for China. China will produce 900 MMT of pig iron by 2019 and about 420 MMT of coke. As a consistent exporter of coke over the years, it is possible that by 2020, China will import coke. China understands this because it already has begun placing a severe 40 percent Value Added Tax (VAT) on coke exports. At this time, virtually no Chinese coke exports can be found. Worldwide coke production totals 550 MMT and this number will grow to nearly 750 MMT by 2019 - a 35 percent increase. It is clear that the market is growing, fuelled by China which produces more than half of the world's coke and steel.

4.2.2.2 Negotiating Power

A coke plant in Chile may be at a disadvantage when negotiating in Chile, as the only pig iron producer that exists is CAP. Although the coke plant would be a virtual monopoly, it would not benefit from the pricing strategy of a true monopolist because it only has one customer. CAP has its own coke production and it may increase its own production rather than be at the mercy of a monopolist. Obtaining negotiating leverage requires access to other markets (i.e. Argentina and Brazil). If the access is limited, then negotiating power will be adversely affected. This may mean additional capital expenditure on infrastructure to ensure the plant can move coke quickly to the broader market.

4.2.2.3 Risk Management

There are a number of ways that Teck mitigates risk. Adding coke to Teck's sales mix would assist it in mitigating risk for a number of reasons. First, coke production would be an added revenue stream for Teck, a company which has stated that it is a diversified company. While coke is not far removed from its coal business and a dip in the steel market would affect both business units, many steel mills do not buy coal. These mills are fully dependent upon purchasing third party coke, so there is an untapped

market in the steel industry that Teck has yet to exploit. An advantage for Teck is that some of these mills belong to existing customers; therefore, relationships can be leveraged.

Secondly, by adding a coke division, Teck can benefit from the longer storability of coke. Should the steel market plummet as it did during the GFC, Teck would have an outlet for its clean coal. Coal would be delivered to Chile, be coked, and stored until the market turned. While it is true that inventory costs would apply, coal carries similar inventory charges; therefore, no additional costs would apply to storing coke. The benefit of storing coke over coal is that coal quality will degrade as it sits. The result is inventory being lost and increasing costs.

Thirdly, producing coal in Chile aids the company's desire to reduce its dependence on the transportation infrastructure in Canada's western corridor. While the same amount of transportation will be required to get Teck's coal to port and then to Chile, having the ability to take coals from various other locations is beneficial. This is particularly important during times when Canadian transportation issues exist, such as during avalanche season and during incidents causing port force majeure (i.e. mechanical issues similar to those experienced in 2011 when a ship loader broke and collapsed on a vessel or weather related issues) . The coke revenue stream can continue unabated during these times helping Teck's bottom line.

Lastly, having its own coke plant provides Teck with the benefits of forward integration. Forward integration gives a supplier a greater ability to reach the end customer and provides better access to information about the customers. Information is a risk mitigating tool. Having access to a coke oven enables Teck to fully assess coke quality using its coals in various blends and would allow Teck to see what the customer sees happening with Teck's coals. The goal is to dispel myths that exist in the market, such as the inability of Teck's coals to be coked in isolation. Poor CSR ratings are another myth that was created from the results of tests being conducted in small one kilogram test ovens. Western Canadian coals are known to test poorly in these small ovens, as they are too small to measure the low pressure and non-expanding characteristics. This is especially important in areas where Teck has not traditionally sold

coal, including some parts of China and India. Only if Teck can better understand what the customer has concluded when using its coal and then provide data to alleviate their concerns, can Teck hope to completely dispel the myths. This is critical because indications are that the coking coal market may move toward an indexed pricing system. In an indexed system, coals will be segregated on quality. The metals market has been priced on an index (London Metals Exchange) for a number of years now. The only way to benefit above the index price is to have qualities that garner a premium. It is essential that Teck be able to prove that its coals rank with the top tier, in order for Teck to get the proper pricing level and premiums where possible. While the metals index is very efficient (it has existed for some time), a developing index for coal will be inefficient in the beginning. While inefficiencies exist, quality will be even more important in achieving the right price. Volatility will be much more commonplace in a newly formed index, due to the inefficiencies, so quality differentials will likely be associated with significantly different prices. In this case, the coke plant would essentially protect the profit margin for Teck's coals as quality data from an actual oven is gathered. If Teck Coal produces 25 MMT of coal, every dollar resulting from maintaining a quality standard adds US$25 million in revenue. In the second and third quarter of 2011, quality differentials of up to US$10 per MT existed. It is not difficult to understand the value of being able to prove quality.

4.2.2.4 Research and Development

The SunCoke technology is relatively new and there is still much to learn about how Western Canadian Coals react within its ovens. Research and development is required. Researching how various coal blends work within the non-recovery oven can help Teck's coal marketing in developing markets using the technology. Brazil and the U.S. are users of the technology and as the 'green' movement gathers steam, it is reasonable to conclude that more non-recovery ovens will be in operation in the future. Teck could also use the oven to develop the best coking blends for its customers utilizing coals the customer is already buying. This is a value added service that no other coal producer could match and would give Teck a competitive advantage. If this research and development lent itself to showing customers that increasing Teck's percentage in the

coke blend does not reduce coke quality, Teck would benefit greatly. Each customer would understand that it could buy more of Teck's coals, thus providing additional options for its marketing efforts. This becomes especially important as Teck prepares to produce from the Quintette mine and as more coal mines around the world get closer to coming online (Mozambique and Mongolia). Global coal supplies will be increasing.

The Quintette mine closed about eight years ago and is located in northeast B.C. The coal from Quintette is expected to be of lower quality than the bulk of the coal from the Elk Valley (CSR is less than 60). Research and development made available from investment in a coke oven will help Teck better understand how Quintette's coal cokes and how it reacts in blends. This will improve the marketability of coal from the Quintette site.

4.3 Derived Demand

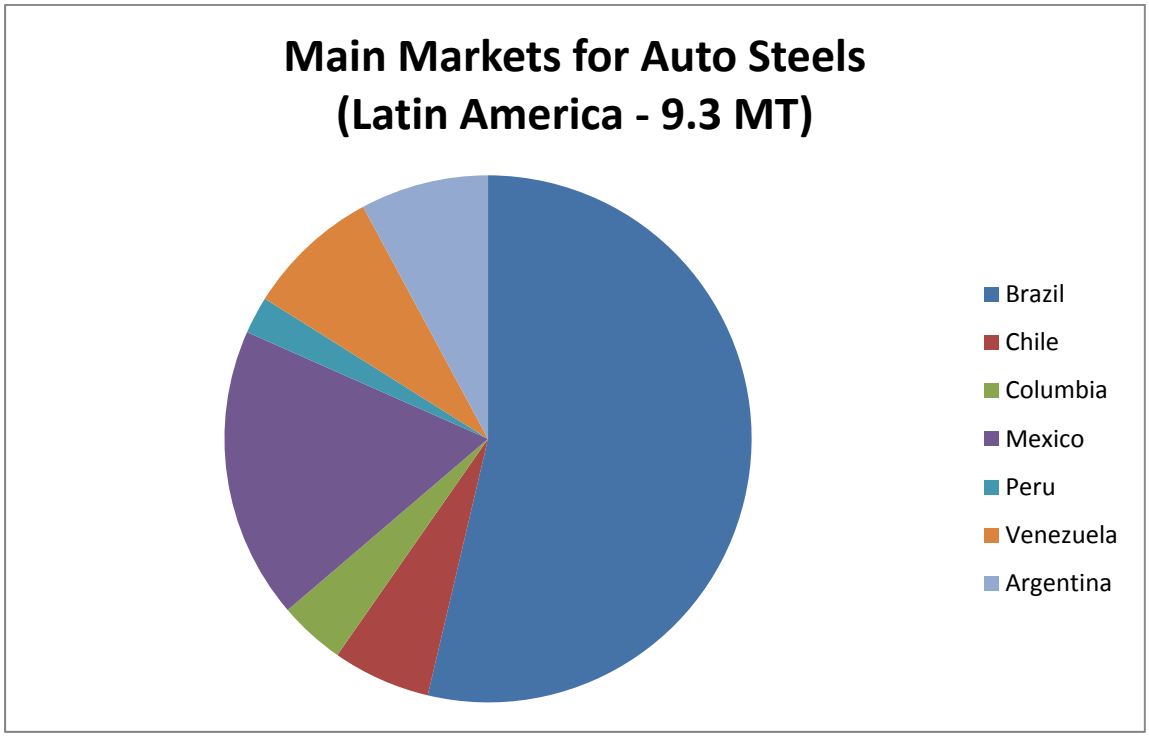
Slot oven batteries have a design flaw that is beneficial to our understanding of the coke market. Slot ovens cannot be turned off. If they are turned off, the bricks that have been heated for years on end will shrink and shift and the oven walls will be damaged. This means that coke production does not rise and fall with the market as perfectly as it could. Unless natural gas is used to idle the ovens by maintaining heat and pressure, the batteries are producing coke. Natural gas is not cheap and only during the GFC did this take place, as there was no more room to store coke. The batteries may coke coal for longer periods of time, but they are still producing coke. It becomes easier to understand the limitations of the coke market because it is very close to what is being produced today (additional capacity is not sitting idle). It is true that non-recovery ovens can be shut-off more easily, but there are not enough in operation to drastically influence total production. If idle capacity does not exist and the world is still coke short, it is easy to see what will happen to the derived demand for coke if hot metal production increases. Therefore, understanding demand for steel products downstream will further aid the understanding of derived demand for coke.

Immediately downstream is the steel business and indications are clear that with the emerging markets wanting to urbanize some 500 million people by 2019, steel is

going to be required for infrastructure, cars, stoves, etc. In response to this, it is expected that hot metal production will increase globally from 955 MMT per annum in 2010 to almost 1.3 billion MT in 2019 (CRU Analysis). That in turn would require an increase of almost two MMT of coke per annum. Adding two (2) MMT is significant and there is no evidence to suggest that current capacity can keep up and known expansions are not going to fill the void. Additional capacity will be required.

The chart below provides additional evidence that the downstream market for steel is strong. Despite the crisis in 2008, steel for automobiles in South America totalled over 9.3 million tonnes and a significant market existed in Brazil and Argentina, two markets accessible to Chile. Even the Chilean automotive industry required 600,000 MT of steel or half the production of CAP.

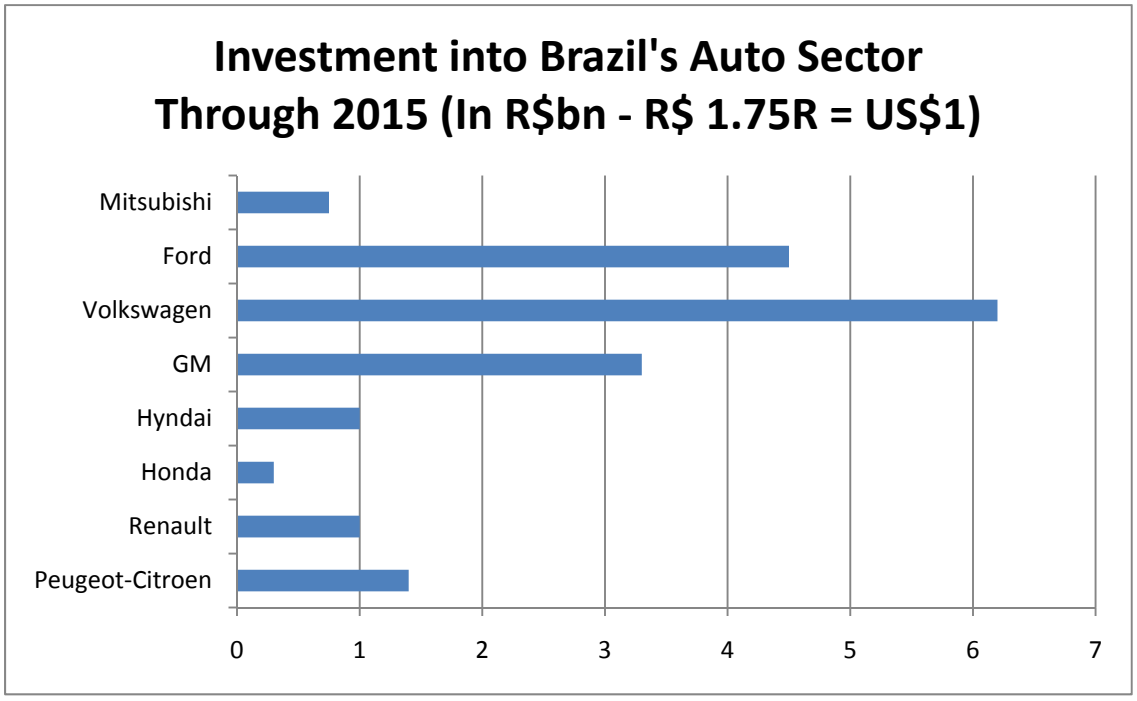
Figure 5 - Latin America Main Markets for Auto Steels (Source: Local Automakers–Teck Market Analysis)



In 2011, Scotiabank analysts believe that Latin American auto growth will be 13 percent in Brazil, Argentina, Chile and Peru. These are all natural markets for Chilean

steel. While this is down slightly from 2010, automotive production in Brazil will surpass four (4) million units, edging closer to the production rate of Korea, which is the fifth largest producer in the world (Scotiabank Global Auto Report - Feb 25, 2011). Of note is that between China, Brazil, Russia, and India, automobile production will grow from 15 million units in 2010, to over 18 million units in 2011. That is a 20 percent increase. Since automotive sales are a very good indicator of steel demand (it is the second most steel intensive industry behind infrastructure/construction), it becomes clear that steel demand will rise. A related data point suggesting increasing steel demand is the planned investment in the auto industry, as automakers have excellent reconnaissance in tracking demand trends. The chart below shows the planned investments in Brazil by the major automotive producers. A total of US$10 billion is a good indication that auto demand is rising and with it steel demand.

Figure 6 - Investment in Brazil's Auto Sector (Source: SBB, PwC, IABr –Teck subscription)



Derived demand also looks at the potential for the market to move to new products. Indirect substitutes will be reviewed in detail later in this report, but essentially, there is

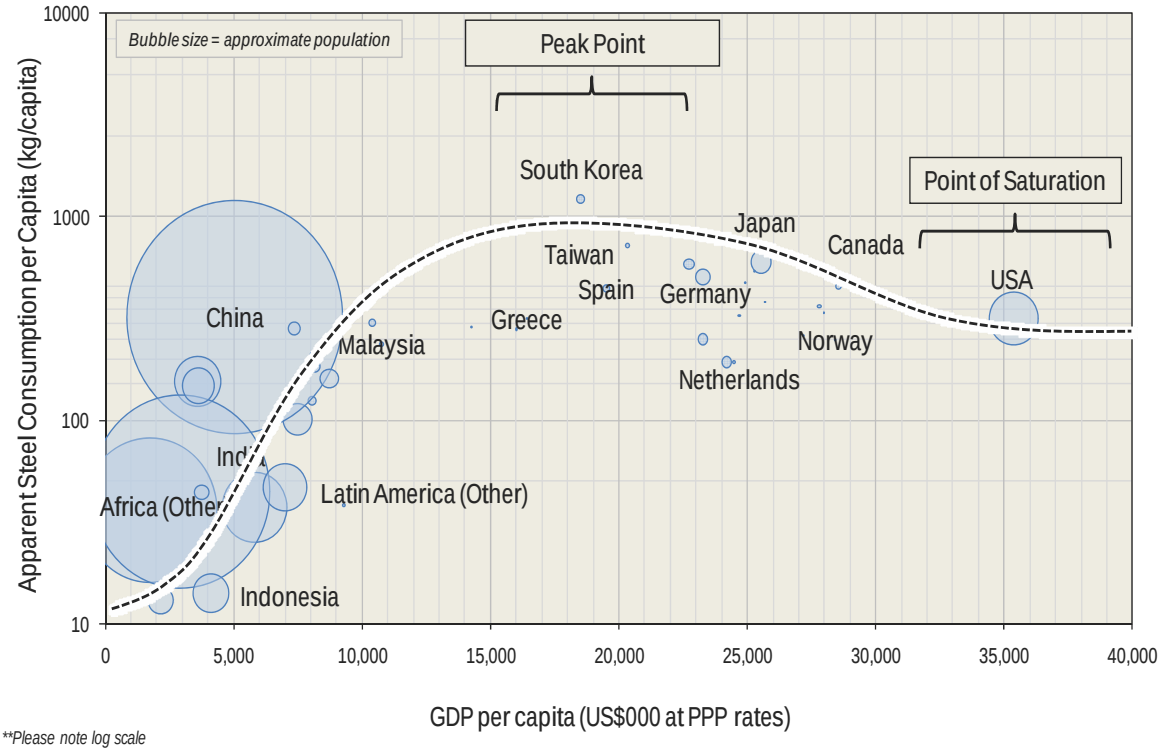
no replacement for coke in the blast furnace at this time. There are ways to attempt to minimize its use, but no technology exists to significantly reduce the need for coke. In the near term, there is little chance for shifting demand away from coke (Meredith – Industrial Marketing Management, Pg 435).

4.4 Temporal Parameters

Temporal parameters in the steel industry are reviewed because steel has such a long time horizon that change variables can drastically affect future demand. Change variables include market expansion and contraction. These forces will impact the steel market for years to come, but it is evident from the data already provided, that the steel industry is currently expanding. The product lifecycle and technology are other temporal parameters that will affect the demand for steel and, in turn, the demand for coke.

The steel market lifecycle is long and storied. The market already witnessed a devastating period when price competition resulted in larger steel producers bankrupting smaller less efficient producers (Meredith, Pg 436). A consolidation occurred. Companies such as Mittal, Tata, and Severstal were the predators. Mittal purchased a vast number of companies growing in size from 60 MMT of steel production per annum to 110 MMT (now known as ArcelorMittal). Consolidation has slowed though even after the GFC when corporate valuations were low and many companies could have been bought at a discount. It is uncertain as to how long this period of reduced consolidation can last. Perhaps another round of consolidation is coming. Escalating raw materials costs in 2011 are straining profit margins for many steel firms, especially those in Italy, where a competitive scrap metal market exists and little infrastructure spending is occurring. What has changed since the last round of consolidations is the demand for steel from the BRIC nations. At this time, China produces half of the world's steel. This was not believed possible when consolidation last occurred. In the chart below, it is clear where the BRIC nations currently sit along the 'per capita steel consumption rate' lifecycle and how far they have to go to join the other more advanced economies. Steel consumption must increase per capita in these BRIC nations as it did for the others before them. The consumption lifecycle clearly does not show a contraction for some time.

Figure 7 - Apparent Steel Consumption Lifecycle (Source: 2004 - 21009 OECD & WSA, Steel Producers) (www.teck.com)



Technology in the coke and steel industry has yet to alter the business. While the new SunCoke technology is an environmentally friendly alternative to the traditional slot oven, it has not made the slot oven obsolete. Coke from either oven is similar; there is no true advantage there. Costs might be slightly less using the SunCoke technology, but not enough to force radical change. Because there is such a large capital outlay and because the ovens last such a long time, a coke producer will not shift between technologies. This is of little consequence, since coke is ultimately what the world needs to produce steel and coke only comes in one form. The belief of many industry experts is that blast furnace production will continue for at least the next 30 years (Low Cost Hot Metal report). Until the steel industry perfects a technology that does not use coke to produce steel, a coke plant seems viable. Even if a new technology is born, the massive steel plants around the world will continue to operate until margins evaporate and they are rendered uncompetitive. For this to occur, technology improvements would need to be massive in scope and be able to capture significant economies of scale to displace

proven steel production. Evidently, temporal forces in the near term will not contract the market for coke.

4.5 Market Complementarity

Market complements are reviewed as they can influence a firm's outputs by both degree and direction of dependence (Meredith, Pg 436). Coke's market complement is iron ore. From a steel producers' point of view, as the price of coke increases, the demand for iron ore decreases, as it will choose to produce less steel. There is a negative cross price elasticity of demand, but it is not high; both products are inputs. This is different from the case of LCD monitors and computer sales. If it is expected that computer sales are going to increase, it is very likely that LCD monitors will also see an increase in sales. LCD monitor sales depend on computer sales, so the negative price elasticity is very high. Steel producers will limit steel production until the price of steel is high enough for the steel producer to make a small margin. This is what is currently occurring in the market place for steel. Margins are just large enough to allow the steel producers to make a small return. The year 2011 will test this premise, as prices for iron ore and coking coal are expected to increase and stay high for the year. Furthermore, to idle a blast furnace is not a simple decision because of the high fixed costs and massive capital expenditure associated with the mill. A steel mill would rather produce and stockpile steel products versus idle the blast furnace. This is a benefit for a coke producer (and for the iron ore producer).

The impact on total market size of the relationship between coke and iron ore is not applicable ('n/a' or not applicable, meaning it has no impact one-way or the other), as the demand for both products is completely dependent upon the demand for steel. If the iron ore market improves, it is only because steel is doing well. The expectation of a strong iron ore year is related to a lack of supply and should not influence a decision to enter the coke trade. In other words, coke's complement does not vary the size of the market for coke one way or the other.

4.6 Cannibalization

Cannibalization is critical in our understanding of the benefits to Teck of entering the coke trade. Since Teck is not introducing a superior product to its coal products, cannibalization of the old may not be beneficial, unless there are financial benefits. Teck's coal will be used in the coke oven – that is a certainty. For every MT of coal sent to the coke plant, that is one MT of lost coal sales. Coal is currently selling for US$330 per MT and the profit margin is US$230 per MT. It has been suggested that product-based cannibalization becomes a problem if the victim product has a higher sales margin than the attacker does. Sales of coke will not likely have the margins that coal will. Other positives must exist for coke to be a viable business for Teck, such as the R&D gains and the ability to have a product in a location other than avalanche threatened western B.C. This paper will review the economics of selling coke versus coal later on, but the margins in most cases will be lower, which in turn decreases the size of the market. This means the impact of cannibalization on derived demand is negative. An added negative is the reduction in the market share of the coal division, if Teck's coal goes to the coke battery and Teck does not increase coal production. With less coal in the market, a reduction of Teck's presence in some coal blends will naturally occur. Fortunately, Teck has plans to increase production of coal to over 30 MMT by 2014/2015. This will limit the damage of cannibalization to the margin loss of selling coke instead of coal.

4.7 Sales Origin Analysis

Sales of coke from a new Chilean plant will not depend on usurping market share from other competitors. In Chile, CAP is the sole user of coke and is the only competitor as far as coke production goes. CAP is expanding, so coke sales result from market growth. In actuality, Teck could look at Chile as just the location of the plant and look only at the world market; it is clear that the market is growing. In both cases, sales are derived from growing demand, not displacing a competitor in a saturated market. Sales origin has a positive effect on the total size of the market.

4.8 Market Evaluation - Total Effect – Derived Demand Forces

The chart that follows demonstrates the impact of all the derived demand forces on the potential to invest in the coke plant. It is clear that the market potential exists for us to continue to the next stage of the Demand Estimation Model – Marketing Plan Development.

Table 5 - Demand Forces Impact on Demand Estimation

Demand Forces	Impact
Total Market	+
Macro-Determinants	+
Industry Determinants (Market Size and Growth)	+
Industry Determinants (Negotiating Power)	−
Industry Determinants (Risk Management)	+
Industry Determinants (R&D)	n/a
Derived Demand	+
Temporal Parameters	+
Market Complementarity	n/a
Cannibalization	−
Sales Origin Analysis	+
Total Impact	+

4.9 Marketing Plan Forces - Indirect Substitutes

To continue our review of the market to understand if a potential exists for coke production to thrive, a thorough investigation of indirect substitutes is vital. In fact, companies are more likely to suffer profit loss from the threats of indirect substitutes than from direct substitutes, because most firms have an excellent understanding of their direct rivals (Meredith, Pg 439). Indirect substitutes to coke include Cokonyx™, PCI, the Finex system, Electric Arc Furnace (EAF) production, and plastics.

4.9.1 Cokonyx™

Cokonyx™ is carbon alloy material created with several forms of carbon by Carbonyx. Coal is blended with other pre-specified carbon based substances at various points in Carbonyx's proprietary Carbon Alloy Synthesis Process (CASP). After several critical reactions in a controlled environment, the resulting product is a semi-crystalline carbon structure, Cokonyx™, that has applications in the iron, steel, and mineral processing industries (www.carbonyx.com). Cokonyx™ has been developed as a coke replacement. Because it is custom-made from several types of raw materials, Carbonyx has developed its own equivalency tests in order to compare it to traditional coke.

U.S. Steel Corp., a current Teck customer for coking coal, is considering building four carbon alloy synthesis plants at its Gary Works in Indiana (American Metal Market – June 4, 2010). This would allow it to substitute traditional blast furnace coke with Cokonyx™. U.S. Steel filed an application with the Indiana Department of Environmental Management and it has been approved (PittsburghLive.com – TribLive Business – Aug 14, 2010). The project will cost US$220 million and will produce one (1) MMT of carbon material per annum. U.S. Steel confirmed that the addition of the Carbonyx system will not have an impact on the company's plans for a US$1 billion investment in new coke batteries and battery repairs at its Clairton Works. This is not surprising as U.S. Steel has been historically coke short.

The initial concept was to use low-rank steam coal from the Powder River Basin heating it at 200C to de-volatize the coal, after which the char is briquetted with tar and heated. The objective is to use the cheapest possible coal to create a coke substitute, thereby lowering overall costs. According to Teck's Technical Marketing department, the coke strength is expected to be far below blast furnace requirements. Carbonyx suggests otherwise. They conducted a trial using 5,550 tons of the material and measured for raw material consumption, energy usage and production levels over a 19-day testing period. After the test, Carbonyx stated that the use of Cokonyx™ created no difference in blast furnace performance, including energy consumption and productivity.

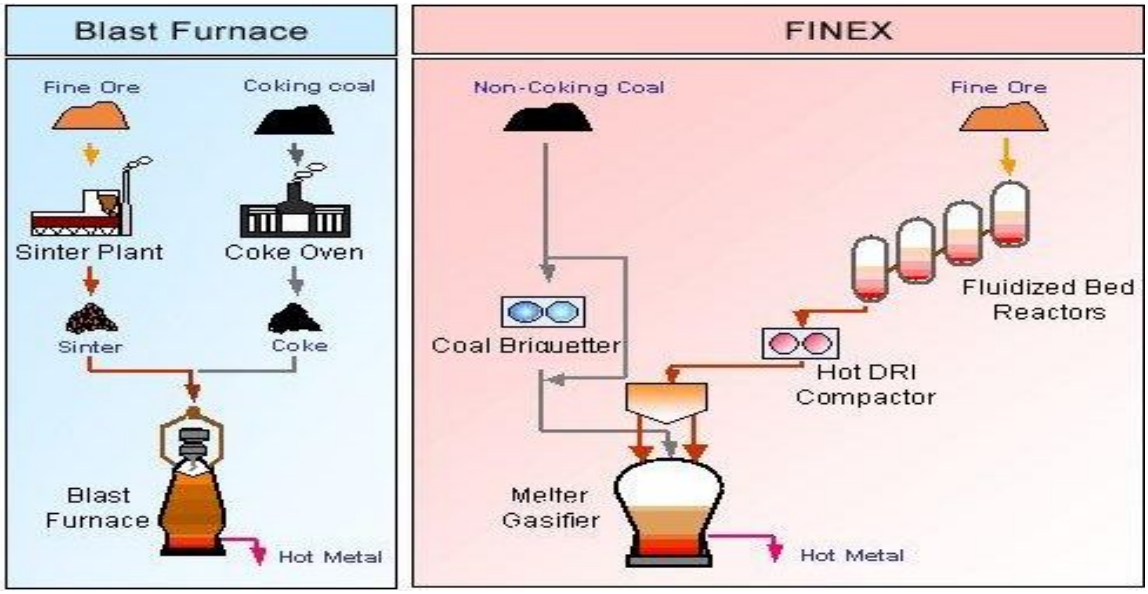
The jury is still out on how productive Cokonyx™ will be, but it is clear that the process must be monitored. For the time being, the fact that U.S. Steel will continue with

its Clairton coke making expansion suggests that the amount of coke that the system can displace is minimal. Gary Works is not even a true customer for a Chilean coke plant, so the threat for the time being is insignificant. The threat will increase should the Carbonyx system attract additional users, but Teck Technical Marketing is confident that the coke quality can only be used as 'sacrificial coke' used to control wall-flow in the blast furnace. Charging finer sinter to the side of the blast furnace makes the outer burden ring less permeable, so the mill will introduce the smaller sacrificial coke, which is made by screening the coke from the coke battery and using the undersize material (<35mm or 20mm - the average size of coarse coke is >50mm); however, only in the neighbourhood of 16 percent of the reductant requirement is comprised (Cornelis Kolijn – Internal Teck memo - June 11, 2010). The threat of this substitute is 'n/a' for now.

4.9.2 Finex

One of Teck's largest customers, POSCO of Korea, and Siemens are behind a new technology to produce hot metal using iron ore fines and non-coking coal, eliminating the costly preliminary processes of sintering and coke making. The process is pictured below, showing its differences to the typical blast furnace technology.

Figure 8 – POSCO's Finex Process (www.posco.com)



POSCO and Siemens have stated that the shorter process will mean an eight percent reduction in construction costs and 17 percent reduction in production costs, versus the typical blast furnace (POSCO website – March 14, 2011). Cost reductions are mainly the result of utilizing cheaper coals that are far more abundant around the world than hard coking coal. Also aiding costs are fewer staff and lower maintenance/facility costs. Productivity and revenue benefits also exist from shorter production times. An added benefit of the new technology is that it will drastically reduce harmful emissions. Sulphur oxides and nitrogen oxides will be 92 and 96 percent lower respectively.

As impressive as the technology is, it again ranks as an 'n/a' with respect to its impact on the size of the coke market. Only one steel producer in the world has chosen to invest in the technology and even POSCO's chairman Lee Ku Taek confessed publically that he was unsure if the technology tested for the 600,000 MT per annum pilot plant can be successfully adapted to a 1.5 MMT per year facility. The elevated business risk of moving more production to an unproven technology is not yet worth relying on stable blast furnace production (Low Cost Hot Metal report). Furthermore, POSCO's internal coke requirements will not decrease with the implementation of Finex; it will just add steel production. Perhaps if steel prices fall far enough, Finex will displace some conventional hot metal production to save costs, but even at 1.5 MMT per year, only 500,000 to 700,000 MT of coke requirement would be lost. That is not enough to affect the coke market. Still, as mentioned with respect to Carbonyx's system, a watchful eye must be kept on Finex.

4.9.3 Pulverized Coal for Injection

PCI is another indirect substitute for coke. PCI is lower on the coal quality spectrum and is far more abundant than high quality hard coking coal. Its use has been proven over the years. Integrated steel mills use PCI to reduce coke as a fuel. Pulverized coal is injected into the blast furnace through the tuyeres to aid in maintaining the proper temperature in the blast furnace. PCI slightly reduces the coke requirement for a steel producer (about US$5 per MT). It is also known to improve hot metal consistency, increase blast furnace productivity, and provide better control over slag chemistry. PCI

can even lower emissions (Cornelis Kolijn, 2011). Clearly, the benefits of utilizing PCI are considerable.

The most important factor to note about PCI is that it can only displace a small amount of coke during hot metal production. Since it does displace some coke, it has a relatively minor negative impact on demand estimation. This is true because PCI simply cannot replace coke as the support for the burden in the blast furnace, it cannot act as the reductant, and not every steel producer uses PCI.

Another product that can aid in heating the blast furnace in a similar way to PCI is blast furnace top gas. If it is recycled and used in the blast furnace, the gas can displace minor amounts of coke and there are some positive environmental side effects. The impact on coke requirements at the mill is too insignificant to have it influence a decision to enter the coke market.

4.9.4 Electric Arc Furnace Production

The EAF is a furnace that heats and melts recycled steel by means of an electric arc. EAFs range in size from one (1) MT to 400 MT per year (www.cim.org). The 400 MT furnaces are the direct competition to the blast furnace and are considered to be 'secondary' steelmaking furnaces, because they use scrap steel. This 'recycling' is viewed very positively around the world. EAFs are an indirect competitor to coke because the system does not require coke or even coal at all. EAF production is cheaper than blast furnace production. Costs are in the range of 500 per tonne in 2011, attributable mostly to scrap metal costs (US$375 per tonne) and electricity (US$33 per tonne). This is compared to a cost of US$570 for virgin pig iron production and US$670 for liquid steel. As expensive as the electricity is, there is a much lower energy requirement for the EAF over the blast furnace. In addition, costs are more variable in nature than for the blast furnace. Of the US$500 cost, almost US$470 is considered variable (steelonthenet.com – March 14, 2011). Also, the EAF can be started and stopped far more easily than the blast furnace to cope with surging or reeling demand. Finally, since EAFs are smaller in design, capital requirements and maintenance costs are far lower than for a blast furnace.

The very fact that EAFs are relatively small in size discounts their impact on the coke market. A 400 MT per year production rate is not considerable. All told, EAF global production capacity is 550 MMT per annum and they provide steel for 'mini-mills' that produce mainly 'long products' (rebar, wire rod, rails, tubes, etc.), hence EAF production only impacts one segment of the steel market. The impact on the overall steel market is not sufficient enough to see a noticeable drop in coke demand. An interesting factor is that as steel demand increases, available scrap is hard to find and EAF production drops. There is an inverse relationship between EAF production and steel demand, meaning EAF production most affects the market in low steel demand cycles. In addition, only southern Europe sees a dramatic influx of EAF steel. EAF production does not make its way into high end steel products or steel for the automotive industry. Coke based blast furnace steel is the highest quality steel for these applications. This again limits EAF's impact on the coke market. As for environmental impacts - there are no benefits over blast furnace production. These mills have issues of their own: sound issues, a significant amount of dust is released, slag is produced, and there are tremendous requirements for water and electricity. When you consider the increased heavy truck traffic to transport scrap metal, EAF production might actually be more hazardous to the environment than the blast furnace and may feel the heat of the green movement sooner than integrated steel mills (World Coal Association, April 1, 2011). When all of these points are considered and with the world being coke short today even with EAF production occurring, steel production from EAFs rates as net 'n/a' for its impact on the coke market. This is especially true because the data researched predicts that steel production has to increase to keep up with future demand. All forms of steel, both primary and secondary, will be needed to satisfy growth demands within the BRIC.

4.9.5 Plastics and other Synthetic Materials

Plastic has long been thought of as a potential replacement for steel. In 2007, scientists at the University of Michigan announced that they had engineered a plastic that was as strong as steel, yet far lighter and transparent. Four years later the world has not witnessed plastic overtaking steel in any significant way. Plastic's durability remains in question and it will be some time before plastic replaces steel in infrastructure such as

bridges and skyscrapers. Still, one must wonder when it could happen. A product that is completely synthetic, needing fewer raw materials that are far more abundant than coal or coke, would indeed change the game. Coke requirements would be impacted, but the level of impact is difficult to determine. An advantage for coke is that much capital has been invested in the steel mills. Plastic would have to show a tremendous benefit for an extended period of time in order to displace steel. Durability would need to be flawless and the price of production would have to be significant enough to render steel production uncompetitive. Not an easy task and not one that will occur in the near future. Furthermore, plastics manufacturing is at least as harmful to the environment as steel production, thus adding capacity enough to displace steel will be challenging. For now, plastics and other synthetic materials are considered to be 'n/a' on its impact of the coke market, because steel production is not yet at risk.

4.10 Marketing Plan Forces - Direct Substitutes

An analysis of direct competition is critical to assessing if a significant market exits to warrant new entry. Companies are more adept at monitoring direct competitors over indirect because they are more visible and the technology used is usually similar. Understanding the advantages and disadvantages of each direct competitor and linking those to market share performance will provide the magnitude of the negative impact on demand estimates (Meredith - Pg 441). Direct competitors are coke production from integrated steel mills and merchant coke producers and they both have a tremendous competitive advantage. The enormous capital cost of a coke battery provides a significant barrier to entry. With capital costs in the range of US$500 million to US$1 billion, not many investors are willing to enter the coke trade. This is even more so when environmental issues could have a negative impact on the investment. It is not surprising that a merchant coke maker has not entered the market in the last two decades.

4.10.1 Integrated Steel Mill Coke Production

Integrated steel mills exist around the globe and many of them produce coke. This production is the single largest direct competitor to a new entrant to the coke market. This direct competitor has some competitive advantages. Integrated mills produce coke

right at the mill to the exact specifications it wants for use in the blast furnace. It has a 'place' advantage (Meredith). A merchant cokery would likely not have the ability to meet a certain specification without being able to match the coal blend exactly, so there is also a 'product' advantage (Meredith). With coal in short supply, this becomes more difficult to do. In addition, this internal production is the first to be used and is the last to be cut when steel demand drops. This means that third party coke is the first to be cut in a down market, due to the fact stated earlier that the typical slot oven cannot be turned off. Even if a merchant cokery produced coke of better quality than the mill itself, it would still be cut first if blast furnace production was being cut back. It has a 'price' advantage (Meredith). Without a doubt, taking market share from the coke production at integrated steel mills will be next to impossible. If a new entrant had to do this, the likelihood of success would be very low.

Fortunately, the most significant disadvantage for this direct competitor is its inability to fulfill Chile's coke requirements in the not too distant future, not to mention falling far short of fulfilling worldwide demand. Another disadvantage is the average age of coke batteries around the world. Although long, the life of a battery is finite and some batteries around the world are going to be decommissioned in the years to come. Moreover, the environmental impacts of the older slot ovens are a cause for concern. It is not unreasonable to think that older ovens will come under increased environmental pressure, even with a fully functioning by-product plant. In actuality, some could be asked to shut down, just as German nuclear reactors are being shut down for safety checks in light of the earthquake and tsunami damage to the reactors in Japan (Bernhard Luemmen, March 22, 2011).

In light of the disadvantages noted and because a new entrant would not be looking to steal market share from the integrated steel mills, the impact on the demand estimation is 'n/a'.

4.10.2 Merchant Coke Production

Merchant coke makers are owners of coking facilities that are not directly connected to steel fabrication. An advantage they have is that the coke they produce has

already been used by certain mills, so there is no need to prove coke quality. If coke price is competitive between producers, existing merchant cokers would likely be chosen over a new entrant, at least until the new entrant was able to prove its coke quality. In down markets, getting in the door to prove quality would be difficult. As a result, there is a slight 'product' advantage (familiarity), but there is no 'price' or 'place' advantage between merchant coke producers (Meredith). The price is the market price and the place is the seaborne coke market.

A disadvantage of merchant coke makers is that many of them are 'mom and pop' operations in China that only feed the Chinese market. They do not enter the seaborne coke trade. This point leads directly to the other disadvantage – there is insufficient coke supply being produced by merchant producers.

To provide further insight into the coke market, a couple of points about two merchant coke companies should be noted. Risun is a coke producer in China. Risun has confirmed that 50 percent of its profits are related to sales derived from the by-product plant (Paul Armstrong – March 20, 2011). That is significant, as a non-recovery oven would not provide access to the profitability of the chemical sales. On the coke side, Risun must adhere to the 40 percent VAT that the government applies to coke exports. Clearly the Chinese government does not want its internal coke capacity to be exported as it understands the enormous internal steel requirements needed to urbanize its people. The government knows there is a shortage of coke.

RVG is a merchant coke producer in Germany. RVG used to mine coking coal and would represent what Teck would look like if it were to enter the coke trade. What is unique about RVG is that it is run as a non-profit organization on coal production (only thermal coal currently) and coke production. A pricing formula has been established to ensure that the costs of producing the coke are covered. If necessary, RVG is given subsidies to breakeven. ArcelorMittal has struck an agreement whereby they will take over the coke making facilities and by 2018 they will have full rights to the plant and the coke it produces. A couple of interesting market factors are at play here. On one hand, with Risun relying on by-product sales and RVG on government subsidies, it is obvious that the economics are questionable. On the other hand, with the VAT in place in China

and ArcelorMittal investing in RVG's coke plant, there is additional credence to the belief that the world is coke short.

4.11 Marketing Plan Forces – Company Product

An understanding of the competitive advantages and disadvantages of the total company product offering compared to the greater market will help us determine if there is an opportunity to collect market share (Meredith Pg 441). No price advantage would exist as a new entrant would want to receive market pricing for its coke. There is an opportunity to cross-sell with Teck's coal products, but a pricing benefit would not be the way to earn market share. Offering a price benefit compared to the market price would only serve to make cannibalization of coal sales even more unattractive.

With so little difference in coke quality in regard to high grade coke, there is no parameter that the competitors could exploit to gain market share (Meredith Pg 442). Teck would only have to prove that its coke is high quality, which it could do by leveraging its customer relationships to get in the door. It could then rely on the growing demand for coke worldwide.

4.12 Marketing Plan Forces – Company Portfolio Congruency

Because Teck would be using its own coals to a large extent in the coke oven, it is fairly safe to say that the coke quality would be good. Teck has spent years proving this very point. In fact, Teck could not afford to produce poor coke, because it would suggest that its coals are not top tier. If coke produced from a Teck oven was seen as being of poor quality, it would not be difficult to believe that customers would think the worst of Teck's coals. This would be a negative, and unanticipated, impact of adding coke to Teck's product mix that could affect the performance of its coals in the market (Meredith Pg 442).

As previously mentioned, cross-selling is an opportunity that Teck would need to exploit. Using the positive outcomes customers have had with its coal, Teck should be able to entice some customers to try its coke. The issue here is whether or not Teck is pushing customers away from high margin business toward a lower margin product. If

Teck was using coke as a defense against the actions of its competitors, this would be acceptable to keep the customers happy. This is not currently the case, however. Teck is selling all of its coal in a tight market. Should excess supply come online as is anticipated, the new product offering might come at a better margin. The financial analysis discussed later suggests that this is not likely to be the case based on the assumptions made, but at least offering coke would act as a defense against coal competitors trying to steal market share. Teck would rather have the customer take a lower margin product than lose them altogether.

If a need to sell coke into alternative industries exists, the cross-selling opportunities available to Teck Coal would be lost. As well, the marketing team who would be responsible for selling the coke would have to understand whether the characteristics for which steel producers buy coke are the same as for other industries. If they are, then congruency still exists, but if additional marketing horsepower is needed for the specific purposes of exploiting the other markets, some congruency is lost. Coke sales become a side business unto itself. Taking this one step further, if Teck needs to sell coke into other industries, the steel community might question if it is a quality concern that is forcing Teck to sell coke elsewhere. At the very least, Teck's focus would be put into question. This has the potential to become another unintended negative impact on Teck's coal business.

With the possibility that the coke quality and selling coke to alternative markets could impact coal sales and because customers would be likely be pushed toward a lower margin product, company product congruency has a negative impact on the estimation of demand.

4.13 Decision Point -Marketing Plan Forces

The chart below demonstrates the impact of all the marketing plan forces on the size of the coke market. The fact that the overall impact of these forces is 'n/a' suggests that the direct and indirect competition that exists is not significant enough to keep Teck out of the coke market. Since a potential market still seems to exist, a financial analysis is required to complete the estimation of demand.

Table 6 -Impact of marketing plan forces on demand estimation

Marketing Plan Forces	Impact
Indirect Substitutes:	
Cokonyx™	n/a
Finex	n/a
PCI	
EAF Production	n/a
Plastics	n/a
Direct Substitutes:	
Merchant Coke Makers	
Integrated Steel Mill Coke Production	n/a
Company Product	
Company Portfolio Congruency	
Total Impact	n/a

4.14 Economic Value to Customer Analysis

Economic Value to Customer (EVC) analysis is important, because the value a customer places on your product is a direct indication if they intend to buy it. Chile will be coke short when CAP increases production, if it does not also increase coke production. Teck would add economic value to CAP and Chile by funding additional coke production. CAP will want to buy Teck's product because it will be closer than any other coke available. This is a competitive advantage compared to other coke makers on the continent.

Influencing EVC is whether or not the customer has the ability to source the product internally. In the steel market, most integrated mills have made the decision to produce coke internally. It is critical to understand the risk to an integrated mill of not having sufficient coke supply. If an integrated steel mill is coke short, they are required to buy third party coke no matter what the coke price is. CAP could be in this situation soon. In the days of US$90 Chinese coke being available on the market, a few integrated mills did not increase their coke capacity because they were so pleased with the price for

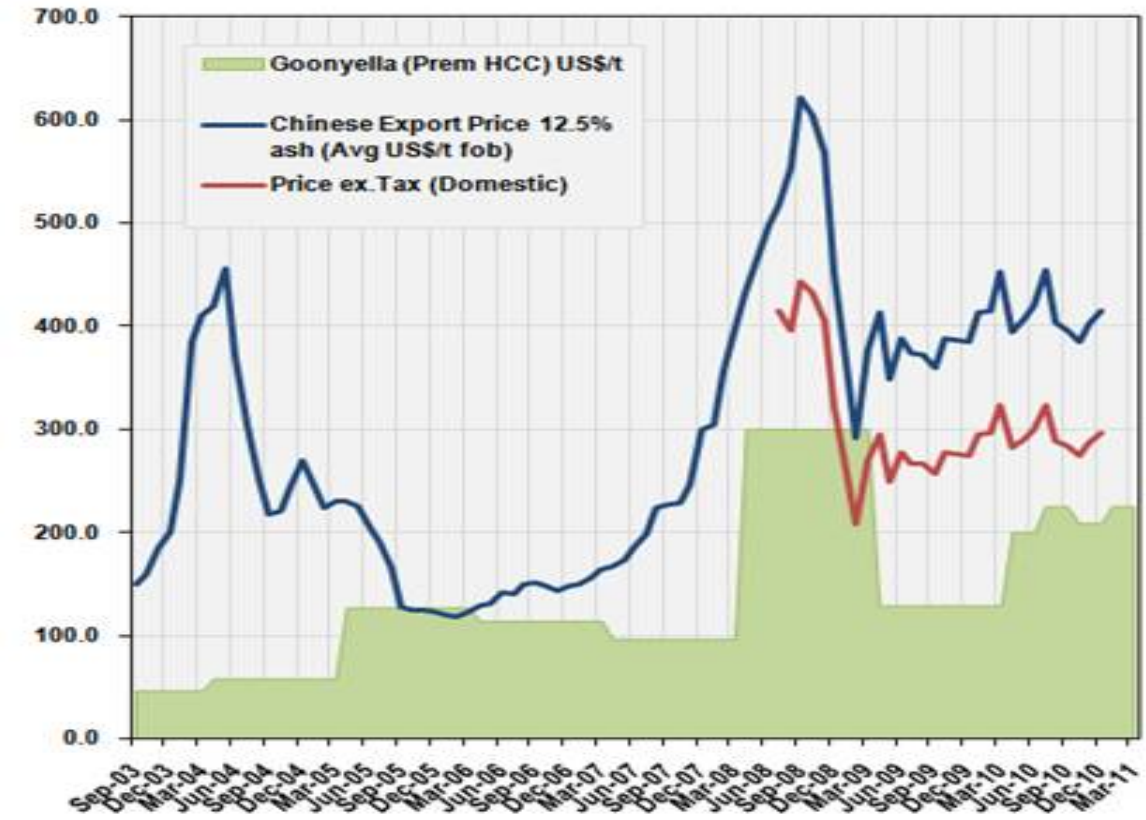
which they could get Chinese coke. There was little incentive to invest in coke plants. There were a few companies that had vision that were more interested in becoming less coke dependent and who understood the cost and risk associated with being dependent on third party coke. TKS is one such company and against what many naysayers proclaimed, they made the investment; it paid off. The coke price increased dramatically and the coke short mills had no coke production to fall back on. They had to pay the market price for coke and had no negotiating leverage. This had a tremendous impact on the bottom line (Bernhard Luemmen – March 23, 2011). Meanwhile, TKS was able to produce its own coke, putting them in the enviable position of controlling its own destiny. ArcelorMittal is continuing this trend right now with its purchase of the RVG coking facility. There are no other available options to increase coke making capacity, so although the facility is not a low cost producer (it is inland Germany so logistics are costly), coke can be made immediately and the environmental concerns of a new plant are not an issue. This suggests that as long as the steel mills are making a decent return, they will invest in maintaining old ovens and building new ones. A question is, if the steel mills are the ones being squeezed by high raw materials prices and low product prices and they watch the mining industry and car producers' profits increase, will they continue to invest in coke batteries? The option is to not invest and wait for steel prices to increase. Either way, the coke market should have positive returns if steel demand continues to rise as expected. In fact, it would be best to enter the market when Teck has excess cash and when the steel producers are not investing in coke capacity. This is the current situation. Teck could establish a presence in the market when demand is higher and represent an alternative for the steel mills to producing their own coke. Timing is currently on Teck's side.

EVC analysis requires a comparison of the incremental value to the customer of your product versus the product produced by competitors. Coke is relatively similar in nature around the globe with few differing attributes (attributes to consider are limited to ash and sulphur). Teck would only have to ensure that its qualities are good enough, for customers to resist the temptation to look for alternative qualities or demand a price discount. With Teck having excellent coal as a base for its coke, this should not be an issue. There should be no incremental benefit of competitors' coke compared to Teck's.

Furthermore, the EVC of Teck's coal will be improved. Earlier it was noted that having good data on how Teck's coals coke will be extremely beneficial, especially to assist marketing Quintette coal. A coke plant will definitely add incremental value to Teck's products over its competitors in the coal market.

Since there is no incremental benefit and Chile/South America will be coke short, Teck would not be looking to alter its price versus the market. With coke being largely sold based on a global price related to prices in China (see chart below), Teck would not be seeking to undercut the market price, but to achieve market pricing and perhaps even a premium price if the quality deserve it. Based on the EVC model, the impact on demand overall is positive.

Figure 9 - Coke and coal price historical relationship (AME Data as at March 25, 2011)(www.teck.com)



4.15 Company's Market Potential

A financial analysis is important as it provides evidence of the value of a project to the business and assists in measuring potential demand. The culmination of the evidence in this section sets the stage for accepting or rejecting the viability of the project, especially in terms of deciding if cannibalization of coal sales is acceptable. Financial analysis often dictates a course of action, but it should not be the lone factor in deciding whether a sufficient market exists for a product. For instance, a situation may exist where the financial analysis suggests that the project is viable, yet developing the market may be inconsistent with corporate goals and objectives (Meredith Pg 444). The financial analysis should be considered as one data point of many in estimating demand.

When preparing the financial analysis, a number of assumptions were made as follows (See model in Appendix A):

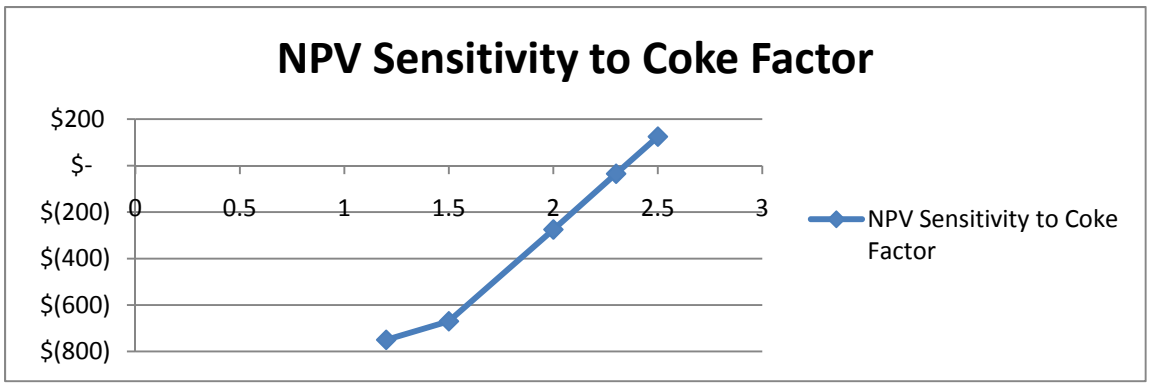
- US$509 million CAPEX
- Inflation is 2 percent per annum
- Three year project start up
- Coke production in 2014
- Labour is 0, in year one, 25 percent of normal in year two, and 50 percent of normal in year three
- Raw material is coal only
- The future price of coal used follows what analysts that follow coal are predicting

Not surprisingly, the most critical factor in the analysis is the selling price of coke, because of its dependence on the input (coking coal) price as well as demand. Accordingly, profitability of the project requires a sufficient margin over the price of coking coal.

A net present value (NPV) calculation for the coke plant was completed with a sensitivity measured on the coal to coke factor (chart below). The analysis shows that coke must be approximately 2.35 times the price of coal for a break-even NPV to result

using a hurdle rate of 10 percent over 20 years. Using a 2.5 times factor, the NPV jumps to US$125 million with an internal rate of return of 14 percent; a very healthy project exists. Looking back at of coal to coke chart above, 2.5 times coal has occurred in the past, so it is definitely possible. The question is - will it happen again? Today (April 2011), coke is about US$530 per tonne, so it is 1.6 times the price of coal. Not the required factor for a similar margin compared to coal, but this is at a time when coal is the highest price ever and a large part of the world is still dealing with the effects of the GFC. Just last quarter (Jan to March 2011) coke was 2.5 times the price of coal, when coal was at a more reasonable price (US$225 / MT). Adding credence to the possibility of a 2.5 times factor into the future is the current profit margin on coal, which is about 66 percent. The profit per tonne of coal is over $230 per tonne, or 3.3 times the total operating costs that are approximately US$100 per tonne. This is an important comparison, because coal is considered to be in short supply and is part of the same value chain. If coal becomes scarcer as predicted, then coke will be scarcer. If a coke shortage continues for the next three to four years, the price will rise in a similar fashion to what coking coal prices are currently doing. The latest development that supports this prediction (April 2011) is the recent purchase of the Sparrows Point steel mill in the U.S. Under the former ownership (Severstal), the mill was not producing pig iron. The new owners have stated that pig iron production will resume as soon as possible. Sparrows Point does not have indigenous coke production. With the closure of their coke plant in 1990, the steel mill has had to import 100 percent of its coke requirements, which are one (1) MMT per annum– a significant amount of coke (Tayfun Zehir April 2011).

Figure 10 - NPV Sensitivity to Coke Factor (Appendix B)



The financial analysis also compared the profit margin for Teck of just selling coal versus selling coal and coke, taking into consideration Teck's coal growth plans to 32 MMT by 2014/2015. The comparison is found below in Table 7. The analysis is as expected considering the NPV results. Unless the coal to coke factor is 2.5 times, the profit margin for coal will always be superior to coal and coke, attributable to the costs of coal into the coke process. The cannibalization issue becomes more apparent when the margins for just coal and just coke are presented. The profit margin on coal is on average about 12 percentage points higher than for coke and coal is in no way a doomed product that Teck needs to replace. What is important to note is that coke production does not severely impact the profit margin of an integrated coal and coke business, even in the worst case scenario. In fact, the combined margin under the base case is on average just two (2) percentage points lower than for coal alone. Over the past five (5) years, Teck's average profit margin is about 50 percent. The combined entity's profit margin would not deter Teck from maintaining that profit margin until 2017 when coal prices start to drop off. Even then, the drop is attributable more to coal's profitability than coke. This suggests that if other benefits exist to operating a coke plant, Teck should definitely consider the investment.

Table 7 - Profit Margin Comparison (Appendix A)

Profit Margin Comparison (percent / red = negative)					
	2014	**2015**	**2016**	**2017**	**2018**
Coal Only	57	50	50	43	33
Teck Coke (1.5x)	(8)	(10)	(10)	(13)	(16)
Teck Coke (2.5x)	35	34	35	32	30
Teck Coke (1.2x)	(34)	(37)	(38)	(41)	(45)
Coal and Coke (1.5x)	54	48	48	41	31
Coal and Coke (2.5x)	55	49	49	42	33
Coal and Coke (1.2x)	53	47	47	40	31

4.16 Decision Point - Value

The chart below demonstrates the impact of the pro-forma forces (EVC and market potential) on the size of the coke market. Without question, the financials for a coke plant are tenuous. The dependence on coal is clear, but the fundamentals exist to support a coke price of two (2) to 2.5 times the price of coal, as coal and coke become scarcer. Due to market fluctuations and the inability to be sure the coke price will remain as high as it is today, the market potential's impact on the demand estimation is considered 'n/a'. When combined with the positive impact that coke production has on the economic value to Teck's customers, the pro-forma forces are a net positive on our estimation of demand.

Table 8 - Impact of the pro-forma forces on demand estimation

Pro-Forma Forces	**Impact**
Economic Value to Customer Analysis	+
Company's Market Potential	n/a
Total Impact	+

Overall, the demand estimation model suggests that there is room to enter the coke market. Demand forces are positive, the marketing plan forces are 'n/a' (had no impact), and the pro-forma forces are positive. There is a potential to make a reasonable profit and even in the worst case scenario, the impact on the profit margin for the entire business is not significant. What Teck stands to gain from the added knowledge is far more valuable, so the opportunity cost of the cannibalization is worth the risk. Another interesting point is that the capital asset turnover ratio for the coke plant, even for the worst case, is higher than what Teck has recently accomplished (0.28 in 2008, 0.34 in 2009, and 0.42 in 2010 – Edwin Shadeo). The asset does have a place in Teck's portfolio of assets from a capital asset 'turns' perspective. Before a final decision is made, however, a review of how a coke plant fits into Teck is required, from a strategic perspective.

5: Strategic Analysis

An important consideration is how the demand estimation and the financial results relate with the big picture corporate strategy and goals of Teck. Even if a potential market exists, developing it may be inconsistent with Teck's plans (Meredith Pg 444). Teck's investor relations statement is that its core competencies are mining and mineral processing and that Teck leverages its expertise to find resources and reserves and then convert them into cash flows effectively and efficiently. It does this ethically and with safety in mind (Edwin Shadeo – March 25, 2011). Teck's home page states, "Setting possibilities in motion. Teck is a diversified resource company committed to responsible mining and mineral development with major business units focused on copper, steelmaking coal, zinc and energy." An investment in a coke plant might not be mineral processing per se, but it is not so different to suggest that it is not consistent with Teck's goals. A more in depth review is required. By reviewing game theory, Porter's Five Forces, strategic fit, and the benefits of forward integration, a better understanding of how a coke plant meshes with Teck's corporate strategy will result.

5.1 Game Theory Implications

The decision to invest in a coke plant should take into account game theory (Brandenburger and Nalebuff, 1995). The question for Teck is whether it needs to change the game. To answer this, a review of the scope of the game, what tactics are employed, and how to add value is necessary. This paper has provided a fulsome review of the scope of the coke game and it suggests that there is a limit to existing coke production capacity. If Teck purchases an oven, it can expand the scope of the game.

Expanding the scope of the game is closely related to adding value. By increasing the scope and investing in a coke oven, Teck can add value in a number of ways:

1. it can add to its bottom line;
2. it can expand its product base for its customers;

3. it can add steel customers to its portfolio who do not buy coal;
4. it can more ably defend the quality of its coals; and
5. it can complete more comprehensive blend studies for its customers.

Blend studies are a true way to attempt to increase Teck's percentage in a customer's blend. Only if the customer can clearly see if adding more Teck coal to the blend is beneficial, will it start to tinker with percentages. The oven can help. Currently no competitors have a coke oven in which to conduct blend studies. BHP, the world's largest supplier of coking coal, owned an oven a few years ago. BHP used the oven to develop blends and to prove the value of its coal. BHP has since sold the oven because they are the largest producer of hard coking coal and with that comes market power. Their need for the oven has been drastically reduced. Furthermore, they were able to use the data gathered from the oven to show that their coals are among the best, if not the best, coking coals in the world (Paul Armstrong & Tayfun Zehir, March 2011). That data will be used for many years to come, but the necessity of continually proving it is gone. Having similar data would elevate Teck to the highest customer service level and will be critical when Quintette coal comes online.

Tactically speaking, steel mills around the globe have some sort of testing facility. The issue here is that Teck's coals show poor results in the one-kilogram test ovens that many of the mills use. Teck continually needs to defend its coals to those mills. The Chinese market tends to use small one-kilogram pilot ovens for testing and so does the Indian market. Teck's ability to defend its coals will be tested if Teck is to penetrate those markets. Clearly, a game changer can assist Teck in its defence strategy – it needs new tactics to aid in its defence. The game changer is to correlate results from the pilot ovens with results from an actual oven. In order to correlate, much testing will be required and it is likely that more capacity will be required than is available in the market today. No other company would have this data and it would be extremely difficult to imitate; a competitive advantage would exist. The advantage would come to bear when a customer has no access to other coals. That customer will be far more willing to use higher levels of Teck's coals if the evidence is there to suggest that it is possible. This occurred in Turkey and Teck coal is a much larger portion of the blend there compared to almost everywhere else in the world. Teck would be more able to execute its strategy of

improving customer relationships if it had this data. Furthermore, earlier in this paper, it was noted that Teck mines 25 MMT of coal per year and expects to increase production to over 30 MMT by 2014/2015. It is easy to see what every dollar of price is worth to the company. In order to make a tactical change in the game, it seems as though Teck should invest in the oven.

5.2 Porter's Five Forces

Porter's Five Forces model is a strategic review of a market to understand what forces are shaping industry competition. It gives additional insight into the likelihood of success of a new entrant into the market place. The demand estimation model takes into consideration most of Porter's Five Forces. For instance, rivalry among existing competitors and threat of substitutes was covered when direct and indirect competitors were analyzed. However, in order to complete a five forces review, bargaining power of buyers, threat of new entrants, and supplier power must be analyzed.

5.2.1 Bargaining Power of Buyers and Threat of new Entrants

The bargaining power of buyers is an important consideration when reviewing the capacity available to Teck in the coke market. The coke market has many buyers around the world and since many buyers produce at least some coke, there is no individual buyer of coke, or even a group of buyers, that has significant bargaining power. In fact, the stability of coke prices over the years, except perhaps during the GFC, suggests that the bargaining power among the buyers' is low. The threat of entry is definitely a factor contributing to the lack of power. Additional coke capacity is not sitting idle and the considerable investment and environmental challenges facing new entrants are significant hurdles to entry. As long as there are hurdles to entry, competition in the coke market will not drastically increase over the years and neither will the bargaining power of buyers. If Teck can hurdle the barriers to entry, the limited power of buyers means that there is capacity in the market for Teck.

5.2.2 Bargaining Power of Suppliers

The suppliers to a coke plant are the coal producers. The coal producers currently have a tremendous amount of power because coking coal is scarce, there are relatively few coking coal producers, and there are significant barriers to entry. The barriers are a lack of resources around the globe and the size of the initial investment in a coal mine. The following chart shows the only operating deposits and the few new deposits that exist. While it is true that all of the new deposits will come online at some point in the future, each one has its challenges: either the coal grade is not what was expected, costs to mine the coal are higher than anticipated, or massive investment in infrastructure is required. For instance, the deposit in Russia is 2,000 km from tidewater and no rail or port exist. As a result, for the next few years at least, the power of suppliers will remain. In fact, if Teck was not a miner of coking coal, the power of suppliers would likely prohibit a potential investment in a coke plant. Since Teck mines coking coal and its resource base is vast (billions of tonnes of resources), a coke plant operated by Teck would have access to much of the coal it would need. Teck would have to negotiate with suppliers for some of its coal requirements. To manage supplier power, Teck could look at the closest reserves that are not of the highest quality, as Teck's coal could still carry them in the blend. These would include some of the U.S. coals and the new coal resource that will be mined in Mozambique. In Teck's particular case, supplier power should not deter entry into the coke market.

Figure 11 - Existing operating metallurgical coal regions and known deposits (www.teck.com)

5.3 Does Teck Coke Fit into Teck's Strategy

Michael Porter examined strategy in his Harvard Business review paper in 1996 and many of his ideas on strategy still hold. Once the heart of strategy, positioning is still an important factor. Essentially, the question to ask is what is the position of a coke plant within Teck? Since Teck would be trying to position itself to meet all of the carbon needs of its customers, it is positioning on a 'needs' basis. Teck currently delivers coal to integrated steel mills. Coal creates coke, which is used for its carbon. If Teck also produced coke, it would be supplying its customers with the full spectrum of carbon they require. Does this help Teck? Teck has already segmented the customer base to just the steel mills around the world, so adding coke to its product mix does not change the segmentation at all. What it would do is provide its customers with a choice in times of need. It has already been mentioned that the western corridor is challenging to navigate coal through during avalanche season. During avalanches, Teck could better service its customers by still being able to provide the carbon they need. This is a certainly a benefit to the customer.

Next to consider are the trade-offs Teck is making to provide the benefit. The biggest trade-off is that Teck is adding coke supply by taking coal off the market. One cannot dismiss the potentially damaging spin this can have on Teck's reputation. Customers could perceive Teck as limiting coal supply, which could impact coal prices. This would be a benefit to Teck, but coal customers would be unhappy. Moreover, customers who wish to blend coals themselves to create specific coke qualities may feel that Teck is interfering with their business. Other coal producers may not be interested in selling coal to the coke plant and may question Teck's motives in entering the coke market. Perhaps it is better for Teck to purposefully limit what it offers its customers (Porter, Pg 69). This is essentially what strategy is – choosing what not to do.

Choosing what not to do requires an analysis of fit. First order fit is simple consistency. While the resulting product of a coke plant is still carbon, which is consistent with Teck's current offerings, Teck is a miner first and foremost and making coke has nothing to do with mining. Teck's competitive advantage as a miner is its ability to mine tremendous resources at relatively low cost. Operating a coke plant would

not benefit from the knowledge Teck has earned over the years – fit is not good. Second order fit is reinforcing. Teck would be able to sell good coke that further proves the value of its hard coking coal reserves. The coke sales would reinforce coal sales – a good fit exists. Third order fit is optimization of effort. Optimizing effort includes information exchange and eliminating redundancies (Porter, Pg 71). Information exchange from the coke plant to the coal technical marketing team and from the coke plant to the customers would be a tremendous benefit; however, there is no elimination of redundancies. Coke production is a completely separate activity from coal mining. In actuality, redundancies would be added in the form of logistical handling. Coal would be transported from Canada to Chile and then it would have to be transported back to the market if CAP did not buy all of the production. Instead of just one railing segment and one ship loading to move coal to a customer, at least two more port activities are required to unload the coal from the ship and load coke back onto a ship. This is the case only if the coke plant could be built near a port. If it could not, additional railing is necessary. This additional transportation requirement is not a good fit for Teck.

Clearly there is some question whether a coke plant fits into Teck's business. Looking at the growth trap, Teck could be venturing down a very similar path as Neutragena did in the 1990s, when it added product lines that did not mesh with its superior hand cream. In an attempt to broaden its product base, Teck may grow into a business it is not known for and mistakenly dilute its image. This may result in customer and shareholder confusion. Furthermore, if Teck tries to compete on too many fronts, employees may also get confused, losing motivation and focus. Revenues are likely to be larger, but profitability will shrink (Porter, Pg 76). Growth evidently can be hazardous. What growth should Teck consider then? Teck should be growing in areas that are an extension of its current strategy that leverage the existing activity system. This means growing organically in coal, copper and zinc. Teck already has plans to do this, so the question is whether there is room for additional expansion and if coke production leverages anything in Teck's repertoire. Teck has cash, so the means for expansion exist. Coke in and of itself does not leverage much. Teck's coke would enter a market where it would not be able to differentiate itself; most coke is similar. The only question remaining is if Teck should be the one to respond to an expected increase in coke demand

and take advantage of timing when no other investments in coke capacity are occurring, while adding a system for better proving the quality of its coal, where much revenue is at stake.

5.4 Forward Integration as a Strategy

The Japanese Keiretsu utilizes forward integration as a means to creating barriers to entry and freeing the firm from the threat of major buyers. Interestingly enough, vertical integration is the brainchild of steel tycoon Andrew Carnegie; hence integration in the steel sector is no surprise. Generally speaking it is the steel mill that is integrating either backward to secure scarce resources or forward into the distribution of steel. It was noted earlier that one of the most important points to forward integration is to better understand your customers. Delving into this a bit further, in Teck's case, the technical marketing group works tirelessly to achieve this understanding. Teck does benefit from the long hours that its technical marketing group spends working closely with its customers. The group has developed a fairly comprehensive understanding of the customers' needs. With the purchase of two testing ovens, this knowledge base should improve. One could easily argue that the incremental knowledge gain resulting from a US$750 million investment is not worth the money. Another goal of forward integration is to give the company better oversight of product distribution. When a farmer goes to the market to sell his goods, he knows how it is being marketed, but when he turns his goods over to a distributor, control is lost. Because coke is a very specific input into the steel making process, Teck would not gain much from having better oversight. Steel making is an age old process that has not changed much and will not change for the next 30 years; there is not much to oversee. Distribution control means little in the coke trade (it is going to go to a steel mill); therefore, it is not a significant enough reason to purchase a coke oven. The chart that follows looks at the benefits of vertical integration and whether coke production would provide the benefits to Teck (Strategic Management – March 25, 2011).

Table 9 - Forward Integration Review

Vertical Integration Benefit	Would Coke Production Provide the Benefit to Teck?
Reduce transportation costs	**NO** – transportation costs would increase to get the coal to Chile.
Better taxes, easier contracts / regulations	**NO** – insufficient advantage to Teck
Capture downstream profits	**YES and NO** - downstream profits exist, as set out in the financial analysis, but at the expense of coal profits that will likely be larger
Increase barriers to entry	**NO** – barriers to entry are already significant and would not be influenced by Teck building a coke plant
Gain access to downstream distribution	**NO** – there is little downstream distribution to gain access to (it is a one way street to the steel mills)
Facilitate investment in specialized assets that upstream firms reluctant to invest	**YES** – as noted earlier, if the steel mills are reluctant to invest in additional coke production because they see the raw materials producers and their steel product customers as garnering all the profits, then an opportunity for Teck to invest may exist, especially as coke supplies shrink in answer to increased steel demand
Lead to expansion of core competencies	**NO** – Teck is a miner

Clearly, the advantages of vertical integration for Teck are not overwhelming, but it would provide Teck with a business that is on a separate industry trajectory than its current businesses (Anita McGahan – How Industries Change - Pg 2). Teck, as a miner, is on a creative change trajectory, as its core activities (i.e. its customers) are stable and its core assets are under attack. Teck must continually restore its resource base as it continues to mine. Adding a coke plant would move a portion of the business to a progressive trajectory where neither assets nor activities are threatened. The benefit to Teck is adding a diversified industry with fewer threats that can protect Teck somewhat when resource availability might be in question. This diversification is similar to what zinc refining at the Trail smelter is to Teck's zinc mining.

5.5 Is Teck an Ambidextrous Organization?

The final strategic consideration is if Teck is structured in such a way as to allow a coke plant to prosper. Charles O'Reilly and Michal Tushman (The Ambidextrous Organization – Harvard Business Review, 2004) believe that in order for a company to be successful at growing emerging businesses, it must be structurally set up to do so. Their research followed three different types of structures to see if breakthrough projects were successful. The structures included four basic types: functional design (completely integrated), cross-functional teams (groups operating within the established organization), unsupported teams (independent units outside the organization), and ambidextrous organizations (structurally separate unit integrated into the whole). Their findings showed that ambidextrous organizations were significantly more successful than the other three types.

Is Teck ambidextrous? Teck is organized into business units related to the ore that is being mined. Teck also has an exploration department, a senior VP that is in charge of project development, and a senior VP in charge of business development. Within Teck Coal, the most recent experience in regard to 'new business' has been the work on the feasibility study for resurrecting the Quintette mine and a new mining area know as Marten Wheeler. The feasibility studies were conducted in accordance with the stage-gate process and involved people from different parts of the company coming together in a project team. This is more akin to the cross-functional team defined by O'Reilly and Tushman (2004). Because Quintette and Marten Wheeler are extensions of the current business, the expertise alone should be sufficient enough to achieve success, but Teck does not seem to be ambidextrous. This could have a negative impact on the success of the projects… time will tell. Looking at other projects within Teck, many of them are established as JVs with other companies (i.e. Antimina, Quebrada Blanca, Galore Creek) to share risk and cost. JVs are run as separate entities, but because different companies are involved that have different cultures, a JV cannot be integrated into the whole of Teck. Teck still does not appear to be ambidextrous. The smelter operation at Trail is probably the closest entity that Teck has to suggest that it is capable of being ambidextrous. It is one of the world's largest integrated zinc and lead smelting and

refining complexes and includes the Waneta hydroelectric dam. The operation produces refined zinc and lead, specialty metals, chemicals, and fertilizer products. The dam provides clean and renewable power to the smelter and surplus power is sold through the transmission system to customers in British Columbia and the U.S. (www.teck.com – March 20, 2011). Trail has operated as a separate entity ever since it became part of the Teck. In actuality, not only does Trail suggest that Teck has the propensity to be ambidextrous, but the smelter is an operation that would be comparable to the coke operation. A product is produced and electricity generated – the two are very similar in deed. It becomes evident that the vision of Teck's CEO Don Lindsay does not preclude businesses different from mining and that Teck can run an emerging business ambidextrously.

6: Conclusion

Five hundred million people worldwide will be move to urban centers over the next decade – a staggering truth. China will be developing a Canada a year for the next several years – another staggering truth. In Brazil, over a trillion dollars will be spent on infrastructure as the country prepares to host the world twice in two years. Without a doubt, steel demand will rise, as it will serve as the foundation for infrastructure, means of transportation, and home goods. China has already matched the rest of the world in steel production and that production will rise faster than in any other part of the world. There is no reason to believe that trend will change. India and Brazil have just begun the journey that China started a few years ago. Clearly, the steel industry warrants investment. Teck has already made one investment to ensure its future in the industry. In 2008 Teck purchased the assets of Fording in a $14 billion transaction to capture massive reserves of metallurgical coal used to make coke. Is there room from one more investment? With no technology on the horizon to displace steel, and no technology to displace blast furnace production of pig iron, metallurgical coke will be a valued product for years to come. It may seem counterintuitive to consider investing in an industry that has not changed much in 100 years, but the fundamentals are still there and are still strong. The world has a limited capacity of coke production and demand is increasing for steel. Coke demand must rise. In addition, very few projects are being contemplated around the world to add coke capacity and there is ample room for a new player.

Throughout this paper evidence has been gathered to determine if room truly exists for a new entrant into the coke market and whether an investment is viable. By analyzing the different coke making technologies, it was determined that a technology exists that will not require Teck to compromise its social license to operate. Next, a review of potential countries suggested that there are a number of countries that are coke short and which desire more foreign investment. Chile appears to be the best place for Teck to invest. The most significant factor is that Teck has already established an

excellent relationship with the Chilean government. In addition, Chile has an attractive re-investment tax incentive and foreign investment-friendly policies. The body of the paper set out the Demand Estimation Model. The derived demand sections were reviewed and were believed to be a net positive when estimating demand. The marketing plan forces were a net 'n/a', meaning that it did not add or detract from overall demand. This is interesting because there are a number of indirect and direct competitors, yet none of them are substantial enough to have a negative impact on the demand estimation. Economic value added was a net positive on demand estimation and the market potential (pro-forma analysis) had mixed results, meaning the combined impact was a positive. Lastly, a review of the strategic fit for the coke business within Teck was completed and it too showed mix results. If nothing else, the coke business is very complicated. It is also highly sensitive to the coke price as compared to the coal price. This is an important fact for Teck to consider, because it can alternatively sell more coal into the market. Margins are very close, but if the Chinese continue to impose a 40 percent VAT on coke exports and steel mills continue to purchase what few international merchant coke makers that remain, profits will come. What is needed is available capital and industry knowledge. Teck has both.

In the introduction to this paper it was noted that a final decision will be made on whether or not Teck's management should approach the Board of Directors and request US$500 to US$750 million to build a coke plant. If steel demand continues on the trajectory it is, coke prices will have to rise since additional coke capacity does not exist. The financial analysis becomes more favorable making it hard to believe that entering the coke trade would not be a sound business decision. In fact it would be difficult to argue that coke prices will not rise. Coke is approaching $600 per tonne today (April 2011). That is roughly two times the spot price of coal during a time when a large part of the world is still finding its way through the rubble that the GFC left behind and coking coal is at its highest price ever. Even if increasing coke prices is not the trend, it is critical for Teck to protect the margins it has on its coal products. This will require more knowledge than the company has today. As discussed above, from a strategic fit sense, a coke plant may not fit well within Teck, but the knowledge gain is far more important. Furthermore, the SunCoke technology is likely to become the technology of choice if the environment

is the influencing factor going forward. If that is true, a better understanding of how Teck's coals coke in the SunCoke oven will be necessary. Teck would gain this knowledge and develop a better understanding of the needs of its coal customers if it forward integrates. In addition, Teck would gain a much better understanding of the cost structure of its coke making customers. This would be valuable in coal price negotiations.

The ultimate wildcard, however, is the environment. Although the SunCoke technology has the blessing of the U.S. Clean Air Act, a coke plant is a massive structure and its carbon footprint considerable. A risk exists that is difficult to mitigate. In the past, Teck has used joint ventures to spread risk. In fact, 13 of the past 15 mines that it has built have been through JVs, with 16 different partners (Keevil Speech). Teck uses JVs to be opportunistic when the chance occurs. In order to be a successful JV partner, Teck has developed a reputation for being a good partner who brings knowledge and fairness to the table (Keevil Speech). Spreading the environmental risk is probably required in this day and age. Teck will enter the environmentally challenged industry of the oil sands in the future and it will be looking to share the risk with its partner Suncor, because its sustainability integrity will be questioned. One thing becomes apparent. Teck is not willing to stop doing business in light of environmental pressures – it just wants to do things right. This should mean that entering the coke market is not an impossibility. Another benefit of the JV with Suncor is the sharing of knowledge. Teck can provide the mining experience, but the partnership with Suncor provides downstream experience and understanding in the oil and gas market. In CAP, a partner for Teck in Chile exists that can share the environmental risk and provide downstream knowledge in steel. CAP has already made it clear they will be expanding; therefore, involving a growing steel mill as a partner also limits sales risk. Off-take agreements can be signed. CAP will be looking for some sort of benefit on coke price and will pressure Teck for all of the coke, thereby limiting flexibility. Clearly, trade-offs will be required, but if the goal is to forward integrate for risk mitigation purposes, knowledge, and profit diversification, then the right trade-offs can be made. Dr. Keevil said it himself. "Has the willingness to participate in joint ventures resulted in value creation? It has…"

Appendices

Appendix A – Profit Comparison (5 Year)

Forecasted Coal Price	$230	$200	$200	$175	$150
Operating Expenditure					
	2014	**2015**	**2016**	**2017**	**2018**
Raw Materials	$272,032,500	$236,550,000	$236,550,000	$206,981,250	$177,412,500
Utilities	$2,000,000	$2,040,000	$2,080,800	$2,122,416	$2,164,864
Power (exported)	$(18,000,000)	$(18,360,000)	$(18,727,200)	$(19,101,744)	$(19,483,779)
Fuel Oil	$40,000,000	$40,800,000	$41,616,000	$42,448,320	$43,297,286
Labor	$7,000,000	$7,140,000	$7,282,800	$7,428,456	$7,577,025
Maintenance	$1,000,000	$1,020,000	$1,040,400	$1,061,208	$1,082,432
Stockyard	$4,000,000	$4,080,000	$4,161,600	$4,244,832	$4,329,729
Total	**$308,032,500**	**$273,270,000**	**$274,004,400**	**$245,184,738**	**$216,380,058**

Teck Coal Forecast
(Based on Forecasted Coal Price)

	2014	**2015**	**2016**	**2017**	**2018**
Production	29,500,000	30,000,000	31,500,000	32,000,000	32,000,000
Coke Price	$230	$200	$200	$175	$150
Revenues	**6,785,000,000**	**6,000,000,000**	**6,300,000,000**	**5,600,000,000**	**4,800,000,000**
Operating Expense	(2,950,000,000)	(3,000,000,000)	(3,150,000,000)	(3,200,000,000)	(3,200,000,000)
Gross Profit	**3,835,000,000**	**3,000,000,000**	**3,150,000,000**	**2,400,000,000**	**1,600,000,000**
Gross Margin	57%	50%	50%	43%	33%

Teck Coke Forecast
(Base Case – Coke 1.5x Coal Price)

	2014	**2015**	**2016**	**2017**	**2018**
Production	830,000	830,000	830,000	830,000	830,000
Coke Price	$345.00	$300.00	$300.00	$262.50	$225.00
Revenues	**286,350,000**	**249,000,000**	**249,000,000**	**217,875,000**	**186,750,000**
Operating Expense	(308,032,500)	(273,270,000)	(274,004,400)	(245,184,738)	(216,380,058)
Gross Profit	**(21,682,500)**	**(24,270,000)**	**(25,004,400)**	**(27,309,738)**	**(29,630,058)**
Gross Margin	(8)%	(10)%	(10)%	(13)%	(16)%
Teck Modelled Margin	50%				
Capital Asset Turnover	0.66	0.58	0.58	0.51	0.43
Teck Modelled CAT	0.40				

Teck Coke Forecast
(Best Case - 2.5x)

	2014	**2015**	**2016**	**2017**	**2018**
Production	830,000	830,000	830,000	830,000	830,000
Coke Price	$575.00	$500.00	$500.00	$437.50	$375.00
Revenues	**477,250,000**	**415,000,000**	**415,000,000**	**363,125,000**	**311,250,000**
Operating Expense	(308,032,500)	(273,270,000)	(274,004,400)	(245,184,738)	(216,380,058)
Gross Profit	**169,217,500**	**141,730,000**	**140,995,600**	**117,940,262**	**94,869,942**
Gross Margin	35%	34%	34%	32%	30%
Capital Asset Turnover	1.11	0.96	0.96	0.84	0.72

Teck Coke Forecast
(Worst Case - 1.2x)

	2014	2015	2016	2017	2018
Production	830,000	830,000	830,000	830,000	830,000
Coke Price	$276.00	$240.00	$240.00	$210.00	$180.00
Revenues	**229,080,000**	**199,200,000**	**199,200,000**	**174,300,000**	**149,400,000**
Operating Expense	(308,032,500)	(273,270,000)	(274,004,400)	(245,184,738)	(216,380,058)
Gross Profit	**(78,952,500)**	**(74,070,000)**	**(74,804,400)**	**(70,884,738)**	**(66,980,058)**
Gross Margin	(34)%	(37)%	(38)%	(41)%	(45)%
Capital Asset Turnover	0.53	0.46	0.46	0.40	0.35

Teck Coke and Coal Forecast
(Base Case - 1.5x)

	2014	2015	2016	2017	2018
Production Coke	830,000	830,000	830,000	830,000	830,000
Coke Price	$345.00	$300.00	$300.00	$262.50	$225.00
Production Coal (Modified)	28,317,250	28,817,250	30,317,250	30,817,250	30,817,250
Coal Price	$230.00	$200.00	$200.00	$175.00	$150.00
Revenues	**$6,799,317,500.00**	**$6,012,450,000.00**	**$6,312,450,000.00**	**$5,610,893,750.00**	**$4,809,337,500.00**
Operating Expense	$(3,139,757,500.00)	$(3,154,995,000.00)	$(3,305,729,400.00)	$(3,326,909,738.00)	$(3,298,105,057.76)
Gross Profit	**$3,659,560,000.00**	**$2,857,455,000.00**	**$3,006,720,600.00**	**$2,283,984,012.00**	**$1,511,232,442.24**
Gross Margin	54%	48%	48%	41%	31%

Teck Coke and Coal Forecast
(Best Case - 2.5x)

	2014	2015	2016	2017	2018
Production Coke	830,000	830,000	830,000	830,000	830,000
Coke Price	$575.00	$500.00	$500.00	$437.50	$375.00
Production Coal (Modified)	28,317,250	28,817,250	30,317,250	30,817,250	30,817,250
Coal Price	$230.00	$200.00	$200.00	$175.00	$150.00
Revenues	**$6,990,217,500.00**	**$6,178,450,000.00**	**$6,478,450,000.00**	**$5,756,143,750.00**	**$4,933,837,500.00**
Operating Expense	$(3,139,757,500.00)	$(3,154,995,000.00)	$(3,305,729,400.00)	$(3,326,909,738.00)	$(3,298,105,057.76)
Gross Profit	**$3,850,460,000.00**	**$3,023,455,000.00**	**$3,172,720,600.00**	**$2,429,234,012.00**	**$1,635,732,442.24**
Gross Margin	55%	49%	49%	42%	33%

Teck Coke and Coal Forecast
(Worst Case - 1.5x)

	2014	2015	2016	2017	2018
Production Coke	830,000	830,000	830,000	830,000	830,000
Coke Price	$276.00	$240.00	$240.00	$210.00	$180.00
Production Coal (Modified)	28,317,250	28,817,250	30,317,250	30,817,25	30,817,250
Coal Price	$230.00	$200.00	$200.00	$175.00	$150.00
Revenues	**$6,742,047,500.00**	**$5,962,650,000.00**	**$6,262,650,000.00**	**$5,567,318,750.00**	**$4,771,987,500.00**
Operating Expense	$(3,139,757,500.00)	$(3,154,995,000.00)	$(3,305,729,400.00)	$(3,326,909,738.00)	$(3,298,105,057.76)
Gross Profit	**$3,602,290,000.00**	**$2,807,655,000.00**	**$2,956,920,600.00**	**$2,240,409,012.00**	**$1,473,882,442.24**
Gross Margin	53%	47%	47%	40%	31%

Profit Margin Comparison

	2014	2015	2016	2017	2018
Teck Coal	57%	50%	50%	43%	33%
Teck Coal Base	-8%	-10%	-10%	-13%	-16%
Teck Coal Best	35%	34%	34%	32%	30%
Teck Coal Worst	-34%	-37%	-38%	-41%	-45%
Teck Coal and Coke Base	54%	48%	48%	41%	31%
Teck Coal and Coke Best	55%	49%	49%	42%	33%
Teck Coal and Coke Worst	53%	47%	47%	40%	31%
Teck Modelled	50%				

Appendix B – NPV Analysis (20 Year)

Heat Recovery Coke Oven Project NPV

Capital Expenditure	2011	***Assumptions:***
Coke Plant	$400,000,000	*Assume 2% rate of inflation*
Power Plant	$31,000,000	*3 year project start up*
Fuel Storage and Distribution	$1,000,000	*produce coke in 2014*
Construction	$77,000,000	*labour at 0 in first year, 25% for year 2, and 50% for year three*
		need to buy some coal in 2013 to be ready for 2014
Total	**$509,000,000**	*raw material is hard coking coal only*

Operating Expenditure

	U	**2011**	**2012**	**2013**	**2014**	**2015**
Raw Materials	$	-	-	35,000,000	272,032,500	236,550,000
Utilities	$	-	-	-	2,000,000	2,040,000
Power (exported)	$	-	-	-	(18,000,000)	(18,360,000)
Fuel Oil	$	-	-	-	40,000,000	40,800,000
Labor	$	-	1,750,000	3,500,000	7,000,000	7,140,000
Maintenance	$	-	-	-	1,000,000	1,020,000
Stockyard	$	-	-	-	4,000,000	4,080,000
Total	**$**	-	**1,750,000**	**38,500,000**	**308,032,500**	**273,270,000**
OPEX per MT	**$/t**	-	-	-	**371**	**$329**
Revenue						
Coke Production	MT				830,000	830,000
Required Coal (1.4*coke)	MT			140,000	1,182,750	1,182,750
Coal price	$	300	270	250	230	200
Raw Materials Cost	$	-	-	35,000,000	272,032,500	236,550,000
Coke Price - Base	$	450	405	375	345	300
Coke Price - Good	$	600	540	500	460	400
Coke Price - Worst	$	360	324	300	276	240
Coke Price - Best	$	750	675	625	575	500
Revenue Good	$	-	-	-	$381,800,000	$332,000,000
Revenue Base	$	-	-	-	$286,350,000	$249,000,000
Revenue Worst	$	-	-	-	$229,080,000	$199,200,000
Revenue Best	$	-	-	-	$477,250,000	$415,000,000
Profit Good	$	(509,000,000)	(1,750,000)	(38,500,000)	73,767,500	58,730,000
Profit Base	$	(509,000,000)	(1,750,000)	(38,500,000)	(21,682,500)	(24,270,000)
Profit Worst	$	(509,000,000)	(1,750,000)	(38,500,000)	(78,952,500)	(74,070,000)
Profit Best	$	(509,000,000)	(1,750,000)	(38,500,000)	169,217,500	141,730,000
Profit Base - Split CAPEX (3 years)	$	(169,666,667)	(171,416,667)	(208,166,667)	(21,682,500)	(24,270,000)
Profit Margin-Base	$/t	-	-	-	(26)	(29)
Profit MarginWorst	$/t	-	-	-	(95)	(89)
Profit Margin-Good	$/t	-	-	-	89	71
Profit Margin-Best	$/t	-	-	-	204	171

Operating Expenditure

	U	2016	2017	2018	2019	2020
Raw Materials	$	236,550,000	206,981,250	177,412,500	153,757,500	153,757,500
Utilities	$	2,080,800	2,122,416	2,164,864	2,208,162	2,252,325
Power (exported)	$	(18,727,200)	(19,101,744)	(19,483,779)	(19,873,454)	(20,270,924)
Fuel Oil	$	41,616,000	42,448,320	43,297,286	44,163,232	45,046,497
Labor	$	7,282,800	7,428,456	7,577,025	7,728,566	7,883,137
Maintenance	$	1,040,400	1,061,208	1,082,432	1,104,081	1,126,162
Stockyard	$	4,161,600	4,244,832	4,329,729	4,416,323	4,504,650
Total	**$**	**274,004,400**	**245,184,738**	**216,380,058**	**193,504,409**	**194,299,347**
OPEX per MT	**$/t**	**330**	**295**	**261**	**233**	**234**
Revenue						
Coke Production	MT	830,000	830,000	830,000	830,000	830,000
Required Coal (1.4*coke)	MT	1,182,750	1,182,750	1,182,750	1,182,750	1,182,750
Coal price	$	200	175	150	130	130
Raw Materials Cost	$	236,550,000	206,981,250	177,412,500	153,757,500	153,757,500
Coke Price - Base (1.5 times coal)	$	300	263	225	195	195
Coke Price - Good (2 times coal)	$	400	350	300	260	260
Coke Price - Worst (1.2 times coal)	$	240	210	180	156	156
Coke Price - Best (2.5 times coal)	$	500	438	375	325	325
Revenue Good	$	332,000,000	290,500,000	249,000,000	215,800,000	215,800,000
Revenue Base	$	249,000,000	217,875,000	186,750,000	161,850,000	161,850,000
Revenue Worst	$	199,200,000	174,300,000	149,400,000	129,480,000	129,480,000
Revenue Best	$	415,000,000	363,125,000	311,250,000	269,750,000	269,750,000
Profit Good	$	57,995,600	45,315,262	32,619,942	22,295,591	21,500,653
Profit Base	$	(25,004,400)	(27,309,738)	(29,630,058)	(31,654,409)	(32,449,347)
Profit Worst	$	(74,804,400)	(70,884,738)	(66,980,058)	(64,024,409)	(64,819,347)
Profit Best	$	140,995,600	117,940,262	94,869,942	76,245,591	75,450,653
Profit Base - Split CAPEX	$	(25,004,400)	(27,309,738)	(29,630,058)	(31,654,409)	(32,449,347)
Profit Margin – Base	$/t	(30)	(33)	(36)	(38)	(39)
Profit Margin – Worst	$/t	(90)	(85)	(81)	(77)	(78)
Profit Margin – Good	$/t	70	55	39	27	26
Profit Margin – Best	$/t	170	142	114	92	91

Operating Expenditure

	U	2021	2022	2023	2024	2025
Raw Materials	$	153,757,500	153,757,500	153,757,500	153,757,500	153,757,500
Utilities	$	2,297,371	2,343,319	2,390,185	2,437,989	2,486,749
Power (exported)	$	(20,676,342)	(21,089,869)	(21,511,666)	(21,941,900)	(22,380,738)
Fuel Oil	$	45,947,427	46,866,375	47,803,703	48,759,777	49,734,972
Labor	$	8,040,800	8,201,616	8,365,648	8,532,961	8,703,620
Maintenance	$	1,148,686	1,171,659	1,195,093	1,218,994	1,243,374
Stockyard	$	4,594,743	4,686,638	4,780,370	4,875,978	4,973,497
Total	**$**	**195,110,184**	**195,937,238**	**196,780,832**	**197,641,299**	**198,518,975**
OPEX per MT	**$/t**	**235**	**236**	**237**	**238**	**239**
Revenue						
Coke Production	MT	830,000	830,000	830,000	830,000	830,000
Required Coal (1.4*coke)	MT	1,182,750	1,182,750	1,182,750	1,182,750	1,182,750
Coal price	$	130	130	130	130	130
Raw Materials Cost	$	153,757,500	153,757,500	153,757,500	153,757,50	153,757,500
Coke Price - Base (1.5 times coal)	$	195	195	195	195	195
Coke Price - Good (2x)	$	260	260	260	260	260
Coke Price - Worst (1.2x)	$	156	156	156	156	156
Coke Price - Best (2.5x)	$	325	325	325	325	325
Revenue Good	$	215,800,000	215,800,000	215,800,000	215,800,000	215,800,000
Revenue Base	$	161,850,000	161,850,000	161,850,000	161,850,000	161,850,000
Revenue Worst	$	129,480,000	129,480,000	129,480,000	129,480,000	129,480,000
Revenue Best	$	269,750,000	269,750,000	269,750,000	269,750,000	269,750,000
Profit Good	$	20,689,816	19,862,762	19,019,168	18,158,701	17,281,025
Profit Base	$	(33,260,184)	(34,087,238)	(34,930,832)	(35,791,299)	(36,668,975)
Profit Worst	$	(65,630,184)	(66,457,238)	(67,300,832)	(68,161,299)	(69,038,975)
Profit Best	$	74,639,816	73,812,762	72,969,168	72,108,701	71,231,025
Profit Base - Split CAPEX	$	(33,260,184)	(34,087,238)	(34,930,832)	(35,791,299)	(36,668,975)
Profit Margin (Coke - Base)	$/t	(40)	(41)	(42)	(43)	(44)
Profit Margin (Coke - Worst)	$/t	(79)	(80)	(81)	(82)	(83)
Profit Margin (Coke - Good)	$/t	25	24	23	22	21
Profit Margin (Coke - Best)	$/t	90	89	88	87	86

Operating Expenditure

	U	2026	2027	2028	2029	2030
Raw Materials	$	153,757,500	153,757,500	153,757,500	153,757,500	153,757,500
Utilities	$	2,536,484	2,587,213	2,638,958	2,691,737	2,745,571
Power (exported)	$	(22,828,352)	(23,284,919)	(23,750,618)	(24,225,630)	(24,710,143)
Fuel Oil	$	50,729,672	51,744,265	52,779,151	53,834,734	54,911,428
Labor	$	8,877,693	9,055,246	9,236,351	9,421,078	9,609,500
Maintenance	$	1,268,242	1,293,607	1,319,479	1,345,868	1,372,786
Stockyard	$	5,072,967	5,174,427	5,277,915	5,383,473	5,491,143
Total	**$**	**199,414,205**	**200,327,339**	**201,258,735**	**202,208,760**	**203,177,785**
OPEX per MT	**$/t**	**240**	**241**	**242**	**244**	**245**
Revenue						
Coke Production	MT	830,000	830,000	830,000	830,000	830,000
Required Coal (1.4*coke)	MT	1,182,750	1,182,750	1,182,750	1,182,750	1,182,750
Coal price	$	130	130	130	130	130
Raw Materials Cost	$	153,757,500	153,757,500	153,757,500	153,757,500	153,757,500
Coke Price - Base (1.5 times coal)	$	195	195	195	195	195
Coke Price - Good (2 times coal)	$	260	260	260	260	260
Coke Price - Worst (1.2 times coal)	$	156	156	156	156	156
Coke Price - Best (2.5 times coal)	$	325	325	325	325	325
Revenue Good	$	215,800,000	215,800,000	215,800,000	215,800,000	215,800,000
Revenue Base	$	161,850,000	161,850,000	161,850,000	161,850,000	161,850,000
Revenue Worst	$	129,480,000	129,480,000	129,480,000	129,480,000	129,480,000
Revenue Best	$	269,750,000	269,750,000	269,750,000	269,750,000	269,750,000
Profit Good	$	16,385,795	15,472,661	14,541,265	13,591,240	12,622,215
Profit Base	$	(37,564,205)	(38,477,339)	(39,408,735)	(40,358,760)	(41,327,785)
Profit Worst	$	(69,934,205)	(70,847,339)	(71,778,735)	(72,728,760)	(73,697,785)
Profit Best	$	70,335,795	69,422,661	68,491,265	67,541,240	66,572,215
Profit Base - Split CAPEX	$	(37,564,205)	(38,477,339)	(39,408,735)	(40,358,760)	(41,327,785)
Profit Margin (Coke - Base)	$/t	(45)	(46)	(47)	(49)	(50)
Profit Margin (Coke Worst)	$/t	(84)	(85)	(86)	(88)	(89)
Profit Margin (Coke - Good)	$/t	20	19	18	16	15
Profit Margin (Coke - Best)	$/t	85	84	83	81	80

NPV Results:

Hurdle Rate	%	10	15	
NPV Good	$	(275,944,667)	(311,414,227)	
IRR Good	%	(2)		
NPV Base	$	(677,322,522)	(586,389,288)	
NPV Worst	$	(755,006,603)	(751,374,325)	
NPV Best	$	125,433,188	(36,439,166)	*Would be positive if split CAPEX*
IRR Best	%	14		
NPV Base - Split CAPEX	$	(636,531,137)	(531,167,787)	

Bibliography

Works Cited

Brandenburger, Adam M. and Nalebuff, Barry J., The Right Game: Use Game Theory to Shape Strategy, Harvard Business Review (July-August 1995), 1995.

Fraser Institute Annual Survey of Mining Companies (2010/2011), Fred McMahon and Miguel Cervantes, 2010/2011.

Gahan, Anita. How Industries Change, Harvard Business Review, Vol. 82, Issue 10 (Oct 2004).

Geerdes, M., van-Laar, Reinoud, and Vaynshteyn, Roman, Low-Cost Hot Metal: The Future of Blast Furnace Ironmaking, This Paper was presented at the AISTech 2010 – The Iron and Steel Technology Conference and Exposition, Pittsburgh, PA., and Published in the Conference Proceedings.

Keevil, Norman B. (Chairman – Teck Resources Limited), Wealth Creation Through Joint Ventures, Presented at the 2006 SEG Conference, May 15, 2006.

Meredith, Lindsay, A Diagrammatical Template for Business Market Demand Estimation, Industrial Marketing Management 35, Pages 431 – 445, 2006.

O'Reilly, Charles A. and Tushman, Michael L., The Ambidextrous Organization, Harvard Business Review (April 2004), 2004.

Porter, Michael E., The Five Competitive Forces That Shape Strategy, Harvard Business Review (January 2008), 2008.

Porter, Michael E., What is Strategy?, Harvard Business Review (November - December 1996), 1996.

Professors: Khanna, Tarun, Musacchio, Aldo, and Reisen De Pinho, Ricardo, Case Study – Vale: Global Expansion in the Challenging World of Mining, Harvard Business School (June 30, 2010), 2010.

Scotiabank Global Auto Report, Global Economic Research, February 25, 2011.

The Iron Ore Market (2009 – 2011), United Nations Conference on Trade and Development Trust Fund Project on Iron Ore Information (June 2010).

Towsey, Paul S., Cameron, Ian, and Gordon, Yakov, (Hatch Ltd. Of Mississauga, ON) Comparison of Byproduct and Heat-Recovery Cokemaking Technologies, This Paper was presented at the AISTech 2010 – The Iron & Steel Technology Conference and Exposition, Pittsburgh, PA., and published in the Conference Proceedings.

http://www.ibtimes.com/articles/122057/20110313/pdac-2011-the-return-of-chile.htm

http://www.infoplease.com/ipa/A0107357.html

http://www.koreatimes.co.kr/www/news/nation/2010/02/117_58699.html

hhtp://en.mercopress.com/2011/02/08/chile-exports-increase-30-in-2010-led-by-copper-and-lumber-sales

http://mercopress.com/2009/07/30/chilean-copper-industry-recovers-and-regains-over-half-lost-jobs

http://m24digital.com/en/2011/03/19obama-praised-brazils-economic-growth-in-a-meeting-with-dilma-rouseff/

http://www.doingbusiness.org (The World Bank International Finance Corporation)

http://www.dredgingtoday.com/2010/10/19/chiles-ports-to-reach-its-maximum-capacity-by-2014/

http://www.huffingtonpost.com/ann-murray/chiles-president-pinera-n_b_722135.html

http://www.internetworldstats.com/sa/br.html

http://laht.com (Latin America Herald Tribune – March 11, 2011, Brazil - Cell Phones)

http://www.metalbulletin.com/Article/2760600/ThyssenKrupp-CSA-to-invest-60-million-to-reduce-dust-emission-in-Brazil.html

http://www.nationsencyclopedia.com/Americas/Brazil – The Encyclopedia of Nations (February and March 2011)

http://www.nationsencyclopedia.com/Americas/Chile – The Encyclopedia of Nations (February and March 2011)

http://pittsburghlive.com/x/pittsburghtrib/business/s_694927.html

http://www.prb.org/Datafinder/Geography/Summary.aspx?region=105&region_type=2

http://www.quickmba.com/strategy/vertical-integration (March 2011)

http://www.state.gov/e/eeb/rls/othr/ics/2009/117415.htm (March 2011), U.S. Department of State – Diplomacy in Action – 2009 Investment Statement – Brazil

http://www.state.gov/e/eeb/ifd/2008/101854.htm (March 2011), U.S. Department of State Chile – Openness to Foreign Investment, 2008 Investment Climate Statement

http://www.steelbb.com/us/login/?r=%2Fus%2F%3FPageID%3D157%26article_id%3D89025

http://www.steelguru.com/international_news/ThyssenKrupp_Brazil_unit_CSA_fined_for_environmental_damage/185231.html

http://www.online.wsj.com/article/BT-CO-20110319-701020.html

http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/CHILEEXTN/0,,contentMDK:22255176~pagePK:1497618~piPK:217854~theSitePK:325273,00.html

http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/BRAZILEXTN/0,,menuPK:322351~pagePK:141132~piPK:141107~theSitePK:322341,00.html

http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2010-11.pdf

Interviews

Paul Armstrong, MBA / PEng (Interviews conducted during January – April 2011). Director, Teck Coal Limited – Coal Marketing. Former Investor Relations Director for Fording Canadian Coal Trust.

Corey Caville, BComm (Finance) (Interviews conducted during January – April 2011). Market Research Analyst, Teck Coal Limited.

Cornelis Kolijn (Interviews conducted during January – April 2011). Manager, Teck Coal Limited – Technical Marketing; formerly of Hoogovens Ijmuiden B.V. as a coal blend specialist for the coke plant. Published works at McMaster University on coke making and coal quality (Canadian Carbonization Research Association – committee member).

Bernhard Luemmen (Interviews conducted during January – April 2011). Principle – Blue Carbon GmBH & Co.KG. Teck's Coal Market Agent in Germany since 2000. 26 years of coal and coke experience. Currently consults for Oxbow Coal B.V. and was formerly with AMCI, RAG (1 year in Australia), and SSM.

Edwin Shadeo, CFA (Interviews conducted during January – April 2011). Manager, Investor Relations, Teck Resources Limited. Former Senior Market Analyst for Teck Coal Limited.

Tayfun Zehir (PEng) - (Interviews conducted during January – April 2011). General Manager, Teck Coal Limited – Coal Marketing and Technical Marketing; prior experience in coke sales and coke plant coal blending. Former V.P. Marketing for Smoky River Coal. Masters – Mine Engineering. Coal and coke industry expert.

Company Documents

CAP Investor Presentation Slides (June 8, 2010)

Committed to the Core – Teck Resources Limited 2010 Annual Report

Setting Possibilities in Motion – More Than 40 Years of Reclamation Research at Teck's Coal Mines (2010 Sustainability Report)

Teck Resources Limited – Investor Presentation Slides including CRU Analysis and AME Group data provided to Teck under subscription (www.teck.com)

Teck Resources Limited – Stage-gate Process Outline Document

Works Consulted

Barney, Jay B., Looking Inside for Competitive Advantage, Academy of Management Executive, (Vol. 9, No. 4), 1995.

Christensen, Clayton M. and Overdorf, Michael, Meeting the Challenge of Disruptive Change, Harvard Business Review – March-April 2000, 2000.

Hu, Yao-Su, The International Transferability of the Firm's Advantages, California Management Review (Vol. 37, No. 4), 1995.

Hutt, Michael D. and Speh Thomas W., Business Marketing Management: B2B, Tenth Edition, South-Western Cengage Learning, 2010.

Pisano, Gary P. and Teece, David J., How to Capture Value from Innovation: Shaping Intellectual Property and Industry Architecture, California Management Review (Vol. 50, No.1), 2007.

Smyth, J.E., Soberman, D.A., and Eason, A.J., The Law and Business Administration in Canada, Eleventh Edition, Pearson Prentice Hall, 2007.

Websites Reviewed

www.ame.com.au

www.amm.com (American Metal Market)

www.carbonyx.com

www.cap.cl/eng

www.cim.org

www.crugroup.com

www.doingbusiness.org

www.dredgingtoday.com

www.fraserinstitute.org (Survey of Mining Companies)

www.huffingtonpost.com

www.imf.org

www.internetworldstats.com

www.ipsnews.net

www.laht.com

www.metalbulletin.com

www.mineweb.com

www.petrobras.com

www.pittsburghlive.com

www.prb.org

www.posco.co.kr

www.reuters.com

www.strategicmanagement.net

www.steelbb.com

www.steelguru.com

www.steelonthenet.com

www.suncoke.com

www.tata.com

www.teck.com

www.ussteel.com

www.vale.com

www.wsj.com

www.worldbank.org

www.worldcoal.org

www.weforum.org (World Economic Forum – Competitiveness Report)