Financial Viability of Standalone Wood Pellet Production Using Pine Beetle Fibre

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ABSTRACT

Northern British Columbia is experiencing an infestation of epidemic proportions from the mountain pine beetle. The British Columbia Provincial and Canada Federal Governments have proposed that uses other than dimensional lumber should be encouraged to maximise the economic value of the dying and dead lodgepole pine. Future wood pellet production facilities would need to become standalone and utilise whole trees as a source of wood fibre inputs. The primary objective of this study was to examine the financial viability of a Northern British Columbia standalone wood pellet production facility located in Prince George when fibre input comes from primary harvesting using a whole mountain pine beetle-killed lodgepole pine tree. The secondary objective was to understand whether incentives by way of stumpage relief provided by the Government of British Columbia would provide financial viability of a standalone wood pellet production facility. Data obtained from the British Columbia Ministry of Forests and Range, Wood Pellets Association of Canada, and European Pellet Centre was used to project cash flow for five, seven, and ten-year baseline, realistic, pessimistic, and optimistic scenarios. Analysis was done using net present value of cash flows with an annual 8.9% return requirement. In all but the optimistic scenario it was proven that a standalone wood pellet production facility was not financially viable. It was further determined that mountain pine beetle-killed lodgepole pine was already assessed the lowest stumpage rate and further relief would have no bearing on the financial viability of a standalone wood pellet production facility. Government encouragement of additional wood pellet production facilities would require direct or indirect subsidies aimed at capital costs and taxation relief.

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1 CHAPTER ONE – INTRODUCTION

It is generally accepted in the forest sector in Northern British Columbia that standalone wood pellet production facilities are not financially viable without harvesting, transportation, and primary processing costs being incurred by a dimensional lumber sawmill. Trees harvested for dimensional lumber purposes are transported from the forest to a sawmill with maximum utilization of the log for production of dimensional lumber. Production of dimensional lumber incurs all of the initial tree harvesting and log transportation costs. Waste fibre from the production of dimensional lumber can then be economically transported and processed in a secondary processing facility such as finger-jointing, pulp, or wood pellets.

Northern British Columbia has been undergoing an infestation epidemic from the mountain pine beetle that started in 1993. It is expected that approximately eighty percent of all lodgepole pine in Northern British Columbia will be dead by 2013 (Ministry of Forests and Range 2006a). The quality of mountain pine beetle-killed fibre degrades after the initial attack, eventually making it unsuitable for processing into dimensional lumber applications (Byrne, Stonestreet and Peter 2005). Significant excess inventory of dead standing mountain pine beetle-killed lodgepole pine is available in the working forest in Northern British Columbia. There is an opportunity for traditional secondary manufacturers such as wood pellet producers to become primary manufacturers if the costs of harvesting, transporting, and processing this dead standing fibre are economically viable. Without an economically viable harvesting solution, there is unlikely to be immediate reforestation and instead the forest will have to rely on natural regeneration to replenish the dead fibre. This is a waste of merchantable standing timber today and further delays the recovery of the forests that both provide employment and act as natural carbon sinks to counteract the effects of pollution and global warming.

The purpose of my study is to determine whether a traditionally secondary manufacturer, a wood pellet producer located in Prince George, British Columbia, could become a primary manufacturer using mountain pine beetle-killed fibre that is no longer suitable for dimensional lumber production.

1.1 BACKGROUND

Production of dimensional lumber from spruce, pine, and fir trees has been the primary industry in Northern British Columbia for decades. The industry has been cyclical in nature, expanding and contracting, following the ebb and flow of the North American economy. The forestry practices in this region are sustainable with a cut-cycle of approximately one-hundred years. A typical spruce, pine, or fir stand reaches a maturity level for harvesting in approximately eighty years creating a natural twenty-year buffer in the standing merchantable timber in Northern British Columbia's forests.

In 1993, the health of Northern British Columbia's forests began to change. An infestation of the mountain pine beetle, *Dendroctonus ponderosae*, in lodgepole pine, *Pinus contorta*, became evident and rapidly increased in magnitude. A combination of fire prevention activities and warmer than normal temperatures during winter lead the infestation to be able to increase in size and eventually begin a rapid expansion into the merchantable standing timber used as the source for lumber production (Gawalko 2004).

In 2006, British Columbia's merchantable mature lodgepole pine was approximately 1.8 billion cubic metres with over 400 million cubic metres already killed by the mountain pine beetle (Ministry of Forests and Range 2007a). Approximately thirty-seven percent of the merchantable standing timber in the Prince George Timber Supply Area is lodgepole pine (Ministry of Forests and Range 2007a). It is expected by 2013 over eighty percent of lodgepole pine will have been killed by the mountain pine beetle. Standing beetle-killed timber may only have a useful life for dimensional lumber of between one and three years post-beetle (Byrne, Stonestreet and Peter 2005).

Currently the British Columbia Ministry of Forests and Range has allocated an Allowable Annual Cut (AAC) of all merchantable standing timber species of almost 69 million cubic metres per year (Ministry of Forests and Range 2007b). There is a projected 1.44 billion cubic metres of merchantable standing lodgepole pine being dead by 2013. Estimates are that it will have a useful life no later than 2016 for late beetle-killed timber. There would be an estimated surplus over the next ten-years of 750 million cubic metres, assuming a harvest of only beetle-killed lodgepole pine. Current regulations and uses cannot utilise this surplus. This equates to a minimum of eleven years of merchantable standing timber that will be dead or dying and will not be suitable for production of dimensional lumber.

In actuality, beetle-killed lodgepole pine only amounts to about seventy-one percent (Ministry of Forests and Range 2007a) of actual annual harvest in the Prince George Timber Supply area. Thus, there is a supply of almost one billion cubic metres available for alternative production, assuming financial viability of the alternate uses.

1.2 OBJECTIVES

The objectives of this study are as follows:

1) The financial viability of a Northern British Columbia standalone wood pellet production facility located in Prince George when fibre input comes from primary harvesting using a whole mountain pine beetle-killed lodgepole pine tree.

2) Whether incentives by way of stumpage relief provided by the Government of British Columbia would provide financial viability of a standalone wood pellet production facility.

2 CHAPTER TWO – BACKGROUND OF WOOD PELLET PRODUCTION

The greatest challenge faced by an industry asked to find alternative uses of mountain pine beetle-killed fibre is the economic implications of those uses. The majority of alternative uses such as pulp, wood pellets, and bioenergy have not proven successful unless paired with a primary dimensional lumber sawmill that typically obtains the highest recovery rates and economic value from a log.

The current mountain pine beetle infestation has presented three main challenges to the forest industry:

1) Burning in the bush is normal practice for waste fibre from branches and tops with a diameter less than five-and-a-half inches (Ministry of Forests and Range 2006b). The majority of tenure holders view this waste as not economically viable to transport out of the bush for alternative uses. Faced with a smaller log profile, Daishowa-Marubeni International Ltd (DMI) of Peace River Alberta is one of the few companies utilizing in-bush chipping as a source of chips for pulp purposes (Tice 2005). The lodgepole pine waste left in the bush is similar in profile to the fibre chipped by DMI and could be used as a model for alternative consumers such as wood pellet producers to source their raw material.

2) Mountain pine beetle fibre is drying in the bush and becoming less dense (Lewis and Hartley 2005) which impacts the use in traditional primary manufacturing facilities to produce dimensional lumber (Byrne, Stonestreet and Peter 2005). As the moisture

content in the wood decreases, it begins to check, or crack, into the heart of the log. As these checks get deeper and wider they reduce the amount of wood that can be sawn into lumber and can cause logs to fracture in the head saw of a sawmill causing delays to clear the log and reduced efficiencies.

3) Transportation of a log is by way of loading it into bunks on a special trailer designed to hold them. Transporters earn their income based on a tonne-hour calculation that compensates them based on the estimated cycle time and weight of each load of logs they are transporting. The loss of density in the mountain pine beetle-killed lodgepole pine logs presents profitability issues for transporters (Jokai 2006). If transporters are going to maintain financial viability there needs to be considerations of increased tonne-hour parameters or greater volume loads on trailers to create incentives for transporters to haul greater volumes of mountain pine beetle-killed fibre.

These industry issues have solutions but involve increased costs for the producer. Traditional producers are seeing their source of pine becoming less attractive for production inputs. This leaves a significant volume of merchantable standing timber in the forest that does not have a destination for consumption. Ultimately, the Government of British Columbia and the industry need to find financially viable alternative uses of this fibre to ensure both a commercial application and regeneration of the working forest for future economic opportunities.

2.1 MARKET OPPORTUNITY

The North American and European wood pellet market consumed an estimated six million tonnes of wood pellets per annum in 2006 and is expected to expand to about sixteen million tonnes by 2010 (Swaan 2006). North America is a small component of the market consuming approximately 1.6 million tonnes in 2006 and projected out to approximately 3.2 million tonnes by 2010. Europe consumed approximately 4.5 million in 2006 and projected to consume approximately 12.75 million tonnes by 2010.

In 2006, North America had a production surplus of approximately one million tonnes while Europe had a two million tonne deficit (Swaan 2006). From 2001 through to 2006, Europe had an average consumption growth of 23.8% (Figure 2-1) with production growth averaging 24.9% (Figure 2-2). The deficit growth between production and consumption during the same period averaged 22.8%

Figure 2-1: European Wood Pellet Consumption
Source: computed using data from European Pellet Centre

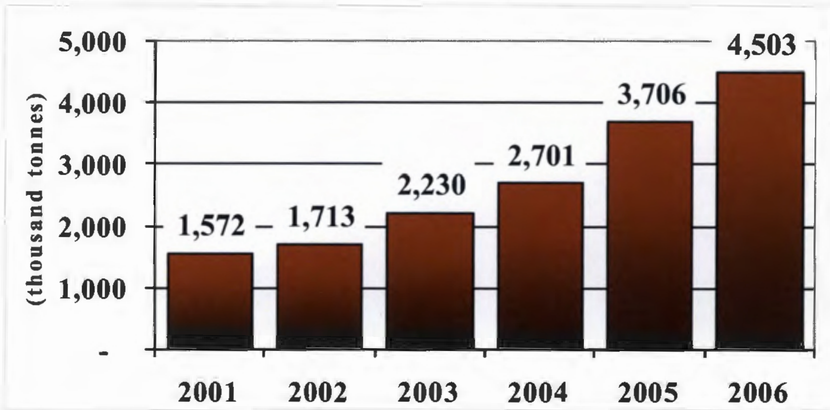
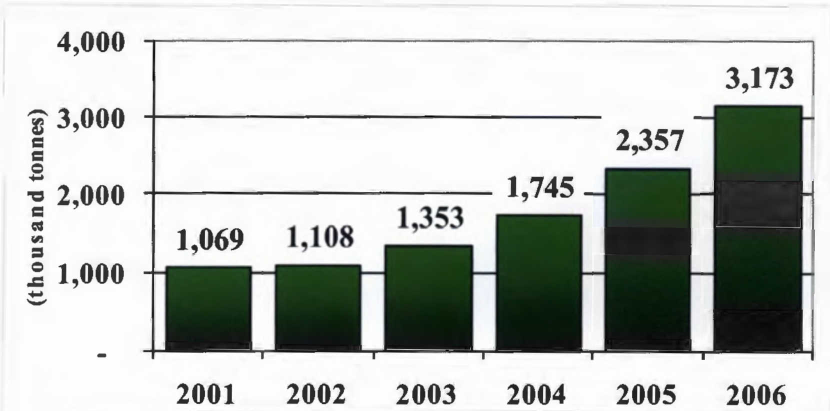
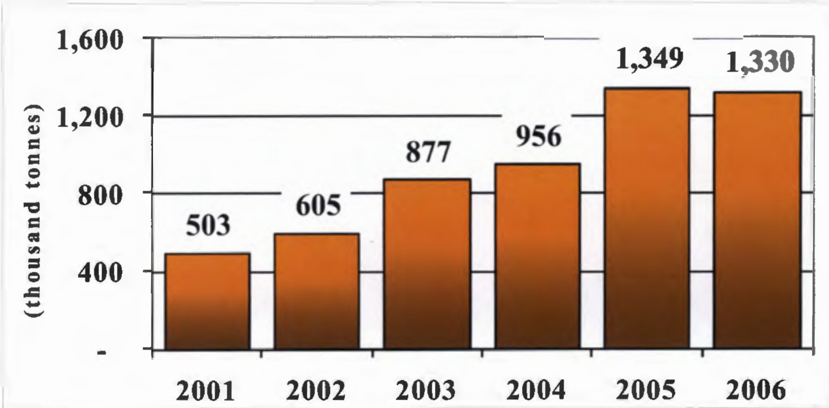


Figure 2-2: European Wood Pellet Production
Source: computed using data from European Pellet Centre



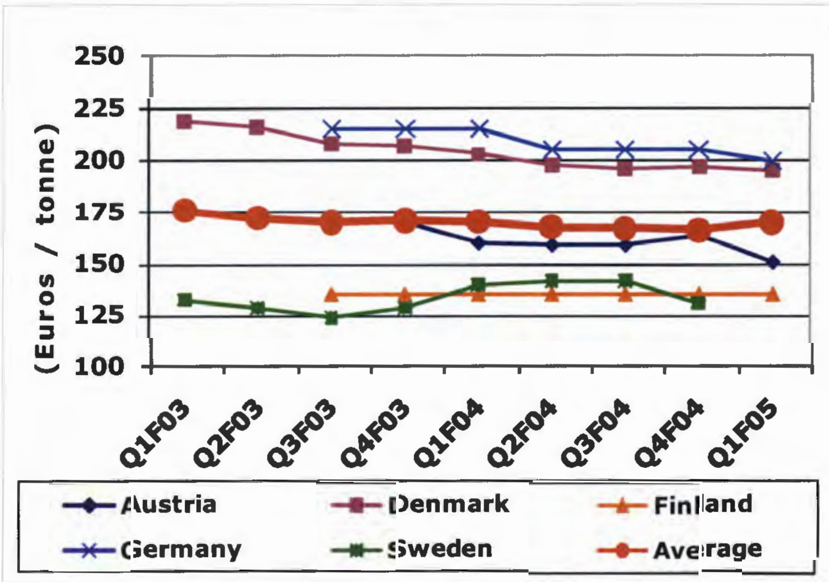
with a lower consumption growth rate in 2006 causing a slight decrease in the deficit (Figure 2-3). Estimates are that Europe will continue to have a deficit of production reaching almost two million tonnes by 2010. Currently Europe imports only about 12% of its total consumption (Swaan 2006). The expected growth in the production deficit provides a great opportunity for new Northern British Columbia based producers to enter the European market.

Figure 2-3: European Wood Pellet Production Deficit
Source: computed using data from European Pellet Centre



Five countries in Europe primarily make up the bulk wood pellet market – Austria, Denmark, Finland, Germany, and Sweden. Consumer prices in each country have a varying levels of cost but stayed relatively

Figure 2-4: European Retail Wood Pellet Price per Tonne
Source: computed using data from European Pellet Centre



static from 2003 through to the first quarter of 2005 (Figure 2-4). The average retail price during this period for one tonne of wood pellets in bulk was €169.

2.2 STATUS OF PELLET PRODUCTION IN NORTHERN BRITISH COLUMBIA

The pellet production competition in Northern British Columbia is relatively small with only three companies operating in the region – Pinnacle Pellet Inc. (Quesnel & Houston), Premium Pellet Ltd. (Vanderhoof), and Pacific BioEnergy Corporation (Prince George). A fourth company, TallOil Canada (Vanderhoof & Prince George) had committed to construction of two wood pellet production facilities but has not completed either (Karidio 2007). More recently, Pinnacle Pellet Inc. purchased TallOil Canada to join that company's operations (Pinnacle Pellet Inc. 2008). These companies are privately held with the exception of a joint venture between Pinnacle Pellet and Canfor Corporation in Houston.

All of the operating wood pellet production facilities have arrangements with dimensional lumber sawmills and utilize the waste material from them. Sourcing wood waste fibre material is a highly competitive market with an increasing demand from the pulp and paper production facilities in Northern British Columbia due to declining dimensional lumber production and increasing world pulp prices. There are no known wood pellet production facilities in Northern British Columbia that operate on a standalone basis using chipped whole logs as a source of input.

The majority of the wood pellet production from Northern British Columbia is sold to the European market in bulk form. Typically, this is under long-term purchase contracts with wholesalers or governments in the European market. The deficit in the European production market has created great opportunities for low-cost wood pellet producers in Northern British Columbia and has not created significant competitive pressure among the companies. An additional competitor in Northern British Columbia producing 150,000 tonnes annually will not have significant difficulties in obtaining access to European consumption demand nor significant competitive pressure from existing producers.

2.3 ENVIRONMENTAL BENEFITS

Wood pellets are created through a process that involves a high-temperature combustion process used to form the materials into a pellet without the need of additives or glues to bind them into shape (Wood Pellet Association of Canada 2007). The consumption of wood pellets does not contribute to particulate pollution in the atmosphere and the carbon dioxide released during combustion is considered carbon neutral under the Kyoto Protocol (Swaan 2007). Consumption of a tree, whether through combustion or natural decay, releases carbon back into the atmosphere to be absorbed by new trees as they grow. The production and consumption of wood pellets as a renewable resource is a part of a natural cycle that exists in nature.

The major devastation caused by the current mountain pine beetle infestation in Northern British Columbia has interrupted the natural cycle of a renewable resource. Huge hectares of dead lodgepole pine trees are in the forest release carbon into the atmosphere as they decay. The death of so many trees within a short period leads to the forest both releasing significant amounts of carbon into the atmosphere because of a lack of regenerating trees and no longer acting as a carbon sink by absorbing the carbon. The lack of such a large carbon sink acting against carbon in the atmosphere does have implications for global warming. Proactive pursuit of alternative applications for consumption of mountain pine beetle-killed lodgepole pine and thereafter regeneration efforts will restore the absorption of carbon in British Columbia's forests (Ames 2000).

2.4 GOVERNMENT POLICIES

In 2006, the British Columbia Provincial government issued its Mountain Pine Beetle Action Plan (Ministry of Forests and Range 2006a). This action plan has seven core objectives with the third objective relating directly to the economics of forestry in mountain pine beetle infested areas, "Recover the greatest value from dead timber before it burns or decays, while respecting other forest values." This objective is consistent with the need to find commercially viable alternative applications for using mountain pine beetle-killed lodgepole pine. The government may need to provide incentives or subsidies to obtain value for timber that is no longer suitable for production of dimensional lumber.

This objective is the basis for the British Columbia Provincial Government and Canadian Federal Government to promote expansion of alternative uses of pine beetle fibre into bioenergy applications (Friesen 2007) such as wood pellets (Ministry of Forests and Range 2005). Both the British Columbia Provincial Government (Konkin 2007) and Canadian Federal Government (Knubley 2007) see mountain pine beetle-killed fibre as a source of energy, not just a source of dimensional lumber (Stennes and McBeath 2006).

3 CHAPTER THREE – METHODOLOGY

This study used secondary data sources to gather the required information to respond with confidence to the financial viability of a Northern British Columbia standalone wood pellet production facility located in Prince George when fibre input comes from primary harvesting using a whole mountain pine beetle-killed lodgepole pine tree. The secondary data sources of information consisted of a thorough literature review concerning the mountain pine beetle, implications on Northern British Columbia's working forest, and wood pellet production. I selected the Prince George geographic area of Northern British Columbia (Figure 3-1) for this study based on two reasons:

Figure 3-1: Prince George Forest District
Source: British Columbia Ministry of Forests and Range

1) The geographic location is ideal with significant access to mountain pine beetle-killed fibre. With almost twenty-two percent (Ministry of Forests and Range 2007b) of British Columbia's existing annual allowable cut and over thirty-seven percent of the harvested timber (Ministry of Forests and Range 2007c) within two-hundred kilometres of Prince George, it provides a sufficient test area size for cost structures. There is also a sufficiently large sample size for harvesting activities to provide a realistic baseline average harvesting and transportation cost assumption.

2) Existing infrastructure already in place for primary manufacturing dimensional lumber mills such as forest service roads, access to railheads, power transmission lines, skilled workforce, and complimentary industry make a wood pellet production facility a natural addition to the existing forest sector.

Information obtained from the British Columbia Ministry of Forests and Range was used to conduct a review of actual costs associated with all stages of harvesting (including bunching, skidding, processing, and loading) and transportation costs.

A Tree-to-Truck Cost Survey Report prepared on behalf of the British Columbia Ministry of Forests and Range using data obtained through the 2003 and 2004 Interior Logging Cost Surveys is the source for harvesting costs. The British Columbia Ministry of Forests and Range utilize this report to determine guidelines for the Interior Appraisal Manual. The British Columbia Ministry of Forests and Range Forest Revenue Branch then use this manual to determine economically viable stumpage rates.

3.1 FRAMEWORK OF FINANCIAL VIABILITY CALCULATIONS

Financial viability is determined using projected income statements of a wood pellet production facility over five-years, seven-years, and ten-years. In year one of all scenarios the capital cost component is considered. External economic factors applied to four scenarios for each return on investment period provide robust project income statements:

1) Baseline Scenario – This scenario is the baseline that assumes all things being equal during the entire return on investment period.

2) Realistic Scenario – This scenario has economic factors considered the most realistic for an operating wood pellet production facility.

3) Pessimistic Scenario – This scenario utilizes the baseline scenario in year one and then provides for pessimistic impact of inflation and currency exchange during the return on investment period.

4) Optimistic Scenario – This scenario utilizes the baseline scenario in year one and then provides for optimistic impact of inflation and currency exchange impacts during the return on investment period. Considerations to reductions in transportation costs are also included in this scenario.

Once the determination of cash flow was established a net present value calculation was utilized to determine the financial viability using a pre-determined minimum rate of return. A positive net present value indicates a financial viability rating while a negative net present value indicates a non-financial viability rating.

4 CHAPTER FOUR – FINANCIAL VIABILITY OF WOOD PELLET FACILITY

4.1 CASH FLOWS OF WOOD PELLET PRODUCTION

Analysis of the financial viability of a standalone wood pellet production facility has three distinct cash flow components:

1) Capital Cost Estimate – This is the estimated capital cost associated with the construction of a suitable wood pellet production facility.

2) Harvesting Cost Estimate – This is the estimated cost for harvest of the fibre in the forest and transportation to the wood pellet production facility. The harvesting cost estimate includes the total cost to harvest the tree, transport it to the wood pellet production facility, and the stumpage royalties paid to the Province of British Columbia.

3) Wood Pellet Production Cost Estimate – This is the estimated cost of production of the raw fibre source into a saleable wood pellet and sale of the finished product. This includes all costs associated with production and transportation to the customer.

4.2 CAPITAL COST ESTIMATE

Estimates of capital cost to build a wood pellet facility are not definitive. The Wood Pellet Association of Canada uses a rule of thumb of $100 per tonne of annual production (Swaan 2006). Wood pellet facility sizes range from annual production of 50,000 tonnes to 200,000 tonnes. There does not appear to be any synergies in scaling a wood pellet facility upwards and is more dependent upon the availability of cost effective fibre supplies and a ready market for the finished product.

My study assumes that the wood pellet production facility will have a finished product capacity of 150,000 tonnes per annum. This is within the typical size of wood pellet production facilities in the Prince George region (Karidio 2007). This equates to a total capital cost estimate of $15,000,000.

4.3 HARVESTING COST ESTIMATE

The harvesting cost estimate encompasses the entire process, specifically getting the tree from the forest into a processing facility. Third-party harvesting contractors will perform this process therefore not requiring either capital investment or harvesting expertise within the wood pellet production facility. There are three distinct stages of this process:

1) Tree-to-Truck Costs – This first stage involves the harvesting of a tree and getting it loaded onto a truck for hauling to a processing facility.

2) Transportation Costs – This stage involves the costs associated with transporting the raw material fibre from the forest to the processing facility.

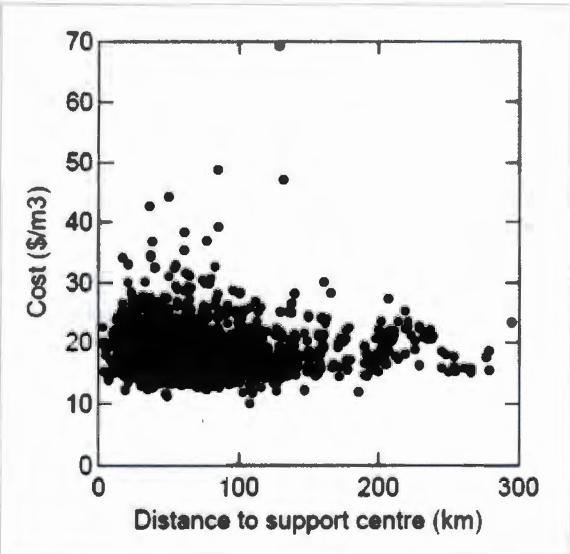
3) Stumpage Costs – This stage does not involve the movement of the fibre but involves the costs associated with harvesting timber from Crown lands in British Columbia.

4.3.1 TREE-TO-TRUCK COST ESTIMATE

The Tree-to-Truck Cost Survey Report prepared on behalf of the Ministry of Forests and Range contained a sample size of 2,230 respondents over a two-year period. The report details five different types of logging methods – ground skidding, overhead cable, skyline, helicopter, and horse (Jahraus & Associates Consulting Inc. 2007). I used the ground skidding method for my study based on its current popularity in harvesting. Approximately eighty-five percent of respondents used the ground skidding logging method.

The Tree-to-Truck Cost Survey Report contained a ground skidding sample size of 1,896 separate respondents over a two-year period of which 632 were within the Prince George region. This sample is more than sufficient in size to assess harvesting and transportation costs within Northern British Columbia and specifically the study area of Prince George.

Figure 4-1: Ground Skidding Cost Scatter Plot
Source: Jahraus & Associates



Harvesting and transportation costs for a standalone wood pellet production facility come from the Tree-to-Truck Survey Report averages. The ground skidding costs had a range from a low of $\$10.00/m^3$ to a high of $\$69.22/m^3$ (Figure 4-1). When excluding the abnormally high and low ranges of survey results the true cost range is estimated to be between $\$14.86/m^3$ and $\$27.11/m^3$ with an average cost of $\$18.32/m^3$. The ground skidding method uses the typical four stages of harvesting operations (Figure 4-2):

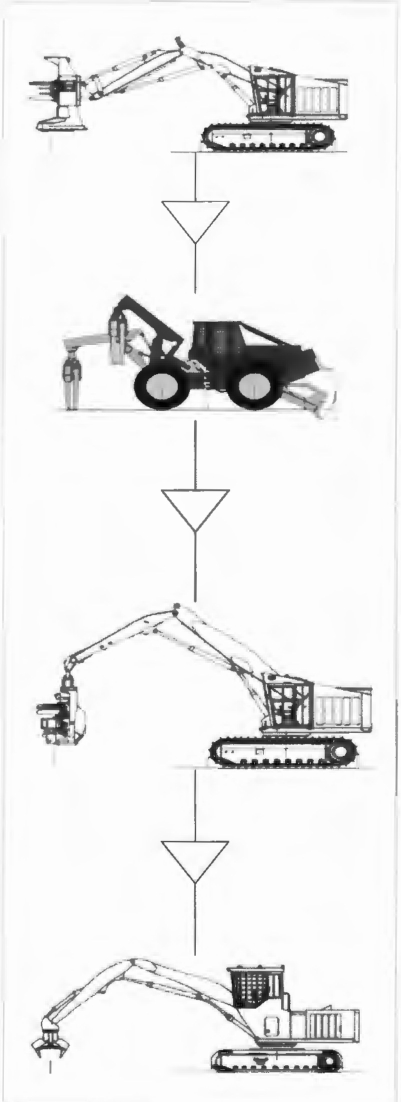
1) Bunching – This process involves harvesting the tree from the stump and laying it in piles on the ground in preparation for skidding to a landing where it will be processed and loaded on to a log truck.

2) Skidding – This process involves dragging the trees from the point of bunching to a central landing within a cut block where it will be processed and then loaded on a log truck.

3) Processing – This process involves removing the branches and cutting the tree into appropriate lengths as logs before being loaded on a log truck.

4) Loading – This process is that last stage prior to transportation and involves loading the logs on to a log truck in preparation for transportation to a processing facility.

Figure 4-2: Harvesting Flow



Alternatively, the fibre can be harvested in the forest using a buncher, skidded to the central landing, and then chipped using a portable chipper. The chips would then be loaded into a chip truck and transported to a wood pellet processing facility as chips. This reduces average harvesting costs prior to transport to $14.24/m^3 (Kumar, Flynn and Sokhansanj 2005). This reduction equates to $4.08/ m^3. Two reasons for the reduction in the average cost:

1) The typical processing and loading costs are no longer undertaken in favour of chipping the entire tree on-site as opposed to later chipping at the wood pellet processing facility. This reduces the number of times that a tree needs handling and the amount of equipment required on-site in the forest. Logs can be skidded to the portable chipper and loaded via a conveyor directly into the chip truck for transport.

2) Instead of using only a log, the entire tree including the branches and the top are used. The branches and top are normally left in the forest and burned after harvesting. This provides a greater fibre contribution with a recovery rate of between 79.9% and 89.9% (Bicho, et al. 2006) for a lower cost as the tree is handled the same amount of times but produces a greater volume of fibre for the same harvesting and processing cost.

Following the typical harvesting model provides more flexibility with the use of logs but still requires incurring a chipping cost at the wood pellet production facility for approximately $4.00/m^3 (Kumar, Flynn and Sokhansanj 2005). This creates a raw fibre input cost, exclusive of transportation, of $22.32/m^3 instead of the $14.24/m^3 realised in roadside chipping. My study examined both cost structures but clearly roadside chipping provides the greatest opportunities for financial viability (Table 4-1).

Table 4-1: Harvesting Method Cost Comparison ($/m^3)

	Logs	Roadship Chipping
Harvesting	$ 18.32	$ 10.24
Chipping	$ 4.00	$ 4.00
	$ 22.32	$ 14.24

The volume of raw fibre required to produce 150,000 tonnes of wood pellets annually in a wood pellet production facility ranges between 2.42 (Bicho, et al. 2006) and 2.78 cubic metres (Peksa-Blanchard, et al. 2007) of raw fibre per tonne of production. The latter study reviewed all types of wood, with a focus on European growing conditions. It does not have the same reference to the fibre quality indigenous to the central interior of British Columbia.

The former study specifically analysed mountain pine beetle-killed lodgepole pine in the red and grey attack stages during both summer and winter harvesting seasons. The harvest of source fibre were from two separate areas, the first 25 kilometres north of Vanderhoof and the second 40 kilometres south of Fraser Lake. Both of these sites are located central to the current mountain pine beetle infestation in British Columbia. They are excellent samples of the fibre quality required for feedstock for a wood pellet production facility.

Based on the results of the Bicho et al (2006) study the average results experienced on a mixed summer and winter harvesting programming using both red and grey attack mountain pine beetle-killed lodgepole pine suggest a requirement of 2.49 cubic metres of raw fibre per one tonne of finished wood pellets. Therefore, approximately 373,500 cubic metres of fibre would need to be harvested and delivered annually (Table 4-2).

Table 4-2: Annual Raw Fibre Material Requirements

Annual Production (tonnes)	150,000
Raw Material Multiplier (m^3/tonne)	2.49
Fibre Requirements (m^3)	373,500

This raw fibre requirement would therefore have a harvesting cost of approximately $5,318,640, inclusive of chipping but exclusive of transportation costs (Table 4-3).

Table 4-3: Annual Raw Fibre Harvesting Cost

	Logs	Roadship Chipping
Harvesting	$ 8,563,855	$ 3,824,640
Chipping	$ 1,869,837	$ 1,494,000
	$ 10,433,692	$ 5,318,640

4.3.2 TRANSPORTATION COST ESTIMATE

Following the type of harvesting operations, there are two ways to transport the raw fibre material to the wood pellet production facility:

1) Log Form – Processing the trees to remove limbs and tops and then loading the logs onto bunks of a typical log trailer for transport. This form has a higher transport cost per recoverable cubic metre of fibre based on a reduced portion of the tree actually being usable for producing wood pellets.

2) Chip Form – Chipping the trees at the roadside and then loading them into a chip truck for transport. This form has a lower cost as the entire tree is recoverable and used for producing wood pellets.

Log transport costs vary greatly depending upon the allocation of tree type, location, and on or off-highway hauling. I used the parameter estimates from the Interior Appraisal Manual (Ministry of Forests and Range 2007d) to determine a log haul price. The calculation for assuming the estimated cost for on-highway hauling is as follows:

$$\$/m^3 = \text{Region Constant} + (1.90 * \text{Cycle Time}) + (0.41 * \text{Balsam\%}/100) + (2.32 * \text{Deciduous Species\%}/100) + (0.87 * \text{Fir\%}/100) + (3.21 * \text{Hemlock\%}/100) + (0.47 * \text{Lodgepole Pine\%}/100)$$

The region constant is a proxy to recognise local hauling factors between regions that may influence the cost regardless of tree species hauled. This number comes directly from the Ministry of Forests and Range. The cycle time is the estimated number of hours required for a truck to transport the logs from the harvest point to the mill and the empty truck to return to the harvest location. The remaining variables are factors related to specific tree species harvested. Weighting allocated according to the percentage of merchantable standing timber of each species within the harvest area.

To calculate a haul price I used the following assumptions:

1) The primary haul would be on-highway and therefore use of the on-highway hauling calculation as opposed to the off-highway hauling calculation.

2) The region for the study is the Prince George area and therefore earns a region constant of -0.26 as per the Interior Appraisal Manual (Ministry of Forests and Range 2007d).

3) The significant quantities of pine beetle-killed lodgepole pine in the Prince George area allow for a short range transportation corridor and therefore a cycle time (defined as the time it takes to load, haul, weigh, unload, return, and including unavoidable delays) of four hours has been deemed appropriate.

4) The study is assuming the primary use of pine beetle-killed lodgepole pine and therefore assumes the composition of the load would be 100% lodgepole pine.

The region constant of -0.26 for Prince George is applied, the cycle time of four hours is multiplied by the 1.9 cycle time factor, and a 0.47 premium is added due to the 100% composition of lodgepole pine. Based on these assumptions the cost per cubic metre to transport the logs would be $7.81 as per the calculation as follows:

$$\$7.81/m^3 = -0.26 + (1.90 * 4) + 0.47$$

The weight versus volume problems outlined for hauling logs does not exist when hauling chips therefore providing a more efficient method of moving the raw fibre material from the forest to the wood pellet processing facility. It is estimated that the cost to transport chips is $5.40/m^3 based on a one-way trip assumption of an average 62 kilometres (Kumar, Flynn and Sokhansanj 2005). The cost to transport raw chips from the forest to the wood pellet production facility is approximately $2.41/m^3 lower than the cost to transport the raw log.

4.3.3 STUMPAGE COST ESTIMATE

The primary source of fibre for a wood pellet production facility in this study is mountain pine beetle-killed lodgepole pine. This fibre is not suitable for dimensional lumber applications and is to be of non-sawlog or salvage quality thereby qualifying for the lowest stumpage rate of $0.25/m^3 (Ministry of Forests and Range 2007e).

The expected cost for stumpage is below one percent of total expenses and is not a significant factor. However, an application using mixed fibre sources or a non-reliance of mountain pine beetle-killed lodgepole pine or sawlog quality fibre sources could have a material impact on the estimated cost base for the raw fibre source. As an example, the average stumpage collected during 2006/2007 in the Northern Interior Region was $13.31/m^3 (Ministry of Forests and Range 2007c).

4.3.4 DELIVERED RAW (CHIPPED) FIBRE COST ESTIMATE

My study addressed two scenarios for harvesting and transportation to the wood pellet production facility. The first scenario (Scenario A) is a traditional harvesting and transportation method used in existing primary lumber applications. The tree is harvested, delimbed, cut-to-length, and transported as a log on a log truck. Under this scenario there is significant waste left in the forest in the form of trees and tops that have a small diameter.

The second scenario (Scenario B) removes the waste issue from the equation and provides a recovery savings that reduces the required net harvested volume of fibre by approximately 20% (Bicho, et al. 2006). Scenario B requires a total harvest of 467,459 cubic metres to transport raw logs to the wood pellet processing facility for chipping to equal Scenario A's 373,500 cubic metres of delivered raw fibre. Scenario B provides a much more cost effective option for the harvesting of raw fibre for the purposes of production of wood pellets with an overall estimated cost approximately 48% less than Scenario A (Table 4-4).

Increased volume of fibre requiring harvesting under Scenario A also causes increased costs for transportation, chipping, and stumpage royalty rates.

Table 4-4: Delivered Raw Fibre Cost ($ thousands)

(thousands)	Scenario A (Logs)	Scenario B (Chips)	Chips Scenario Savings
Harvesting Cost	8,564	3,825	(4,739)
Pre-Transport Chipping Cost	-	1,494	1,494
Transportation Cost	3,651	2,017	(1,634)
Post-Transport Chipping Cost	1,870	-	(1,870)
Stumpage Royalty Cost	117	93	(23)
Delivered Raw Fibre Cost	14,201	7,429	(6,772)

4.4 CONVERSION COST ESTIMATE

Conversion of raw fibre into wood pellets involves a five-step process. This process uses a continuous production line arrangement.

1) Drying – Before it is processed, the raw fibre needs to have moisture removed. Feeding the fibre into a rotating heated drum accomplishes this. The drum dries the raw fibre material to a moisture content of approximately 12% to prepare it for further processing and pelletisation (Urbanowski 2005). The heat used to remove the moisture typically comes through natural gas but converting some of the raw fibre material to generate heat has potential to reduce costs. For the purposes of my study, I used the standard natural gas heat cost structure.

2) Grinding – A hammer mill grinds the dried raw fibre to a size small enough to incorporate into a pellet but not too small that its fibre properties are lost. Further moisture is lost during the grinding stage by both the heat involved and the pressure that squeezes moisture from the fibre.

3) Pelletisation – A compression system receives the ground fibre and forces it through a rotary die. No additives are required due to the natural lignin released during the drying and grinding processes binding the fibre together as it cools after going through the rotary die. The die determines both the diameter and length of the pellets as the fibre is processed.

4) Cooling – Pellets coming out of the pelletisation process are very soft and require cooling to harden. A conveyor gradually cools the pellets making them hard and transportable.

5) Storage – The cooled pellet is stored in preparation for transportation. Sale of pellets is in bulk form. Therefore, storage is low cost in preparation for loading on to railcars for transport to a bulk port facility.

The conversion process varies by region with a high of $150 per tonne in Austria (Thek and Obernberger 2004) to a low of $25 per tonne for fibre not requiring drying. The average wood pellet produced in Northern British Columbia requires drying with a total conversion cost of $35.57 per tonne or 18.5% of total sale price (University of British Columbia 2007).

4.5 FINISHED WOOD PELLET TRANSPORTATION COST

Once the wood pellets have completed the production stage, transportation occurs from the production facility to the end user. In the case of Northern British Columbia, this requires the wood pellets to be loaded into railcars for transport by rail to the Port of Vancouver. Once they arrive at the Port of Vancouver, they are stored until they can be loaded on a suitable ship for ocean transport to Europe.

Total finished product transportation costs are approximately $67.85 per tonne or 35.3% of sale price.

4.5.1 RAIL TRANSPORTATION TO PORT OF VANCOUVER

Wood pellets stored at the production facility get loaded into bulk container railcars operated by Canadian National Railway. Typically, these railcars deliver the finished wood pellet product to the Port of Vancouver but there is likely to be greater opportunities for cost and time savings to use the new Port of Prince Rupert. For the purposes of my study, the cost to transport to the Port of Vancouver is \$35.71 per tonne or 18.6% of total sale price (Swaan 2006).

4.5.2 PORT PROCESSING COSTS

Once the railcars arrive at the Port of Vancouver, the finished wood pellets need to be unloaded, stored, and then loaded onto a freighter for transport to the European markets. The cost of this processing at the port is \$7.14 per tonne or 3.7% of total sale price (Swaan 2006).

4.5.3 OCEAN FREIGHT COSTS

Ocean going bulk product ships transport the finished wood pellets to Europe. Cost of shipment is high at approximately \$25 per tonne or 13% of total sale price (Swaan 2006).

4.6 RETURN ON INVESTMENT ESTIMATE

The return on investment is calculated using the projected cash flow and capital cost estimates. A wood pellet production facility would need to obtain an annual return similar to that obtained by the lumber industry over the past ten-years of 8.9% (Dufour 2007).

The calculated return uses a net present value of cash flows calculation for five, seven, and ten-years. A shorter payback period would likely permit mostly debt financing while a longer payback period would likely require mostly equity financing. A payback period of seven-years would likely be eligible for an equal debt and equity financing combination.

The decision for a company to choose to finance by way of debt or equity is related to management's decisions and the strategic direction of the company. The difference between debt and equity financing is ignored for the purposes of my study. I assumed the return based on earnings after taxes but before interest, depreciation, and amortization (EBIDA).

4.7 ECONOMIC FACTOR ESTIMATES

I used four different scenarios, baseline, realistic, pessimistic, and optimistic, when calculating an estimated return of investment for a standalone wood pellet production facility. Under each scenario, I provided various economic factor projections such as exchange rate, future bulk wood pellet prices, inflation, and other rising costs.

4.7.1 EXCHANGE RATE PROJECTIONS

The baseline projections use historical exchange rates during the years 2003 through 2005 of €0.63 per $1.00 Canadian (Bank of Canada 2008). The economic forecast during 2007 through 2009 predicts an average exchange rate of €0.80 per $1.00 Canadian (Royal Bank of Canada 2008). A rising Canadian dollar relative to the Euro will have negative implications on the sale price for bulk wood pellets.

The baseline scenario will assume that the exchange rate will stay relatively static over the five, seven, and ten-year return periods.

The realistic scenario will assume that the Canadian dollar will continue to appreciate, but at a much slower rate of two percent per annum. This places the exchange rate at €0.70 per $1.00 Canadian over five-years, €0.72 per $1.00 Canadian over seven-years and €0.77 per $1.00 Canadian over ten-years.

The pessimistic scenario will take the baseline currency exchange rate value of €0.63 per $1.00 Canadian and assume an annual appreciation of 6.6% during 2007 through 2009. This is in line with the appreciation from the 2003 through 2005. This places the exchange rate at €0.87 per $1.00 Canadian over five-years, €0.99 per $1.00 Canadian over seven-years and €1.19 per 1.00 Canadian over ten-years.

The optimistic scenario will assume the Canadian dollar will actually depreciate against the Euro by one percent a year. This places the exchange rate at €0.60 per $1.00 Canadian over five-years, €0.59 per $1.00 Canadian over seven-years and €0.57 per $1.00 Canadian over ten-years.

4.7.2 BULK WOOD PELLET PRICE PROJECTIONS

The baseline scenario assumes the bulk wood pellet price will stay the same throughout the entire return period.

The realistic scenario assumes that while other economic factors will have an impact on the finished bulk wood pellet cost overall the market will see a slight increase of 2.1% in the Euro cost per tonne.

The pessimistic scenario assumes that other economic factors will have a greater price impact on the finished bulk wood pellet cost but that overall there will be a slight one percent increase in the Euro cost per tonne.

The optimistic scenario assumes that the cost of wood pellets will stay in alignment with normal inflationary pressures I assumed for this scenario. This means the Euro cost per tonne will increase by two percent per annum.

4.7.3 INFLATION PROJECTIONS

The baseline scenario assumes there will be net zero inflation to all costs. Some will rise while others will fall by a similar amount over the entire return period. This affects the harvesting, chipping, stumpage, conversion, and port processing costs.

The realistic and optimistic scenarios assume that the Canadian headline inflation rate will be at the desired midpoint of the inflation control range set by the Bank of Canada at two percent per annum (Bank of Canada 2006).

The pessimistic scenario assumes that the Canadian headline inflation rate will be at the highpoint of the inflation control range set by the Bank of Canada at three percent per annum (Bank of Canada 2006).

4.7.4 TRANSPORTATION COST PROJECTIONS

Transportation costs for both truck and rail continue to rise at very high rates, typically in line with the rising cost of fuel. The baseline scenario assumes that while fuels costs are rising other costs are falling creating a net zero impact on transportation costs.

The realistic scenario assumes that rising fuel costs will have an impact on long-term transportation costs but believes the annual increases will occur at the lower end of the spectrum for truckload costs at a rate of only 2.6% per annum (Trunick 2005).

The pessimistic scenario assumes that rising fuel costs are just one of the many factors involved in the longer-term implications for transportation. This scenario assumes costs will rise similar to the past and projected factors for rail logistics at a rate of approximately five percent per annum (Trunick 2005).

The optimistic scenario assumes that trucking costs will rise to transport the raw fibre from the forest to the mill site but that rail costs will decrease through the ability to transport finished wood pellets to the Port of Prince Rupert instead of the Port of Vancouver. The trucking costs expected to rise by two percent per annum while the rail costs expected to fall by two percent per annum.

4.7.5 SHIPPING COST PROJECTIONS

Oceanic freight shipping rates have been fluctuating over the last few decades with no clear extended up or downwards trend. The baseline scenario assumes that over the return periods that prices will rise and fall for a net zero affect.

The realistic and optimistic scenarios assume that on average over the return periods that oceanic freight shipping rates will decrease by 2% per annum.

The pessimistic scenario assumes that on average over the return periods that oceanic freight shipping rates will increase by 2% per annum.

4.7.6 TAXATION TRENDS

During times of economic prosperity, there is pressure to reduce corporate taxation. However, during weaker economic times there is pressure to tax corporations heavier while maintaining a status quo situation for individual taxpayers. All four scenarios assume that the corporate tax rate will on average stay static at approximately 30% per annum.

4.8 CALCULATIONS

The four primary scenarios were analysed with the source information provided to determine proof of the hypothesis. All four scenarios used the same base-starting place and then adjusted using the various economic factors. A fifth scenario was prepared to examine the financial viability of using mixed sources of wood fibre.

All five scenarios are summarised according to five-year return (Appendix A), seven-year return (Appendix B), and ten-year return (Appendix C).

Table 4-5: Scenario Average Income Statement Percentages

	Baseline	Realistic	Pessimistic	Optimistic	Other Fibre
Annual Gross Revenue	100.0%	100.00%	100.00%	100.0%	100.0%
Raw Fibre Cost	25.8%	28.3%	38.8%	24.6%	42.7%
Conversion Cost	18.5%	20.2%	27.2%	17.7%	18.5%
Shipping Cost	35.3%	36.8%	53.6%	23.6%	35.3%
Gross Profit	20.3%	14.7%	-19.6%	34.1%	35.3%
General and Administrative Expenses	10.0%	10.0%	10.0%	10.0%	10.0%
Taxes	3.1%	1.4%	-8.9%	7.2%	-2.0%
Net Cash Flow (EBIDA)	7.2%	3.3%	-20.7%	16.8%	-4.6%

4.8.1 BASELINE SCENARIO

I used the baseline scenario to determine whether there is a potential business case to proceed with a standalone wood pellet production facility under circumstances void of changes in the economic factors (Appendix D).

Under the baseline scenario, I estimate gross revenues of approximately $29 million annually with net cash flow (EBIDA) of approximately $2 million. The capital cost expenditure estimate of $15 million is recorded as an outflow of cash in year one. Using a net present value calculation with an annual return rate of 8.9% after year five the operation will still be cash flow negative by almost $6.9 million. By year seven negative cash flow is about $4.5 million and by year ten, it is further reduced to $1.6 million. Under this scenario the operation will become cash flow positive during year eleven.

Shipping and raw fibre costs is on average 35.3% and 25.8%, respectively, and total production and transportation costs are 79.6% of total gross revenues (Table 4-5). This provides for a cash flow average of 7.2% of total gross revenue after overhead costs and taxes.

4.8.2 REALISTIC SCENARIO

The realistic scenario attempts to be more robust than the baseline scenario when determining the impact of economic factors (Appendix E).

On average gross revenue of almost $29 million is realised annually with approximate net cash flow (EBIDA) of $1 million. The capital cost expenditure estimate of $15 million is recorded as an outflow of cash in year one. Using a net present value calculation with an annual return rate of 8.9% after year five it is determined that the operation will still be cash flow negative by $8.6 million, a significant improvement over the pessimistic scenario and only $1.7 million behind the baseline scenario. By year seven negative cash flow improves to $7.7 million and by year ten it improves slightly, but stays at approximately $7.7 million. It is possible that in time the realistic scenario will provide positive cash flow depending on fluctuations in the economic factors.

As compared to the baseline scenario, the costs for the realistic scenario only increased slightly with gross profit showing an average decline of 5.6% (Table 4-5). Net cash flow shows an even smaller decline of 3.9% after adjustments for taxes. Unfortunately, the realistic scenario shows a downward trend in net cash flows with a negative cash flow occurring in year ten. It is very likely that without some moderate to significant changes in economic factors that the realistic scenario will eventually follow the direction of the pessimistic scenario.

4.8.3 PESSIMISTIC SCENARIO

I made overly pessimistic adjustments to the baseline scenario economic factors to determine whether a standalone wood pellet production facility can be successful in a more adverse economic environment (Appendix F).

On average gross revenue of approximately \$22 million is realised annually with approximate negative net cash flow (EBIDA) of \$4.7 million. The capital cost expenditure estimate of \$15 million is recorded as an outflow of cash in year one. Using a net present value calculation with an annual return rate of 8.9% after year five it is determined that the operation will be significantly cash flow negative by \$17.9 million. By year seven negative cash flow deteriorates further to almost \$25 million and by year ten it erodes further to negative \$38.5 million. Under this scenario the operation will never become cash flow positive and will always be a drain for its shareholders and investors.

The significantly increased cost of shipping incurring 53.6% of total gross revenue, an increase of 18.3% over the baseline scenario, have the greatest detrimental impact on the success of this scenario (Table 4-5). Delivered raw fibre costs also increase by 13% to 38.8% of total revenue. This leads to an overall decrease in gross profit of 39.9% causing a permanent state of negative cash flow.

Over the entire ten-years of the pessimistic scenario, the average net cash flow is negative 20.7% requiring significant annual capital injection to maintain operations.

4.8.4 OPTIMISTIC SCENARIO

I have used the optimistic scenario to consider other factors that will provide a better return on investment for a wood pellet production facility. I assume there is an established market for wood pellets in China with the European bulk wood pellet commodity price. The opportunity to ship a finished product to Shanghai as the nearest port to Canada and using the Port of Prince Rupert as the departure location significantly reduces ocean freight costs by about half. The impact on the economic factors has been more favourable than those in the other scenarios (Appendix G).

On average gross revenue of almost $33 million is realised annually with approximate net cash flow (EBIDA) of $5.6 million. The capital cost expenditure estimate of $15 million is recorded as an outflow of cash in year one. Using a net present value calculation with an annual return rate of 8.9% after year five it is determined that the operation will be cash flow positive by $1.5 million, a significant improvement over all other scenarios scenario. By year seven cash flow improves to $8.4 million and by year ten it improves further to $18.6 million.

As compared to the baseline scenario, the costs for the optimistic scenario decreased significantly with gross profit showing an average improvement of 13.7% (Table 4-5). Net cash flow shows a smaller improvement of 9.6% after adjustments for taxes. The economic factors continue to improve the results as time goes on. The largest benefit to the optimistic scenario over all other scenarios is the significantly reduced shipping cost.

4.8.5 MIXED FIBRE SOURCE SCENARIO

I also examine the possibility of using a raw fibre supply that comes from sources other than mountain pine beetle-killed lodgepole pine (Appendix H). Consideration given to other softwood sources, specifically spruce and fir, was based on the prevalence of those species within the Prince George region of Northern British Columbia.

Modification of the baseline scenario by adding the cost of stumpage based on a mixed fibre source that will utilise sawlog quality fibre. This dramatically increases stumpage rates from $0.25 per cubic metre to an average of $13.31 per cubic metre of fibre harvested. This increase in stumpage rates affects the delivered raw fibre cost upwards by 16.9% reducing net cash flow by 11.9% from the baseline scenario. This ultimately results in negative cash flow of $1.3 million per annum.

5 CHAPTER FIVE – CONCLUSIONS

Delivered raw fibre and transportation costs are the greatest hurdles to the financial viability of a standalone wood pellet production facility. Mountain pine beetle-killed lodgepole pine is the lowest cost raw fibre source input available on a standalone basis. Further cost reductions in the raw fibre source are not possible while maintaining a standalone basis.

Rail and ocean freight transportation costs compose over a third of total sale price. Reduction of rail and ocean freight distances can improve the financial viability. The optimistic scenario suggests this possibility but new markets need to be found for final determination.

5.1 FINANCIAL VIABILITY

Existing markets for bulk wood pellets are primarily located in Europe. The cost of rail transport to the Port of Vancouver and ocean freight costs to Europe make it unlikely that a standalone wood pellet production facility will be financially viable. The baseline, realistic, and pessimistic scenarios clearly demonstrate this. Alternative markets can provide transportation cost reductions. Developing a new market in China will reduce the ocean freight transportation costs.

5.2 STUMPAGE RELIEF INCENTIVES

The non-sawlog or salvage stumpage rates provided for mountain pine beetle-killed lodgepole pine are of nominal value. Further stumpage relief provided by the Government of British Columbia is not sufficient to make a standalone wood pellet production facility financially viable. Fibre from mixed fibre sources of sawlog quality has an appreciably higher stumpage rate. Subsidies provided by the Government of British Columbia in the form of stumpage relief will have material benefit to the cash flow of a standalone wood pellet production facility. Unfortunately complete stumpage relief does not change the ultimate findings in my study that a standalone wood pellet production facility is not financially viable.

5.3 POLICY IMPLICATIONS

The Governments of British Columbia and Canada both view wood pellets as a solution to the devastation caused by the mountain pine beetle in Northern British Columbia. Standalone production facilities are not financially viable under the existing model of selling wood pellets to Europe. Both governments will need to review the current policies to encourage wood pellet production. Symbiotic relationships with dimensional sawmills as a source of raw fibre is also in jeopardy. The dimensional lumber market continues to suffer and additional mill closures are a foregone conclusion. As these sawmills undergo curtailments and shutdowns the available supply of raw fibre on the market will be reduced. This raw fibre reduction places existing wood pellet production facilities at risk of failure if new raw fibre sources do not become available.

If governments want to promote investment in wood pellet production there needs to be considerations to provide subsidies. Individually or together the following subsidies would promote growth of wood pellet production facilities:

1) Capital Construction Grants – A typical government subsidy would be an interest free loan. In this case, an interest free loan would have no bearing on the financial

viability of a wood pellet production facility. My study has ignored the cost of financing. Therefore, governments would need to provide direct grants to offset some or all of the wood pellet production facility capital construction costs. In all scenarios, except pessimistic, reduction in cash outflow for capital costs would significantly improve the financial viability.

2) Taxation – In all scenarios there are periods of positive cash flow that result in taxation. A taxation subsidy period where little or no income taxes were paid to the governments would improve the financial viability of a wood pellet production facility.

Ultimately, governments would need to decide whether there is sufficient long-term socio-economic benefits to provide direct or indirect subsidies to a start-up wood pellet production facility.

5.4 STUDY LIMITATIONS

My study has had an extremely narrow area of focus of primarily using mountain pine beetle-killed lodgepole pine and sales to an existing European market. I have not considered in depth other existing markets or geographic locations that may have lower cost production and transportation costs. The optimistic scenario used a fictional market in China with European pricing to consider the impact of lower transportation costs. During the preparation of my study I did not establish the existence of a bulk wood pellet market in China.

Lastly, the financial numbers I used were from a variety of sources not directly related to wood pellet production. Real financial results from an operating wood pellet production facility and specific harvesting costs could provide different conclusions than I discovered during the course of my study.

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7 APPENDICES

APPENDIX A – FIVE-YEAR RETURN PERIOD COMPARISON

(totals, thousands)	**Baseline**	**Realistic**	**Pessimistic**	**Optimistic**	**Other Fibre**
Annual Gross Revenue	143,954	144,242	128,709	152,854	143,954
Harvesting Cost	19,123	19,904	20,306	19,904	19,123
Chipping Cost	7,470	7,775	7,932	7,775	7,470
Transportation Cost	10,085	10,623	11,145	10,496	10,085
Stumpage Royalty Cost	467	486	496	486	24,856
Raw Fibre Cost	37,145	38,787	39,878	38,660	61,534
Conversion Cost	26,678	27,766	28,327	27,766	26,678
Mill to Port Shipping Cost	26,783	28,212	29,598	25,732	26,783
Shipping Port Processing Cost	5,355	5,574	5,686	5,574	5,355
Ocean Freight Cost	18,750	18,015	19,515	9,007	18,750
Shipping Cost	50,888	51,800	54,799	40,313	50,888
Gross Profit	29,244	25,889	5,705	46,114	4,855
General and Administrative Expenses	14,395	14,424	12,871	15,285	14,395
Taxes	4,455	3,439	- 2,150	9,249	- 2,862
Net Cash Flow (EBIDA)	10,394	8,025	- 5,016	21,580	- 6,678
Net Present Value	**- 6,893**	**- 8,581**	**- 17,901**	**1,522**	**- 20,209**

APPENDIX B – SEVEN-YEAR RETURN PERIOD COMPARION

(totals, thousands)	**Baseline**	**Realistic**	**Pessimistic**	**Optimistic**	**Other Fibre**
Annual Gross Revenue	201,536	202,141	170,666	220,608	201,536
Harvesting Cost	26,772	28,433	29,306	28,433	26,772
Chipping Cost	10,458	11,107	11,448	11,107	10,458
Transportation Cost	14,118	15,269	16,422	14,994	14,118
Stumpage Royalty Cost	654	694	715	694	34,799
Raw Fibre Cost	52,002	55,503	57,891	55,229	86,148
Conversion Cost	37,349	39,666	40,883	39,666	37,349
Mill to Port Shipping Cost	37,496	40,550	43,613	35,319	37,496
Shipping Port Processing Cost	7,497	7,962	8,206	7,962	7,497
Ocean Freight Cost	26,250	24,726	27,879	12,363	26,250
Shipping Cost	71,243	73,239	79,698	55,645	71,243
Gross Profit	40,942	33,734	- 7,805	70,069	6,797
General and Administrative Expenses	20,154	20,214	17,067	22,061	20,154
Taxes	6,237	4,056	- 7,462	14,403	- 4,007
Net Cash Flow (EBIDA)	14,552	9,464	- 17,410	33,606	- 9,350
Net Present Value	**- 4,502**	**- 7,747**	**- 24,993**	**8,425**	**- 21,745**

APPENDIX C – TEN-YEAR RETURN PERIOD COMPARISON

(totals, thousands)	Baseline	Realistic	Pessimistic	Optimistic	Other Fibre
Annual Gross Revenue	287,908	289,207	225,196	330,054	287,908
Harvesting Cost	38,246	41,879	43,845	41,879	38,246
Chipping Cost	14,940	16,359	17,127	16,359	14,940
Transportation Cost	20,169	22,700	25,368	22,084	20,169
Stumpage Royalty Cost	934	1,022	1,070	1,022	49,713
Raw Fibre Cost	74,289	81,960	87,411	81,345	123,068
Conversion Cost	53,355	58,422	61,166	58,422	53,355
Mill to Port Shipping Cost	53,565	60,287	67,373	48,992	53,565
Shipping Port Processing Cost	10,710	11,727	12,278	11,727	10,710
Ocean Freight Cost	37,500	34,299	41,061	17,149	37,500
Shipping Cost	101,775	106,313	120,713	77,869	101,775
Gross Profit	58,489	42,512	- 44,093	112,418	9,710
General and Administrative Expenses	28,791	28,921	22,520	33,005	28,791
Taxes	8,909	4,077	- 19,984	23,824	- 5,724
Net Cash Flow (EBIDA)	20,789	9,514	- 46,629	55,589	- 13,357
Net Present Value	**- 1,600**	**- 7,701**	**- 38,479**	**18,612**	**- 23,610**

APPENDIX D – BASELINE SCENARIO

Assumptions - *amounts in thousands unless otherwise stated*			
Annual Production (tonnes)	150,000	Sale Price Rate (Δ/annum)	0.00%
Sale Price ($/tonne)	191.94	Inflation Rate (all costs except)	0.00%
Sale Price (€/tonne)	120.00	Currency Fluxuation (Δ/annum)	0.00%
Exchange Rate Baseline (€/$)	0.63	Transportation Cost (Δ/annum)	0.00%
Raw Fibre (m^3)	373,500	Shipping Cost (Δ/annum)	0.00%
		Tax Rate	30.00%
		Required Internal Rate of Return	8.90%

	Year One	Year Two	Year Three	Year Four	Year Five	Year Six	Year Seven	Year Eight	Year Nine	Year Ten
Wood Pellet Sale Price ($/tonne)	192	192	192	192	192	192	192	192	192	192
Capital Cost Expenditure	15,000									
Annual Gross Revenue	28,791	28,791	28,791	28,791	28,791	28,791	28,791	28,791	28,791	28,791
Harvesting Cost	3,825	3,825	3,825	3,825	3,825	3,825	3,825	3,825	3,825	3,825
Chipping Cost	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494
Transportation Cost	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017
Stumpage Royalty Cost	93	93	93	93	93	93	93	93	93	93
Raw Fibre Cost	7,429	7,429	7,429	7,429	7,429	7,429	7,429	7,429	7,429	7,429
Conversion Cost	5,336	5,336	5,336	5,336	5,336	5,336	5,336	5,336	5,336	5,336
Mill to Port Shipping Cost	5,357	5,357	5,357	5,357	5,357	5,357	5,357	5,357	5,357	5,357
Shipping Port Processing Cost	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071
Ocean Freight Cost	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750
Shipping Cost	10,178	10,178	10,178	10,178	10,178	10,178	10,178	10,178	10,178	10,178
Gross Profit	5,849	5,849	5,849	5,849	5,849	5,849	5,849	5,849	5,849	5,849
General and Administrative Expenses	2,879	2,879	2,879	2,879	2,879	2,879	2,879	2,879	2,879	2,879
Taxes	891	891	891	891	891	891	891	891	891	891
Net Cash Flow (EBIDA)	2,079	2,079	2,079	2,079	2,079	2,079	2,079	2,079	2,079	2,079
Net Present Value					- **6,893**		- **4,502**			- **1,600**

APPENDIX E – REALISTIC SCENARIO

Assumptions - *amounts in thousands unless otherwise stated*			
Annual Production (tonnes)	150,000	Sale Price Rate (Δ/annum)	2.10%
Sale Price ($/tonne)	191.94	Inflation Rate (all costs except)	2.00%
Sale Price (€/tonne)	120.00	Currency Fluxuation (Δ/annum)	-2.00%
Exchange Rate Baseline (€/$)	0.63	Transportation Cost (Δ/annum)	2.60%
Raw Fibre (m^3)	373,500	Shipping Cost (Δ/annum)	-2.00%
		Tax Rate	30.00%
		Required Internal Rate of Return	8.90%

	Year One	Year Two	Year Three	Year Four	Year Five	Year Six	Year Seven	Year Eight	Year Nine	Year Ten
Wood Pellet Sale Price ($/tonne)	192	192	192	193	193	193	193	193	193	194
Capital Cost Expenditure	15,000									
Annual Gross Revenue	28,791	28,820	28,848	28,877	28,906	28,935	28,964	28,993	29,022	29,051
Harvesting Cost	3,825	3,901	3,979	4,059	4,140	4,223	4,307	4,393	4,481	4,571
Chipping Cost	1,494	1,524	1,554	1,585	1,617	1,649	1,682	1,716	1,750	1,785
Transportation Cost	2,017	2,069	2,123	2,178	2,235	2,293	2,353	2,414	2,477	2,541
Stumpage Royalty Cost	93	95	97	99	101	103	105	107	109	112
Raw Fibre Cost	7,429	7,590	7,754	7,922	8,093	8,268	8,448	8,631	8,818	9,009
Conversion Cost	5,336	5,442	5,551	5,662	5,775	5,891	6,009	6,129	6,251	6,376
Mill to Port Shipping Cost	5,357	5,496	5,639	5,785	5,936	6,090	6,248	6,411	6,577	6,749
Shipping Port Processing Cost	1,071	1,092	1,114	1,137	1,159	1,182	1,206	1,230	1,255	1,280
Ocean Freight Cost	3,750	3,675	3,602	3,529	3,459	3,390	3,322	3,255	3,190	3,127
Shipping Cost	10,178	10,263	10,354	10,451	10,554	10,662	10,776	10,897	11,023	11,155
Gross Profit	5,849	5,525	5,189	4,842	4,484	4,114	3,731	3,337	2,930	2,511
General and Administrative Expenses	2,879	2,882	2,885	2,888	2,891	2,894	2,896	2,899	2,902	2,905
Taxes	891	793	691	586	478	366	251	131	8	- 118
Net Cash Flow (EBIDA)	2,079	1,850	1,613	1,368	1,115	854	585	306	20	- 276
Net Present Value					- **8,581**		- **7,747**			- **7,701**

APPENDIX F – PESSIMISTIC SCENARIO

Assumptions - *amounts in thousands unless otherwise stated*			
Annual Production (tonnes)	150,000	Sale Price Rate (Δ/annum)	1.00%
Sale Price ($/tonne)	191.94	Inflation Rate (all costs except)	3.00%
Sale Price (€/tonne)	120.00	Currency Fluxuation (Δ/annum)	-6.60%
Exchange Rate Baseline (€/$)	0.63	Transportation Cost (Δ/annum)	5.00%
Raw Fibre (m^3)	373,500	Shipping Cost (Δ/annum)	2.00%
		Tax Rate	30.00%
		Required Internal Rate of Return	8.90%

	Year One	Year Two	Year Three	Year Four	Year Five	Year Six	Year Seven	Year Eight	Year Nine	Year Ten
Wood Pellet Sale Price ($/tonne)	192	181	171	161	152	144	136	128	121	114
Capital Cost Expenditure	15,000									
Annual Gross Revenue	28,791	27,179	25,657	24,220	22,863	21,583	20,374	19,233	18,156	17,140
Harvesting Cost	3,825	3,939	4,058	4,179	4,305	4,434	4,567	4,704	4,845	4,990
Chipping Cost	1,494	1,539	1,585	1,633	1,682	1,732	1,784	1,837	1,893	1,949
Transportation Cost	2,017	2,118	2,224	2,335	2,452	2,574	2,703	2,838	2,980	3,129
Stumpage Royalty Cost	93	96	99	102	105	108	111	115	118	122
Raw Fibre Cost	7,429	7,692	7,965	8,249	8,543	8,848	9,165	9,494	9,836	10,190
Conversion Cost	5,336	5,496	5,660	5,830	6,005	6,185	6,371	6,562	6,759	6,962
Mill to Port Shipping Cost	5,357	5,624	5,906	6,201	6,511	6,836	7,178	7,537	7,914	8,310
Shipping Port Processing Cost	1,071	1,103	1,136	1,170	1,205	1,242	1,279	1,317	1,357	1,397
Ocean Freight Cost	3,750	3,825	3,902	3,980	4,059	4,140	4,223	4,308	4,394	4,482
Shipping Cost	10,178	10,552	10,943	11,351	11,775	12,218	12,680	13,162	13,664	14,189
Gross Profit	5,849	3,438	1,088	-1,210	-3,460	-5,669	-7,842	-9,985	-12,103	-14,201
General and Administrative Expenses	2,879	2,718	2,566	2,422	2,286	2,158	2,037	1,923	1,816	1,714
Taxes	891	216	-443	-1,090	-1,724	-2,348	-2,964	-3,572	-4,175	-4,774
Net Cash Flow (EBIDA)	2,079	504	-1,035	-2,542	-4,022	-5,479	-6,915	-8,335	-9,743	-11,140
Net Present Value					**-17,901**		**-24,993**			**-38,479**

APPENDIX G – OPTIMISTIC SCENARIO

Assumptions - *amounts in thousands unless otherwise stated*			
Annual Production (tonnes)	150,000	Sale Price Rate (Δ/annum)	2.00%
Sale Price ($/tonne)	191.94	Inflation Rate (all costs except)	2.00%
Sale Price (€/tonne)	120.00	Currency Fluxuation (Δ/annum)	1.00%
Exchange Rate Baseline (€/$)	0.63	Transportation Cost (Δ/annum)	-2.00%
Raw Fibre (m^3)	373,500	Shipping Cost (Δ/annum)	-2.00%
		Tax Rate	30.00%
		Required Internal Rate of Return	8.90%

	Year One	Year Two	Year Three	Year Four	Year Five	Year Six	Year Seven	Year Eight	Year Nine	Year Ten
Wood Pellet Sale Price ($/tonne)	192	198	204	210	216	223	229	236	243	250
Capital Cost Expenditure	15,000									
Annual Gross Revenue	28,791	29,655	30,544	31,460	32,404	33,376	34,378	35,409	36,471	37,565
Harvesting Cost	3,825	3,901	3,979	4,059	4,140	4,223	4,307	4,393	4,481	4,571
Chipping Cost	1,494	1,524	1,554	1,585	1,617	1,649	1,682	1,716	1,750	1,785
Transportation Cost	2,017	2,057	2,098	2,140	2,183	2,227	2,271	2,317	2,363	2,410
Stumpage Royalty Cost	93	95	97	99	101	103	105	107	109	112
Raw Fibre Cost	7,429	7,577	7,729	7,884	8,041	8,202	8,366	8,533	8,704	8,878
Conversion Cost	5,336	5,442	5,551	5,662	5,775	5,891	6,009	6,129	6,251	6,376
Mill to Port Shipping Cost	5,357	5,249	5,144	5,041	4,941	4,842	4,745	4,650	4,557	4,466
Shipping Port Processing Cost	1,071	1,092	1,114	1,137	1,159	1,182	1,206	1,230	1,255	1,280
Ocean Freight Cost	1,875	1,838	1,801	1,765	1,729	1,695	1,661	1,628	1,595	1,563
Shipping Cost	8,303	8,179	8,059	7,943	7,829	7,719	7,612	7,508	7,407	7,309
Gross Profit	7,724	8,456	9,205	9,972	10,758	11,564	12,391	13,239	14,109	15,002
General and Administrative Expenses	2,879	2,965	3,054	3,146	3,240	3,338	3,438	3,541	3,647	3,757
Taxes	1,453	1,647	1,845	2,048	2,255	2,468	2,686	2,909	3,138	3,374
Net Cash Flow (EBIDA)	3,391	3,843	4,305	4,778	5,262	5,759	6,267	6,788	7,323	7,872
Net Present Value					**1,522**		**8,425**			**18,612**

APPENDIX H – BASELINE SCENARIO USING MIXED WOOD SPECIES

Assumptions - *amounts in thousands unless otherwise stated*			
Annual Production (tonnes)	150,000	Sale Price Rate (Δ/annum)	0.00%
Sale Price ($/tonne)	191.94	Inflation Rate (all costs except)	0.00%
Sale Price (€/tonne)	120.00	Currency Fluxuation (Δ/annum)	0.00%
Exchange Rate Baseline (€/$)	0.63	Transportation Cost (Δ/annum)	0.00%
Raw Fibre (m^3)	373,500	Shipping Cost (Δ/annum)	0.00%
		Tax Rate	30.00%
		Required Internal Rate of Return	8.90%

	Year One	Year Two	Year Three	Year Four	Year Five	Year Six	Year Seven	Year Eight	Year Nine	Year Ten
Wood Pellet Sale Price ($/tonne)	192	192	192	192	192	192	192	192	192	192
Capital Cost Expenditure	15,000									
Annual Gross Revenue	28,791	28,791	28,791	28,791	28,791	28,791	28,791	28,791	28,791	28,791
Harvesting Cost	3,825	3,825	3,825	3,825	3,825	3,825	3,825	3,825	3,825	3,825
Chipping Cost	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494	1,494
Transportation Cost	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017	2,017
Stumpage Royalty Cost	4,971	4,971	4,971	4,971	4,971	4,971	4,971	4,971	4,971	4,971
Raw Fibre Cost	12,307	12,307	12,307	12,307	12,307	12,307	12,307	12,307	12,307	12,307
Conversion Cost	5,336	5,336	5,336	5,336	5,336	5,336	5,336	5,336	5,336	5,336
Mill to Port Shipping Cost	5,357	5,357	5,357	5,357	5,357	5,357	5,357	5,357	5,357	5,357
Shipping Port Processing Cost	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071
Ocean Freight Cost	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750
Shipping Cost	10,178	10,178	10,178	10,178	10,178	10,178	10,178	10,178	10,178	10,178
Gross Profit	971	971	971	971	971	971	971	971	971	971
General and Administrative Expenses	2,879	2,879	2,879	2,879	2,879	2,879	2,879	2,879	2,879	2,879
Taxes	- 572	- 572	- 572	- 572	- 572	- 572	- 572	- 572	- 572	- 572
Net Cash Flow (EBIDA)	- 1,336	- 1,336	- 1,336	- 1,336	- 1,336	- 1,336	- 1,336	- 1,336	- 1,336	- 1,336
Net Present Value					**- 20,209**		**- 21,745**			**- 23,610**