Pre-Feasibility Analysis of Pellet Manufacturing on the Former Loring Air Force Base Site

A Study Prepared in Partnership with the Environmental Protection Agency for the RE-Powering America's Land Initiative: Siting Renewable Energy on Potentially Contaminated Land and Mine Sites

Randolph Hunsberger and Gail Mosey

Produced under direction of the U.S. Environmental Protection Agency (EPA) by the National Renewable Energy Laboratory (NREL) under Interagency Agreement IAG-09-1751 and Task No. WFD3.1001.

NREL is a national laboratory of the U.S. Department of Energy
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Technical Report
NREL/TP-5D00-60755
April 2014

Contract No. DE-AC36-08GO28308

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The following provided significant contributions to this analysis: William Strauss of FutureMetrics, LLC, did the majority of the analysis and writing appearing in this report; Eric Kingsley from Innovative Natural Resource Solutions, LLC (INRS), performed the biomass resource assessment, which was based, in part, on reports from Ernest Bowling of James W. Sewall Company; and Steve Walker of New England Wood Pellet provided photos for the pellet manufacturing photo tour.

Executive Summary

The U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response, in accordance with the RE-Powering America's Lands initiative, engaged the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) to conduct feasibility studies to assess the viability of developing renewable energy generating facilities on contaminated sites.

This site, in Limestone, Maine—formerly the location of the Loring Air Force Base but now owned by the Aroostook Band of Micmac[1]—was selected for the potential to produce heating pellets from woody feedstock.

Biomass was chosen as the renewable energy resource to evaluate based on abundant woody-biomass resources available in the area. NREL also evaluates potential savings from converting existing Micmac property (not located at the Loring site) from oil-fired heating to pellet heating.

Results

A wood pellet production plant constructed on the Loring site would have a high chance of economic success, while providing jobs and money to the local economy. Combined pellet production with conversion of Micmac buildings from fuel oil to wood chip heating systems shows even more promise.

A 10,500 tons-per-year (tpy) pellet manufacturing facility (9,800 tpy at 93% capacity factor) was evaluated based on the expected local market and on biomass feedstock availability. It is estimated that 19,000 green tons per year of suitable biomass would be required to supply this facility. Locally available biomass resources appear to be adequate for the described facility, but these numbers should be confirmed, as described below.

Recommendations and Next Steps

Based on very preliminary numbers, wood pellet manufacturing is a good option for the Loring site. Further analysis can confirm assumptions used in this report, particularly biomass availability and cost, equipment sizing and cost, and operation and maintenance costs. At a minimum, the following tasks should be included in a more detailed study.

- Determine the location within the available land for the pellet manufacturing facility, including fuel storage
- Perform a site-specific and project-specific biomass resource assessment
- Contact foresters, wood utilization specialists, lumber mills, and others to get a firmer analysis of available biomass, biomass properties, and biomass cost
- Study rough order of magnitude capital costs and operation and maintenance costs further to refine those costs

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[1] For the purposes of this study, we will refer to the site as "the Loring site" and to the Aroostook Band of Micmac as "the Band."

- Perform an updated economic analysis on various sizes of pellet manufacturing facilities to determine the optimum size after more accurate numbers for costs and energy savings are acquired

Evaluate costs of retrofitting existing buildings to replace oil heating equipment with pellet heating.

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1 Background

The U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response, in accordance with the RE-Powering America's Lands initiative, engaged the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) to conduct feasibility studies to assess the viability of developing renewable energy generating facilities on contaminated sites. This site, in Limestone, Maine—formerly the location of the Loring Air Force Base but now owned by the Aroostook Band of Micmac[2]—was selected for the potential to produce heating pellets from woody feedstock.

The area surrounding the site has ample woody biomass to support a biomass pellet manufacturing facility (see Section 4). There is potential for Micmac to use pellets to displace oil for internal heating loads (e.g., residential and commercial), supply nearby facilities with pellets, and market pellets in the local region, including to nearby regions in Canada.

1.1 Scope of Work

The primary purpose of this report is to analyze the feasibility of building and operating a wood-pellet manufacturing facility. The report provides summary results of a biomass resource assessment, a market assessment, and technical and economic analyses. It also includes a high-level assessment of replacing current Tribal heating fuel—primarily heating oil—with pellets.

1.2 Study Level and Uncertainty

This study is a high-level analysis that serves as a first step toward deciding whether conditions seem favorable for a biomass pellet manufacturing facility at the Loring site. As such, there is a high level of uncertainty in most of the study components, including biomass availability and cost, equipment costs, operation and maintenance costs, annual energy use, and other figures.

Recommend steps to reduce these uncertainties are provided in each section, as appropriate, for the next level of analysis.

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[2] For the purposes of this study, we will refer to the site as "the Loring site" and to the Aroostook Band of Micmac as "the Band."

2 Development of Biomass Energy on Brownfield Sites

One very promising and innovative use of contaminated sites is to serve as locations for various types of biomass projects, such as heat, power, and pellet manufacturing. Biomass installations work well on brownfield sites where there is an adequate biomass fuel supply and favorable market conditions.

Cleaning and reusing potentially contaminated properties provides many benefits, including:

- Preserving greenfields
- Reducing blight and improving the appearance of a community
- Raising property values and creating jobs
- Allowing for access to existing infrastructure, including electric transmission lines and roads
- Enabling a potentially contaminated property to return to a productive and sustainable use.

By taking advantage of these benefits, biomass can provide a viable, beneficial reuse—in many cases generating revenue on a site that would otherwise go unused.

The site evaluated in this analysis is in Limestone, Maine, and is owned by the Aroostook Band of Micmacs (the Band). As with many contaminated or formerly contaminated sites, the local community has significant interest in the redevelopment of the site; community engagement is critical to match future reuse options to the community's vision for the site.

The subject site has potential to be used for other functions beyond the biomass project proposed in this report. Any potential use should align with the community vision for the site and should work to enhance the overall utility of the property.

3 Site Description

This analysis concerns property located at the former Loring AFB in Limestone, Maine. The portion of the property owned by the Band is approximately 650 acres, of which about 100 acres could be available for a biomass project.

Figure 1 is an overview of a potential area for installation of a pellet manufacturing site. The site is fairly flat, with plenty of room for all manufacturing operations, as well as storage of raw materials.

Figure 1. Overview of the site. ***Photo from Mike Daly, EPA***

The map in Figure 2 shows the area around the site—which is in northeastern Maine—with the Loring site in the center.[3] The site is very close to the border with Canada, which is to the east of the site and depicted primarily in darker green.

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[3] OpenStreetMap. Accessed November 20, 2013: http://www.openstreetmap.org/?lat=46.951&lon=-67.868&zoom=11&layers=M. Map source is © OpenStreetMap contributors.

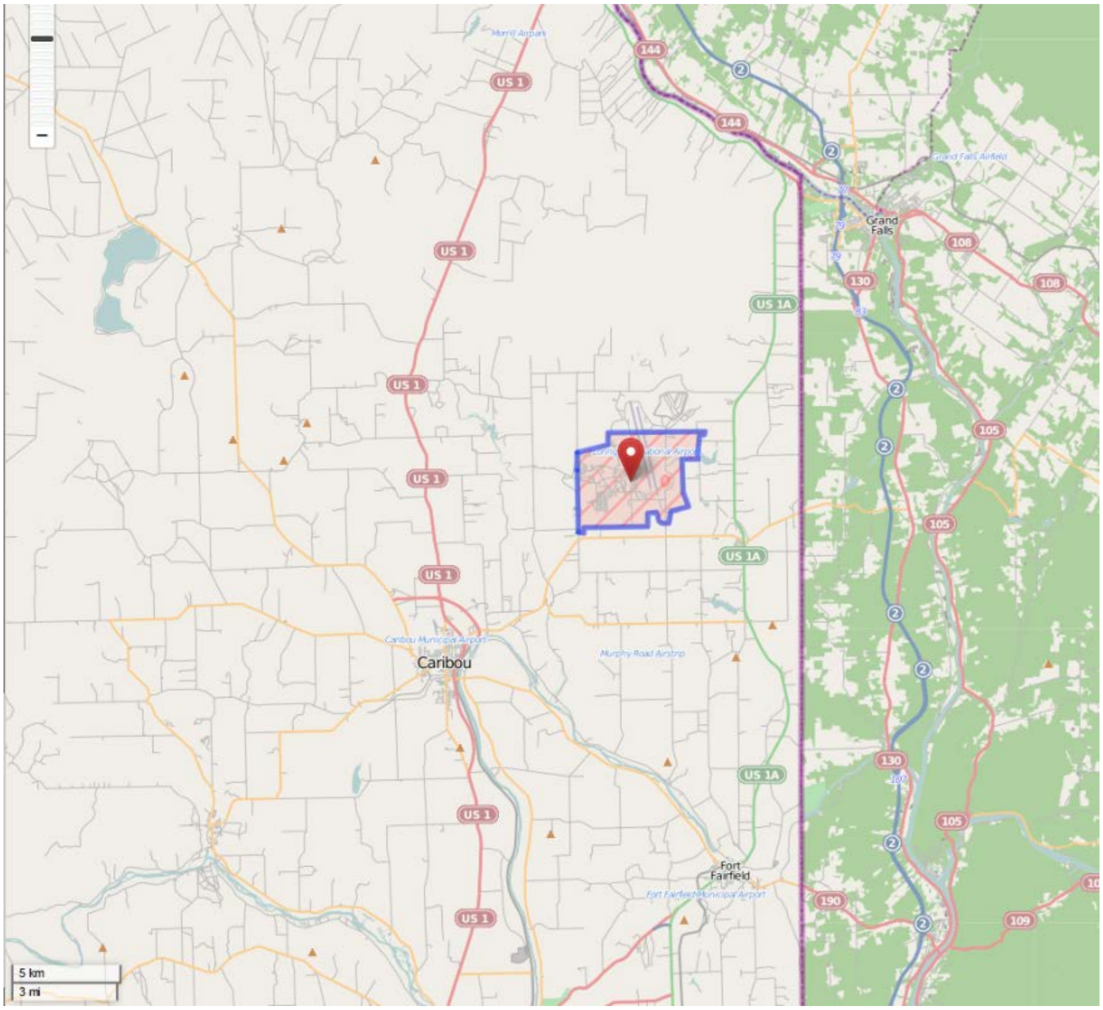

Figure 2. Map showing location of the former Loring Air Force Base in eastern Maine

Illustration generated in OpenStreetMap

There are several tanks on the site, formerly used to store oil or jet fuel (see Figure 3 and Figure 4). We considered the potential for using these tanks as storage, or as part of the pellet manufacturing process, but the consensus opinion was that they will need to be removed as part of the site clean-up process.

Figure 3. Tanks at Loring site. ***Photo from Mike Daly, EPA***

Figure 4. One of the larger tanks at the Loring site. ***Photo from Mike Daly, EPA***

3.1 Site Ownership and History

The Loring site was originally chosen as an AFB because of its proximity to Europe.[4]

The Band, which have no reservation but have about 1,350 acres of land in northern Maine,[5] acquired part of the former Loring AFB in 2009. Since that time, the Band has been investigating potential uses for the site.

3.2 Recommended Activities for Next-Level Analysis

Pellet production facilities range in size from a few acres up to about 100 acres. The available site should be reviewed for an appropriate location for the manufacturing facility.

An engineering feasibility study should be performed to determine the suitability of the location for construction and to ensure that there are no environmental concerns. The location should also be evaluated for truck access.

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[4] More information about the base can be found at the following links: http://yosemite.epa.gov/r1/npl_pad.nsf/8b160ae5c647980585256bba0066f907/01550369a32b31bb8525691f0063f6d6!OpenDocument and http://www.loringairforcebase.com/.

[5] EPA. "The Aroostook Band of Micmacs." Accessed November 20, 2013: http://www.epa.gov/region1/govt/tribes/aroostoockmicmacs.html.

4 Site Review[6]

A recent visit to the Loring AFB site on April 17, 2013, indicates that it appears suitable for a pellet manufacturing operation. The site has easy access to high voltage power and has very good road access. Water and sewer utilities are available.

A walk around the site did not reveal any obvious obstructions to construction. However, if the project does proceed, an engineering feasibility study would be necessary to determine the suitability of the location for construction and to ensure that there are no environmental concerns with the location.

Maps of the site are provided on the following pages, which show the site in relation to Presque Isle and the surrounding area. The land owned by the Band is inside the whited areas.

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[6] The analysis and writing in this section are provided under contract by Dr. William Strauss of FutureMetrics, LLC. Additional biomass analysis can be found on their website at www.futuremetrics.com.

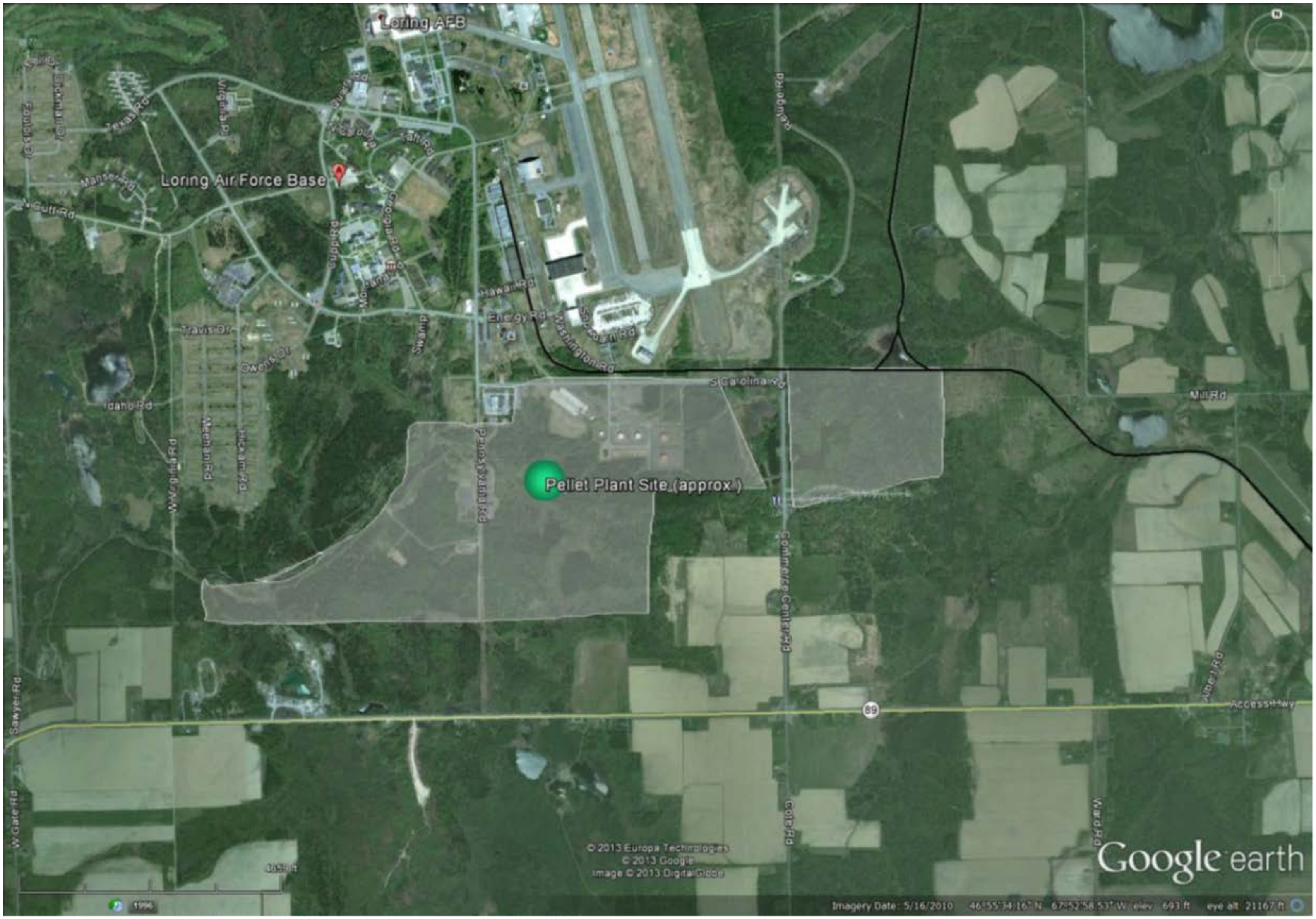

Figure 5. Loring Air Force Base site map; the land owned by the Band is the shaded area south of the runways

Illustration created in Google Earth

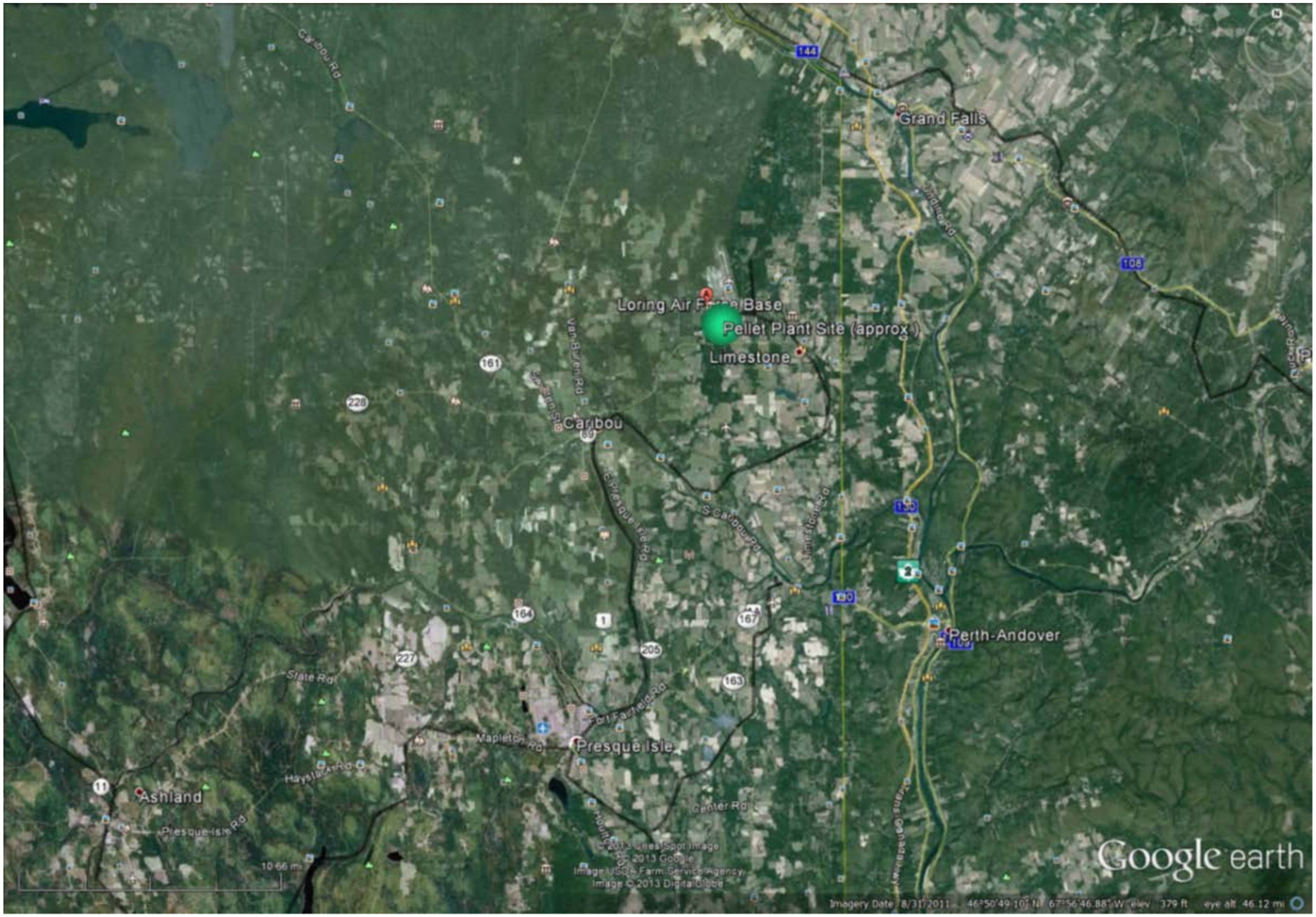

Figure 6. Map of the Loring site (green dot) in relation to the surrounding area

Illustration created in Google Earth

5 Biomass Feedstock: Properties, Cost, and Availability

This section assesses the woody feedstock availability for a biomass pellet manufacturing facility on the site.[7]

5.1 Resource Assessment

For the purposes of this analysis, Innovative Natural Resource Solutions, LLC (INRS), was contracted to conduct a preliminary wood supply analysis for a community-scale wood pellet mill near Presque Isle, Maine.

5.2 Aroostook Band of Micmac Lands

INRS was provided several documents pertaining to lands owned and managed by the Band in the vicinity of Presque Isle, Maine. These documents included two that were relied upon for key information:

- *Micmac Forest Inventory Analysis*, May 25, 2012, prepared by Ernest Bowling of James W. Sewall Company
- *Forest Management Plan, Aroostook Band of Micmacs*, May 25, 2012, prepared by James W. Sewall Company.

INRS accepted these documents as accurate and relied upon them for certain information. According to the information contained in these documents, the annual allowable cut on the Band's forest holdings is 588 cords. Assuming harvest levels proportional to the current species mix, INRS expects the annual harvest to be 33% hardwood and 67% softwood. If 70% of the annual harvest is low-grade roundwood (with 30% as sawlog material), INRS would expect that roughly 1,015 green tons of low-grade roundwood would be available for pellet manufacturing annually from the Band's land. As this is enough feedstock for roughly 500 tons of pellets per year, this volume will need to be augmented significantly in order to justify the investment in a community-scale pellet mill.

5.3 USDA Forest Inventory & Analysis

Using the U.S. Department of Agriculture (USDA) Forest Inventory & Analysis (FIA)[8] database,[9] INRS determined the growth and loss (harvest) for a region within a 25-mile radius of

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[7] This analysis was performed by Eric Kingsley of Innovative Natural Resource Solutions, LLC (INRS), under contract to FutureMetrics, LLC.

[8] Since 1930, the Forest Inventory & Analysis program of the USDA Forest Service collects, analyzes, and reports information on the status and trends of America's forests.

[9] USDA Forest Service EVALIDator 4.01, http://fiatools.fs.fed.us/Evalidator401/tmattribute.jsp , using "Net growth of growing stock on timberland" categories for dynamic measurements.

Presque Isle, Maine (Figure 7). INRS used the most recent complete FIA information, which incorporates data collected between 2007 and 2011.[10]

Figure 7. 60-minute drive time and 25-mile radius around Presque Isle, Maine

Within this area of analysis, INRS used data only from land that met the following criteria:

- Located within the United States (based upon data limitations)
- Has a slope of less than or equal to 40% (roughly 22 degrees)
- Is privately owned (no public lands are included as part of supply analysis).

These restrictions are used to provide a conservative estimate of potentially available feedstock.

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[10] Maine has ±3,500 total FIA plots randomly distributed around the state. Lausten, K., personal communication, Maine Forest Service, February 14, 2012.

5.3.1 Land Ownership

In the region within 25 miles of Presque Isle, Maine (United States only), there are 753,184 acres of timberland.[11] Of this, 93% is in private ownership (Figure 8).

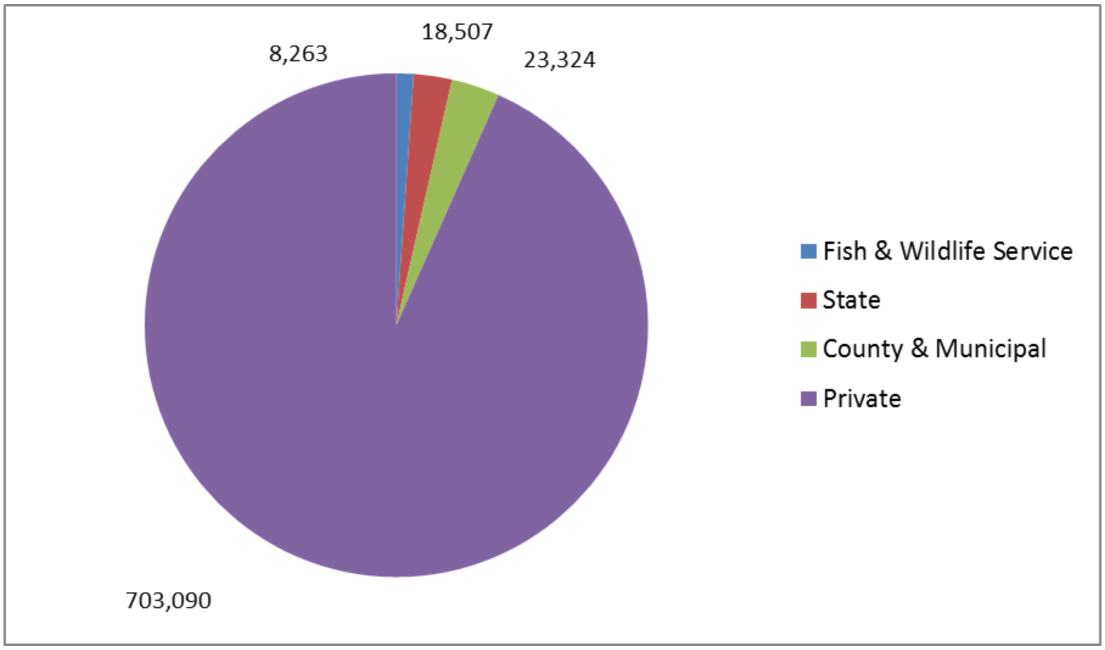

Figure 8. Land ownership (acres) within 25-mile radius of Presque Isle, Maine (United States only)

5.3.2 Annual Growth

Within the 25-mile radius region, INRS used the USDA Forest Service EVALIDator tool[12] to estimate annual growth of roughly 230,000 green tons annually.[13] Of this, roughly 125,000 green tons are non-sawlog material and would be economically appropriate for use in wood pellet manufacturing.[14] See Table 1 for details.

Table 1. Annual Net Growth, Green Tons per Year, within a 25-Mile Radius of Presque Isle, Maine (United States only)

Net Growth	Softwood	Hardwood	Total
All	124,998	106,581	231,579
Sawtimber	86,564	21,230	107,793
Non-Sawtimber	38,434	85,352	123,786

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[11] "Timberland" is land that is physically and legally capable of producing commercial timber. The FIA definition of "timberland" is "Forest land that is producing or capable of producing in excess of 20 cubic feet per acre (1.4 cubic meters per ha) per year of wood at culmination of mean annual increment (MAI). Timberland excludes reserved forest lands." FIA. "FIA Glossary." Accessed November 20, 2013: http://socrates.lv-hrc.nevada.edu/fia/ab/issues/pending/glossary/Glossary_5_30_06.pdf.

[12] USDA Forest Service EVALIDator 4.01, http://fiatools.fs.fed.us/Evalidator401/tmattribute.jsp.

[13] USDA Forest Service data is presented in cubic feet. INRS calculated green tons assuming 85 cubic feet of solid wood per cord and that a green cord of wood weighs 2.6 tons for hardwood and 2.3 tons for softwood.

[14] This does not account for current harvest/removal levels.

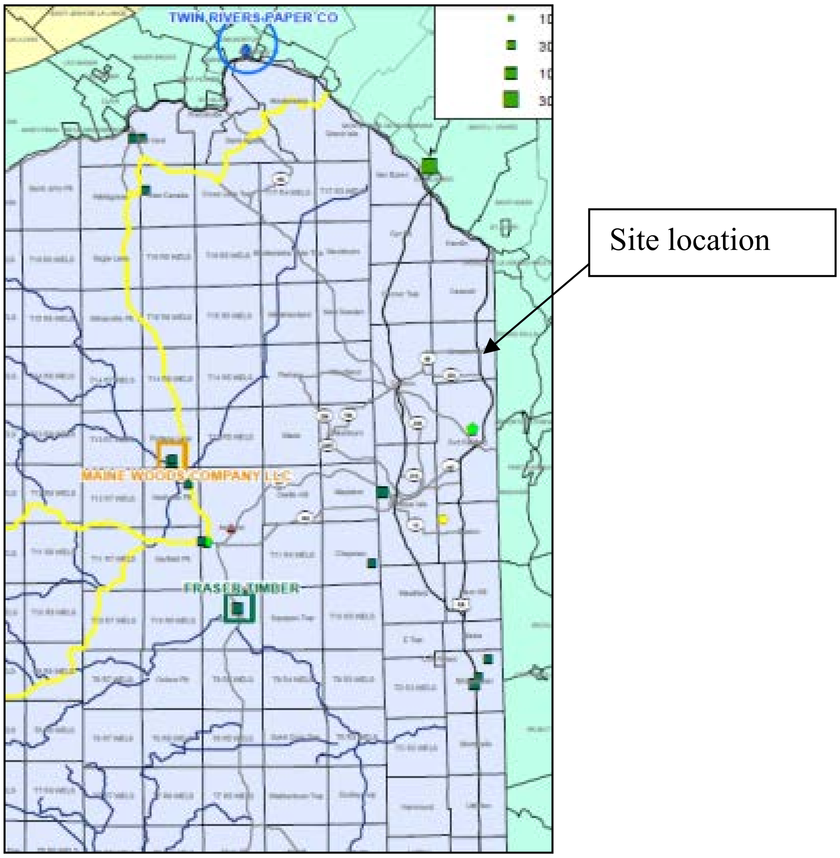
5.4 Existing Major Users of Low-Grade Wood

It is important to note that, in the Limestone region, there are a number of existing large users of low-grade roundwood and biomass chips (which can contain some percentage of low-grade roundwood), and that a competitive and dynamic market exists for wood in this region. Major users of low-grade wood in the region are shown in Table 2.

Table 2. Major Regional Users of Low-Grade Wood

Facility	Wood Used	Distance (road)
Huber – Easton OSB Plant	Roundwood	7 miles
ReEnergy – Ft. Fairfield	Biomass chips	11 miles
ReEnergy – Ashland	Biomass chips (idle)	20 miles
Northeast Pellets	Roundwood, clean chips, sawdust	20 miles
Louisiana Pacific – New Limerick OSB Plant	Roundwood	49 miles
Twin River Pulp Mill (Edmundston, NB)	Roundwood	62 miles

Figure 9 shows these facilities on a map.



Site location

Figure 9. Wood-using facilities in northeast Maine

This figure is extracted from a map of wood-using facilities prepared in 2011 by the Maine Forest Service. A complete map is provided at the end of this section (Figure 12).

5.4.1 Major Landowners

In northeastern Maine there are a number of large landowners, as well as some smaller "family" owners. Figure 10 shows the major land ownerships identified by the owner/manager. None of these lands are known to have fiber supply agreements with regional wood-using facilities that would restrict a new project from accessing fiber.

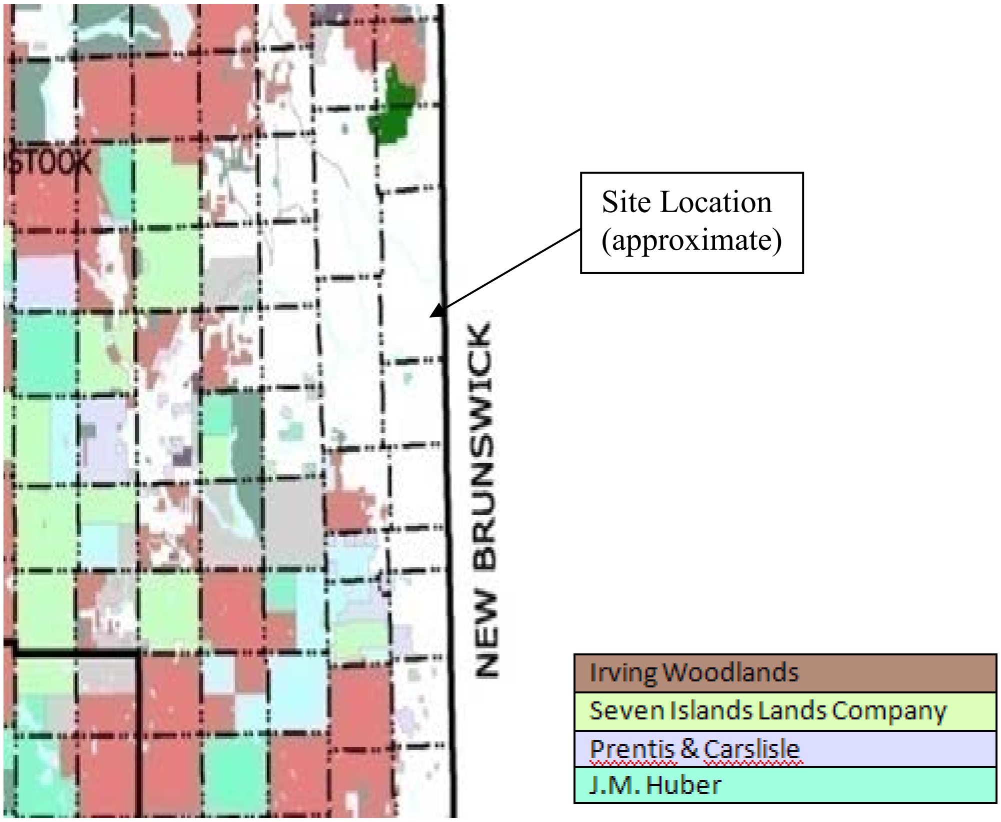


Figure 10. Major landowners in northeast Maine

5.5 Wood Pricing

As noted above, northeast Maine has a number of existing markets for low-grade roundwood. Figure 11 shows quarterly average prices for pulpwood from both hardwood and softwood, delivered. A new pellet mill in this region should expect to pay slightly above market prices, at least during the first several years of operation, while it is establishing its supply relationships.

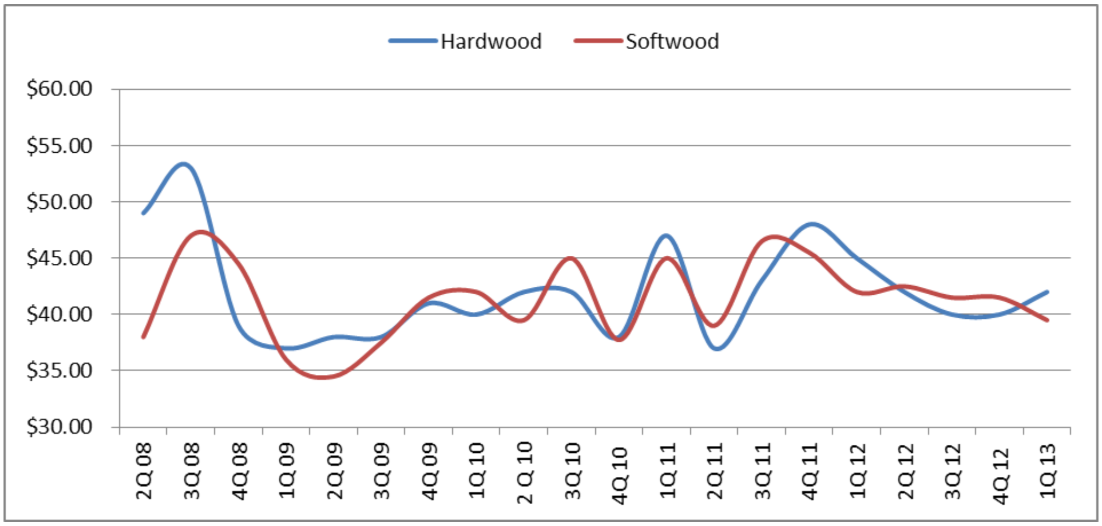


Figure 11. Historical market prices for hardwood and softwood

For a facility purchasing 15,000 to 30,000 green tons of pulpwood[15] annually, INRS would recommend using $45.00 (2013 dollars) as an initial wood price for any business plans or *pro forma* estimates. This could change as regional market conditions or input prices—including but not limited to diesel prices—change.

5.6 Conclusion of Wood Study

Presque Isle, Maine is a competitive region for wood but benefits from a strong and diverse existing wood harvesting and transport infrastructure. The Band can supply a limited volume of low-grade wood to a pellet manufacturing facility from its own lands but will need to supplement this significantly with purchased wood.

Given forest growth patterns in the region and the competitive nature of the regional fiber basket, INRS recommends a facility be sized to meet the needs of the Band, potentially with a slight buffer capacity to account for unplanned outages.

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[15] INRS expects the feedstock requirement for the facility to be roughly identical to pulpwood specifications.

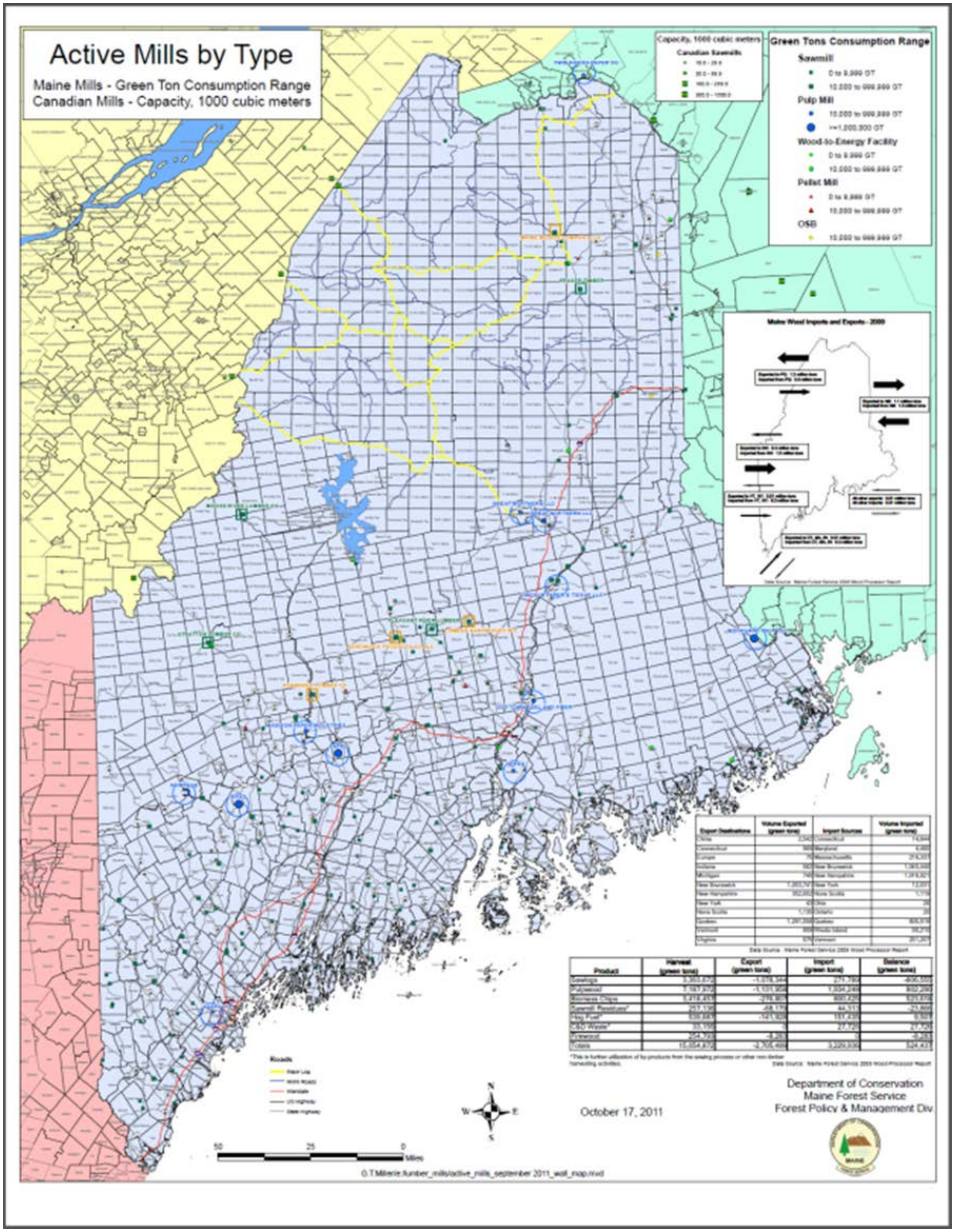

Figure 12. Active wood mills in Maine

5.7 Recommended Activities for Next-Level Analysis

The range of predictions of available biomass for this region highlights the importance of performing a site-specific biomass resource assessment for a biomass pellet manufacturing facility.

As a next step, we recommend contacting foresters, wood utilization specialists, and lumber mills to get a firmer analysis of available biomass, biomass properties, and biomass cost.

6 Wood Pellet Manufacturing Technology[16]

This section presents the basics of woody biomass pellet manufacturing.

6.1 Wood Pellets Basics

Wood pellets are compressed wood fiber. They are about 30% denser than whole wood and are a renewable energy source that is manufactured using an established and proven production process. The pellets have a cylindrical form and are typically 5/16 inch in diameter and 1.5 inches long. They are an easily managed, free-flowing, and dust-free fuel. The average wood pellet made from non-resinous species has an energy content of about 8,500 Btu per pound. Wood pellets are sold in 40-pound bags or can be bulk delivered.

The Micmac facility would produce pellets using a typical well-established process flow. The basic process is as follows:

1. The raw materials are delivered. The raw materials are wood chips (no bark) or green or kiln-dried sawdust.
2. The wood chips are screened for tramp materials (dirt, metal) and pre-shredded to a specific size.
3. The wood chips (and sawdust if necessary) are dried in a rotary dryer to 10%–12% moisture content.
4. The chips and sawdust are further milled to a fine size.
5. The wood fiber is extruded in pellet mills and made into pellets. There are no additives because the wood lignin softens under temperature and pressure to become the binding agent.
6. The pellets are cooled and screened for residual fibers (fines).
7. The pellets are packed for delivery.

6.2 Photo tour of an Existing Pellet Plant

The following photos of a New England wood pellet manufacturing plant in Jaffrey, New Hampshire, illustrate equipment found in a typical pellet plant similar to the one analyzed in this report.

As shown in Figure 13, the manufacturing process begins when tractor trailer-loads of raw material (wet and dry sawdust, chips, etc.) arrive at the plant. The material is unloaded by a skid steer, a live-floor or a truck dump.

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[16] The writing in this section is provided by Dr. William Strauss of FutureMetrics, LLC. The photos are courtesy of, and used by permission of, Steve Walker of New England Wood Pellet. They were taken in 2007.

Figure 13. Load of raw biomass being delivered

Figure 14 shows a truck dump being used to empty a trailer-load of wood chips.

Figure 14. Truck dumping

In Figure 15, a front end loader is being used to move feedstock materials from piles to the pellet plant feed system.

Figure 15. Front end loader transferring materials

The in-feed system meters the raw materials into a screener, which separates the chips from the sawdust (Figure 16).

Figure 16. Biomass in-feed system

The chips pass through a pre-grinder and then mixed back in with the sawdust (Figure 17).

Figure 17. Pre-grinder

The material resulting after the chips are ground and mixed with sawdust is stored in a silo, as shown in Figure 18, from which it is metered into the wood dryer.

Figure 18. Silo for sawdust

Figure 19 shows the dryer, which, in this case, is 12-feet in diameter and 60-feet long.

Figure 19. Dryer

Figure 20 shows the boiler that supplies heat to the dryer. This boiler is fueled with waste biomass.

Figure 20. Biomass boiler for dryer

The metering bin can be seen in Figure 21; these augers deliver fuel to the burner/boiler.

Figure 21. Burner feed augers and metering bin

Figure 22 shows cyclones, which separate water vapor from the sawdust. The moist air is then exhausted.

Figure 22. Cyclones for separating out water vapor

A screener separates the fine and coarse sawdust (Figure 23).

Figure 23. Sawdust screen separator

Figure 24 shows a hammer mill, which is used to further reduce the particle size of the coarse sawdust.

Figure 24. Hammer mill

Figure 25 shows another silo. This one is used to store the fine sawdust.

Figure 25. Silo for fine sawdust

Figure 26 shows the pelletizing equipment.

Figure 26. Sawdust pelletizing equipment

The pellets are hot when they come out of the pelletizers and need to be cooled. Figure 27 shows the pellet cooling system.

Figure 27. Pellet cooling equipment

After being cooled, the pellets are conveyed to a large storage silo, as shown in Figure 28.

Figure 28. Pellet storage silo

Pellets can be delivered in bulk, but are more typically packaged in 40-pound bags, as shown in Figure 29. This figure also shows an automated packaging system, which is more common for large-scale production. For the system recommended for Loring, the bags would be filled and stacked manually.

Figure 29. Bagged pellets and stacker

7 Market Assessment[17]

There are two potential markets for pellets manufactured at the Loring site: The Micmac's own set of buildings and the retail market in the region. The size of the potential market and existence of another pellet manufacturing facility in Ashland, Maine, will help to set the upper bounds for the capacity of the facility.

7.1 The Potential Micmac Direct Market for Pellet Fuel

The Micmac Band properties include a number of buildings and residences near Presque Isle in northern Maine. The cost savings for heating those buildings with pellet-fueled furnaces and/or boilers versus heating oil would be very significant. Heating fuel cost savings primarily drive the wood pellet market. However, if the Tribe were to manufacture its own pellets, it could sell the pellets into its own buildings at cost.[18]

Table 3 shows the most recent heating oil consumption data. The table also shows the equivalent number of tons of wood pellets that would be consumed if the buildings were converted.

Table 3. Current Heating Fuel Usage by Micmac Properties

One Year Fuel Usage (June, 2010 - May 2012)	Heating Oil Gallons	Cost	$/gal	Pellet Equivelant Tons	Cost at $145 per ton
Micmac Service Unit	1,156	$3,716	$3.216	9.38	$1,360
Admin - 7 Northern Rd.	5,365	$17,255	$3.216	43.55	$6,315
Little Feathers Head Start	2,061	$6,435	$3.123	16.73	$2,426
Spruce Haven	3,418	$11,096	$3.247	27.74	$4,023
Farm	650	$2,090	$3.216	5.28	$765
Employees	21,543	$67,710	$3.143	174.88	$25,357
Housing Vacancies	11,361	$35,255	$3.103	92.22	$13,372
LIHEAP/CITGO Housing Fuel	83,977	$236,254	$2.813	681.70	$98,846
TOTALS	**129,531**	**$379,812**		**1051.48**	**$152,465**

Given the data and assumptions in Table 3, the Tribe would save $227,300 per year. That would set the cost of heating at about 40% of its current cost.

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[17] The analysis and writing in this section are provided under contract by Dr. William Strauss of FutureMetrics, LLC. Additional biomass analysis can be found on their website at www.futuremetrics.com.

[18] The Band would sell to itself at mill cost of about $145/ton (not the wholesale cost to external buyers of $174/ton as shown in the cash flow analysis below). The loss of revenue from 1,050 tons per year sold at cost is about $30,500. The savings to the Band are about $227,000/year as the table above shows. The net savings for the Band are about $197,000/year.

7.2 The Potential for Selling Pellets Regionally

The Houlton/Presque Isle area has very strong growth both in the pellet stove and pellet boiler market. Daigle Oil, located in Presque Isle, Caribou, Houlton, and other nearby towns, has the only bulk pellet fuel delivery truck in northern Maine. Because heating oil prices are very high in the region—about 75% higher than pellets[19]—and because natural gas infrastructure does not exist in the region, a significant percentage of people have been converting their heating systems from oil to pellet fuel.

The current total demand for pellets in the region is at least 15,000 tons per year.[20] Growth in the region is expected to double that demand in the next five years.[21]

There are several large users of pellets near the site, as listed below:

- The Northern Maine Community College (directly across the street from the Micmac properties in Presque Isle) uses pellets for heating. Their annual consumption is about 600 tons per year.
- The University of Maine at Presque Isle (about 23 miles from the Loring site) uses pellets for heating. Their annual consumption is about 200 tons per year.
- The University of Maine at Fort Kent (about 50 miles from the Loring site) uses pellets for heating. They consume about 300 tons per year.

The cost of pellets delivered depends upon feedstock costs and the distance that the pellets have to travel to market. Figure 13 shows population centers within a three-hour drive time and within a 100-mile radius of the Loring site. The sizes of the circles represent population.

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[19] Pellet prices of $220/ton equate to a heat cost of about $0.05/kWh. Heating oil at $3.59 (average price in the region on May 20, 2013) is equivalent to a heat cost of about $0.09/kWh.

[20] Based on production from the Ashland, Maine, mill.

[21] Based on analysis by FutureMetrics on the development of bulk and bag pellet demand in Maine.

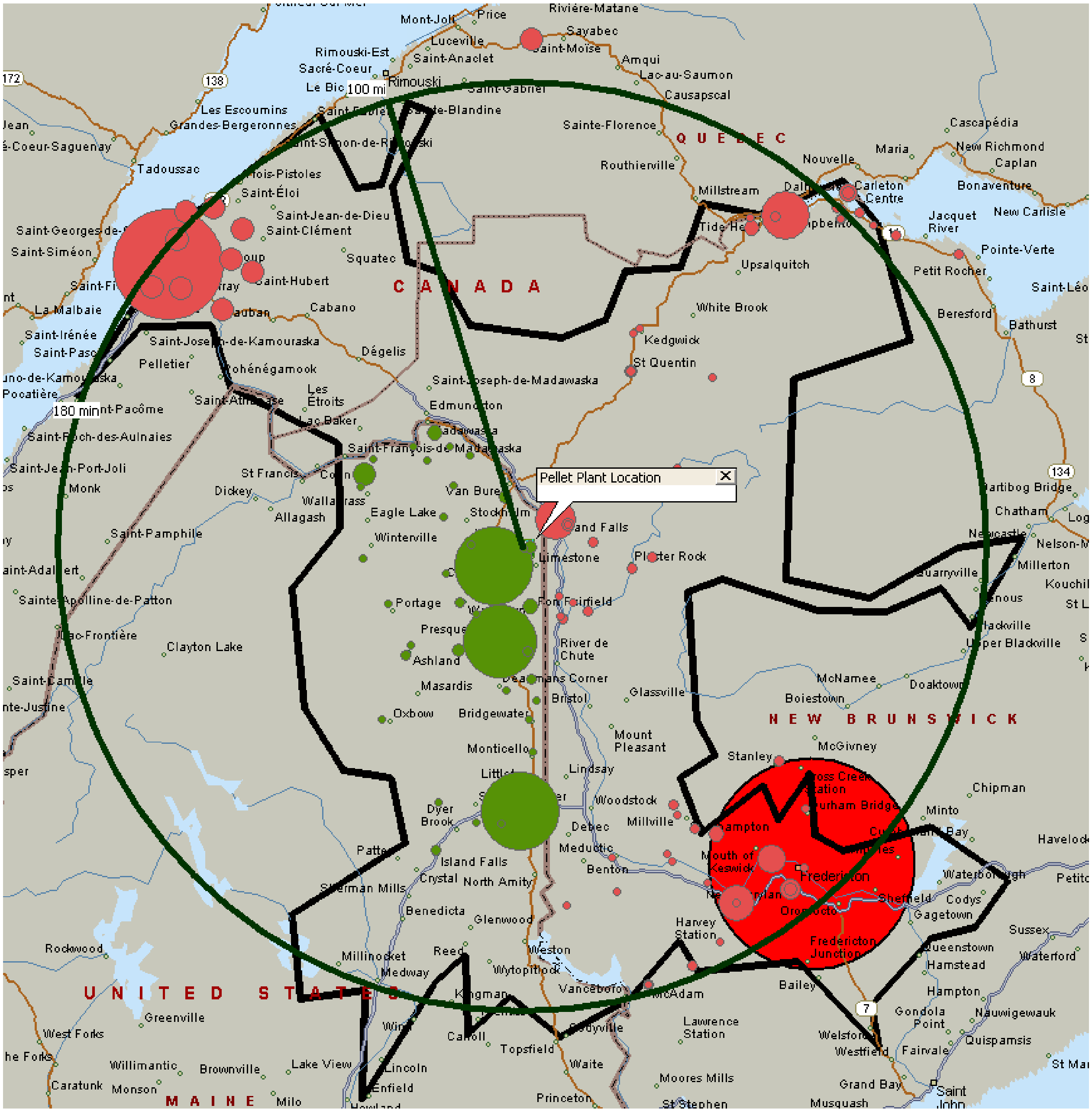

Figure 30. Population centers within a three-hour drive time and within a 100-mile radius of the Loring site; the sizes of the circles represent population

Within a 100-mile radius of the site, the population in the U.S. segment is about 70,000[22] and the Canadian population is about 176,000.[23] Of the Canadian population, 47,000 are in Fredericton (the large red circle in the lower right).

Most of the Canadian population, with the exception of Fredericton, does not have natural gas pipelines nearby, which means that they would have a significant incentive to switch to pellet heat.

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[22] U.S. Census data by town.

[23] Statistics Canada by town.

There is another pellet manufacturing facility in the region in Ashland, Maine. Ashland is about 20 miles west of Presque Isle. The Ashland facility has the capacity to produce about 30,000 tons per year and relies entirely on residuals (sawdust) from sawmills. The mill has been running at a much lower output than its nameplate. Maximum production has been about 14,000 tons per year. That output level defines the market in the region. However, operating at below 50% of capacity also presents that operation with challenges. Primarily, the facility is constrained on how low it can price its pellets with such low production volumes relative to the capital cost. The production from the Loring facility would likely compete with the Ashland production for some market share in the early years.

However, the modest size of the proposed facility at Loring and the local existing markets nearer to the facility than Ashland (particularly Grand Falls, the Rivière-du-Loup region in Canada, and the relativity high density population along the Caribou-Presque Isle-Houlton corridor on U.S. Route 1) would suggest that the Loring location will have lower transportation costs and thus be able to deliver lower-cost pellets. The potential for some 40,000 to 60,000 households in the region to convert from heating oil to pellet fuel,[24] each of which would use about 8 to 10 tons per year, suggests that the plant at Loring will be able to sell its production in 2015.

If the Band converts its buildings, and the schools near the Loring facility are customers, the project will already have about a quarter of its annual production accounted for.

Locating a wood-pellet plant and converting local buildings to pellet heat would add jobs, keep money in the local community, and reduce heating expenses for the community.

7.3 Recommended Activities for Next-Level Analysis

We recommend that the following steps be taken as part of a follow-on analysis to clarify the market for pellets in the region:

- Perform an evaluation of existing Micmac facilities for conversion to pellets
- Contact other local pellet users (e.g., Northern Maine Community College, University of Maine at Presque Isle, and University of Maine at Fort Kent) to evaluate their potential as pellet customers
- Define the seasonality of the pellet market
- Review the regulations and duties for selling pellets into the Canadian market
- Determine the status of the Ashland, Maine, pellet manufacturing facility.

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[24] For a complete overview of modern fully automatic high-efficiency pellet-fueled central heating systems, go to www.MaineEnergySystems.com.

8 Project Technical and Economic Analysis

8.1 Optimal Sizing of the Project

Given the current demand in the region, current production from the Ashland mill, the expected growth in demand over the next 10 years, and the sensitivity of the local wood market to demand for feedstock, the project should be modestly sized to manufacture about 9,800 tons per year of pellets. This is 93% of the nameplate capacity of the system evaluated. The facility is expected to operate at a rate of 1.2 tons per hour and produce up to 9,800 tons of pellets per year, operating three shifts per day, 7 days per week.

This sizing will have a negligible impact on the regional wood basket and therefore will have an insignificant impact on regional wood pricing. The operation will have to source about 19,000 tons per year of clean white wood chips.

The total capital cost for the project is estimated to be $2,113,000. This includes all process equipment, buildings, engineering, construction, and working capital needs. Details of the estimate are in Table 4.[25] The project financing assumptions used in the analysis include: 75% debt + 25% equity, a loan term of 10 years, and a 4% interest rate.

Table 4 presents the estimated capital costs for a 1.2 ton-per-hour plant. These costs were derived by scaling known cost data from previous analysis.

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[25] The capital cost and operating cost data are based on generic models scaled to the size of this project. The actual costs will need to be refined by a technical engineering study of the project.

Table 4. Pellet Plant Capital and Installation Costs

9,800 Ton Per Year Wood Pelleting Plant Capital Costs to Startup Projections 1.2 Tons Per Hour Full Capacity Production (7 days, 3 shifts, 93% CF) Equipment Requirements	 Approximate Cost
Truck Scales	$50,000
Truck Dumper	$0
Raw Material Infeed Station and Silo	$17,500
Raw Material Transfer Conveyor	$6,650
Suspended Magnet	$3,220
Dryer Infeed and Discharge Conveyors	$5,250
Dryers	$175,000
Dryer Fuel Storage Silo, Unloader, and Discharge Conveyor	$50,000
Dryer Burner Fuel Conveying System (pneumatic)	$50,000
Dryer Burner (wood fueled with controls and feed system)	$90,000
Chip Screeners	$14,000
Screener Output (Acceptable and Oversized) Conveyors	$2,800
Hammer Mills (course input and processed chips mills)	$53,900
Pneumatic System (Hammer Mill Take-Aways pre-dryer and post dryer)	$14,850
Dry Material Silos, Unloaders, and Conveyors (dust and dryed chips)	$39,600
Pellet Mill Surge Hoppers	$5,950
Pellet Mills, Conditioners and Motors	$275,550
Start-up Dies for Pellet Mills	$8,250
Spare Rollers and Shells for Pellet Mill	$20,000
Pellet Mill Discharge Conveying System	$3,500
Pellet Cooler	$5,250
Cooler Air System and Filters	$7,000
Screener for Removing Fines	$2,450
Fines Conveying System	$1,750
Finished Pellets Screener Discharge Conveyor and Bucket Elevator	$3,220
On Site Pellet Storage Silos	$40,600
Pellet Storage Discharge Conveyor and Fines Screener	$5,950
Bagging System (Hopper, Scale, Fill and Seal Bagger, Stacker, Wrapper)	$180,000
Structural Steel (not including buildings)	$33,600
Electrical Service, Controls, and Control Systems	$36,400
Engineering (includes permitting)	$35,000
Boiler & Hardware (Office and Maintenance Area Heat)	$20,000
Miscellaneous Spare Parts	$24,500
Process Equipment Budget	**$1,281,740**
Other Costs	
Front End Loaders	$42,000
Fork Lift	$12,950
Land	$0
Buildings (Process and Warehouse - Includes all site prep work and erection)	$129,500
Site & Driveway Work	$66,500
Fire Protection and Spark Detection Systems	$41,650
Start-up Bags, Slip-Covers & Pallets	$10,000
Other Start-up Costs (including payroll and vendor oversight) & Working Capital	$16,800
Freight	$18,550
Marketing & Administrative Costs	$0
Total Other Costs	**$337,950**
Contracting and Construction Costs (mechanical and electrical other than buildings)	$66,500
Debt Contingency for Construction Period and Startup	$70,000
20% Contingency (due to small project scale)	**$351,238**
Total Debt	**$526,857**
Total Equity Investment	**$1,580,571**
Total Capital Cost	**$2,107,428**

8.2 Analysis of Cash Flows and Estimated Return on Investment

The pellet manufacturing facility is expected to have annual operating costs of about $1,021,000 in the first year of operation. Revenues in the first year are expected to be $1,219,000 for a gross operating profit of about $198,000. The first year of operation is expected to be at 65% of full nameplate capacity (about 6,800 tons per year). All following years are expected to be near 93% of nameplate (about 9,800 tons per year).

Wood costs in the Loring region are higher than in some other regions of Maine. As the wood study section of this analysis suggests, the cash flow model assumes a cost of $45/ton for all tons procured outside of the Band's lands. The assumption is that about 1,000 tons per year will be procured from Micmac lands at a cost of $30/ton.

The model assumes the price for pellets at the mill will be $174/ton at the time the project begins to manufacture pellets (early 2015 if the development follows a typical trajectory and proceeds with little delay).

The operating cost assumptions shown in Table 5 are based on experience developing previous pellet plants.

Table 6 shows motor loads for the facility, which can be used to estimate typical peak demand and annual electric consumption. Past experience has shown that not all motors will be operating simultaneously and that a 60% scaling factor can be used to estimate the operating load.

Table 5. Operation and Maintenance Costs for 1.2 Ton per Hour Pellet Manufacturing Facility

Operating and maintenance costs for 9,800 tons per year pellet production		
Wood Cost (avg delivered from outside Micmac lands)	**$45.00**	**per ton**
Wood Cost (avg delivered from Micmac lands)	**$30.00**	**per ton**
Ratio of Outside Wood to Micmac Wood	19.00	
Average Wood Cost	**44.25**	Chips/Pellets
		Sawdust/Pellets
Tons per hour of Pellets Produced	**1.20**	tons/hour
Electricity Cost	$0.08	per kWh
Operator and Maintenance Labor + Benefits	$17.00	per hour
Loader and Fork Truck Driver Labor + Benefits	$17.00	per hour
Office Staff + Benefits	$14.00	per hour
Plant Manager	$75,000	per year
Material Supply Manager	$0	per year
Sales Manager	$0	per year
Delivery Costs to Buyers	$0.00	per ton mile (truck)
Average Delivery Distance per ton Delivered	-	miles
Kilowatts/HP	0.7457	kW/HP
Moisture Content of Raw Material	45%	
Btu per Ton of Dry Chips and/or Sawdust	17,400,000	Btu/Ton
Tons per Hour of Chips and Sawdust to Run Dryer	**0.27**	**ton/hour**
Cost of Wood for Dryer Burner	**$15.00**	**per ton**
Sales Price of Pellets Delivered (current price)	**$165.00**	**per ton**
Percent of Full HP Load Converted to kWh	60%	
Other Electricity Usage	2%	of kW Demand
Die Capacity	2,000	tons
Die Cost	$4,000	per die
Roller Shell Capacity	3,000	tons
Roller Shell Cost (3 shells per set)	$1,200	per shell
Roller Bearing Capacity	2,500	tons
RTO Operating Cost	-	
Roller Bearing Cost (three rollers)	$900	per bearing
Other Parts and Maintenance Cost	$49,932	per year
Bag Cost	$0.28	per bag
Shrink Wrap Cost	$0.75	per pallet
Pallet Cost	$5.00	pallet
On-Site Fuel Usage (loaders and fork trucks)	11	gallons/day
On-Site Fuel Cost	$3.60	gallon
Tax Rate	0%	
Cost of Borrowing	4%	
Working Capital	3%	of annual revenue
Useful Life of Equipment	10	years
Term of Debt	10	years
Average Annual Inflation Rate (cost of goods and parts, and wages)	**3.00%**	per year
Fuel (pellet) Price annual escalator above baseline	**2.50%**	per year
Annual Plant Production (except first year)	93%	of capacity

Table 6. Electric Loads for 1.2 Ton per Hour Pellet Manufacturing Facility

Horsepower Needed ==> Annual Pellet Output	10,512
Bark handling	22.3
Bark Hog	27.9
Bark Burner	13.5
Chip Hog	69.8
Wet chip handling	44.8
Dryer motors and ID fan	46.2
Dry chip handling	3.2
Dry hammermill	48.8
Milled wood handing	10.5
Pelletizers	111.6
Pellet handling and cooler	20.2
Pellet conveying	7.7
Bagging and wrapping system	14.0
Plant air compressor	3.5
Total Horsepower	**444**
Total Connected HP MAX Electricity Demand (kW)	**331**
Total kW Demand at 60.0% of MAX	**199**

Estimated staffing levels, hours, and hourly rates are shown in Table 7.

Table 7. Operating Labor Requirements for Pellet Plant Operating 24 Hours per Day, Seven Days per Week

	#	**Shifts**	**Rate**	**Hours**	**$/year**	**% Soft**	**$/year**	**$/position**
Plant Manager	1	1			**$ 75,000**	**30%**	$ 97,500	$ 97,500
Raw material handler	1	4	**$ 17.00**	2,200	$ 37,400	**30%**	$ 48,620	$ 194,480
Plant operator	1	4	**$ 17.00**	2,200	$ 37,400	**30%**	$ 48,620	$ 194,480
Utility Operator	1	2	**$ 17.00**	2,200	$ 37,400	**30%**	$ 48,620	$ 97,240
Mechanical / Electrician	1	2	**$ 17.00**	2,200	$ 37,400	**30%**	$ 48,620	$ 97,240
Total Labor cost		**13**						**$ 680,940**

Ten-year cash flows are calculated for two scenarios: Scenario 1 is for the pellet plant only; Scenario 2 includes cost savings from converting tribal buildings from heating oil to pellet fuel.[26] We assume that the conversions from heating oil to pellet fuel take place over 4 years with an equal number of conversions each year. After four years it is assumed that all of the buildings and residences are heated with high-efficiency automatic pellet boilers.

Note that the pellet price inflation is assumed to be a combination of both the overall inflation rate and an increase on top of inflation that is a proportion of the rate of increase in heating oil price. Heating oil and diesel fuel prices are highly correlated.[27]

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[26] This assumes a comingling of the finances of the pellet project with the heating costs for the Band's offices and housing.

[27] See research by FutureMetrics at www.FutureMetrics.com.

By 2023 if heating oil and diesel fuel are about $5.50/gallon, pellet prices are expected to be about $282/ton.[28]

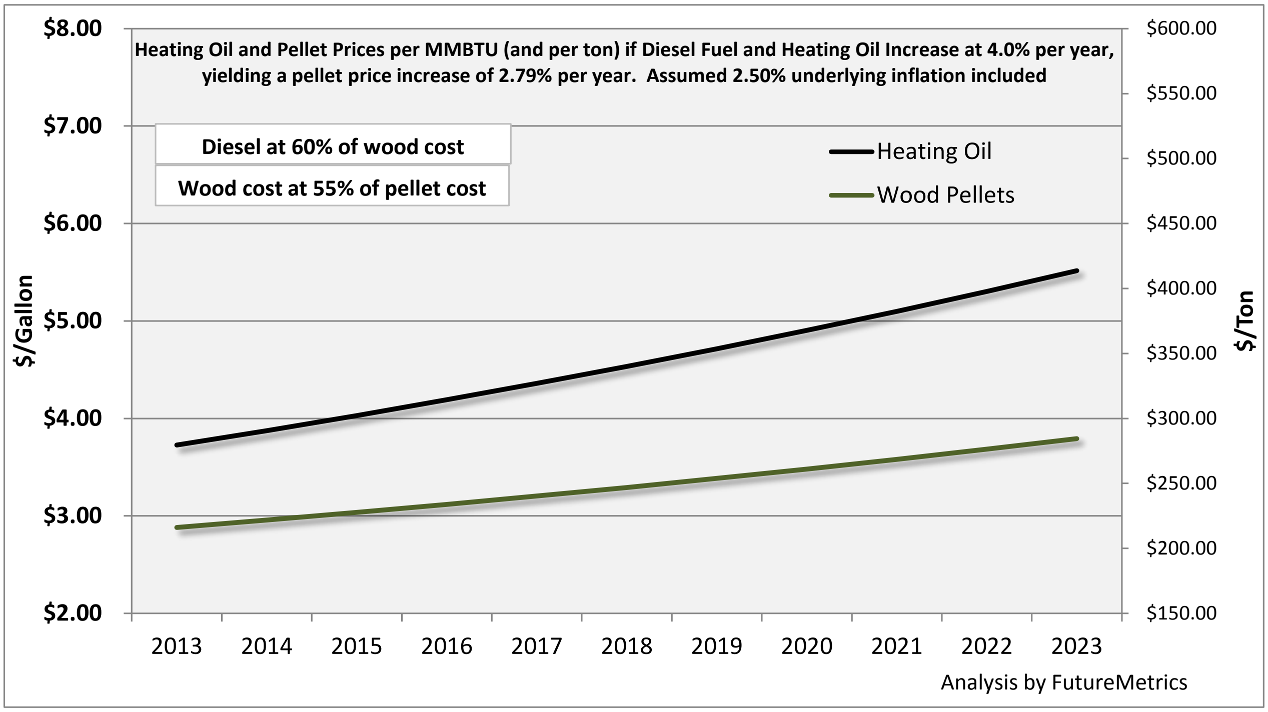

Figure 31. Projected costs of diesel fuel and wood pellets, 2013–2023

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[28] This is a very conservative estimate on future prices based on U.S. Energy Information Administration data. FutureMetrics estimates that heating oil will be close to $8/gallon in 2023.

Table 8. Economic Analysis of Pellet Facility, Scenario 1

extra borrowing for early cash flow needs ====>	$ 200,000	1	2	3	4	5	6	7	8	9	10
Scenario 1 - Projected Cash Flows -- Return on Investment (ROI) -- Net Present Value Calculation (NPV)											
Capacity		65%	93%	93%	93%	93%	93%	93%	93%	93%	93%
Tons		6,833	9,776	9,776	9,776	9,776	9,776	9,776	9,776	9,776	9,776
Pellet Price Delivered		$174	$184	$194	$204	$216	$228	$240	$253	$267	$282
Debt Percentage	75%										
Equity Percentage	25%										
Year	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Capital Costs (less "other startup" and contingency costs)	$2,021,328										
Change in Working Capital	$36,575										
Revenue	$0	$1,219,155	$1,886,275	$2,039,770	$2,205,756	$2,385,250	$2,579,350	$2,789,244	$3,016,219	$3,261,664	$3,527,082
Subtract Cost of Goods (includes labor)	$0	1,021,217	1,503,691	1,547,659	1,593,827	1,641,903	1,692,275	1,744,523	1,798,944	1,855,977	1,915,398
Gross Operating Cash Flow		**197,938**	**382,583**	**492,111**	**611,929**	**743,346**	**887,074**	**1,044,721**	**1,217,275**	**1,405,686**	**1,611,684**
Subtract General Selling and Admin (includes Plt.Mgr.)	$75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Potential Heating Cost Savings Scenario		-	-	-	-	-	-	-	-	-	-
Subtract Annual Debt Service (includes interest)	$70,000	219,917	219,917	219,917	219,917	219,917	219,917	219,917	219,917	219,917	219,917
Annual Taxes	-	-	-	-	-	-	-	-	-	-	-
Salvage Estimates											
Net Operating Cash Flows	**($2,002,903)**	**($96,979)**	**$87,666**	**$197,194**	**$317,013**	**$448,430**	**$592,158**	**$749,804**	**$922,358**	**$1,110,770**	**1,316,767**
Cash at the start of the period	$2,111,628	**$108,725**	**$11,746**	**$99,413**	**$296,607**	**$613,620**	**$1,062,049**	**$1,654,207**	**$2,404,011**	**$3,326,369**	**$4,437,139**
Cash inflow (outflow) during the period	($2,002,903)	**($96,979)**	**87,666**	**197,194**	**317,013**	**448,430**	**592,158**	**749,804**	**922,358**	**1,110,770**	**1,316,767**
	($527,907)										
Cash at the end of the period	**$108,725**	**$11,746**	**$99,413**	**$296,607**	**$613,620**	**$1,062,049**	**$1,654,207**	**$2,404,011**	**$3,326,369**	**$4,437,139**	**$5,753,906**
EBITDA		(25,630)	153,073	256,420	369,811	494,543	631,319	781,735	946,769	1,127,361	1,325,226
ROI for total CAPEX (10 Yrs.)	**14.10%**	**NPV (@ 8%, 10 Yrs.)**		**$1,043,047.17**				**Equity Cash Out ==>**			**$5,225,999**

Table 9. Economic Analysis of Pellet Facility, Scenario 2

extra borrowing for early cash flow needs ====>	$ 200,000	1	2	3	4	5	6	7	8	9	10
Scenario 2 - Projected Cash Flows -- Return on Investment (ROI) -- Net Present Value Calculation (NPV) WITH COST SAVINGS FROM FUEL SWITCHING											
Capacity		65%	93%	93%	93%	93%	93%	93%	93%	93%	93%
Tons		6,833	9,776	9,776	9,776	9,776	9,776	9,776	9,776	9,776	9,776
Pellet Price Delivered		$174	$184	$194	$204	$216	$228	$240	$253	$267	$282
Debt Percentage	75%										
Equity Percentage	25%										
Year	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Capital Costs (less "other startup" and contingency costs)	$2,021,328										
Change in Working Capital	$36,575										
Revenue	$0	$1,219,155	$1,886,275	$2,039,770	$2,205,756	$2,385,250	$2,579,350	$2,789,244	$3,016,219	$3,261,664	$3,527,082
Subtract Cost of Goods (includes labor)	$0	1,021,217	1,503,691	1,547,659	1,593,827	1,641,903	1,692,275	1,744,523	1,798,944	1,855,977	1,915,398
Gross Operating Cash Flow		**197,938**	**382,583**	**492,111**	**611,929**	**743,346**	**887,074**	**1,044,721**	**1,217,275**	**1,405,686**	**1,611,684**
Subtract General Selling and Admin (includes Plt.Mgr.)	$75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Potential Heating Cost Savings Scenario		(56,837)	(119,143)	(187,285)	(261,651)	(274,120)	(287,145)	(300,747)	(314,953)	(329,788)	(345,279)
Subtract Annual Debt Service (includes interest)	$70,000	219,917	219,917	219,917	219,917	219,917	219,917	219,917	219,917	219,917	219,917
Annual Taxes	-	-	-	-	-	-	-	-	-	-	-
Salvage Estimates											
Net Operating Cash Flows	**($2,002,903)**	**($40,142)**	**$206,809**	**$384,479**	**$578,663**	**$722,550**	**$879,302**	**$1,050,552**	**$1,237,311**	**$1,440,558**	**1,662,046**
Cash at the start of the period	$2,111,628	**$108,725**	**$68,583**	**$275,392**	**$659,871**	**$1,238,534**	**$1,961,084**	**$2,840,386**	**$3,890,938**	**$5,128,249**	**$6,568,807**
Cash inflow (outflow) during the period	($2,002,903)	**($40,142)**	**206,809**	**384,479**	**578,663**	**722,550**	**879,302**	**1,050,552**	**1,237,311**	**1,440,558**	**1,662,046**
	($527,907)										
Cash at the end of the period	**$108,725**	**$68,583**	**$275,392**	**$659,871**	**$1,238,534**	**$1,961,084**	**$2,840,386**	**$3,890,938**	**$5,128,249**	**$6,568,807**	**$8,230,852**
EBITDA		31,207	272,215	443,705	631,461	768,663	918,463	1,082,483	1,261,723	1,457,149	1,670,504
ROI for total CAPEX (10 Yrs.)	**21.84%**	**NPV (@ 8%, 10 Yrs.)**		**$2,576,873.64**				**Equity Cash Out ==>**			**$7,702,945**

Given the assumptions shown above, the estimated return on investment (ROI) on the full capital cost for Scenario 1 is about 14%.[29] The net present value (NPV) of the project over 10 years at a discount rate of 8% is $1,043,000.

The accumulated excess cash in year 10 netted against the equity investment will give the equity investor(s) an expected payout of $6,227,000 in year 10. This is an annualized return on equity (ROE) of about 46% over the 10 years.

Scenario 2, in which the cost saving from converting the Band's buildings over 4 years to pellet fuel is included in the cash flow analysis, has an expected ROI of about 22%. The ROE is about 62%.

Table 10 shows the sensitivity of free cash flows for Scenario 1 in the second year (when the project is operating near capacity) to different pellet prices and wood prices.

Table 10. Scenario 1, Second-Year Free Cash Flows; Pellet Prices versus Wood Cost

		Pellet Sales Prices [$/ton]								
		$155	$160	$165	$170	$175	$180	$185	$190	$195
Wood prices [$/ton]	$35	$112,942	$164,297	$215,652	$267,007	$318,362	$369,717	$421,072	$472,427	$523,782
	$36	$95,345	$146,700	$198,055	$249,410	$300,765	$352,120	$403,475	$454,830	$506,185
	$37	$77,748	$129,103	$180,458	$231,813	$283,168	$334,523	$385,878	$437,233	$488,588
	$38	$60,151	$111,506	$162,861	$214,216	$265,571	$316,926	$368,281	$419,636	$470,991
	$39	$42,554	$93,909	$145,264	$196,619	$247,974	$299,329	$350,684	$402,039	$453,394
	$40	$24,957	$76,312	$127,667	$179,022	$230,377	$281,732	$333,087	$384,442	$435,797
	$41	$7,360	$58,715	$110,070	$161,425	$212,780	$264,135	$315,490	$366,845	$418,200
	$42	($10,237)	$41,118	$92,473	$143,828	$195,183	$246,538	$297,893	$349,248	$400,603
	$43	($27,834)	$23,521	$74,876	$126,231	$177,586	$228,941	$280,296	$331,651	$383,006
	$44	($45,431)	$5,924	$57,279	$108,634	$159,989	$211,344	$262,699	$314,054	$365,409
	$45	($63,028)	($11,673)	$39,682	$91,037	$142,392	$193,747	$245,102	$296,457	$347,812
	$46	($80,625)	($29,270)	$22,085	$73,440	$124,795	$176,150	$227,505	$278,860	$330,215
	$47	($98,222)	($46,867)	$4,488	$55,843	$107,198	$158,553	$209,908	$261,263	$312,618
	$48	($115,819)	($64,464)	($13,109)	$38,246	$89,601	$140,956	$192,311	$243,666	$295,021
	$49	($133,416)	($82,061)	($30,706)	$20,649	$72,004	$123,359	$174,714	$226,069	$277,424
	$50	($151,013)	($99,658)	($48,303)	$3,052	$54,407	$105,762	$157,117	$208,472	$259,827

8.3 Probabilistic Analysis of the Cash Flow Model

The expected values for the ROI, ROE, and NPV are based on a series of fixed assumptions. However, the actual values of key parameters will never be exactly equal to the mean values used in the cash flow analysis. The uncertainty in the estimation of the values can be quantified by estimating probability distributions for the inputs that are based on actual project data from similar projects or from historical price and cost data.

The modeling that follows incorporates uncertainty of some of the key inputs to both the capital cost and the operating cost models. The modeling is based on Monte Carlo simulations. Monte Carlo simulations reveal the expected distributions of key cash flow metrics and the sensitivity of the key cash flow metrics to changes in inputs. The analysis shows the risk of insufficient cash

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[29] This is the internal rate of return (IRR) on the full investment against the net operating cash flows over 10 years.

flows to the project and identifies those cost inputs whose changes generate the greatest risk of project failure.

All of the simulations that follow have 5,000 iterations. That is, the cash flow model is recalculated 5,000 separate times and each recalculation randomly samples from the input distributions to create a set of outputs. All of those outputs are stored and aggregated into a single probability distribution. Those distributions and the inputs that contribute significantly to the variability of the outcomes are shown in the follow pages.

8.3.1 Key Inputs to the Cash Flow Simulations

As this is a high-level feasibility study, there is a significant amount of uncertainty in the capital cost estimates; therefore, the total capital cost was modeled using a PERT distribution,[30] with the median value of about \$2.1 million. Figure 32 shows the distribution representing the capital costs.

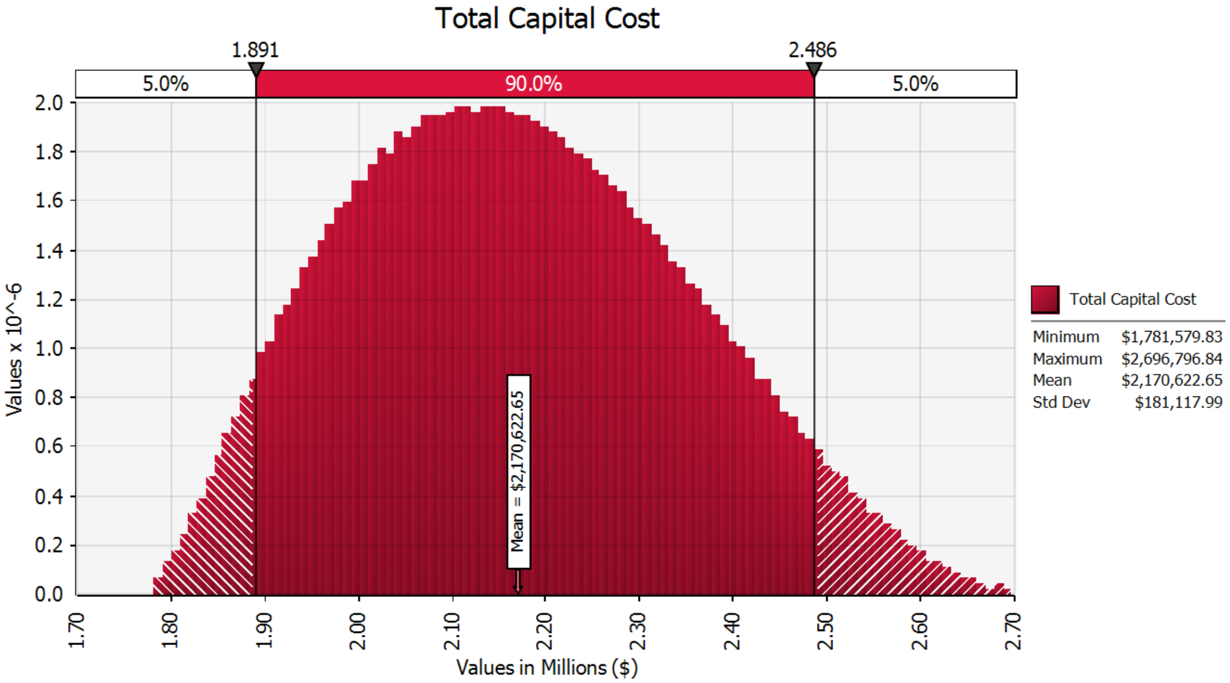

Figure 32. Distribution of values of expected capital costs

The wood cost is critical to the project's ROI. Wood prices are primarily influenced by diesel fuel costs.[31] Figure 33 is a chart of historical (shown by the blue line) and forecast diesel fuel prices in the region. The price has a 50% chance of being within the dark grey bands and a 90% chance of staying within the overall grey region. A sample time series path is indicated by the

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[30] The PERT distribution is used for modeling expert estimates, where one is given the expert's minimum, most likely, and maximum estimates.

[31] See FutureMetrics research on the components of wood costs. Diesel fuel contributes between 50% and 65% to the cost of wood delivered to the mill.

red line. The model predicts a sample diesel price time path based on the probability model and uses that price to estimate wood costs.

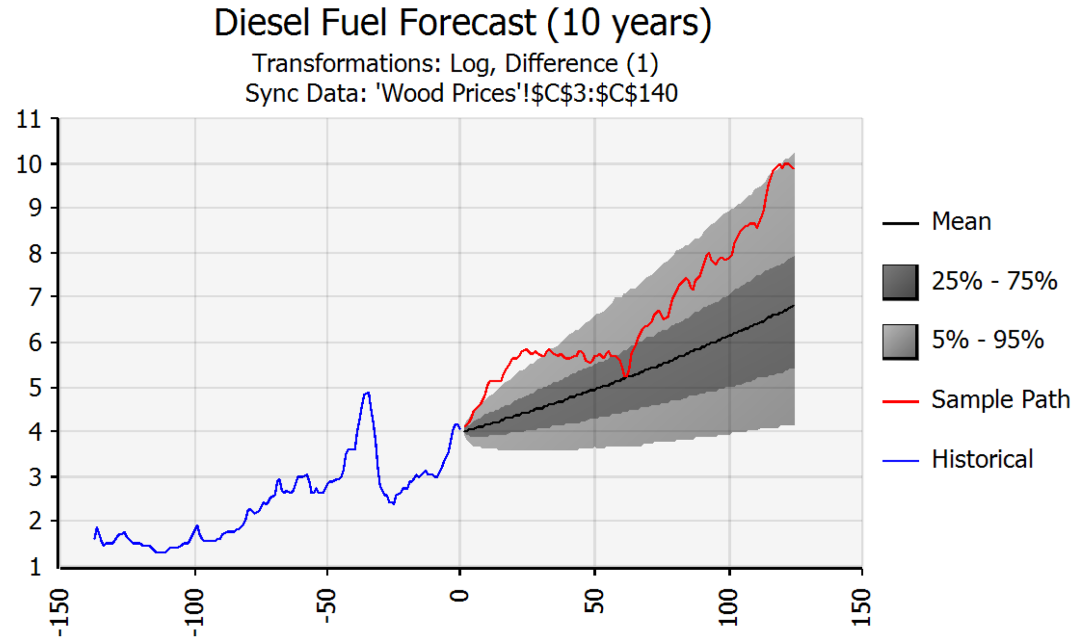

Figure 33. Forecast diesel fuel prices ($/gal) by month for 10 years

Figure 17 shows the wood price forecasts for the next 10 years and the distribution of those forecasts.

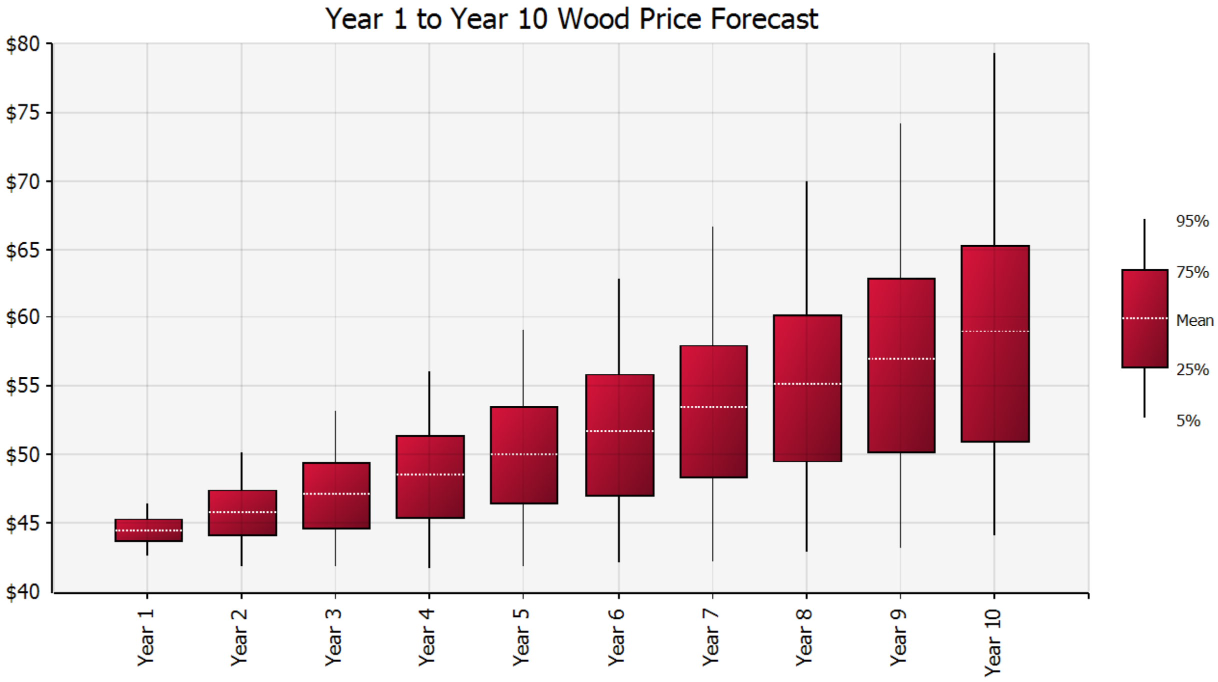

Figure 34. Wood price forecast ($/green ton) for 10 years

Figure 35 shows the expected sales price for pellets over the next 10 years. Notice that the price uncertainty increases with time.

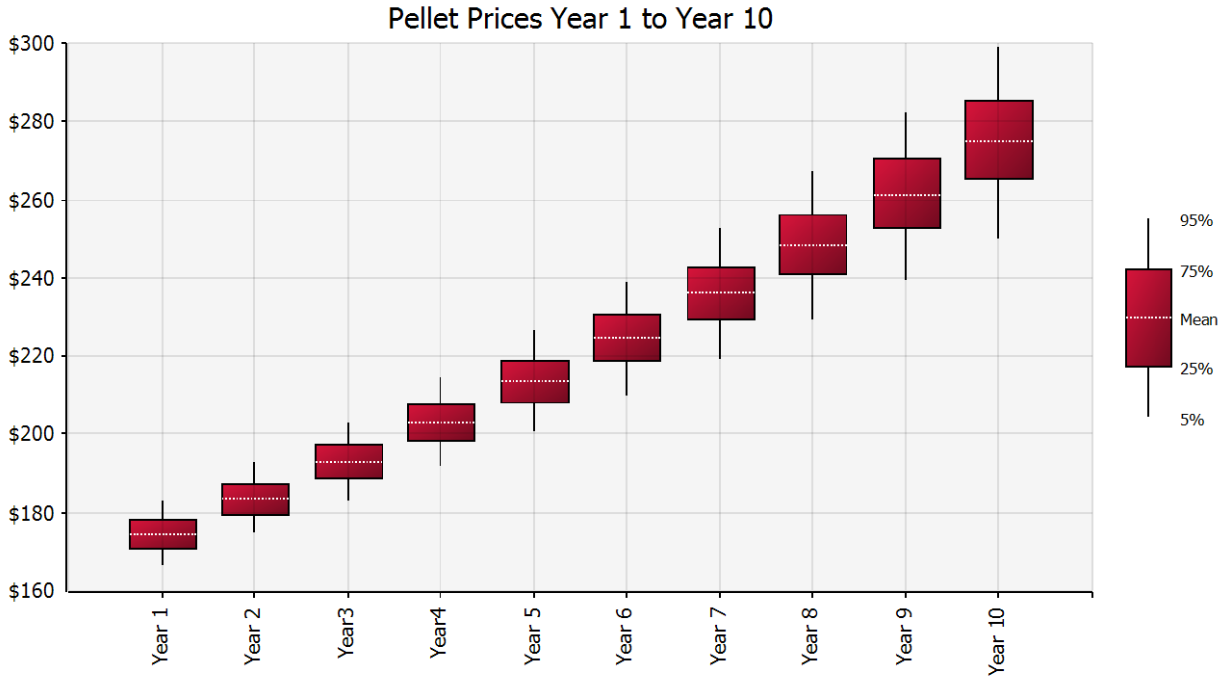

Figure 35. Pellet selling price forecast for a 10-year period

A key factor in estimating pellet prices is the expectation that pellet prices will escalate at a rate that is faster than general inflation. They will increase as a proportion of the increase in heating oil prices. That parameter is also connected to wood costs (pellet feedstock). If diesel fuel (and therefore heating oil) prices escalate less than forecast, pellet prices will also escalate at a lower rate than forecast, and wood costs will be lower than the forecast, contributing an offsetting effect to the ROI. So, although a lower pellet price escalator lowers the ROI, lower wood costs raise the ROI. The model incorporates this relationship between costs for diesel fuel, heating oil, and wood.

For this analysis we use the lower end of the influence that diesel has on wood prices—wood costs are modeled to have a positive 0.50 correlation to diesel price changes and, therefore, to heating oil prices. That means that higher wood prices will translate into higher pellet prices and vice versa.

Plant capacity utilization is also important. Figure 20 shows the input to the cash flow model for plant uptime.

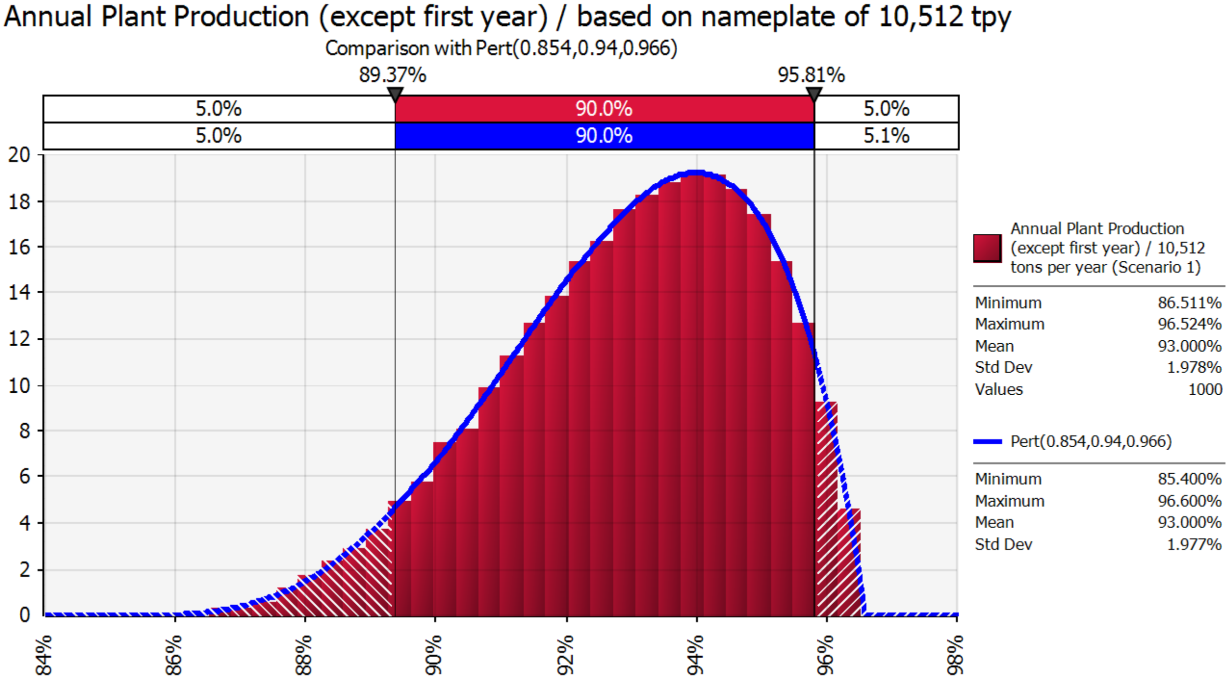

Figure 36. Distribution of annual pellet production capacity factor

8.3.2 Results of the Simulations

Each simulation was run with two scenarios. Scenario 1 is only for the pellet production plant and does not include the savings from conversion of the buildings and residences on the Band's land. Scenario 2 includes the pellet production as well as those conversion savings in the cash flow model.

Figure 20 shows the ROI from both simulations depicted as a cumulative probability distribution. The difference between the two scenarios is significant.

The probability of the project having a result with a 4% ROI (effective cost of capital) or lower is about 12% under Scenario 1 and is about 0.3% with Scenario 2. The probability of an ROI less than zero is about 3.9% with Scenario 1 and is zero with Scenario 2.

The ROI is calculated on the full capital cost for the project against all cash outflows including debt service. Thus, a zero ROI is the breakeven for the project.

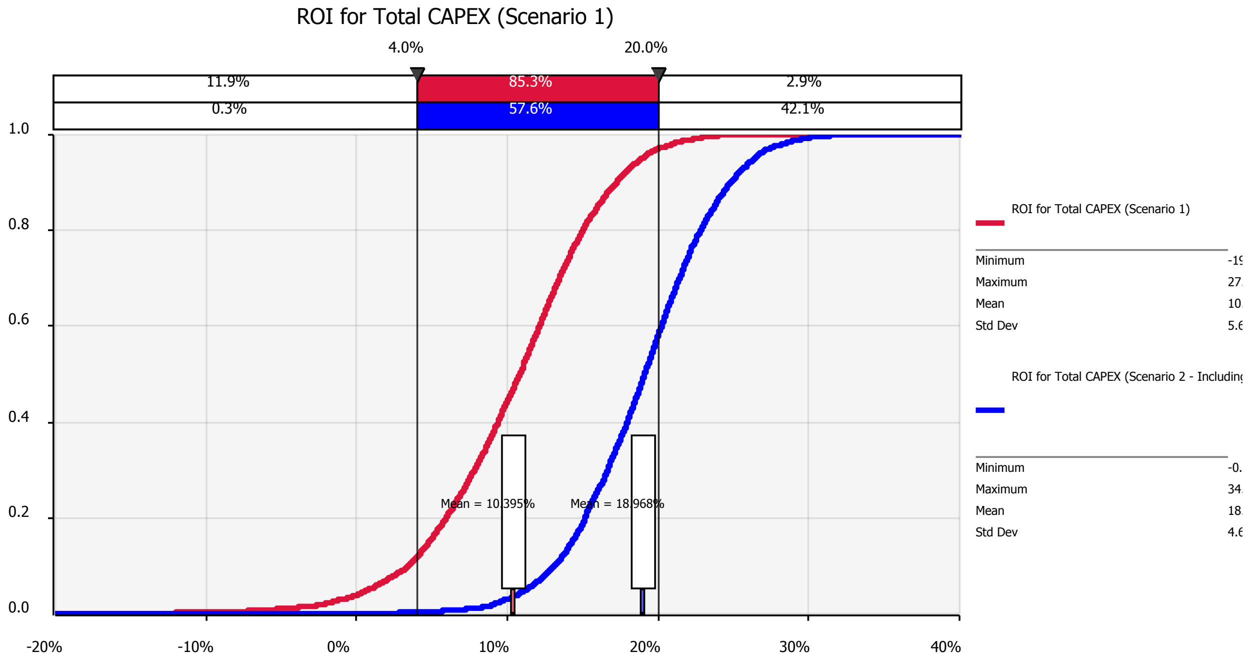

Figure 37. Estimated range of return on investment for 1.2 t/h pellet facility

If the project's finances include the economic benefits of the conversion from heating oil to pellet fuel, then there is a high probability of a project with a strong buffer against a loss, or even a breakeven outcome.

The conversion costs (capital costs and installation costs) for converting from heating oil to pellet fuel are outside of the scope of this analysis. However, many buildings in the area around Presque Isle have already converted due to the very compelling reduction in building heating costs. That includes the Northern Maine Community College just across the street from the Band's offices and homes. The economics of conversion have been proven to be very good.

The ROE is shown in Figure 21. The expected equity return for Scenario 1 is an annualized 40.5% over 10 years. There is a 0.7% probability that the ROE will be less than 12%. Both scenarios have a healthy return to the equity investors.

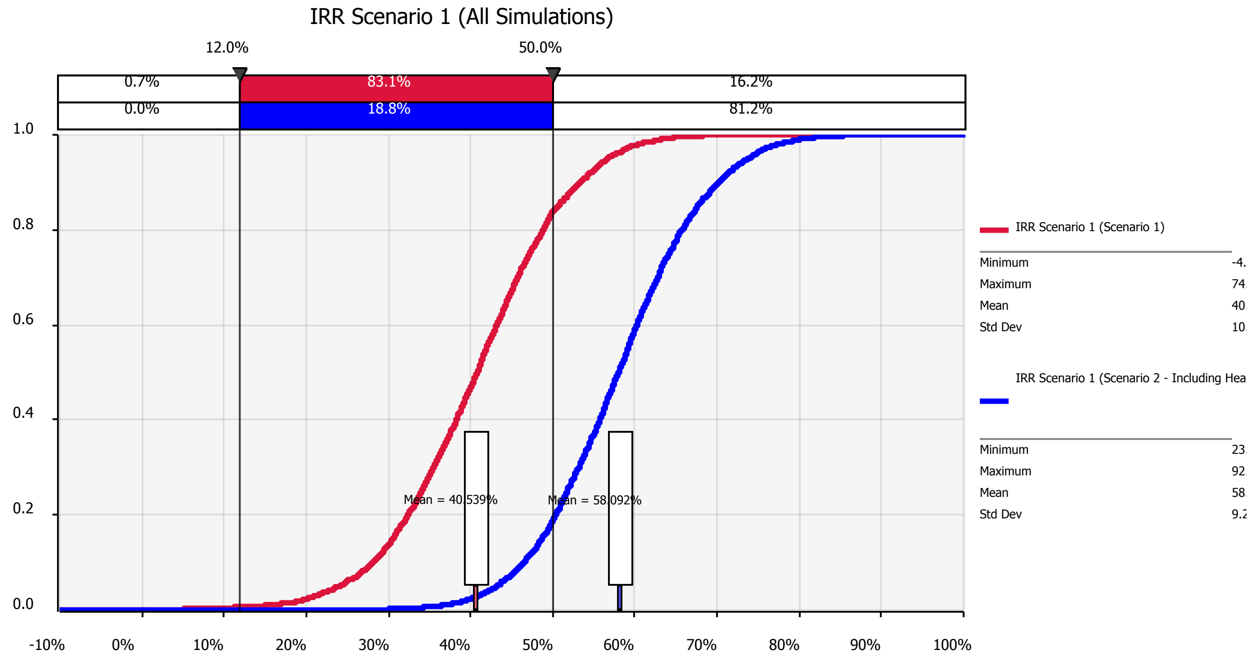

Figure 38. Estimated range of return on equity for 1.2 t/h pellet facility

The net equity cash out—excess cash in year 10 minus the equity investment—is shown in Figure 39.

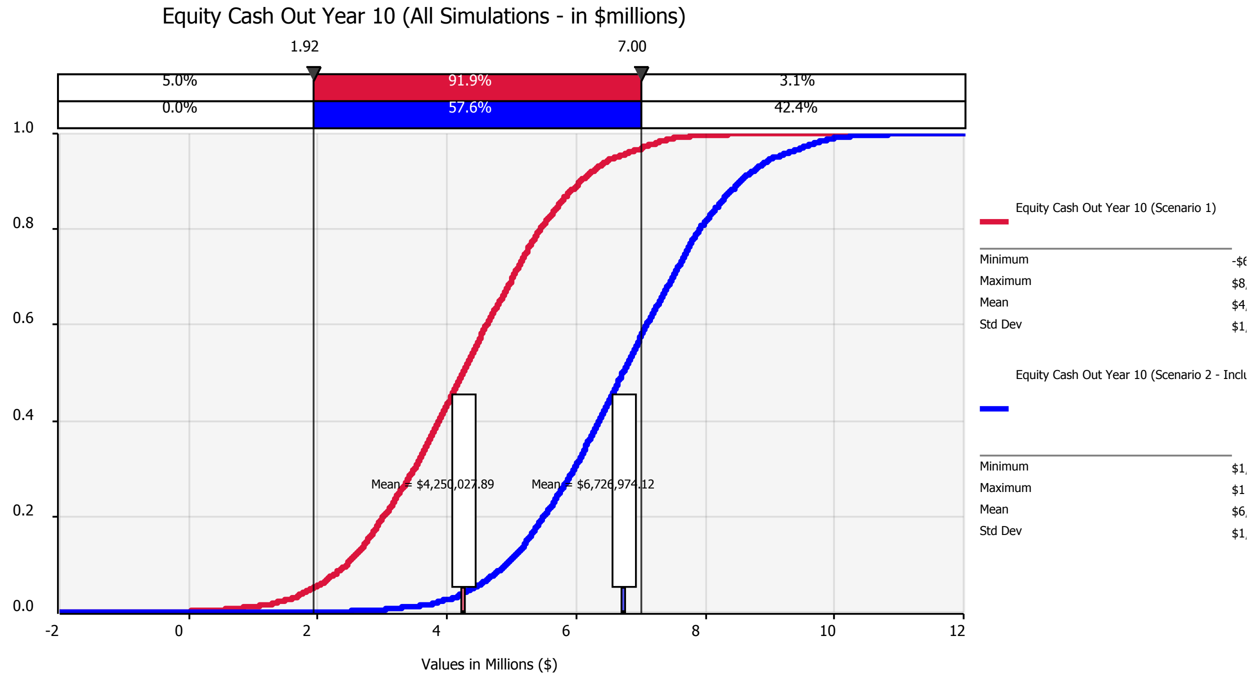

Figure 39. Net equity cash out (excess cash in year 10 minus the equity investment) for pellet facility

We can investigate the inputs that contribute the most to the variability of the ROI output. Figure 40 shows the inputs ranked in order of their influence on the project's ability to break even. The input with the largest effect is the pellet price escalator. This is the parameter that models the expected increase in fuel costs over inflation.

The chart shows that the worst case (the lowest outcome from 5,000 iterations of the simulation), all other inputs held constant, will have a negative influence on the ROI, and reduces the ROI to about 5.8%.

As noted above, if pellet prices do not escalate as fast as forecast it will be because heating oil (and therefore diesel fuel) have not risen as fast as forecast. Thus, wood prices will be lower than the forecast contributing an offsetting effect to the ROI.

The price of pellets (market risk) and the capital cost of the project (technology risk) are the other two leading drivers of ROI variation.

Other inputs not shown have lower forcing effects on the ROI.

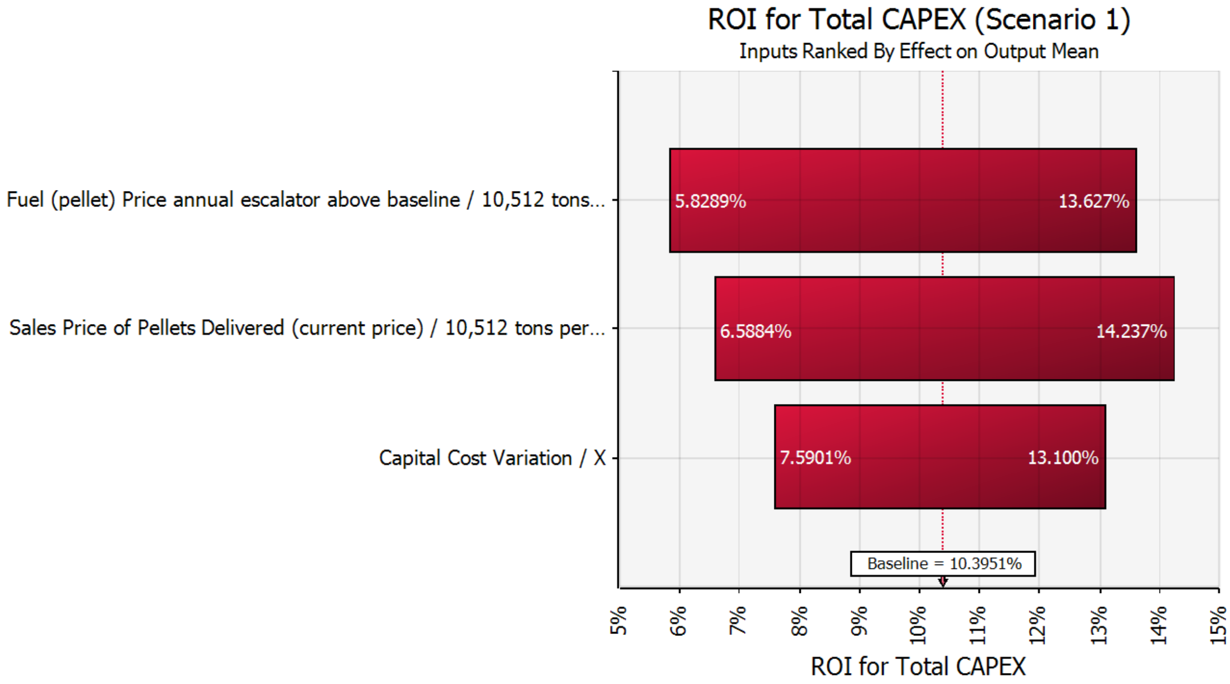

Figure 40. Primary factors contributing to uncertainty in calculation of return on investment

To further illustrate the effects of the pellet price escalator on ROI, below shows the results of all 5,000 iterations of the simulation. The ellipse shows the 95% confidence boundary.

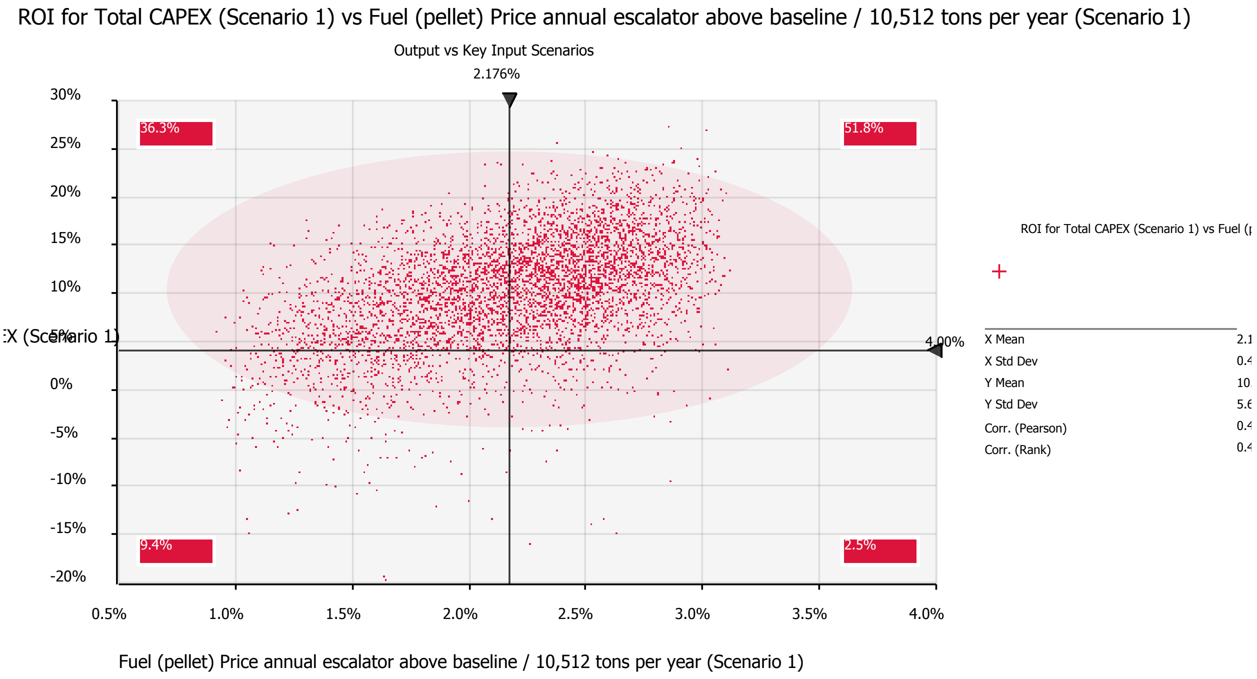

Figure 41. Relationship between distribution of pellet price escalation and ROI—Scenario 1

About 12% of the results fall into the lower quadrants—the region at which the project has an ROI of less than 4.0%.

8.4 Recommended Activities for Next-Level Analysis

Capital, installation, operation, and maintenance costs have been estimated for a generic 1.2 ton-per-hour wood pellet manufacturing facility. These costs, and the resultant calculations of economic factors such as NPV, ROI, and ROE, contain a high degree of uncertainty. A detailed analysis should include manufacturer-provided quotes for equipment and site- and location-specific refinements of installation, engineering, operation, and maintenance costs.

These costs should be combined with a refined feedstock cost estimate to produce an updated economic analysis.

9 Conclusions

This pre-feasibility analysis suggests that there is enough potential for success with a small pellet manufacturing facility located on the former Loring AFB to justify a full feasibility study—which would include a detailed wood supply analysis, detailed marketing analysis, preliminary technical/engineering analysis, environmental (air and land use) analysis, and updated financial analysis.

The most challenging risk to the project will be the strength of the wood pellet market and its support of prices. Based on the forecasts for heating oil and the lack of alternative heating fuels in the region around the plant, it is expected that pellet prices will support the project. Also, given the regions of population density near the project with no access to natural gas and the advantages the location has over the Ashland location in terms of transport costs, 9,800 tons of pellets per year should find a market, while being small enough to not disrupt the existing wood markets; wood prices should remain stable relative to their historical values.

If the project is analyzed with the fuel cost savings from conversion of the Band's buildings factored into the decision metrics, there is a very low probability of the aggregated cash flows being below 8.0%. The scatter plot below shows the 5,000 iterations of Scenario 2 relative to the annual pellet price escalator with the ROI delimiter set at 4%. Only 0.2% of the simulation's iterations (10 of 5,000) fall into the lower quadrants.

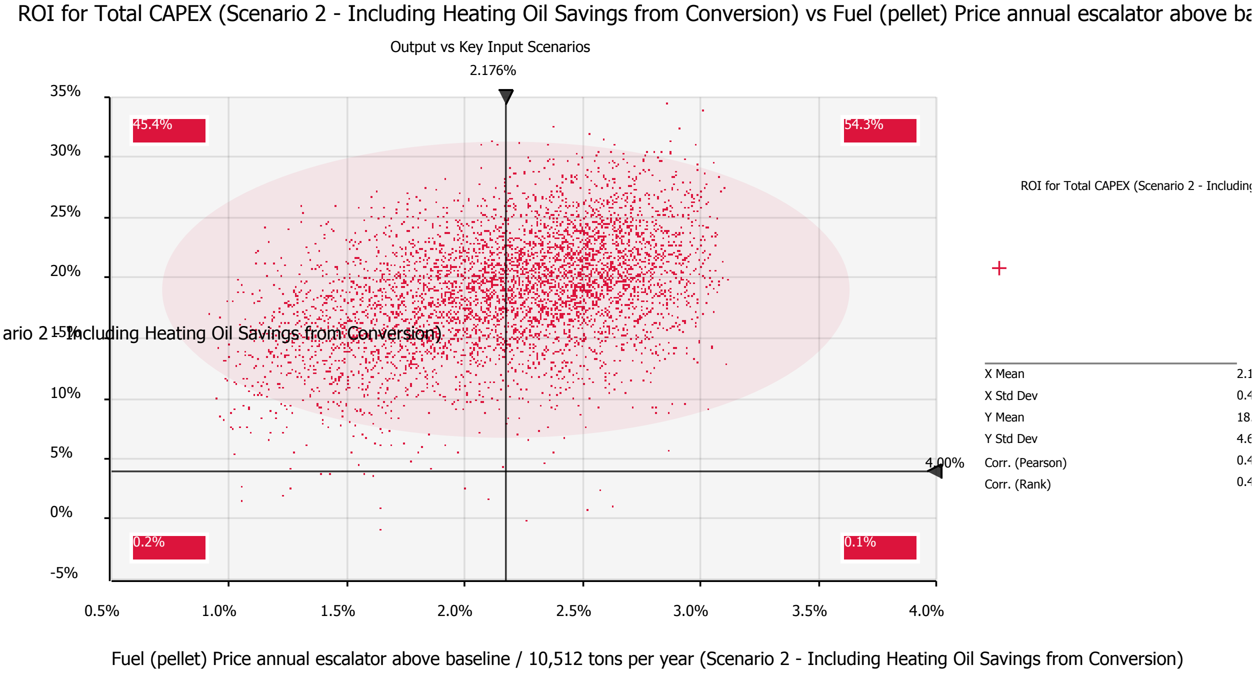

Figure 42. Relationship between distribution of pellet price escalation and return on investment—Scenario 2

Because there is an existing small pellet manufacturing plant in Ashland, Maine, the project has to be relatively small to serve the local needs of the region, including population clusters in nearby Canada.

As the market analysis suggests, the current demand and expected growth in the market should be sufficient to support production of 9,800 tons per year of pellets by the heating season of 2015.

Key recommendations include:

- Perform a site-specific and project-specific biomass resource assessment
- Contact foresters, wood utilization specialists, lumber mills, and others to get a firmer analysis of available biomass, biomass properties, and biomass cost
- Study rough order of magnitude capital costs and operation and maintenance costs further to refine those costs
- Perform an updated economic analysis on various sizes of pellet manufacturing facilities to determine the optimum size after more accurate numbers for costs and energy savings are acquired
- Evaluate costs of retrofitting existing buildings to replace oil heating equipment with pellet heating.