Phase II of a Project:

Feasibility Analysis of Medium Density Fiberboard Manufacturing in New Hampshire

Developed for the
NH Department of Resources and Economic Development

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July 2001

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Innovative Natural Resource Solutions LLC and Draper Lennon, Inc.

July 2001

Natural resource policy in New Hampshire has long identified that markets for low grade and underutilized wood products are critical to the health of the state's economy and the sustainability of New Hampshire's forest resource. Recognizing the importance of these markets, and the pending potential disappearance or reduction of the 1.4 million ton per year market currently represented by New Hampshire's wood-fired electric plants, the State of New Hampshire's Department of Resources and Economic Development (DRED) contracted with Innovative Natural Resource Solutions LLC (INRS) and Draper/Lennon, Inc. (D/L) to explore the feasibility of developing a new market or markets for low grade and underutilized wood in New Hampshire.

Following an analysis of likely retained, expanded or new markets for low-grade wood in Phase 1 of this project, INRS and D/L were asked to explore the feasibility of siting a medium density fiberboard manufacturing facility in New Hampshire. Medium density fiberboard is a composite wood/adhesive panel that is manufactured by pulping chipped wood to release individual fibers, coating the fibers with a liquid adhesive, and then forming and pressing the coated fibers into a solid panel 1/8" to 1-1/2" thick. MDF has excellent structural, machining, and finishing properties, and finds its widest markets in the production of furniture and cabinetry. It can be manufactured either from roundwood or mill residues.

This report presents the results of the Phase II analysis. These results include two major sections:

(1) an assessment of the sources and costs of roundwood and mill residues available for MDF production in New Hampshire, and an assessment of these fiber sources against MDF raw material specifications required; and

(2) a detailed technical and economic evaluation of MDF production.

In this analysis, INRS and its subcontractors were able to go significantly beyond the scope of work originally considered for Phase II. Specifically, we were able to complete most of the aspects of detailed business planning originally scoped as part of Phase III, so that the results presented here offer a thorough and conclusive assessment of the prospects to develop an MDF facility in New Hampshire, and of the factors most important to sustaining or rejecting the possibility of successful MDF development in this state. This business planning was pursued aggressively when it became clear that electricity and wood costs in New Hampshire could serve as barriers to economic viability of an MDF plant.

An MDF plant producing 130 million square feet of product each year would represent a significant new market for low-grade wood. MDF furnish could provide a new market for 280,000 tons of roundwood, as well as a significant new market for sawmill chips, each year. In addition, generation of electricity for the facility and for sale would provide a market for 297,000 tons of whole-tree chips. This would provide a replacement market for roughly one and a half wood-fired power plants, assuming they close at the termination of their rate orders. An analysis shows that mill residue and roundwood is potentially available in parts of the state to supply a plant of this size.

An MDF plant is a major consumer of electricity. Electricity is consumed in significant quantities at all points in the production process, with major points of consumption in the roundwood chipping operation, the refiner, the fiber drier, and the press line. Total horsepower for all electric equipment in the specified facility is 26,500 HP. When the plant is operating at full capacity, total electricity consumption is approximately 88,000 MWh/yr — approximately the equivalent of the full-time output of a 10 MW generating facility.

Wood-fired generation of electricity and heat was specified as an integral part of the MDF operation because the cost of supplying thermal energy and electricity to a plant located in New Hampshire is otherwise prohibitive. Once this initial decision to add cogeneration had been justified, the cogeneration plant itself was scaled to 25 MW to provide the optimum total economic return to the combined MDF/cogeneration facility, specifically considering economies of scale in the cogeneration plant and combined net cash flows from cogeneration plus MDF production.

Construction of an MDF plant with associated cogeneration would represent a major industrial development in the state. The total capital cost is estimated to be approximately $153 million dollars. The required site encompasses approximately 60 acres of level and cleared land — 40 acres for the MDF production and cogeneration facilities, plus 20 acres for the wood yard and chipping operation. The size of the main production building alone (housing the forming, press, and sanding/sawing lines, plus product warehouse space) is approximately 500,000 square feet, over 11 acres.

Because of the scale of MDF production and the long lead time between concept and production, MDF operating costs are broken sequentially into four sets:

(1) Pre-approval costs, which include all costs prior to construction startup (e.g., site selection, land acquisition, site engineering and mapping, legal, permitting);
(2) Pre-startup costs (management and administration, site infrastructure, etc.);
(3) Startup ramp (operating costs over an approximately 1.5-year shakedown period during which the plant gradually achieves full production); and
(4) Steady state operating costs.

Compared to regions where MDF plants are concentrated, New Hampshire suffers a serious disadvantage in two areas of operating costs. The first, clearly, is the cost of electricity. The combination of high electricity consumption for MDF production coupled with New Hampshire's very high electricity rates implies a huge electricity bill. The only way to bring MDF into the realm of economic feasibility in New Hampshire has been to attach a cogeneration facility large enough, at a minimum, to supply all of the plant's own needs (approximately 10 MW of generating capacity). Under the financial scenario constructed in this analysis, cogeneration is a net revenue source for the facility at or beyond this capacity, with returns that increase with increasing cogeneration output. Therefore the cogeneration facility was scaled up to 25 MW, freeing nearly 60% of its output for sale into the Northeastern utility grid. Even at this scale, however, electricity sales revenues are insufficient to overcome the financial burden imposed by the combined capital, raw material, and operating costs of cogeneration (which together are greater than the cost of purchased electricity to MDF manufacturers elsewhere in the country).

The second major disadvantage is the cost of wood for MDF production. According to the industry experts consulted for this analysis, the projected wood procurement cost in New Hampshire, $22.55/ton, is 20% to 25% higher than procurement costs in regions where MDF plants are currently being sited. These include areas (primarily in the South) where wood is procured from company-owned and managed plantations, and where MDF furnish is typically procured in the form of residues from sawmill and related operations. Similar savings were obtained in many parts of Canada, in locations where a large proportion of wood is procured from government lands, and where mill residues are also abundant.

If the results of this analysis do not present a positive outlook for MDF production in New Hampshire, they provide a positive conclusion in another way. Phase I of this project identified MDF, along with co-firing of wood and coal at the PSNH Bow generating facility and retention of the existing base of wood-fired electric plants, as the only potentially viable options available in New Hampshire to sustain low grade wood markets at anything like their current size. This analysis, we believe, has conclusively demonstrated that MDF is ***not***, in fact, a viable option. This conclusion leaves the continued operation of some or all of the existing wood-fired plants – under their current owners or new ownership – as the State's best, indeed its only, practicable option to maintain markets for low grade forest products in the foreseeable future. There is no strong reason for the State not to pursue this option aggressively.

SECTION ONE
INTRODUCTION

This report presents the results of Phase II of an analysis of markets for low-grade wood in New Hampshire.

Natural resource policy in New Hampshire has long identified that markets for low grade and underutilized wood products are critical to the health of the state's economy and the sustainability of New Hampshire's forest resource. Recognizing the importance of these markets, and the pending very likely disappearance of the 1.4 million ton per year market currently represented by New Hampshire's wood-fired electric plants, the State of New Hampshire's Department of Resources and Economic Development (DRED) contracted with Innovative Natural Resource Solutions (INRS) and Draper/Lennon, Inc. (D/L) to explore the feasibility of developing a new market or markets for low grade and underutilized wood in New Hampshire.

The project was planned in Phases. Phase I of the project identified and reviewed a large number of technologies which offered the potential to consume a large quantity of low-grade wood. These included:

- Existing biomass power plants
- Pulp and paper manufacturing
- Pellets (fuel)
- Chip export
- Small-scale gasification
- Process heat / co-location (i.e., co-location of a major process heat consumer at an existing biomass power site)
- Ethanol and biochemicals
- Production of solid wood composites (oriented strand board, medium density fiberboard, particleboard)
- Firewood
- Animal bedding
- Landscaping much
- Densified logs
- Production of lumber from small-diameter material
- Co-firing with wood at Public Service Company of New Hampshire's (PSNH) coal-fired generating plant in Bow, NH.

The final report of Phase I, titled "Phase I Final Report: Use of Low Grade and Underutilized Wood Resources in New Hampshire", concluded that only three of these potential markets offered the potential to consume low-grade wood in quantities comparable to those now being consumed for electricity generation. These are: 1) Production of medium density fiberboard (MDF); 2) Continued production of wood-fired electricity; and 3) Co-firing with wood at the PSNH coal-fired plant in Bow.

For reasons having primarily to do with the uncertain status of PSNH's ownership of the Bow generating plant, as well as rapid change in the technologies that affect the viability of co-firing wood with coal, DRED concluded that detailed analysis of the co-firing option should not be carried out at this point in time. Addressing the option of maintaining the existing population of wood-fired generating plants, DRED requested INRS and D/L to outline a strategy that will allow DRED to monitor developments in electricity markets and New Hampshire's electric generating industry (including the independent wood-fired power producers), with the goal of supporting the maintenance of the wood-fired plants if economic and market conditions suggest this as a viable option. This strategy has been provided to DRED under separate cover.

As the core of Phase II, therefore, DRED requested a detailed analysis of the third option, production of medium density fiberboard.

Medium density fiberboard is a composite wood/adhesive panel that is manufactured by pulping chipped wood to release individual fibers, coating the fibers with a liquid adhesive, and then forming and pressing the coated fibers into a solid panel 1/8" to 1-1/2" thick. MDF has excellent structural, machining, and finishing properties, and finds its widest markets in the production of furniture and cabinetry. It can be manufactured either from roundwood or mill residues (satisfying DRED's request that future markets be considered for both of these materials). The Phase I analysis indicated that North American and worldwide demand for MDF are strong and growing, and that MDF markets are not currently affected by issues of overcapacity which are currently deterring investment in other type of wood and composite panels.

This report presents the results of the Phase II analysis. These results include two major sections: (1) a detailed assessment of the sources and costs of roundwood and mill residues available for MDF production in New Hampshire, and an assessment of these fiber sources against MDF raw material specifications required; and (2) a detailed technical and economic evaluation of MDF production. In this analysis, INRS and its subcontractors were able to go significantly beyond the scope of work originally considered for Phase II. Specifically, we were able to complete most of the aspects of detailed business planning originally scoped as part of Phase III, so that the results presented here offer a thorough and conclusive assessment of the prospects to develop an MDF facility in New Hampshire, and of the factors most important to sustaining or rejecting the possibility of successful MDF development in this state.

The report is organized as follows:

- Section Two summarizes current New Hampshire markets for low-grade wood, updating information presented in Phase I, and addressing issues related to the sustainability of these markets.
- Section Three presents INRS and D/L's assessment of the mill residue and roundwood resources available to support MDF production, and of MDF facility siting considerations in New Hampshire.
- Section Four describes the MDF production process.
- Section Five provides a detailed description of the scale and resource requirements of an MDF facility sized to meet the economic conditions of the MDF industry and the local preconditions necessary to potential establishment of MDF production in New Hampshire.
- Sections Six, Seven, and Eight discuss the capital costs, operating costs, and revenue projections for a New Hampshire MDF facility, respectively.
- Section Nine provides the projected profit-and-loss statement for MDF production in New Hampshire, and summarizes various estimates of return on investment for the facility. Section Nine also presents sensitivity analysis of projected MDF financial performance against several critical financial variables, and compares financial performance of the facility with and without cogeneration.
- Section Ten provides the conclusions of INRS and D/L's assessment of the economic potential for MDF production in New Hampshire, and suggestions for the most promising avenues to pursue in Phase III of this project.

SECTION TWO
CURRENT NEW HAMPSHIRE MARKETS FOR LOW-GRADE WOOD

At present, New Hampshire has two major markets for low-grade wood: the region's pulp and paper industry, and the region's wood-fired energy plants. In 1999, these markets combined to consume in excess of four million tons of low-grade wood from New Hampshire timber harvesting operations and residue from sawmills.

New Hampshire has eight wood-fired power plants, six of which are presently operational. These operational plants sell power to Public Service Company of New Hampshire (PSNH) under long-term rate orders. Of these six, three – Whitefield Power & Light, Hemphill Power & Light, and Bio-Energy – have buyout arrangements pending at the NH Public Utilities Commission (NHPUC). These buyouts seek to terminate the rate orders, eliminating a stable and secure market for the power produced at these facilities. If these buyouts are approved by the NHPUC, it is anticipated that the rate orders would end in the Fall of 2001 – threatening a market for an estimated 466,000 tons of whole-tree chips and mill residue.

If the buyouts are approved, it is anticipated that these plants will have the ability to sell power into the competitive electricity market. Previous buyouts of the Timco and Bristol Energy facilities resulted in severe restrictions on sales of power from these facilities. However, since these earlier buyouts the legislature has passed NH RSA 362-A:4-c, which states that the NHPUC "…shall not approve any renegotiation that places restrictions on selling the output of the qualifying facility in a competitive generation market". However, it is anticipated that *if* these plants are able to remain operational following the termination of rate orders, it is unlikely that they will consume the same volume of forest-derived wood that they do now.

SECTION THREE
MEDIUM DENSITY FIBERBOARD RESOURCE USE AND LOCATION

3.1 Review of Rationale For Investigating MDF As A Low Grade Market Option In New Hampshire

In Phase 1 of this study, INRS and D/L reviewed major market possibilities for low-grade wood, including:

- Wood energy (including "green power")
- Pulp and paper
- Medium density fiberboard (MDF)
- Particleboard
- Co-firing with coal at Merrimack Station
- Oriented strand board (OSB)
- Bio-ethanol
- Chip exporting
- Lumber from small-diameter wood

A final report for Phase 1, titled *Use of Low Grade and Underutilized Wood Resources in New Hampshire*, was presented to the New Hampshire Department of Resources and Economic Development in February 2001. This report thoroughly reviewed each potential market, and its opportunity to provide a retained, expanded or new outlet for low-grade wood and sawmill residue. For each potential market, the following were investigated:

- The quantity of wood a facility or facilities could be expected to consume;
- If mill residue could be used as a feedstock, and if any limitations to this exist;
- The strongest reasons for pursuing this market at this time;
- The greatest concerns identified that may serve as obstacles to pursuit of this market; and
- Costs for the feedstock in the form necessary for this market.

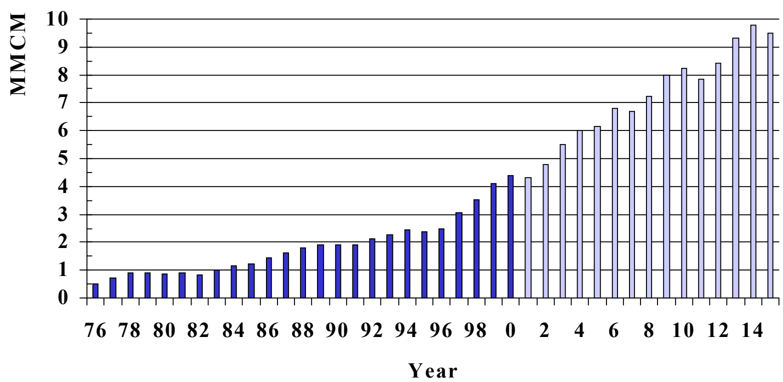
Following the conclusion of Phase 1, Innovative Natural Resource Solutions LLC and Draper/Lennon, Inc. were asked to proceed with a full-scale feasibility study for a Medium Density Fiberboard plant located in New Hampshire, which follows.

INRS and D/L were also asked to provide strategies for continued operation of wood-fired power (including green power alternatives), as well as investigate potential for co-firing with wood at Merrimack Station, presently owned and operated by Public Service Company of New Hampshire. These analyses have been presented to DRED under separate cover.

3.2 General Market Conditions for Medium Density Fiberboard

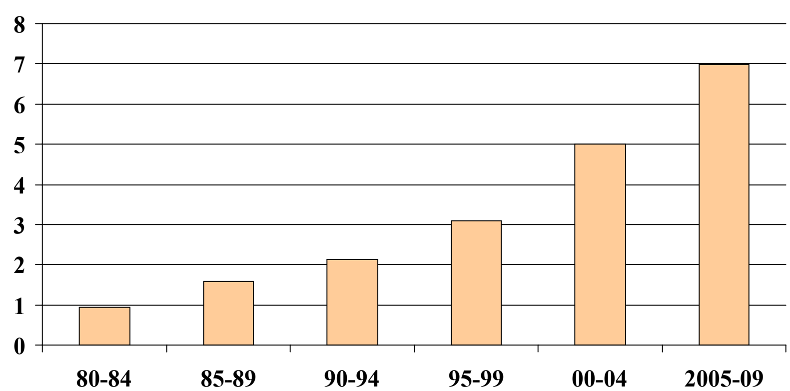
Medium Density Fiberboard (MDF) markets and production are anticipated to grow for the foreseeable future (Figures 3-1 and 3-2). Major markets for MDF include cabinets, store fixtures, "ready-to-assemble" furniture, laminated flooring, and moldings. In recent years, MDF has found new applications in paneling and the automotive industry. Because of new applications, as well as growing market share of existing applications, MDF growth is expected to remain steady, with North American production nearly doubling over the next decade (Figure 3-1).

Figure 3-1
North American MDF Production, 1976-2014 (Projected)
Source: Resource Information Systems, Inc.



This growth in production tracks an anticipated growth in consumption, with annual North American consumption more than doubling from the years 1995-1999 (3.012 MMCM average annual consumption) to the years 2005-2009 (6.973 MMCM average annual consumption) (Figure 3-2).

Figure 3-2
MDF Consumed in North America, 1980-2009
(Million Cubic Meters Per Year)
Source: Resource Information Systems, Inc.



Anticipated North American consumption of MDF is one component of expected worldwide growth. Significant increases in MDF production and consumption have also been seen in Asia and Europe, and are also projected to continue into the foreseeable future.

3.3 New Hampshire Mill Residue and Roundwood Available for MDF Production

New Hampshire has a mix of species, particularly south of the Notches, that is well suited for the manufacturing of MDF.

3.3.1 Sawmill Residue

Medium Density Fiberboard can be manufactured from sawmill residues, a key market considered in this study. In fact, many MDF mills run exclusively on sawmill residue, because it is an inexpensive and consistent feedstock.

In order to better understand sawmill residue production and markets, INRS/DL contracted with the firm North Country Procurement (NCP) to speak with major sawmills in New Hampshire, Vermont and Massachusetts to determine the volume and consistency of sawmill residue available to a manufacturing facility. These contacts were undertaken in April and May of 2001.

Many sawmills consider information regarding their chip production, as well as their markets and price received for their chips, to be proprietary. In order to obtain accurate information from sawmills, NCP needed to assure mills that the information gathered would be presented only in an aggregate form, providing no information attributable to a single mill.

New Hampshire. NCP contacted nineteen white pine and hardwood sawmills in New Hampshire, with a combined annual lumber production of 210 MMBF. This represents roughly two-thirds of the state's sawmill production (excluding spruce, which is not suited for MDF manufacturing). Clean chip generation from these mills is presented in Table 3-1.

Table 3-1
Clean Chip Production, Major New Hampshire Sawmills

Species	**Monthly**	**Annual**
	tons	
White Pine	13,685	164,220
Hardwood (all, mixed)	5,130	61,560
Other softwood (primarily hemlock)	1,735	20,820
Total	**20,550**	**246,600**

Using a ratio of chip production based upon the direct information presented above, we estimate that the volume of chips generated at all other NH white pine and hardwood sawmills is 3,257 tons/month (39,082 tons/year) of white pine chips, 690 tons/month (8,280 tons/year) of hardwood chips and 2,990 tons/month (35,880 tons/year) of mixed hardwood and softwood chips.

White pine chips are presently sold to paper mills, with the Pulp & Paper of America mill in Berlin (NH), International Paper's mills in Jay (ME) and Ticonderoga (NY), and Mead's Rumford (ME) mill identified as important markets. Delivered prices received ranged from $11 to $30 per ton, with a weighted average price of $21.60 per ton.

Hardwood chips are sold to paper companies and used in production of electricity, with the Groveton paper mill, Whitefield Power & Light and Pinetree Power – Bethlehem identified as major markets. A number of hardwood sawmills indicated that their chips went to "paper companies", but declined to provide a specific company. Delivered prices ranged from $11 - $29 per ton, with a weighted average price of $19.25 per ton.

Vermont. NCP contacted thirteen white pine and hardwood sawmills in Vermont, all likely to be within the procurement circle of a NH-based MDF plant. These mills generate clean chips in the quantities shown in Table 3-2.

Table 3-2
Clean Chip Production, Major Vermont Sawmills

Species	Monthly	Annual
	Tons	
White Pine	2,925	35,100
Hardwood (all, mixed)	7,475	89,700
Total	**10,400**	**124,800**

We were unable to estimate the chip production of other Vermont mills, because mills report ranges of production, not actual production, to the state. The use of these ranges makes an accurate estimate of chip production from mills not surveyed impossible.

White pine chips from Vermont are presently sold to paper mills and wood energy plants, with the Pulp & Paper of America mill in Berlin (NH), International Paper's mills in Jay (ME) and Ticonderoga (NY), Mead's Rumford (ME) mill, Burlington Electric and Ryegate Power & Light identified as important markets. Delivered prices received ranged from $17 to $28 per ton, with a weighted average price of $23.24 per ton.

Hardwood chips are sold to paper companies and used in production of electricity, with the International Paper, Burlington Electric, American Tissue Company's Gilman mill, Whitefield (NH) Power & Light, and Pinetree Power – Bethlehem (NH) identified as major markets. Schools, municipalities and mulch companies were also identified as markets. Delivered prices ranged from $10 - $30 per ton, with a weighted average price of $15.17 per ton.

Massachusetts. NCP contacted nine white pine and hardwood sawmills in Western Massachusetts, located in Berkshire, Franklin, Hampden, Hampshire and Worcester Counties, representing nearly half of the sawmill production in those counties. These mills are likely to be within a procurement radius for a New Hampshire based MDF plant. These mills generate clean chips in the quantities shown in Table 3-3.

Table 3-3
Clean Chip Production, Major Western Massachusetts Sawmills

Species	Monthly	Annual
	tons	
White Pine	1,855	22,260
Hardwood (all, mixed)	665	7,980
Total	**2,520**	**30,240**

It is estimated that the remaining sawmills in the four county area produce roughly 3,119 tons / month of mixed white pine and hardwood chips.

White pine chips from Massachusetts are presently sold to paper mills and MDF plants, with Norboard's Deposit (NY) MDF plant a market for several companies in the southwestern part of the state. One company grinds their chips and directly sells them as playground bedding. Delivered prices received ranged from $12 to $26 per ton, with a weighted average price of $17.32 per ton.

Hardwood chips are sold to paper companies, medium density fiberboard plants, and mulch suppliers, with International Paper and Norboard's Deposit (NY) MDF plant identified as markets. Delivered prices ranged from $8 - $26 per ton, with a weighted average price of $23.26 per ton.

Regional Totals. The entire region (New Hampshire, Vermont, and Western Massachusetts combined) is estimated to produce over a half million tons of clean chips each year (Table 3-4). Over half of this production is in white pine, with the remainder in mixed hardwoods or a mix of hardwood and softwood species.

Table 3-4
Clean Sawmill Chips Available from Three-State Region
(estimated, tons per month and tons per year)

State	White Pine	Hardwood	Mix	All Chips
NH – surveyed	13,685	5,130	-	18,815
NH – estimated	3,257	690	2,990	6,937
VT – surveyed	2,925	7,475	-	10,400
MA – surveyed	1,855	665	-	2,520
MA – estimated	-	-	3,119	3,119
Total (month)	**21,722**	**13,960**	**6,109**	**41,791**
Total (year)	**260,664**	**167,520**	**73,308**	**501,492**

Mill Residue Prices. Prices for chips vary significantly from by species, region, market and mill. The weighted average delivered price for all white pine chips in the region is $21.43, and the weighted average price for hardwood chips is $17.15 (Table 3-5). At present most or all of these sawmill chips have a market, but many sawmills anecdotally noted that these markets are distant, unstable or unreliable.

Table 3-5
Weighted Average Chip Price (per ton), Delivered, Three-State Region

State	White Pine	Hardwood
New Hampshire	$21.60	$19.25
Vermont	$23.24	$15.17
Massachusetts	$17.32	$23.26
Region	**$21.43**	**$17.15**

In follow-up phone conversations by INRS, many mills indicated a willingness to send chips to a new market, but were very clear that an increase in price of between $1.00 and $2.00 per ton would be necessary for them to sever existing relationships with chip markets. It may be possible, in some cases, for this pricing increase to be met through decreased distance to market, resulting in lower shipping costs.

A complete list of mills contacted as part of this research is included as an appendix.

3.3.2 Roundwood Resource Inventory

Critical to the operation of a Medium Density Fiberboard plant is an adequate supply of wood, available on a sustainable basis. While many MDF facilities strive to use the greatest amount of mill residue possible (and thus the least amount of roundwood possible), we were asked to model a facility that utilized roundwood for two-thirds of its wood supply. This request was made to help assure that any facility advocated by the state could provide a significant market for low-grade wood.

Using information developed in Phase I of this project, confirmed with Forest Inventory Analysts of the USDA Forest Service, it was determined that there are adequate supplies of wood available on a sustainable basis.

An MDF facility producing roughly 130 million square feet of product (3/4" basis), utilizing roundwood for two-thirds of its production, would use roughly 281,000 wet tons of roundwood annually. In the hypothetical 75-mile procurement circles surrounding Keene and Bridgewater, NH, there is adequate annual growth to provide this level of wood from either white pine or red maple.

In either the Keen or Bridgewater area, annual growth of white pine is double what would be necessary for an MDF plant (Table 3-6). Red maple growth in both areas is in even higher quantities, with red maple growth almost triple the amount needed in the area surrounding Bridgewater.

Table 3-6
Annual Growth (average) in 75-mile Procurement Areas Surrounding Keene and Bridgewater, NH

	tons
White Pine	
Bridgewater	593,023
Keene	568,295
Red Maple	
Bridgewater	802,327
Keene	679,098
All other species	
Bridgewater	1,006,031
Keene	1,113,530

It is certain that not all of this wood would be available for timber harvesting, due to governmental restrictions, landowner attitudes and physical inaccessibility. However, the fact that in a reasonable procurement area double the amount necessary for operation is grown annually provides an assurance that wood is available for a facility.

As part of this feasibility, INRS contacted a number of foresters and loggers based or working in the region under consideration. These professionals were asked about pricing for white pine and red maple wood in their region. Foresters and loggers in the area all confirmed that, in their judgment, low-grade white pine and red maple exist in sufficient quantities to meet the projected needs of an MDF plant. These resource professionals also indicated that, while a strong logging infrastructure exists in the region, many small firms might need to expand or upgrade existing equipment in order to provide steady product to a mill of this size. Prices for wood meeting eight-foot pulpwood specifications used by paper mills in the Northeast, anticipated to be similar to specifications of a MDF plant, are anticipated to be between $21 and $22 per ton (Table 3-7).

Table 3-7
Projected MDF Raw Material Prices: White Pine and Red Maple Roundwood

	$ per tons		
	Low	High	Mean
White Pine	$19.04	$24.76	$21.71
Red Maple	$18.60	$23.02	$21.21

While both white pine and red maple are available in sufficient quantities and at comparable prices to supply an MDF facility, we have assumed the use of white pine only for the remainder of this analysis. This is because pine produces a lighter colored board, favored in the marketplace because of the ease of painting and other value-added processes. Any manufacturer seeking to site a plant in New Hampshire could obviously revisit this issue.

The roundwood used in this process is assumed to be the only part of this plant that would require new harvesting. The mill residue used in the manufacturing of MDF is a byproduct of lumber manufacturing, and is presently being generated. While a new mill would cause present markets to compete for this resource or find substitutes, such competition would help the state's sawmill industry. Wood from the forest used for the generation of electricity, discussed later, would be fewer than 100,000 wet tons above the 200,000 to 210,000 wet tons used annually at Hemphill Power & Light. In this feasibility study, we assume that Hemphill Power & Light will not continue to operate after the termination of their rate order. This is based upon informal statements by the company in the process of purchasing the facility, as well as a review of their pending rate-order buyout. For this reason, the wood-fired boiler for this facility primarily serves as a replacement for an existing market for whole-tree chips. The new market created for under 100,000 wet tons of whole-tree chips can easily be met with a fraction of the over one million tons of "all other species" (all species except white pine and red maple) that grows within the vicinity of either Keene or Bridgewater.

3.4 Location of an MDF Facility in New Hampshire

This feasibility study does not recommend a particular town or location for siting of a plant, but does determine what area of the state is best suited for an MDF plant.

The resource analysis above shows that within a reasonable radius of Keene and Bridgewater, NH a sufficient amount of wood exists to supply an MDF plant. These areas are also close to the region's sawmill centers, and as such would be well positioned to receive mill residue.

Major competition for the forest resource will come from paper mills and wood energy plants in New Hampshire and elsewhere in New England. Competition in New Hampshire includes the Pulp & Paper of America mill in Berlin and Gorham, the paper mill operated by Wausau Paper / Groveton Paper Board in

Groveton, and wood energy facilities in Tamworth, Bethlehem, Bridgewater and Hopkinton. Competition from outside of New Hampshire includes Mead's paper mill in Rumford, ME; International Paper's paper mills in Jay and Bucksport, ME and Ticonderoga, NY; Finch, Pruyn & Co. in Glens Falls, NY; and Ryegate Power in Vermont. The majority of these markets, particularly the very large paper markets, are distant from the southern and western portions of New Hampshire. Low demand for low-grade wood, particularly pulpwood, has been seen in this region for some time, and is confirmed by comparatively low pulpwood prices in this region.

While mills were universally unwilling to share their procurement areas, citing competitive and anti-trust reasons, it is certain that mills procure wood from within this region for their operations. However, procurement ranges shift regularly, given changes in market conditions, pricing, competition and other factors. The southwestern and central-western portions of the state – distant from paper markets – have seen procurement come and go. So long as this area is distant from markets, it will continue to be on the outer fringes of procurement and will face weak and shifting markets for low-grade wood.

The southeast portion of the state faces a similar issue. However, this area of the state is rapidly developing, and it is unlikely that a sustainable supply of wood for an MDF plant could come from this region, or that the region would find such a plant socially acceptable.

For reasons of existing competition and resource availability, the southwest and central-west portions of the state are recommended as most appropriate for an MDF plant. The area roughly bordered by Keene, Claremont and Bridgewater, NH is best suited for location of this facility. Further analysis would be required to determine where in this region a facility would be best situated, given infrastructure, labor availability, social acceptance, and other factors.

3.5 Sustainability Standards

In addition to assurances that the wood required for this facility is available from the region's forests, appropriate sustainability certification standards were reviewed as part of this feasibility study.

There is one North American manufacturer that presently produces MDF certified by the Forest Stewardship Council (FSC), a third-party certification program designed to assure compliance with certain harvesting practices. FSC-certification is a land and chain-of-custody based process that assures certified land is managed in accordance with certain standards, and that wood from this land is carefully tracked following harvesting. FSC-certified product is only a portion of this facility's output, and is run with sawmill residue from one large lumber manufacturer that owns significant FSC-certified timberlands. A number of industry sources made clear that without a large sawmill or sawmills to provide large and reliable volumes of FSC-certified residue, FSC-certified product was not a realistic option for a New Hampshire MDF plant at this time. Because of the small volume of wood presently harvested in New Hampshire and the region from FSC-certified timberland, it is impossible to discuss pricing implications for adoption of an FSC-certification at this time.

A number of MDF manufacturers around the nation participate in the Sustainable Forestry Initiative SM (SFI), a forest sustainability program created by the American Forest & Paper Association. SFI offers third-party verification of compliance with specified forestry and wildlife objectives. Unlike FSC certification, the SFI program clearly contemplates significant volumes of wood coming from non-certified land, so long as certain standards are maintained in the harvesting and management of these lands. Periodic monitoring of harvesting operations for compliance with SFI is anticipated to add $0.20 - $0.30 of cost per ton, primarily for staff and transportation to visit harvesting sites. Many loggers and foresters contacted indicate that they are presently meeting or exceeding SFI standards, and that compliance would cost them less than $0.10 per ton. While overall compliance may be significantly more costly, the fact that a number of markets for low-grade wood, particularly paper companies, participate in SFI makes this less costly to assimilate into existing operations.

It should be noted that, while it is appropriate to discuss harvesting standards, a number of manufacturers contacted indicated that their harvesting standards were based upon the laws of the jurisdiction in which they operated, as well as demands from their customers. All manufacturers noted that sustainability standards add costs, and unless there were clear market or operational benefits to incorporating such standards, they would need to carefully evaluate the benefits of adopting such standards.

For purposes of this feasibility analysis, we assumed no incremental cost to wood due to sustainability standards. According to industry experts, the price of wood modeled for a New Hampshire facility is roughly 20 percent greater than prices paid in other areas. In order to control costs to the greatest extent possible for primary analysis, we did not add any costs for compliance with sustainability standards.

SECTION FOUR
THE MDF PRODUCTION PROCESS

4.1 Overview

Medium density fiberboard is a panel that consists of individual wood fibers bonded with an organic adhesive. It is manufactured in pressed panels ranging from 1/8" to 1-1/2" in thickness. Panels are typically 4' or 5' wide (finished width). Thanks to relatively new continuous pressing processes, finished panels can be manufactured to virtually any length. MDF is dense (approximately 45-50 lbs/cuft), smooth-surfaced, with a homogeneous cross section. It can be machined with a variety of shaping tools to produce clean and durable edge moldings, it holds a variety of paints, stains, and other finish treatments, and it is a good substrate for laminates and veneers. Because of these characteristics, MDF finds its widest application in the manufacture of furniture, including high-end, high value-added pieces as well as commodity products.

MDF is manufactured in a three-step process. Raw materials consist of clean, bark-free wood chips, typically procured from mill residue or from an on-site roundwood chipping operation. In the first production step, the chips are softened with high pressure steam and then ground in a mechanical refiner to release the individual fibers. The second production step is drying and adhesive application. The fibers are dried in a heated turbulent air stream, and adhesive (typically urea formaldehyde resin) is injected in a process engineered to assure nearly 100% coating of the air-entrained fibers. In the final production step the adhesive-coated fibers are first sifted into a thick, low-density mat in a continuous forming process. The mat is then drawn into a continuous press between heated steel rollers, where the adhesive is set by a combination of heat and pressure. MDF panel thickness, density, and cross section characteristics are modified by manipulating the matforming and pressing processes. The formed continuous panels are then sanded, sawn to marketable lengths and widths, and packaged for shipment in truckload or railcar quantities.

4.2 Major Unit Processes

There are six major unit processes in MDF production:

1. Chipping yard
2. Refiner
3. Drier
4. Forming and pressing line
5. Sanding and sawing line
6. Product handling area

The thermal energy system — which can be natural gas-fired, solid fuel-fired (using production residuals plus purchased wood fuel), or part of a cogeneration system — comprises a seventh major process, although it is not strictly part of the MDF production line.

Chipping Yard: The chipping yard is precisely analogous to a chipping operation for pulp production. Roundwood is debarked and chipped by automated equipment to produce chips roughly 1" x 1" x 1/4" in dimension, and chips, sorted by wood type (hardwood vs softwood) are stored in bins to be fed into the MDF production process.

Most MDF plants consume a large fraction (in some cases all) of their furnish in the form of sawmill chips and sawdust. These are delivered directly from mills and stored in bins prior to use.

Refiner: A chemical-free semi-mechanical process, the refining step is also similar to the analogous pulp production process in the pulp and paper industry. Wood chips are steam heated under pressure to loosen the fiber bonds, and then mechanically ground in between finely machined steel plates to liberate individual fibers. The refiner is the major consumer of electricity in an MDF facility. At the size scoped in this analysis, the refiner motor alone is rated at 14,000 horsepower, or about 56% of all electrical requirements in the plant.

Drier. The drier is the major consumer of thermal energy in an MDF facility. The wet fibers output from the refiner are injected into a high-volume heated air stream, which can be a flue gas stream or a separate air stream output from a heat exchanger. In a high-velocity turbulent flow, the fibers are first dried and then coated with a liquid adhesive resin (typically urea formaldehyde) which is injected as a fine spray into the air stream.

Forming and Pressing Line. The forming and pressing line is the heart of MDF production. Since the late 1980s, most of the MDF lines in the world have been constructed around continuous presses manufactured by one of two German firms, Dieffenbacher GmbH and Siempelkamp GmbH. In the matforming process, the air/fiber stream is concentrated and metered through a series of jets and thickness control vanes onto a continuously moving belt. The mat as it exits the mat forming unit is of very low density and up to several inches thick (mat thickness correlates to ultimate panel thickness). There is at this point little contact between adhesive-coated fibers, and few bonds have been formed. The mat is then fed into a heated continuous press line. The mat is gradually compressed between two endlessly revolving stainless steel belts which are heated by a thermal oil bath. Pressure on the mat increases as the gap between the belts is decreased down the length of the forming line (which can be 100 meters or more long). The ultimate pressure applied to the compressed MDF panel is determined by panel thickness and desired panel properties. The final step in the pressing line is air cooling to bring the fresh panel down to near ambient temperature to be sawn and sanded.

There is some waste from the forming process, in the form of unused adhesive-coated fiber. In most MDF facilities (including the facility specified in this analysis) this waste is recycled and consumed as fuel.

Sanding and Sawing. In the plans prepared for the New Hampshire MDF facility, the pressing line produces a continuous panel up to 10 feet in width, capable of being sawn to either 4-foot or 5-foot finished product. The sawing line that produces these finished panels is a fully automated process which cuts the continuous panel into pre-programmed lengths and widths. There is little waste in this process, which is optimized to manufacture as much product as possible. The waste that is generated is typically consumed as fuel.

Prior to sawing to size, the panel product is sanded to eliminate surface inconsistencies and minor variations in thickness.

Product Handling. Inventory management and shipping is a major operation in a plant that produces over 60,000 pounds per hour of finished product. Most MDF facilities, including that specified in this analysis, have computerized and automated material handling and racking systems which sort and store finished product by size and thickness, and are capable of automatically retrieving and packaging finished product for shipment. Finished MDF is typically fully plastic wrapped (MDF can be damaged by water penetration), and then shipped in truckload or train-car quantities.

Thermal Energy System. Major sinks of thermal energy in MDF production include the refiner (steam), the drier (dry gaseous heat), and the pressing line (heat exchange to produce thermal oil). Many existing MDF plants use natural gas as their primary heat source, with or without cogeneration, and with or without supplemental solid-fuel combustion to consume waste fiber from the chipping yard, mat-forming, sanding, and sawing processes, and scrap panel from the saws. In the plant specified for the New Hampshire facility, the thermal energy system is a solid fuel combustor married to a 25 MW cogeneration plant, which produces about twice the electricity required by the plant (in addition to supplying all thermal requirements), and sells the excess power.

The thermal energy system also includes a control unit for nitrogen oxide emissions. This is the only emission control required in MDF production. There are discernible emissions of volatile organic compounds (VOCs) from the drier and press line, which are captured and thermally oxidized as part of the makeup air stream in the thermal energy system.

4.3 Cogeneration

As a major consumer of both thermal energy and electricity, and a generator of significant quantities of solid fuel as wastes, MDF is a logical candidate for cogeneration. Every MDF facility we know of combusts its own wastes to provide thermal energy, but a much smaller proportion, the minority of U.S. plants, include cogeneration capabilities. The reasons that cogeneration has not seen greater penetration are threefold: (1) where electricity and/or natural gas prices are low (as they are in many of the regions where MDF production is concentrated), the economics of cogeneration are marginal or unfavorable; (2) the addition of cogeneration adds significant complexity to an MDF production facility and operations; and (3) the thermal and electricity outputs of cogeneration need to be matched to the requirements of MDF production, not necessarily a simple engineering task.

Cogeneration was considered and selected as a component of the MDF facility specified in this analysis for three reasons: (1) Natural gas as a thermal heat source is not available in the portions of the state identified as potential plant sites; (2) Even if available, natural gas prices in New Hampshire are high enough to make cogeneration economically competitive; (3) Preliminary financial analysis indicated that, because New Hampshire electricity prices are so high, cogeneration is necessary for a facility to have any chance of economic success. A comparison of capital costs, projected income, and return on investment with and without cogeneration is presented in Section Nine

SECTION FIVE
SCALE OF POTENTIAL NEW HAMPSHIRE MDF / COGENERATION FACILITY

The specified MDF plant was scaled to produce 130 million square feet (MMSF) of MDF annually, calculated on a 3/4" basis. (3/4" is the most common MDF thickness, and most calculations related to MDF production are normalized to this value.) Expressed in tons, this equates to approximately 33 tons of product per hour, or approximately 255,000 tons/year (based on 350 day/yr, 22 hr/day production). The plant was specified with a 10-foot wide continuous press, which allows the facility to manufacture panels that meet all current North American demand specifications.

This scale is typical of recently developed or under-development MDF plants in the North America. Table 5-1 summarizes the population of existing MDF plants and planned new plants and expansions in the U.S. and Canada. With the development and improvement of the continuous press, there has been rapid evolution in the industry toward construction of plants in the 125-150 MMSF size range, and it was the unanimous opinion of industry experts consulted for this study that a plant of this size was the only facility with a chance of being developed by any player in the North American MDF industry.

5.1 Product Mix

Economic projections for the plant were built around a product mix that would generate an average board thickness of almost exactly 1/2", with the majority of product in 1/8", 5/8", and 3/4" panels. Table 5-2 summarizes the plant's projected output mix by thickness, including the projected selling price for each thickness, and total sales revenues. The output mix was selected to match current U.S. MDF demand, and prices were estimated on the basis of historic price data and projected trends (additional detail on price and revenue forecasts is presented in Sections Six and Seven).

5.2 Wood Consumption

Table 5-3 summarizes projected wood consumption and costs for MDF production and cogeneration. Projected furnish for MDF includes a total of approximately 420,000 wet tons per year, at a mean delivered price of $21.84/ton. This furnish includes approximately 67% (281,000 tons) of white pine roundwood, 22% (93,000 tons) of hardwood mill chips, and 11% (46,000 tons) of softwood mill chips. Additional information on the match between wood consumption and supplies available in the New Hampshire "wood baskets" identified for this analysis is presented in Section Three.

This raw material mix was selected to optimize a combination of raw material price and product quality. MDF demand is greatest for "light" product — light in both color and density. For both characteristics, softwoods are preferred over hardwoods, and this preference dictated the relative dominance of white pine and other softwoods in the raw material mix. The relative proportions of mill chips and roundwood were influenced by the availability and price of both types of furnish in our raw material analysis (see Section Three). Within reasonable bounds, the plant would have options to change both the composition and sources of its raw materials, and would do so routinely to optimize its operations and economic performance. It is important to note that changing the raw material mix in Table 5-3, within bounds established by the cost and availability of roundwood and residues in New Hampshire and neighboring states, would not have a discernible impact on the economic conclusions of this analysis.

Table 5-3 also presents the projected furnish for thermal energy production and cogeneration. This consists of approximately 166,000 tons/year of whole tree chips (in an unspecified combination of hard- and softwoods) at a delivered price of $18.00/ton, plus 40,000 tons/year of "urban wood fuel" consisting

Table 5-1

Existing MDF Plants and Planned New Plants or Expansions, U.S. and Canada

State or Province	Company	Location	Capacity (MMSF)	Press (feet)
EXISTING PLANTS				
UNITED STATES				
AL	Louisiana-Pacific	Eufala	135	8xContinuous
AR	Del-Tin Fiber	Eldorado	150	9xContinuous
AR	Willamette Industries	Malvern	147	5x18, 5x24
GA	Georgia-Pacific	Monticello	36	4xContinuous
GA	Langboard	Willacoochee	120	5x18
LA	Louisiana-Pacific	Urania	50	8xContinuous
NY	Norbord Industries	Deposit	90	5x18
NC	SierraPine	Moncure	75	5x24
OK	Pan Pacific Products	Brokern Bow	62	8x20
PA	Temple	Mount Jewett	100	9x26
PA	Temple	Shippenville	135	10xContinuous
SC	Georgia-Pacific	Holly Hill	100	8x25
SC	Willamette Industries	Bennettsville	130	5x18
VA	Basset Furniture Industries	Bassett	21	Unknown
	Subtotal, Eastern U.S.		1,351	
CA	CanFibre Group	Riverside	70	8x96
CA	Louisiana-Pacific	Oroville	49	8xContinuous
CA	SierraPine	Rocklin	90	5x18
MT	Plum Creek	Columbia Falls	144	5x18
OR	SierraPine	Medford	110	5x18
OR	Willamette Industries	Eugene	65	4x16
	Subtotal, Western U.S.		***528***	
	TOTAL UNITED STATES		**1,879**	
CANADA				
Alberta	West Fraser Mills, Ltd.	Whitecourt	140	5x24
B.C.	West Fraser Mills, Ltd.	Quesnel	105	10xContinuous
N.B.	Flakeboard Company, Ltd.	St. Stephen	91	5xContinuous
Ontario	G-P Flakeboard, Ltd.	Sault Sainte Marie	140	10xContinuous
Ontario	Temple	Pembroke	135	10xContinuous
Quebec	Uniboard Canada, Inc.	La Baie	130	10xContinuous
Quebec	Uniboard Canada, Inc.	Mont-Laurier	71	9xContinuous
	TOTAL CANADA		**812**	
	TOTAL NORTH AMERICA		**2,691**	
EXPANSIONS AND NEW PLANTS				
UNITED STATES				
IL	CanFibre Group, Ltd.	Chicago	70	
NY	CanFibre Group, Ltd.	Lackawanna	72	
NC	Homanit USA, Inc.	Mt. Gilead	141	
MT	Plum Creek MDF, Inc.	Columbia Falls	100	
CA	California Agriboard, LLC	Willows	100	
CANADA				
Quebec	Uniboard Canada, Inc.	Mont Laurier	45	
TOTAL EXPANSIONS AND NEW PLANTS			**528**	

Table 5-2

Product Mix and Revenues, New Hampshire MDF Facility

	Board Thickness									Total
	1/8 in.	**1/4 in.**	**3/8 in.**	**1/2 in.**	**5/8 in.**	**3/4 in.**	**1 in.**	**1-1/8 in.**	**1-1/4 in.**	
Output Mix (Percent, 3/4" basis)	5.8%	5.2%	3.5%	9.0%	28.6%	37.8%	5.5%	3.3%	1.3%	100.0%
Annual Invoiced Output, MSF, 3/4" Basis	7,553	6,799	4,537	11,674	37,167	49,127	7,150	4,356	1,638	130,001
Annual Invoiced Output, MSF, As Run	45,318	20,397	9,074	17,511	44,600	49,127	5,363	2,904	983	195,277
Net Mill Price, $/MSF, 3/4" Basis	$752.40	$519.75	$455.40	$420.75	$376.20	$386.10	$440.55	$440.55	$440.55	$422.58
Net Mill Price, $/MSF, As Run	$125	$173	$228	$281	$314	$386	$587	$661	$734	Not Appl.
Gross Revenues, $1,000	$5,683	$3,534	$2,066	$4,912	$13,982	$18,968	$3,150	$1,919	$722	$54,935

Table 5-3

Wood Consumption, Sources, and Price, New Hampshire MDF Facility

Wood Source and Use	Tons/Yr Delivered	Price ($/Ton)	Total Cost ($/Yr)
MDF Furnish			
White Pine Roundwood	280,985	$22.71	$6,381,169
Hardwood Mill Chips	92,725	$18.65	$1,729,321
Softwood Mill Chips	45,672	$22.93	$1,047,259
Subtotal, MDF	***419,382***	***$21.84***	***$9,157,750***
Cogeneration			
Whole Tree Chips	297,384	$18.00	$5,352,912
Urban Wood Fuel	40,000	$9.00	$360,000
Subtotal, Cogeneration	***337,384***	***$16.93***	***$5,712,912***
Total Wood Requirement	**756,766**	**$19.65**	**$14,870,662**

of ground pallets and other clean wood wastes, at a delivered price of $9.00/ton. In addition, nearly 47,000 oven dry tons/year of additional fuel from MDF production wastes would be available and used for thermal energy production. This includes resinated wastes (saw trim, unused resinated fiber, etc.), bark and other rejects from the roundwood chipping operation, sawdust, and other minor waste fiber streams.

5.3 Electricity Consumption

An MDF plant is a major consumer of electricity. Electricity is consumed in significant quantities at all points in the production process, with major points of consumption in the roundwood chipping operation, the refiner, the fiber drier, and the press line. Total horsepower for all electric equipment in the specified facility is 26,500 HP (approximately 19,000 KW), of which approximately 14,000 HP is represented by the refiner. When the plant is operating at full capacity, total electricity consumption is approximately 88,000 MWh/yr — approximately the equivalent of the full-time output of a 10 MW generating facility.

5.4 Thermal Energy Consumption

An MDF plant is also a major consumer of thermal energy. The major areas of thermal energy consumption are in the refiner (steam), the drier (flue gases, or hot air produced by heat exchange), and the press (thermal oil). In the plant as specified, all thermal energy required for MDF operations is output from the cogeneration facility, which, as scaled for the specified facility, produces more than ample thermal energy for MDF production (see Section 2.5).

5.5 Cogeneration Facility

The cogeneration plant was scaled at 25MW. This is about 2.5 times the size required to supply the electricity and thermal energy requirements for MDF production alone, which requires about 10 MW of electric generation capacity.

As discussed in Section 1.3, cogeneration was specified as an integral part of the MDF operation because the cost of supplying thermal energy and electricity to a plant located in New Hampshire is otherwise prohibitive. Once this initial decision to add cogeneration had been justified, the cogeneration plant itself was scaled to 25 MW to provide the optimum total economic return to the combined MDF/cogeneration facility, specifically considering economies of scale in the cogeneration plant and combined net cash flows from cogeneration plus MDF production.

This is not an ideal outcome, from either a financial or a policy perspective. Financially, the fact that significant income from cogeneration is needed to improve the overall economic performance of combined MDF/cogeneration operations is one indicator that MDF production alone is, at best, marginally economical in New Hampshire (see Section Nine). The addition of such a large cogeneration facility also establishes the MDF operator as a large electricity producer, an outcome which is not in the business plans of most of the major forest product firms likely to invest in MDF production.

From a policy perspective, the addition of cogeneration at this scale essentially replaces one of New Hampshire's existing wood-fired plants with a new facility of the same size. This outcome runs at cross purposes to the core postulate of this study, which has been to find an alternative market for wood currently used for electricity production. If the MDF plant could be co-located at an existing wood-fired plant site, this might be a positive outcome. But engineering and siting considerations preclude this possibility. Similarly, if an existing wood-fired plant could be purchased by the MDF operator (presumably at a much lower capital cost than a new cogeneration plant), disassembled, and re-located at the MDF plant site, then the policy drawbacks of large-scale cogeneration would be similarly mitigated. But in the opinion of the experts consulted for this study, this outcome is also precluded by engineering and cost considerations. This financially necessary addition of large-scale cogeneration to MDF operations is one of the factors supporting our ultimate conclusion that MDF is not, at the current time, a viable alternative or replacement for existing low grade wood markets.

SECTION SIX
CAPITAL COSTS, NEW HAMPSHIRE MDF FACILITY

Figure 6-1 summarizes the projected capital costs of the combined MDF / cogeneration facility. The total capital cost is estimated to be approximately $153 million dollars.

These capital cost estimates were developed for this project by Dan Dolecheck, Vice President of Project Development with Casey Industrial, Inc. Casey is the leading independent engineering and construction firm serving the MDF and related particleboard (PB) and oriented strandboard (OSB) industries in the United States. Casey has been involved as general contractor or a prime subcontractor in the development of over a dozen MDF, PB, and OSB plants in the past five years, for clients that have included Georgia-Pacific, Louisiana-Pacific, Temple-Inland, Masonite and others of the major MDF manufacturers in the U.S. Based on the recommendation of multiple contacts in the industry, including the suppliers of the major process equipment used in MDF production, INRS and D/L retained Casey and Mr. Dolecheck to develop detailed capital and operating cost estimates provided here. Mr. Dolecheck's resume can be found in an Appendix, along with the resume of Mr. William Peek, who assumed major responsibility for preparation of operating cost estimates.

INRS and D/L double-checked Mr. Dolecheck's estimates by consulting other industry experts, including suppliers of the major items of capital equipment used in MDF production, who provided current and historical data regarding the magnitude of MDF development costs.

An MDF plant is a major industrial installation. The required site encompasses approximately 60 acres of level and cleared land — 40 acres for the MDF production and cogeneration facilities, plus 20 acres for the wood yard and chipping operation. The size of the main production building alone (housing the forming, press, and sanding/sawing lines, plus product warehouse space) is approximately 500,000 square feet, over 11 acres.

6.1 Site Development, Utilities, and Structures

These costs account for about 20% of total capital costs, or nearly $30 million. One-third of this subtotal is represented by building costs. Other major cost elements include concrete ($6.5 million), site development ($4.7 million), and structural steel ($3.5 million). These estimates were based on data derived from similar projects developed by Casey.

6.2 MDF Equipment and Installation

Total equipment and installation costs are estimated at $67.8 million, or 44% of all capital costs. The forming/pressing line is the largest single cost item, at nearly $18 million. Energy (fluidized bed combustion and boiler) and environmental (emission control) systems are a close second at $17.5 million. Post-production systems (outfeed, storage, sanding, sawing, packing) account for a total of over $11 million. Other major subsystems are the chipping facility ($4.8 million), raw material handling ($4.9 million), the refiner ($3.4 million), and drier ($3.8 million). Equipment costs are based on current quotes provided by the major suppliers of MDF production equipment; erection and installation costs are based on Casey's experience in developing similar facilities in the past few years.

Figure 6-1

Capital Costs, NH MDF Facility

CAPITAL COST ITEM	**COST ($1,000)**	
Site Development, Utilities, Structures, MDF Facility		
Site Development	$2,391	
Concrete	$6,215	
Piping	$2,524	
Underground Utilities	$1,051	
Structural Steel	$3,393	
Buildings	$10,976	
Subtotal, Site Development, Utilities, Structures, MDF Facility		***$26,550***
Site Development, Utilities, Structures, Chipping Facility		
Site Development	$1,308	
Concrete	$270	
Piping	$154	
Underground Utilities	$241	
Structural Steel	$120	
Buildings	$490	
Subtotal, Site Development, Utilities, Structures, Chipping Facility		***$2,583***
MDF Equipment and Installation		
Raw Material Handling	$4,921	
Energy and Environmental Systems	$17,536	
Refiner System	$3,377	
Two-Stage Fiber Dryer System	$3,790	
After-Dryer Equipment	$465	
Forming and Pressing Line	$17,874	
Press Outfeed System	$1,618	
Intermediate Storage (Press through Presand)	$2,192	
Sanding Line	$2,478	
Sawing Line	$3,032	
Packing Lines	$2,065	
Pneumatic Systems	$3,591	
Chipping Facility	$4,773	
Miscellaneous Costs	$172	
Subtotal, MDF Equipment and Installation		***$67,884***
Electrical Equipment and Installation		
MDF Facility	$14,163	
Chipping Facility	$1,365	
Cogeneration Facility	$2,310	
Subtotal, Electrical Equipment and Installation		***$17,838***
Equipment Insulation		
Subtotal, Equipment Insulation		***$1,371***
Cogeneration Unit (25MW)		
Fuel Storage and Handling	$1,039	
Steam Turbine Generator Set	$5,775	
Condenser	$751	
Cooling Tower	$1,051	
Heat Unit Boiler Pressure Upgrade to 1250PSI	$1,502	
Foundations, Building, Piping, Etc.	$6,006	
High Pressure Steam System	$4,504	
Equipment and Piping Insulation	$924	
Subtotal, Cogeneration Unit		***$21,552***
Engineering		
Subtotal, Engineering		***$6,232***
General Contractor Costs (Construction Labor, Supplies, Equipment, Etc.)		
Subtotal, General Contractor Costs		***$9,437***
PROJECT GRAND TOTAL		**$153,447**

6.3 Cogeneration

Cogeneration capital costs include all systems required for steam and electricity production and management outside of the core solid fuel combustion and boiler systems, and the NOx emission control system (which are accounted under MDF equipment). Their total is approximately $21.5 million, or 14% of all capital costs. Over half of this subtotal is associated with high pressure steam production and management (required for cogeneration but not MDF production) and the turbine generator set, and another quarter of the cost encompasses the required foundation, building, and piping systems. These estimates were derived from capital costs for a similar 20 MW cogeneration facility currently under development in the northeastern U.S.

6.4 Electrical Equipment and Installation

These costs include $15.5 million for electrical equipment and wiring associated with MDF production, plus $2.3 million in costs associated with the substation, switching, and distribution facilities for cogeneration. Costs for the MDF plant are based on current experience with similar facilities; costs associated with cogeneration are based on current experience with similarly scaled cogeneration facilities.

6.5 Engineering and General Contractor Costs

Casey based these costs on its own experience and cost structure for development projects in the wood panel industry. They total approximately $15.7 million, or just over 10% of total capital costs for the MDF facility.

SECTION SEVEN
OPERATING COSTS, NEW HAMPSHIRE MDF FACILITY

Because of the scale of MDF production and the long lead time between concept and production, MDF operating costs are broken sequentially into four sets: (1) Pre-approval costs, which include all costs prior to construction startup (e.g., site selection, land acquisition, site engineering and mapping, legal, permitting); (2) Pre-startup costs (management and administration, site infrastructure, etc.); (3) Startup ramp (operating costs over an approximately 1.5-year shakedown period during which the plant gradually achieves full production); and (4) Steady state operating costs.

With the exception of pre-approval costs, operating cost estimates were also provided for this project by Casey Industrial, based on experience with a number of very similar facilities developed by Casey, supplemented by industry norm data based on a much larger base of facilities across the U.S. Pre-approval costs were estimated by D/L and INRS based on local information and evaluation of equivalent pre-startup and startup ramp cost elements provided by Casey.

7.1 Pre-Approval Costs

These are the smallest subset of operating costs, and the most dependent on site-specific and other local considerations. They include all costs incurred prior to groundbreaking, and include the following allowances:

Site evaluation (including surveying, mapping, geotechnical investigation, etc.): $500,000;

Land acquisition: $120,000

General management and administration (including business planning, product and market analysis, preliminary engineering, etc.): $500,000

Permitting: $125,000;

Legal and other outside service fees: $150,000.

The sum of the pre-approval activities is estimate to equal approximately $1.4 million.

7.2 Pre-Startup Costs

Pre-startup costs include all costs associated with MDF facility planning (including marketing and sales planning), design, and operations which are borne by the developer during an approximately 18-month construction period. They include the following cost categories:

Selling, general, and administrative salaries;

Employee training, employee relations;

Management oversight (including basic site infrastructure and utilities not included in the capital budget);

Marketing and sales planning and development;

On-site operations;

General and administrative operations;

Owner-purchased equipment.

Total pre-startup costs are estimated to equal nearly $11 million (Figure 7-1). The largest single component of this cost is site infrastructure development ($3.5 million). General management salaries, employee relations and training, general operations, and owner-purchased equipment each contribute an additional $1.4 million to $1.7 million to this total.

7.3 Startup Ramp

After startup, it can take from 16 months to two years for a new MDF plant to reach steady state operations and cash flow. Very few plants achieve steady-state operations in less time; a number of plants have taken more, sometimes much more. During this period all operations are functional, but the plant is not operating at full capacity, and a proportion of product must either be discarded or sold at less than first-quality prices. Especially in the early months of the startup ramp, the plant is idle for a significant proportion of potential operating hours while equipment is tested and debugged.

The associated cogeneration facility passes through a similar startup and debugging period. This is typically somewhat shorter for cogeneration — about 12 months.

During the startup period, major cost and revenue elements are the same as they are during subsequent steady-state operations (see Section 4.4). Revenues increase slowly from zero at startup to their steady-state value (approximately $4.5 million/month) as the plant gears up to full-time operation and the proportion of reject or low-quality product diminishes. Operating costs also increase during the startup period, but more slowly than revenues. The full steady-state employment burden is taken on a soon as the plant turns on, so employee-related costs are constant throughout the startup period. Most other operating costs — for raw materials, energy, adhesives, etc. — start at relatively low values and increase with increasing production.

Figure 7-2 summarizes projected revenues and costs from combined MDF and cogeneration operations for the first 24 months after startup. The plant is projected to operate at a deficit for six months, amassing a cumulative operating deficit of approximately $5.2 million. Breakeven is achieved in Month 7, and the initial operating deficit is erased in Month 14. Costs and revenues continue to grow through Month 18, when steady state operation and cash flow are achieved.

7.4 Steady State Cost Structure

Figure 7-3 summarizes the steady-state operating cost structure for the combined MDF and cogeneration facility. Total operating costs are projected to equal $38.8 million/year.

By far the largest single component of operating cost is MDF wood procurement — $9.5 million/year, or nearly 25% of total operating costs. As discussed in Section Five, we estimate the delivered price of the roundwood and mill residues used for MDF production will equal $21.84/ton (see Table 5-3). According to the Casey Industrial consultants who assisted in budgeting the facility, this cost is some 20% higher than raw material procurement costs for competitive MDF facilities operating or under development elsewhere in the country, particularly in the southeastern U.S.

Wood for cogeneration adds an additional $5.7 million, or 14.7% of total costs, to the combined operating budget. As noted in Section Five, the budget assumes that about 20% of this wood supply will be procured as “urban wood” fuel (e.g., pallets and construction wastes) at a net cost of $9.00/ton, a situation which will require development of supplies that do not now exist in New Hampshire. The balance of cogeneration wood supply is specified as low grade whole tree chips, procured at a cost of $18.00/ton, equivalent to current trading prices for chips delivered to New Hampshire’s existing wood-fired plants.

Figure 7-1

Pre-Startup Budget, New Hampshire MDF Facility

Costs incurred over 18 months post approval and prior to plant startup

Cost	**Amount ($1,000)**	
Selling, General and Administrative Salaries		1,603
Employees Relations and Training		1,405
Training and Organizational Development	347	
Direct Training Salaries	908	
Other Costs	150	
Management Oversight		4,084
Site Office Operations	551	
Site Infrastructure and Utilities	3,500	
Other Cost	33	
Marketing and Sales		544
Office Operations	139	
Market Development	405	
Plant Operations		1,713
Office Operations	63	
Operating Supplies	1,460	
Other Operating Costs	190	
G&A Operations		184
Office Operations	9	
Other Costs	175	
Owner-Purchased Equipment		1,443
Total		**10,976**

Figure 7-2
Cash Flows During Two-Year Startup Ramp, NH MDF Facility

Cost or Revenue Stream	Month																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Revenues, MDF Sales	0	957	1,278	1,919	2,316	2,539	2,683	2,836	2,974	3,198	3,350	3,507	3,763	3,918	4,018	4,240	4,251	4,445	4,518	4,528	4,539	4,549	4,559	4,570
Revenues, Electricity Sales	256	278	299	320	342	352	359	367	376	385	393	402	410	419	427	427	427	427	427	427	427	427	427	427
Total Revenues	256	1,235	1,577	2,239	2,658	2,891	3,042	3,203	3,350	3,583	3,743	3,909	4,173	4,337	4,445	4,667	4,678	4,872	4,945	4,955	4,966	4,976	4,986	4,997
Operating Costs	1,823	2,550	2,835	3,013	2,904	2,896	2,808	2,844	2,847	2,909	2,938	2,966	3,092	3,052	3,061	3,142	3,146	3,212	3,236	3,236	3,236	3,236	3,236	3,236
Net Cash from Operations	(1,567)	(1,315)	(1,258)	(774)	(246)	(5)	234	359	503	674	805	943	1,081	1,285	1,384	1,525	1,532	1,660	1,709	1,719	1,730	1,740	1,750	1,761
Cumulative Cash from Operations	(1,567)	(2,882)	(4,140)	(4,913)	(5,159)	(5,165)	(4,931)	(4,571)	(4,068)	(3,394)	(2,589)	(1,647)	(565)	720	2,104	3,629	5,162	6,822	8,531	10,250	11,981	13,721	15,471	17,233

Figure 7-3

Operating Cost Summary, New Hampshire MDF Plant

	Total Cost	Cost Per 1,000 Sft	Percent of Operating Cost
MANUFACTURING COSTS			
Wood, MDF Production	$9,158	$70.45	23.5%
Wood, Cogeneration	$5,713	$43.95	14.7%
Additives (Resin, Wax, Urea)	$7,357	$56.59	18.9%
Cogeneration Operating Costs (Net of Fuel)	$4,200	$32.31	10.8%
Labor			
Operating and Technical	$2,221	$17.08	5.7%
Maintenance and Service	$1,390	$10.69	3.6%
Maintenance and Repair Supplies	$1,200	$9.23	3.1%
Refiner plates, press belts & plates, oils and lubricants			
Operating Supplies	$2,427	$18.67	6.2%
Maintenance contractors, sanding belts, packaging matls, other op. supplies			
Subtotal, Manufacturing Costs	**$33,666**	**$258.97**	**86.6%**
SELLING, GENERAL, AND ADMINISTRATIVE COSTS			
Selling Costs	$1,965	$15.12	5.1%
Salaries & benefits, discounts, commissions			
General and Administrative Costs	$3,257	$25.05	8.4%
Mgmt and administrative salaries & benefits, taxes, insurance, etc.			
Subtotal, Selling, General and Administrative	**$5,222**	**$40.17**	**13.4%**
TOTAL OPERATING COSTS	**$38,888**	**$299.14**	**100.0%**

Additives required for MDF production are the second most expensive item in the steady-state cost structure: $7.4 million, or 18.9% of total operating costs. There is little or no difference between additive costs estimated in New Hampshire and those incurred for MDF production elsewhere in the U.S.

Direct labor costs are estimated to equal $3.6 million per year, or 9.3% of total operating costs. Figure 7-4 summarizes labor requirements, wages, and total labor costs. Although an MDF facility is highly automated, it is still a major employer, with a total of 83 production personnel. Fifty-eight employees are required for direct production operations, divided evenly between panel production (30 employees) and finishing and shipping (28 employees). An additional 25 employees are required for plant and equipment maintenance and related functions. Payroll cost estimated are based on current New Hampshire wage scales in similar job functions in the pulp and paper, wood energy, and related industries. The direct payroll is $2.7 million per year (including estimated overtime), with an average hourly wage of $13.10/hour.

Operating and maintenance supplies are the final major direct cost category, at $3.6 million/year, or 9.3% of total operating costs. These include items such as replacement belts and plates, sanding belts, lubricants, packaging materials, and contracted maintenance services.

General and administrative costs add an additional $5.2 million, or 13.5%, to the total cost structure. Of this total, just over $2 million is represented by direct and indirect salary costs. Non-production employment at the facility is projected to include 32 salaried positions, as specified in Figure 7-5, with an average annual salary of $46,000/year. The balance of general and administrative costs include a broad array of items including, for example, non-production utilities (space heat, lighting, electricity), taxes, insurance, office supplies and equipment, legal and other outside services, selling and marketing expenses, and a large number of others.

Figure 7-4

Operating Staff, NH MDF Facility

Department and Position	Number of Employees by Shift					$/Hr	Annual $/Position	Total $/Yr
	A	B	C	D	Total			
DIRECT LABOR COSTS								
Panel Production								
Log Yard / Chipping	5	5			10	$10.00	$21,840	$218,400
Raw Material Prep.	1	1	1	1	4	$10.00	$21,840	$87,360
Refiner	1	1	1	1	4	$12.50	$27,300	$109,200
Forming/Pressing	1	1	1	1	4	$12.50	$27,300	$109,200
Utility Operator	1	1	1	1	4	$11.00	$24,024	$96,096
Shift Supervisor	1	1	1	1	4	$13.00	$28,392	$113,568
Subtotal, Panel Production	***10***	***10***	***5***	***5***	***30***	***$11.20***	***$24,461***	***$733,824***
Panel Finishing								
Sander	1	1	1		3	$12.50	$27,300	$81,900
Grader	1	1	1		3	$12.00	$26,208	$78,624
Book Saw	1	1	1		3	$12.50	$27,300	$81,900
Reman Saw	1	1	1		3	$12.00	$26,208	$78,624
Unitizing	1	1	1		3	$11.00	$24,024	$72,072
Fork Lift	2	2	2		6	$11.00	$24,024	$144,144
Shift Supervisor	1	1	1		3	$13.00	$28,392	$85,176
Subtotal, Panel Finishing	***8***	***8***	***8***		***24***	***$11.88***	***$25,935***	***$622,440***
Shipping	***4***				***4***	***$12.50***	***$26,000***	***$104,000***
Maintenance								
Shift Mechanic	2	2	2	2	8	$16.50	$36,036	$288,288
Shift Electric	2	2	2	2	8	$17.50	$38,220	$305,760
Mechanical Shop	4				4	$16.50	$36,036	$144,144
Electrical Shop	3				3	$17.50	$38,220	$114,660
Vehicle Maintenance	1				1	$17.50	$38,220	$38,220
Subtotal, Maintenance	***12***	***4***	***4***	***4***	***24***	***$17.00***	***$37,128***	***$891,072***
Stores and Services	***1***				***1***	***$11.00***	***$22,880***	***$22,880***
PLANT TOTAL, DIRECT COSTS					**83**	**$13.10**	**$28,605**	**$2,374,216**
LOADING ON DIRECT LABOR (Percent of Direct Labor Cost)							**38.0%**	**$902,202**
OVERTIME ESTIMATE (Percent of Direct Labor Cost)							**14.1%**	**$334,764**
TOTAL LOADED LABOR COST								**$3,611,183**

Figure 7-5

Management and Administrative Positions and Salaries, NH MDF Facility

Department and Position	Annual Salaries
GENERAL MANAGEMENT	
General Manager	$100,000
Production Superintendent	$65,000
Purchasing Agent	$45,000
Wood Procurement Manager	$45,000
Project Coordinator	$55,000
Technical Manager	$65,000
QC / Optimization Technicians (2 total)	$70,000
Maintenance Superintendent	$65,000
Mechanical Supervisor	$57,000
Electrical Supervisor	$57,000
Production Supervisor (4 total, 1 per 4 shifts)	$180,000
Finishing Supervisor (3 total, 1 per 3 shifts)	$135,000
Subtotal, General Management	***$939,000***
SALES MANAGEMENT	
Sales Manager	$100,000
Inside Sales Manager	$50,000
Customer Service Representative	$30,000
Scheduler	$35,000
Shipping Clerk	$25,000
Subtotal, Sales Management	***$240,000***
ADMINISTRATIVE MANAGEMENT	
Controller	$55,000
Accounts Payable/Sales	$30,000
Scale Clerk (4 total, 1 per 4 shifts)	$100,000
Administrative Assistant	$25,000
Subtotal, Administrative Management	***$210,000***
HUMAN RESOURCES	
HR Manager	$55,000
HR Staff	$25,000
Subtotal, Human Resources	***$80,000***
TOTAL SALARIES, UNLOADED	**$1,469,000**
LOADING ON SALARIES AT 38%	**$558,220**
TOTAL SALARIES, FULLY LOADED	**$2,027,220**
NUMBER OF SALARIED STAFF	**32**

SECTION EIGHT
REVENUES, NEW HAMPSHIRE MDF FACILITY

The facility has two sources of revenue: MDF sales and electricity sales. Under steady state production, total revenues are projected to equal $60.1 million /year. Of this total, 91.5% ($54.9 million/year) are derived from MDF production, the remaining 8.5% ($5.1 million/year) from electricity sales.

8.1 Revenues from MDF Sales

Steady-state revenues from MDF sales (net price, FOB MDF facility) are projected to equal $54.9 million per year (Table 5-2). The product mix underlying this revenue estimate was specified to match current North American demand, and prices were equated to current North American MDF prices by thickness. A freight penalty of about 2.5% was included in the sales price estimates to account for New Hampshire's distance to the majority of U.S. MDF markets, which are in the Southeast. No attempt was made to project future price trends; projected revenues are constant throughout the plant's projected 20-year life.

8.2 Revenues from Cogeneration

Projected revenues from electricity sales are $5.1 million per year, based on sale of 122,102 MWh/year at $0.042/KWh. Total power production from the 25 MW cogeneration facility is estimated to equal 210,000 MWh/year, of which 87,898 MWh/year are consumed for MDF production. Projected unit revenues of $0.042/KWh are equal to current baseload clearing prices on the Northeastern power grid. No attempt has been made to adjust this estimate to account for future changes in northeastern electricity markets.

SECTION NINE
NET INCOME AND RATE OF RETURN ON INVESTMENT

Figure 9-1 provides a *pro forma* income statement for the combined MDF and cogeneration operation, while Figure 9-2 summarizes a number of Rate of Return calculations. Although the combined plant drops nearly 35% of revenues to the bottom line as profit before interest and taxes (PBIT), it is the conclusion of this analysis that this level of return is insufficient to justify investment in MDF production in New Hampshire.

9.1 Pro Forma Income Statement

Figure 9-1 combines cost and revenue estimates to provide a *pro forma* income statement for the combined MDF and cogeneration operations. Total annual revenues are projected to equal approximately $60.1 million/year — $54.9 million/year from MDF sales plus $5.1 million/year from electricity sales. Total production costs are estimated to equal $34.0 million/year, or approximately 56% of total revenues. Wood for MDF production (15.2% of revenues) and cogeneration (9.5% of revenues) plus additives (12.2% of revenues) are the major cost components of MDF production (see Section Seven), followed by direct labor costs (6.0%) and operating and maintenance supplies (6.0%). The gross profit from MDF production and cogeneration is estimated to equal $26.4 million/year, or 43.9% of revenues.

Additional, indirect expenses are estimated to equal $5.2 million/year, or 8.7% of revenues. Net profit before interest and income taxes, therefore, is calculated to equal $21.2 million/year, or 35.3% of revenues.

9.2 Rate of Return Calculations

The projected rate of return on investment in a New Hampshire MDF/cogeneration facility is presented in Figure 9-2, calculated using the four most common yardsticks of investment performance.

The total direct capital cost of the combined facility is $153.4 million, as discussed in Section Six. To calculate rate of return, this was accounted as a one-time cost incurred in the year prior to plant startup. Pre-approval costs of $1.4 million (Section Seven), and pre-startup costs of $11.0 million (Section Seven) were accounted in the same way — as a one-time cost incurred in Year 0.

Net income was calculated as described in Sections Seven and Eight. Steady-state income is estimated at $21.2 million/year (Section Eight). We have not projected future changes in MDF prices, electricity sales prices, or the MDF/cogeneration cost structure, which would affect steady state cash flows. To the extent that these changes track changes in the overall consumer and produce price indices, they would have no impact on the projected overall economic performance or rate of return of the MDF/cogeneration facility. Cash flows do not reach this steady-state value until Year 3 of operations. As presented in Section Seven, the plant runs through an approximately 18-month startup ramp before steady state is achieved. Net cash flow in the first year after startup is negative (by approximately $1.6 million). Cash flow in Year 2 is positive, but is about $2 million below the steady state value because of startup deductions which last through the first half of the year.

We do not factor income tax estimates into rate of return calculations because these are unpredictable and to some extent manipulable by the plant operator. Their omission is normal in rate of return calculations for a new project, until it is demonstrated that project economics are favorable and that tax treatment could have a meaningful impact on overall financial performance.

Under these assumptions, cost, and cash flow projections, the projected financial performance of a New Hampshire MDF/cogeneration facility is feeble. Simple payback is nine years. The net present value (NPV) of the facility (the value of all future cash flows, minus the cost of the initial investment), using an

Figure 9-1

Pro Forma Income Statement, New Hampshire MDF Plant

	Dollars (1,000)	Percent of Revenues
REVENUES		
MDF Sales	54,935	91.5%
Electricity Sales	5,128	8.5%
Total	***60,063***	***100.0%***
COST OF GOODS SOLD		
Wood, MDF	9,158	15.2%
Wood, Cogeneration	5,713	9.5%
MDF Operating Costs		
Labor, Operating & Technical	2,221	3.7%
Labor, Maintenance & Service	1,390	2.3%
Supplies, Operating	2,427	4.0%
Supplies, Maintenance & Repair	1,200	2.0%
Additives (Resin, Wax, Urea)	7,357	12.2%
Cogen Operating Costs	4,200	7.0%
Total Cost of Goods Sold	***33,666***	***56.1%***
GROSS PROFIT	**26,397**	**43.9%**
EXPENSES		
Selling Costs	1,965	3.3%
General and Administrative Expenses	3,257	5.4%
Total Expenses	***5,222***	***8.7%***
PROFIT BEFORE INTEREST AND TAXES	**21,175**	**35.3%**

Figure 9-2
Rate of Return Calculations, New Hampshire MDF Facility

Total Capital Investment:	**$153,447,000**	Accounted at beginning of Year 1
Pre-Approval Costs:	**$1,395,000**	Accounted at beginning of Year 1
Pre-Startup Costs:	**$10,976,000**	Accounted at beginning of Year 1

Steady-State Cash Flow		**Annual Net Cash Flow**		
Revenue or Cost	**Cash Flow ($1,000)**	**Year**	**Cash Flow ($1,000)**	**Cumulative Cash Flow**
Revenues, MDF Sales	54,935	0	(165,818)	----
Revenues, Electricity	5,128	1	(1,647)	(1,647)
Total Revenues	**60,063**	2	18,980	17,333
Operating Costs	38,888	3	21,175	38,508
Net Cash Flow	**21,175**	4	21,175	59,683
		5	21,175	80,858
		6	21,175	102,033
		7	21,175	123,208
		8	21,175	144,383
		9	21,175	165,558
		10	21,175	186,733
		11	21,175	207,908
		12	21,175	229,083
		13	21,175	250,258
		14	21,175	271,433
		15	21,175	292,608
		16	21,175	313,783
		17	21,175	334,958
		18	21,175	356,133
		19	21,175	377,308
		20	21,175	398,483

RATE OF RETURN CALCULATIONS

Net Present Value at 8% ($1,000)	$19,068
Return on Investment at 8% ($1,000)	11.50%
Internal Rate of Return	9.35%
Simple Payback (years)	9.0

8% discount rate, is $19.1 million. On an investment of $166 million, this NPV generates a return on investment of 11.5%. The final calculated yardstick of economic return is the Internal Rate of Return (IRR), which is the interest rate that drives the net present value of the facility to zero (i.e., a higher interest rate would generate a negative NPV, or a financial loss from the investment; a lower interest rate would generate a positive NPV, or a financial gain from the investment). The IRR for the New Hampshire MDF/cogeneration facility is calculated to equal 9.35%.

By any of these measures, it is implausible to expect that an MDF/cogeneration facility in New Hampshire would attract investment from any of the major players in North American panel production. An internal rate of return of 9.2% is barely more than the cost of capital for an investment of this size, and leaves the facility vulnerable to the impact of the slightest general economic downturn, weakness in MDF markets, or inflation in MDF-related costs. According to industry experts contacted for this study, the major panel manufacturers currently seek an IRR of at least 14% to 16% for any new investment in panel production; smaller manufacturers or an independent investor would see an even higher value. The investment returns we calculate for MDF production in New Hampshire would not generate even a spark of interest.

9.3 Sensitivity to Economic Variables

We investigated whether modifying of the economic assumptions in the cost and revenue model would affect the conclusions of this analysis. Specifically, we reviewed all of the major cost and revenue elements, identified those where our assumptions could be open to significant variation in coming years, and investigated the impact of changing these assumptions.

Table 9-1 summarizes the major cost and revenue elements associated with MDF production and cogeneration, the likelihood of significant deviation from the estimates used in this analysis, and the potential impact of such deviation on the overall economic performance of the facility. We identified two areas where future are both unpredictable and potentially of a magnitude to affect the economic viability of MDF production in New Hampshire. These are the potential revenues from cogeneration, and the cost of wood for MDF production. We conducted sensitivity analysis for the projected plant internal rate of return against both of these variables.

Sensitivity to Electricity Sales Revenues. We explored the impact of raising revenues from electricity sales by 25% to 100% (Table 9-2), by increasing the net price received per kilowatt-hour from $0.042/KWh to $0.084/KWh. Each 10% ($.0042/KWh) increment in electricity sales revenues adds approximately $1.3 million in annual steady state revenues to the MDF income statement. As shown in Table 9-2, the impact on overall financial performance is not large. Even with a doubling of electricity sales revenues, the increase in internal rate of return is only 3.1% (from 9.35% to 12.5%), and other measures of investment return are affected by an equally small amount. This impact does not bring the projected return close to the range expected by investors in MDF capacity.

Sensitivity to the Cost of Wood for MDF Production. Table 9-3 presents of sensitivity analysis to the cost of wood procurement for MDF. We explored the impact of decreasing wood procurement price by up to 40% from our base case. Each 10% decrease in wood procurement costs from a base estimate of $22.55/ton generates approximately $950,000 in annual savings. Although the impacts on net present value and return on investment appear substantial, the impact on internal rate of return, the most important investment criterion, is much less so. IRR increases only from 9.35% to 11.3% as wood costs drop by up to 40%. The impact is not sufficient to alter the fundamental conclusion of this analysis.

Table 9-1
Assessment of Major Cost and Revenue Elements for Sensitivity Analysis

Cost or Revenue Element	Considerations Related to Sensitivity Analysis
Revenues from MDF Sales	Historically, MDF sales price has remained stable or declined in constant dollars, with industry-wide overcapacity much more common than any capacity constraints which would tend to drive up sales prices. We do not foresee a likely case in which sales prices are significantly higher than projected. No sensitivity analysis performed.
Revenues from Electricity Sales	Extremely volatile, and at least somewhat likely to increase in coming years. Sensitivity analysis performed.
Cost of Wood, MDF	Single largest cost element. Sensitivity analysis performed.
Cost of Wood, Cogeneration	Third largest cost element. Price used in analysis equivalent to current NH prices for low-grade whole-tree chips, which have been relatively stable for a number of years, and which are barely sufficient to sustain profitable logging. Given these facts, we do not see much likelihood that prices will drop meaningfully. No sensitivity analysis performed.
Additives	Second largest cost element. Prices based on established price history. Unlikely that technical or economic changes would result in significantly lower prices. Even if they did, lower prices would be enjoyed by all competitive facilities. No sensitivity analysis performed.
Labor (Production and Management)	Number of personnel based on precise plant specifications, and not manipulable. Wage scale used is relatively low, and unlikely to be brought much lower. No sensitivity analysis performed.

Table 9-2
Rate of Return Calculations, New Hampshire MDF Facility
Sensitivity to Electricity Sales Revenues

	Change in Electricity Revenues (Percent of Base Estimate)				
	Base	**Plus 25%**	**Plus 50%**	**Plus 75%**	**Plus 100%**
Electricity Sales Price ($/kWh)	$0.042	$0.053	$0.063	$0.074	$0.084
NPV at 8% ($1,000)	$19,068	$30,838	$42,608	$54,379	$66,149
ROI at 8% ($1,000)	11.50%	18.60%	25.70%	32.79%	39.89%
Internal Rate of Return	9.35%	10.16%	10.94%	11.71%	12.46%
Simple Payback	9.0	8.5	8.1	7.7	7.4

Table 9-3
Rate of Return Calculations, New Hampshire MDF Facility
Sensitivity to Cost of Wood for MDF Production

	Change in Wood Cost (Percent of Base Estimate)				
	Base	**Less 10%**	**Less 20%**	**Less 30%**	**Less 40%**
Cost of Wood for MDF ($ million)	$9,158	$8,242	$7,326	$6,411	$5,495
NPV at 8% ($1,000)	$19,068	$26,426	$33,785	$41,143	$48,501
ROI at 8% ($1,000)	11.50%	15.94%	20.37%	24.81%	29.25%
Internal Rate of Return	9.35%	9.85%	10.34%	10.81%	11.27%
Simple Payback	9.0	8.7	8.5	8.2	8.0

9.4 The Case Without Cogeneration

Figure 9-3 is a *pro forma* income statement for the New Hampshire MDF facility ***without*** cogeneration. Compared to Figure 9-1 (income statement with cogeneration), income decreases by $5.1 million/year (electricity sales revenues) when cogeneration is eliminated. On the cost side, cogeneration operating costs of $4.2 million/year are eliminated, as are cogeneration wood procurements costs of $5.7 million/year. These cost savings are more or less balanced, however, by the cost of purchased electricity ($8.2 million/year, based on a purchase price of $0.075/KWh) plus the cost of purchased fuel for thermal energy production ($0.74 million/year). The net impact (including other small changes elsewhere in the cost budget) is that projected operating costs without cogeneration are $502,000 less than operating costs with cogeneration. Combining these with the projected loss in electricity sales revenue, the income statement without cogeneration projects a net loss in income of $4.6 million/year compared to the combined MDF plus cogeneration income statement.

Capital costs are also substantially reduced if cogeneration is eliminated. The entire $21.5 million cost of the cogeneration plant is canceled, as is the $2.3 million cost of a substation, switching, and distribution facilities to connect the facility to the electric grid. The cost of the thermal energy production system is also reduced by approximately 50%, or $8.7 million. The total impact of these changes is that the capital cost of the facility is reduced by approximately $33 million if cogeneration is eliminated, to $120.8 million instead of $153.4 million.

Figure 9-4 presents rate of return calculations for the New Hampshire MDF facility without cogeneration (equivalent to the calculations presented in Figure 9-2 for the case with cogeneration). By all calculations, the plant without cogeneration fares worse than the plant with cogeneration. Net present value decreases from $19.1 million to $9.8 million, return on investment (8% interest rate) decreases from 11.5% to 7.3%, and internal rate of return decreases from 9.35% to 8.9%.

We also conducted sensitivity analysis to several significant financial variables for the no cogeneration case. As expected, electricity cost has a major impact (Table 9-4). If electricity costs are reduced by about 40% (more or less to the cost of electricity in the southeastern U.S., where most recently sited MDF facilities have been located), IRR increases by over 2.5%. Reducing electricity costs an additional 10% (to the equivalent of the price paid by many Canadian panel plants) adds almost another percent to MDF IRR.

The cost of wood procurement has a similarly large impact (Table 9-5). Reducing wood costs by 20% to 30%, to the equivalent of costs paid for mill residues in the southeastern U.S., improves IRR by 2.2% to 2.8%. In reality, the southern (and many Canadian) MDF plants running exclusively on sawmill residues would enjoy even higher rates of return, in that capital and operating costs for the wood yard would also be eliminated.

In Table 9-6, we postulate a set of financial variables that generate a viable MDF investment opportunity. These are roughly the conditions that underlie the investments currently being made in new MDF, and demonstrate the combination of factors which, at the present time, make MDF an unattractive investment in New Hampshire. The single largest economic and operating assumption reflected in Table 9-6 is the elimination of cogeneration, which is not a component of most MDF facilities. Other changes are the reduction of wood procurement costs by 25%, reduction of electricity costs from $0.075/KWh to $0.042/KWh, increase in MDF sales price of 7.5%, and a modest (5%) reduction in hourly wages. All of these approximate improvements in financial variables which would be enjoyed by a facility sited in the Southeast (or, with some additional modifications, in parts of Canada), and their cumulative impact is to bring the internal rate of return to something over 14%. If capital and operating costs of the wood yard are also eliminated (by siting a plant in a location where mill residues can provide 100% of raw materials), IRR jumps into the range of 15%-plus that makes MDF a very attractive investment.

Figure 9-3

Pro Forma Income Statement, New Hampshire MDF Plant
No Cogeneration

	Dollars (1,000)	Percent of Revenues
REVENUES		
MDF Sales	54,935	100.0%
Total	***54,935***	***100.0%***
COST OF GOODS SOLD		
Wood, MDF	9,158	16.7%
Electricity	8,204	14.9%
Heating Fuel	738	1.3%
MDF Operating Costs		
Labor, Operating & Technical	2,221	4.0%
Labor, Maintenance & Service	1,390	2.5%
Supplies, Operating	2,427	4.8%
Supplies, Maintenance & Repair	1,500	2.7%
Additives (Resin, Wax, Urea)	7,357	13.4%
Total Cost of Goods Sold	***33,194***	***60.4%***
GROSS PROFIT	**21,741**	**39.6%**
EXPENSES		
Selling Costs	1,965	3.6%
General and Administrative Expenses	3,227	5.9%
Total Expenses	***5,192***	***9.5%***
PROFIT BEFORE INTEREST AND TAXES	**16,549**	**30.1%**

Figure 9-4
Rate of Return Calculations, New Hampshire MDF Facility

No Cogeneration

Total Capital Investment:	**$120,817,000**	Accounted at beginning of Year 1
Pre-Approval Costs:	**$1,395,000**	Accounted at beginning of Year 1
Pre-Startup Costs:	**$10,976,000**	Accounted at beginning of Year 1

Steady-State Cash Flow		**Annual Net Cash Flow**		
Revenue or Cost	**Cash Flow ($1,000)**	**Year**	**Cash Flow ($1,000)**	**Cumulative Cash Flow**
Total Revenues	54,935	0	(133,188)	----
Operating Costs	38,386	1	(2,593)	(2,593)
Net Cash Flow	16,549	2	14,435	11,842
		3	16,549	28,391
		4	16,549	44,940
		5	16,549	61,489
		6	16,549	78,038
		7	16,549	94,587
		8	16,549	111,136
		9	16,549	127,685
		10	16,549	144,234
		11	16,549	160,783
		12	16,549	177,332
		13	16,549	193,881
		14	16,549	210,430
		15	16,549	226,979
		16	16,549	243,528
		17	16,549	260,077
		18	16,549	276,626
		19	16,549	293,175
		20	16,549	309,724

RATE OF RETURN CALCULATIONS

Net Present Value at 8% ($1,000)	$9,756
Return on Investment at 8% ($1,000)	7.33%
Internal Rate of Return	8.86%
Simple Payback (years)	9.3

Table 9-4
Rate of Return Calculations, New Hampshire MDF Facility
Sensitivity to Electricity Cost
No Cogeneration

	Change in Cost of Electricity (Percent of Base Estimate)				
	Base	**Less 10%**	**Less 25%**	**Less 40%**	**Less 55%**
Electricity Sales Price ($/kWh)	$0.075	$0.068	$0.060	$0.053	$0.032
NPV at 8% ($1,000)	$9,756	$17,817	$29,175	$40,532	$51,889
ROI at 8% ($1,000)	7.33%	13.38%	21.90%	30.43%	38.96%
Internal Rate of Return	8.86%	9.56%	10.51%	11.44%	12.34%
Simple Payback	9.3	8.9	8.3	7.9	7.4

Table 9-5

Rate of Return Calculations, New Hampshire MDF Facility

Sensitivity to Cost of Wood for MDF Production

No Cogeneration

	Change in Wood Cost (Percent of Base Estimate)				
	Base	**Less 10%**	**Less 20%**	**Less 30%**	**Less 40%**
Cost of Wood for MDF ($ million)	$9,158	$8,242	$7,326	$6,411	$5,495
NPV at 8% ($1,000)	$9,756	$17,114	$24,473	$31,831	$39,189
POI at 8% ($1,000)	7.33%	12.85%	18.37%	23.90%	29.42%
Internal Rate of Return	8.86%	9.49%	10.09%	10.68%	11.25%
Simple Payback	9.3	9.0	8.6	8.3	8.0

SECTION TEN

CONCLUSIONS: ECONOMIC VIABILITY OF MDF PRODUCTION IN NEW HAMPSHIRE, AND RECOMMENDATIONS FOR PHASE III RESEARCH

10.1 Conclusions

The conclusions of this analysis, unfortunately, are clear: Under no likely combination of circumstances is MDF production, in the short term, a financially viable option in New Hampshire.

Compared to regions where MDF plants are concentrated, New Hampshire suffers a serious disadvantage in two areas of operating cost. The first, clearly, is the cost of electricity. As explained in Section XXX, the combination of high electricity consumption for MDF production coupled with New Hampshire's very high electricity rates implies a huge electricity bill. The only way to bring MDF into the realm of economic feasibility in New Hampshire has been to attach a cogeneration facility large enough, at a minimum, to supply all of the plant's own needs (approximately 10 MW of generating capacity). Under the financial scenario constructed in this analysis, cogeneration is a net revenue source for the facility at or beyond this capacity, with returns that increase with increasing cogeneration output. Therefore the cogeneration facility was scaled up to 25 MW, freeing nearly 60% of its output for sale into the Northeastern utility grid. Even at this scale, however, electricity sales revenues are insufficient to overcome the financial burden imposed by the combined capital, raw material, and operating costs of cogeneration (which together are greater than the cost of purchased electricity to MDF manufacturers elsewhere in the country). This is part of the reason for the negative conclusion of this analysis.

The second major reason is the cost of wood for MDF production. According to the industry experts consulted for this analysis, the projected wood procurement cost in New Hampshire, $22.55/ton, is 20% to 25% higher than procurement costs in regions where MDF plants are currently being sited. These include areas (primarily in the South) where wood is procured from company-owned and managed plantations, and where MDF furnish is typically procured in the form of residues from sawmill and related operations. Similar savings obtain in many parts of Canada, in locations where a large proportion of wood is procured from government lands, and where mill residues are also abundant.

In other cost and revenue elements, New Hampshire compares equally or slightly unfavorably to other regions. One additional element in which New Hampshire suffers a discernible disadvantage is its distance to markets. Unlike structural panels (e.g., oriented strand board, plywood), most MDF is used in furniture production, which is concentrated in the southeastern U.S. A New Hampshire facility would incur either a freight penalty to sell into these markets, or an increase in other selling costs to develop and maintain more local markets large enough to consume its full output. Other operating costs in New Hampshire (labor, maintenance, supplies, etc.) are equivalent to or slightly higher than those in other regions of the U.S., and capital costs, adjusted for local variation in labor and material costs, are also quite close to capital costs for plant and equipment construction and installation elsewhere in the U.S.

10.2 Recommendations for Phase III Research

If the results of this analysis do not present a positive outlook for MDF production in New Hampshire, they provide a positive conclusion in another way. Phase I of this project identified MDF, along with co-firing of wood and coal at the PSNH Bow generating facility and retention of the existing base of wood-fired electric plants, as the only potentially viable options available in New Hampshire to sustain low grade wood markets at anything like their current size. This analysis, we believe, has conclusively demonstrated that MDF is ***not***, in fact, a viable option. Meanwhile, recent developments in electricity deregulation and PSNH's interaction with state regulators continue to indicate, equally clearly, that further investigation and encouragement of the co-firing option is not worth pursuing at the present time. This option may merit further assessment when a new owner takes possession of the Bow facility, but this transfer will not occur for three to four years. In the interim, PSNH has no incentive whatever to analyze, much less to implement the co-firing option at Bow, and the State has no leverage to encourage the company to do so.

This combination of conclusions leaves the continued operation of some or all of the existing wood-fired plants – under their current owners or new ownership – as the State's best, indeed its only, practicable option to maintain markets for low grade forest products in the foreseeable future. There is no strong reason for the State not to pursue this option aggressively.

Therefore, we conclude this analysis with the recommendation that resources available for Phase III of the project be directed toward a more authoritative analysis of the conditions under which some or all of the current wood-fired plants can continue to operate following termination of their rate orders, and toward positioning the state to achieve this end result. Specifically, we recommend that Phase III resources be used to pursue three objectives:

1. Find a buyer for the non-operational plants, or for still operating facilities as their current owners move to take them off line;
2. Identify and plan to implement options to reduce costs at the plants;
3. Encourage incentives to improve the economics of biomass-fired electric generation.

10.2.1 Find a Buyer for Existing Wood-Fired Plants

This work would encompass the following tasks:

A. Provide business planning in sufficient detail to allow investors (particularly non-traditional investors) to understand investment opportunity
   - i. Acquire operating cost information from other plants, inserting New Hampshire and New England specific information in appropriate locations
   - ii. Use electricity price forecasts to estimate revenue opportunities
   - iii. Use revenue streams to "back calculate" possible purchase price thresholds, providing information on capital costs that can be absorbed while keeping plants profitable
   - iv. Develop financial statements and business plan information, including inputs, product, markets and competition

B. Identify potential investors and sources of funding for purchase of a plant. In addition to traditional energy investors, explore non-traditional and charitable investors with expressed interest in Northern Forest and local economic development. With each investor / investor type determine:
   - i. What returns they need to consider investment
   - ii. Risk acceptance
   - iii. Current holdings and how they may integrate with wood energy
   - iv. What economic incentives may be necessary in order to attract investment
   - v. Factor in possible cost savings through use of urban wood (below)

10.2.2 Identify and Develop Plans to Implement Options to Reduce Costs

Recognizing that fuel costs are a major component of biomass electricity costs, and that large sources of clean, source-separate wood wastes ("urban wood") may be available to biomass combustion facilities in the Northeast, this work would explore strategies to reduce some fuel costs in order to improve profitability of wood-fired plants operating in competitive market. Specific tasks would include:

i. Determining technical and political thresholds for use of urban wood;
ii. Estimating quantities currently and potentially available to New Hampshire's wood-fired plants;
iii. Exploring sourcing issues;
iv. Estimating costs to bring clean wood to plants;
v. Estimating costs to process wood into form necessary for biomass energy production;
vi. Identifying changes to the plants necessary to use urban wood (e.g. storage area, mixing of fuels, etc.)

10.2.3 Encourage Incentives To Improve The Economics Of Biomass-Fired Generation

This work would pursue two objectives: (1) To analyze and develop information on the federal biomass credit proposed as part of the Bush administration's energy policy; and (2) To develop information that promotes understanding of the comparative benefits of biomass-fueled electricity, as the possible foundation for market-based or policy incentives for biomass electricity production.

A. Investigate and analyze the proposed federal biomass tax credit:

i. Work with state and forestry community to review the proposed tax credit and offer suggestions for improvements
ii. Develop communication material explaining the tax credit and its importance to New Hampshire
iii. Educate congressional delegation, key partners, congressional committees and federal agencies about importance, economic, and environmental benefits of the biomass-fired electricity industry in New Hampshire and elsewhere.

B. Using published sources of information, quantify the value of the environmental and social benefits provided by New Hampshire biomass plants (e.g., climate change, wildlife habitat, emissions, etc.). Where possible, develop comparable information on other energy sources to allow reasonable, fact-based comparison.

Appendix 1

Power Issues for Siting an MDF Plant in NH

Purchased Electricity

Electricity is a major input to the manufacture of MDF, with a 130 MMSF manufacturing facility consuming power equivalent to the output of a 10 MW power plant. For this reason, MDF manufacturing is highly sensitive to electricity rates.

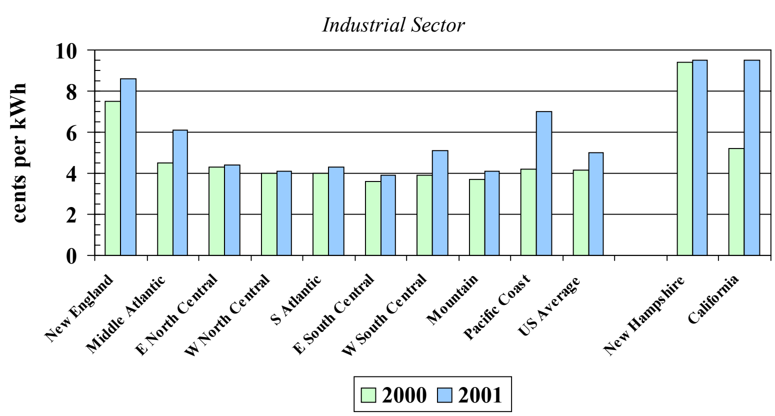
The Northeast, and New Hampshire in particular, is known for high electricity rates. While industrial electricity rates vary in different service territories in the state, and the advent of a restructured marketplace will eventually provide customers the opportunity to secure electricity in the competitive market, the state's industrial rates are high compared with other areas.

According to information provided by the Energy Information Agency, US Department of Energy, the Northeast has higher electricity rates than any other region of the nation for both 2000 and 2001 (predicted, based upon three months information). The Northeast's industrial rates charged to customers are presently predicted to be higher than those in the Pacific and Mountain regions, which have recently received considerable national media attention for high power costs.

Estimated 2000 and 2001 Continental US

Electric Utility Average Revenue per kWh

Source: US Department of Energy, Energy Information Agency

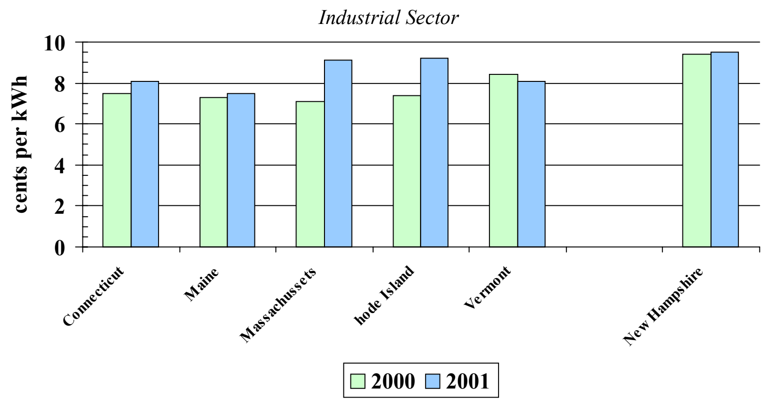


In the Northeast, New Hampshire has the highest average industrial electricity rate in the region. For a large consumer of electricity, this high rate eliminates purchase of power from the electricity grid an option when siting a plant in New Hampshire.

Estimated 2000 and 2001 New England

Electric Utility Average Revenue per kWh

Source: US Department of Energy, Energy Information Agency



Several companies that plan to sell electricity in the competitive marketplace (following the termination of transition service) were contacted to price electricity. While none were willing to provide firm rates for this project, all indicated that $0.050 per kWh of generation was a very optimistic quote for this project. This cost accounts for generation only, and does not include the considerable charges for delivery, stranded costs, systems benefits or the state energy tax. These charges add costs to bring the final cost to consumers to between $0.075 and $0.095, depending upon where in the state a facility is located

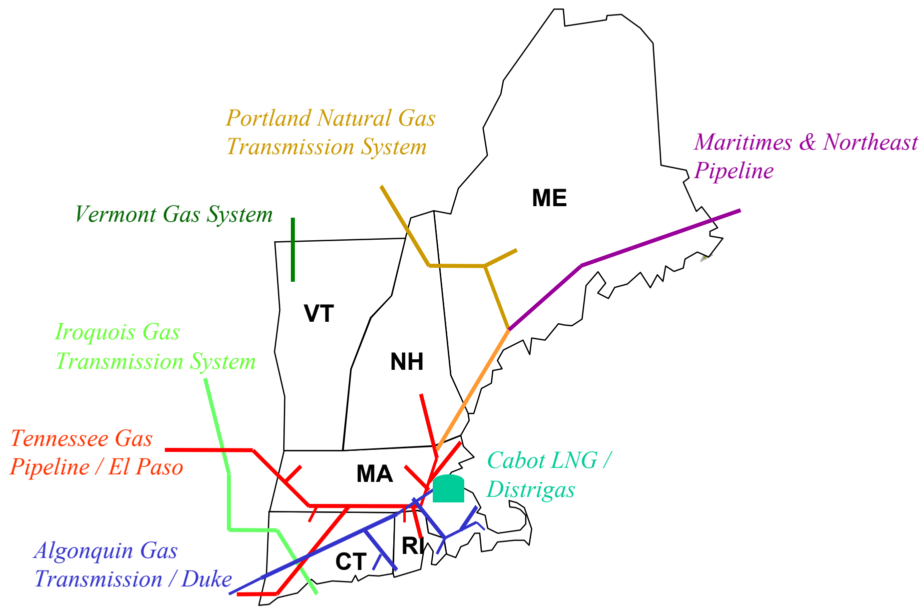
Natural Gas

New Hampshire does have natural gas lines, in the far northern and southwestern parts of the state. Due to the location of the forest resource, and the high costs of transporting wood that is roughly half moisture, these locations are not favorable for siting of an MDF plant.

The Portland Natural Gas Transmission System runs through the northern part of New Hampshire, and provides gas to a number of paper mills in New Hampshire and Maine. This area is not well suited for location of an MDF plant because of the distance to mill residue markets (primarily located in the southern and central part of the state), the nearby competition from pulp and paper mills, the predominance of spruce / fir softwood (undesirable for MDF manufacturing), and the unstable harvest volumes coming from the White Mountain National Forest (three quarters of a million acres of forestland to the south of the pipeline).

A separate natural gas line runs through the southeastern portion of the state. This area is also poorly suited to location of an MDF manufacturing facility, in part because of distance to the resource, but also because of social acceptance. The southeastern portion of the state, including Rockingham and Hillsborough counties, are the most affluent in the state. The economy in these areas is robust, with significant recent growth in high technology and services. In addition to the strong economy in the region, many residents commute to Massachusetts for work, choosing to live in New Hampshire because of its quality of life. If a site large enough for an MDF facility could be found along the natural gas pipeline, it would certainly face very strong local opposition. In addition to local opposition, expenses for a sixty-acre site along a gas pipeline, coupled with increased labor costs, make siting a plant in this area an unattractive proposition.

Location of Natural Gas Pipelines in New England



Wood-fired Generation

Because of the comparatively high cost of electricity in New Hampshire, and because of the factors working against natural gas, we have assumed wood-fired power production for heat and electricity used in the MDF manufacturing process. While this is not the industry norm, the relative price of power in New Hampshire mandates that this be viewed as the best possible solution. Wood-fired generation does occur at some non-structural board plants in North America, but add significant capital costs and operating issues for a manufacturer.

Based upon work in Phase 1 of this project, confirmed through follow-up conversations with individuals presently involved in the wood energy industry, it was assumed that generation of electricity would cost $0.050 per kWh. This accounts for roughly $0.020 in operations and maintenance costs, as well as $0.030 per kWh in fuel costs. Because generation would be on-site, there would be no charges associated with delivery, stranded costs, or systems benefits. The state electricity tax of $0.00055 per kWh would be charged, and the company would have responsibility for reporting of and compliance with this tax.

The electricity cost of $0.05 per kWh does not allocate any money for profit or debt service. Because this plant is dedicated to serving the needs of a manufacturing facility, it does not anticipate profit in the same manner as a stand-alone plant would. Any electricity generated in excess of the needs of the power plant would be sold competitively into the region's electricity grid. Because excess electricity could be generated and sold without adding significantly to operations and maintenance costs, any sales in excess of fuel costs would help contribute to the profitability of the entire operation. However, because of the particular needs of an MDF plant, it would be necessary to construct a new plant, adding very significant capital costs to the overall project. The wood-fired generation would provide the MDF plant with electricity, heat and pollution abatement, making retrofitting an existing plant a highly improbable scenario.

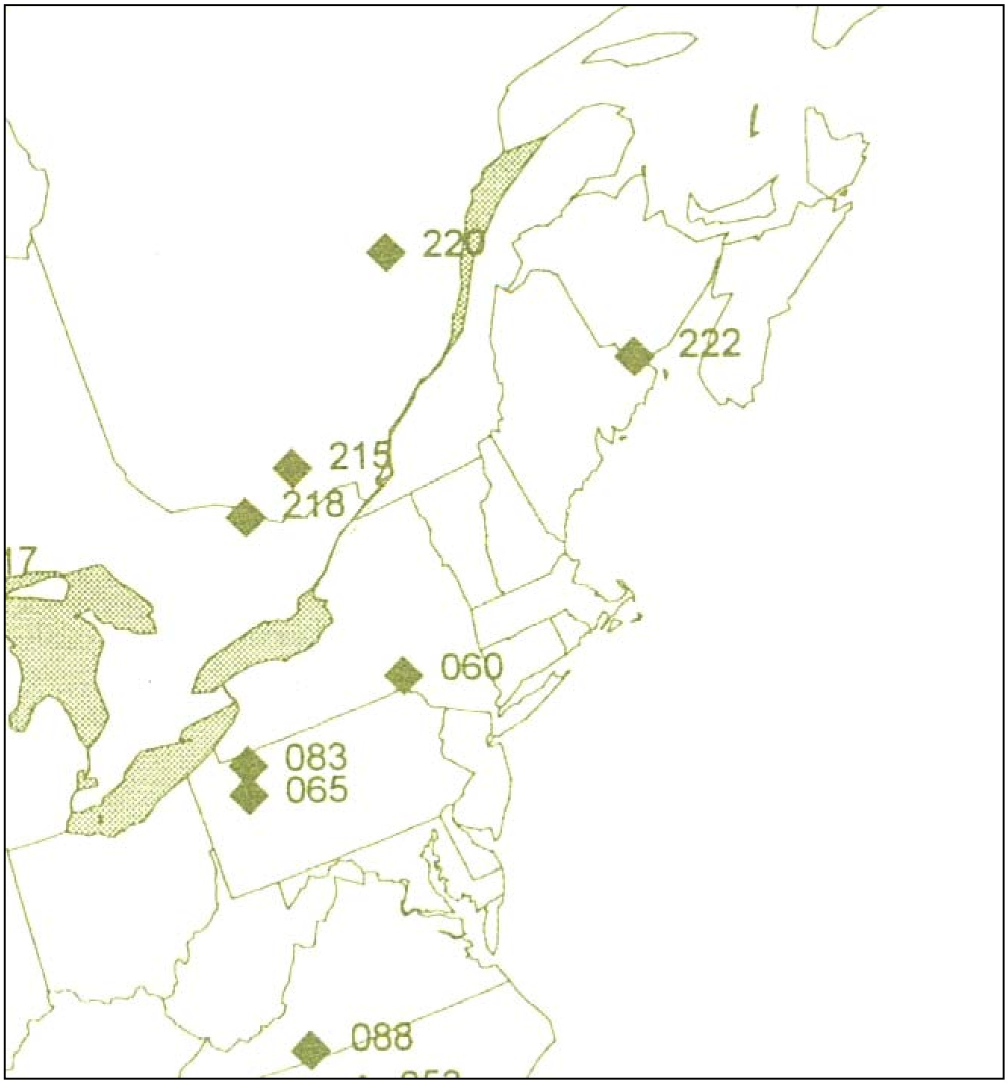
Debt service is not considered independently in this analysis, as the additional cost of a wood-fired power plant is included in the cost of the project. This additional capital investment of almost $22 million decreases the ultimate profitability of the plant.

For this feasibility analysis, it was assumed that a 25 MW plant would be constructed, in order to maximize potential revenues from electricity. This is larger than any current wood-fired power plant in the state, but of a reasonable scale. This size does trigger review by the state's Site Evaluation Committee, and would add delay of roughly one year during the pre-operation period. Because of this delay, anyone seeking to construct such a facility would need to weigh potential revenues from electricity against the desire to begin operations as quickly as possible.

Appendix 2

Location of Medium Density Fiberboard Plants
In States and Provinces surrounding New Hampshire

Source: Composite Panel Association



Appendix 3

The following sawmills were contacted and surveyed as in order to develop accurate information regarding sawmill residue in the region:

New Hampshire

Timco	Barnstead
Chocorua Valley	S Tamworth
International Paper	W Ossipee
Beaman Lumber	Winchester
Monadnock Forest Products	Jaffrey
Tomilla Brothers	Troy
Perras Lumber	Lancaster
Paul Valee Lumber	Berlin
White Mountain Lumber	Berlin
Cersosimo Lumber	Rumney
King Forest Industries	Wenworth
Newman Lumber	Woodsville
Precision Lumber	Wentworth
HG Woods	Bath
Bingham Lumber	Brookline
Durgin & Crowell	New London
Granite State Forest Products	Henniker
HHP, Inc.	Henniker
Three Branches	Plaistow
Middleton Building Supply	Middleton
Chute Lumber	Newport

Vermont

A. Johnson Co.	Bristol
Clair Lanthrop Bandmill, Inc.	Bristol
Eagle Lumber Co.	Stamford
Burke Lumber Co.	West Burke
Buffalo Mountain Lumber	Hardwick
Britton Lumber Co.	Fairlee
Columbia Forest Products	Newport
Mill River Lumber Co.	N. Clarendon
Killington Forest Products	West Rutland
Rutland Plywood Corp.	Rutland
Allard Lumber Co.	Brattleboro
Cersosimo Lumber Co.	Brattleboro
DCI Sawmill	S. Royalton

Massachusetts

Dalton Hardwood	Dalton
Gingras Lumber Co., Inc.	Ashley Falls
Lenox Lumber Co.	Lenox
Bannish Lumber, Inc.	Chester
Hubbard Forest Industries	Royalton
Green Meadow Lumber Co.	Westfield
Berkshire Hardwoods	Chesterfield
Lashway Lumber, Inc.	Williamsburg
Robinson Lumber	Barre

Appendix 4

Forested land in potential procurement area, by county

	Timberland	All Land	% timberland
	000 acres		
New Hampshire			
Belknap	200.9	256.8	78%
Cheshire	366.2	452.8	81%
Grafton	821.1	1,096.6	75%
Hillsborogh	383.0	560.9	68%
Merrimack	474.1	598.1	79%
Sullivan	281.1	344.0	82%
Vermont			
Orange	342.6	440.8	78%
Rutland	472.5	596.6	79%
Windham	436.2	504.8	86%
Windsor	510.5	621.6	82%
Massachusetts			
Franklin	361.5	449.4	80%
Hampden	218.2	395.9	55%
Hampshire	237.8	338.6	70%
Worcester	593.1	968.4	61%
Regional Total	5,698.8	7,625.3	75%

Appendix 5

Volume of wood occurring in selected forest types for potential procurement area, by county

	White Pine / Red Pine	Oak / Pine	Oak / Hickory	Elm / Ash / Red Maple	Northern Hardwoods
	Million Cubic Feet				
New Hampshire					
Belknap	164.1	44.4	78.9	-	93.1
Cheshire	176.0	71.9	198.7	12.8	360.0
Grafton	255.9	25.7	91.4	-	983.1
Hillsborogh	337.3	101.4	192.8	20.9	265.8
Merrimack	335.2	124.2	148.3	8.4	345.1
Sullivan	150.5	13.6	62.4	-	300.7
Vermont					
Orange	210.3	18.5	13.7	-	384.9
Rutland	145.5	10.9	125.3	8.0	508.3
Windham	218.7	13.5	107.2	-	718.3
Windsor	216.5	-	52.2	0.5	752.6
Massachusetts					
Franklin	283.3	-	79.0	-	539.4
Hampden	61.1	56.4	81.0	53.6	203.6
Hampshire	98.3	42.8	110.1	1.8	313.2
Worcester	333.3	129.3	488.6	5.6	308.9
Regional Total	2,986.0	652.6	1,829.6	111.6	6,077.0
• percent	25.6	5.6	15.7	1.0	52.1