

Identifying and Implementing Alternatives to Sustain the Wood-Fired Electricity Generating Industry in New Hampshire

Phase III of a Project

**Developed for the
NH Department of Resources and Economic Development**

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EXECUTIVE SUMMARY

Markets for low-grade wood are a critical cornerstone to New Hampshire's forest products industry, and of its efforts to conserve open space and assure the vibrancy of rural economies. For the past two decades, wood-fired electricity has been a major market for low-grade wood.

But this market may disappear. Of the eight wood-fired generators that have been developed in New Hampshire, two are shuttered, and two have recently negotiated the termination of their guaranteed power purchase contracts, leaving them with an extremely uncertain future attempting to sell power into unregulated electricity markets. Power purchase contracts for the four remaining plants will expire between 2006 and 2008.

This report documents the third phase of a study initiated by the N.H. Department of Resources and Economic Development to identify and begin to develop alternative markets for low-grade wood. Phases 1 and 2 of the study evaluated the technical and economic feasibility of over a dozen possible markets, and reached the following conclusion:

In the foreseeable future, no other market exists to replace wood-fired electricity as an outlet to consume significant volumes of low-grade wood in New Hampshire

Based on this conclusion, Phase 3 of the study, the results of which are presented in this report, has sought to fully document the environmental and economic costs and benefits associated with wood-fired electricity in New Hampshire, and to develop and analyze policy options that the state can employ to sustain this industry and its associated market for low-grade wood.

Markets for Low-Grade Wood in New Hampshire: The Current Situation

Markets for low-grade forest products are critical to the forest products industry and the practice of forestry in New Hampshire. These markets provide an outlet for wood that cannot be used to manufacture lumber, but that are removed during forestry operations to allow other, better quality trees to grow into high value sawlogs. A viable market for low-grade wood serves to enhance the future of the state's forest products industry, allow for the practice of sustainable forest management, and increase the economic viability of privately owned forestland in New Hampshire.

In addition, markets for low-grade wood also provide an outlet for sawmill residue that is generated during the manufacture of lumber. In order to operate economically, sawmills must be able to sell their residues or dispose of them at minimal cost. Markets for low-grade wood that are capable of absorbing these residues are therefore critical to the economic health of New Hampshire's \$475 million sawmill industry.

For the past 20 years there have been two primary markets for low-grade forest products in New Hampshire. The first, which has been a mainstay of New Hampshire's economy for over 100 years, is the pulp and paper industry. Prior to the recent closing of the Pulp and Paper of America mills in Berlin and Gorham, the pulp and paper industry provided a market for approximately 2.8 million tons/year of low-grade wood. Even with the Berlin-Gorham closures, pulp and paper markets are still consuming over 1.5 million tons/year of New Hampshire forest products.

The second major low-grade wood market has been wood-fired electricity. Developed in response to the energy crises of the 1970s, and the soaring fossil fuel and nuclear power costs witnessed in that decade, the wood-fired electricity industry in New Hampshire at its peak included eight operating plants with a total capacity of over 108 megawatts (MW), and generated

about 10% of the electricity consumed in New Hampshire (Table ES-1). The six plants still operating represent 89 MW of generating capacity, and consume some 1.3 million tons per year of low-grade wood.

Table ES-1 New Hampshire Wood-Fired Electric Generating Plants			
Plant and Location	Size (MW)	Annual Wood Consumption (tons/yr)	Status
Bio Energy – Hopkinton	11	146,000	Rate order bought out 11/2001; expects to continue operating after buyout
Bridgewater Power – Bridgewater	15	229,000	Rate order expires 8/31/2007
Hemphill Power & Light – Springfield	13.8	208,000	Rate order expires 11/30/2007
Pinetree Power – Bethlehem	15	227,000	Rate order expires 11/30/2006
Pinetree Power – Tamworth	20	286,000	Rate order expires 3/31/2008
Whitefield Power & Light – Whitefield	13.8	187,000	Rate order bought out 11/2001; expects to continue operating for 1-3 years
Alexandria Power – Alexandria (CLOSED)	15	225,000	Rate order bought out mid-1994; restrictions on future power sales
Timco – Pittsfield (CLOSED)	4	55,000	Rate order bought out 1994; restrictions on future power sales

As electricity prices declined during the 1990s, however, these plants became expensive sources of electricity. The prices reflected in their “rate orders” (contracts that guarantee purchase of their power at predetermined prices) are now two to three times higher than the market rate for electric power in the Northeast, and have contributed in part to the very high rates paid by electricity consumers in New Hampshire.

The New Hampshire Public Utilities Commission (NHPUC) approved the termination of the rate orders for two of the wood-fired plants in 1994. The six remaining plants have continued to consume about 1.3 million tons of low-grade wood each year. In late 2001, the NHPUC approved rate order termination for two more plants – Bio Energy in Hopkinton and Whitefield Power & Light in Whitefield. Although both plants are expected to continue to operate for some period, the likelihood of their long-term operation is in doubt, as is the operation of the remaining four plants after termination of their rate orders beginning in 2006.

The state therefore faces the likely loss of what has been a critical market for low-grade wood and sawmill residues, one using locally grown and produced fuel. The loss of the Alexandria and Timco plants reduced this market by about 300,000 tons per year in the mid-1990’s. Closure of the Bio Energy and Whitefield plants will reduce this market by an additional 300,000 tons/year. The probable closure of the remaining wood-energy plants beginning in 2006 will eliminate the market entirely, with serious consequences for good forest management in New Hampshire, for the state’s forest management and logging economy, and for the state’s vibrant sawmill industry.

Alternative Markets for Low-Grade Wood

This study was initiated by the N.H. Department of Resources and Economic Development to attempt to identify and begin to develop alternative markets for low-grade forest products and sawmill residues in New Hampshire. This analysis has proceeded in three phases.

Phase 1 of the study assessed a total of thirteen alternative markets for low-grade wood, evaluating them against criteria related to their technical and economic feasibility, and their capability to absorb a large fraction of the low-grade wood that can be expected to come onto the market with closure of the wood-fired power plants. This work was documented in the *Phase I Final Report: Use of Low-grade and Underutilized Wood Resources in New Hampshire* (NH Dept of Resources and Economic Development, January 2001, http://www.nhdf.com/publications/div_publications.htm). Phase 1 concluded that of all alternative markets identified, Medium Density Fiberboard (a nonstructural composite wood-resin panel that can be manufactured from roundwood and mill residues) represented the best and economically most feasible option to replace wood-fired electricity as a major market for low-grade wood in New Hampshire.

Phase 2 of the study comprised a detailed feasibility assessment for Medium Density Fiberboard (MDF). Its goal was to provide economic and technical analysis in sufficient detail to support efforts to attract an MDF manufacturer to locate in New Hampshire. This work is documented in *Phase II of a Project: Feasibility Analysis of Medium Density Fiberboard Manufacturing in New Hampshire* (NH Dept of Resources and Economic Development, July 2001). Phase 2 concluded that, while MDF will continue to enjoy rapid growth in the U.S. and Canada, and while New Hampshire's forest resources are clearly capable of supporting MDF production, New Hampshire is unlikely to attract an MDF manufacturer to locate in the state. There are three major, and ultimately insurmountable, barriers:

- 1) Raw material costs, which in New Hampshire are about 20% higher than whole-tree chip and residue costs elsewhere in the U.S. and Canada;
- 2) High electricity costs; and
- 3) Excessive distance to MDF markets.

Combined, the results of Phases 1 and 2 of the analysis generated a clear conclusion: In the foreseeable future, no other market exists to replace wood-fired electricity as an outlet to consume low-grade wood in New Hampshire.

This conclusion formed the basis for the work carried out in Phase 3, which has sought to document the costs and benefits of wood-fired electricity to New Hampshire's economy and environment, to document the types and amounts of economic or other assistance that might be required to sustain the industry, and to develop and analyze policy options that the state can employ to sustain this industry and its associated market for low-grade wood

Economic Benefits of Wood-fired Power in New Hampshire

Direct Economic Impacts: The direct economic impact of the six operating wood-fired power plants is approximately \$38,300,000 per year. This value reflects the payments made and jobs created directly as a result of spending by the six plants. It does not encompass the impact this spending has through suppliers to the wood-energy facilities, or to the secondary economic activity this spending generates. Direct economic impacts are as follows (Table ES-2):

Table ES-2		
Direct Annual Economic Impact of Six Wood-Fired Generating Plants		
Item	Description	Annual Impact
Employment	The six plants employ an estimated 116 individuals, including wood handling staff, three-shift production staff, plant management, and support personnel. With direct support for procurement, total employment is estimated at 125.	
Payroll	The estimated average compensation package of all plant personnel, including wages and benefits, is \$45,000 per year.	\$5,850,000
Property Taxes	The plants currently each pay approximately \$200,000 per year in property taxes (or local payments in lieu of taxes).	1,350,000
Maintenance	The plants spend an average of approximately \$350,000 per year in this category	2,100,000
Utilities, Supplies, Services, Other	Utilities (water, sewer, electricity), legal and accounting services, taxes other than property taxes, insurance, and other costs average approximately \$825,000/plant/year.	4,950,000
Fuel	Wood chips are the largest single expense for all of the wood-fired plants. The 1.3 million tons they collectively procure come at an average delivered cost of approximately \$18.00/ton.	24,300,000
Total Direct Impact of Six Wood-Fired Plants		\$38,550,000

Total Economic Impacts: The total economic impact of an industry sector is the sum of its direct and indirect impacts on the local economy. Indirect impacts encompass the expenditure of money by suppliers as the result of their relationship with the plants, as well as the impact of this spending circulating in the local economy. It is estimated using a “multiplier” which captures the total circulation of money in the economy as a result of expenditures by a firm.

Two multipliers were used to approximate the total economic impact of wood-fired power production in New Hampshire. A multiplier of 1.84 was used with all non-fuel related expenditures (wages and salaries, utilities, taxes, parts and supplies, etc.). A multiplier of 2.95 was used for fuel purchases, reflecting the fact that wood chip production is a labor-intensive activity with high employment and its associated direct benefits. Multiplying these values by their associated direct expenditures, the total economic impact of wood-fired electricity in New Hampshire is estimated to equal approximately \$96,000,000. Roughly \$70,000,000 of this total is associated with wood chip procurement, and \$26,000,000 is associated with direct plant operations.

Importance of Wood-fired Power to the New Hampshire Forest Industry

New Hampshire’s forest industry is the third largest sector of the state’s manufacturing economy in terms of value of shipments, and fourth largest in terms of employment and payroll. It includes over thirty thousand private landowners with ten or more acres -- owning roughly four million

acres of forestland (or nearly two-thirds of the state's land area), an estimated 1,400 loggers, over 300 licensed foresters, roughly 100 sawmills, three major paper mills and six wood-fired power plants. Its importance is magnified by the fact that forest industries are located predominantly in rural areas of the state, where other industries often do not have a significant presence.

Strong markets for low-grade wood are critical to every sector of this industry. If these markets are allowed to disappear, the impacts will be felt not just in the forest industry, but throughout all sectors of New Hampshire's economy that rely directly or indirectly on the state's forest resources.

Impact on Timber Sales: A surplus of commercially undesirable species and low quality trees exists in New Hampshire's forests. Analysis by the State's Division of Forests and Lands indicates that 37%-44% of the standing timber volume in the state is "low-grade."

Low-grade wood is removed during every timber harvest in the state. Depending on stand quality and management objectives, the proportion of low-grade wood ranges between about 20% and 80% of all timber cut. It is critical that landowners have markets for this wood. Most of the value in timber harvesting comes from sawlogs and veneer. If markets for low-grade wood are not available, one of two outcomes will result.

- Landowners and loggers can choose to "high grade" their stands, harvesting the high-value saw and veneer logs and leaving the low-grade timber on the stump. This practice results in rapid deterioration of stand quality, reducing the value of all future timber sales.
- Alternatively, landowners can choose to defer timber harvests until low-grade markets rebound. This practice has the immediate impact of eliminating forest-related employment and income, and the equally serious impact of reducing the supply of quality saw and veneer logs for the state's sawmills.

There is strong evidence that the state is already witnessing both of these outcomes as a result of the Berlin-Gorham mill closures and the uncertainty of the market represented by wood-fired power.

Loss of Open Space: The ability of individuals and firms to own and manage land for the long term is the cornerstone of New Hampshire's land conservation efforts. If landowners are unable to derive long-term value from management for forest products, the economic pressure to derive value from other uses may, over time, become unbearable, and New Hampshire may witness increasingly rapid loss and development for other purposes of its forested land area. Once again, the ability to manage for long-term value hinges on the ability to remove low-grade timber at each harvest, thereby improving stand quality and increasing the expected economic returns from future harvests.

Reduction in Property Values. The limitation on returns to forest management will also be reflected in declining property values for forested land, another factor that may promote conversion to other uses. The state has already witnessed this economic impact, in the International Paper lands in northern New Hampshire. According to the Trust for Public Lands (the anticipated interim buyer of the parcel), the value of the International Paper land has been reduced by millions of dollars – perhaps \$6.00 to \$18.00 per acre – because of the loss of the Berlin pulpwood market coupled with the uncertainty regarding other long-term markets for low-grade wood.

Loss of Logging Infrastructure and Employment. Loss of low-grade markets and the associated deferral of many logging operations have the direct and immediate impact of eliminating logging

jobs and capabilities. Sawmill operators contacted during this study report that this has already occurred in response to the Berlin-Gorham mill closures, with the shutdown of a number of logging firms statewide, including several large, established operations.

Impacts on Sawmill Procurement: New Hampshire's sawmill industry has witnessed strong growth in recent years, partly as a result of the forestry practices encouraged by existence of the wood-fired plants and other low-grade markets. The loss of low-grade wood markets will jeopardize this trend. In fact, the loss of low-grade markets has already been felt.

There are two principal short-term impacts on the state's sawmills. First, as landowners and loggers scale back harvest schedules, fewer sawlogs are coming on the market. Mills are facing a shortage of logs, and are forced to pay higher prices for the logs that do come onto market. Production cutbacks and reduced profits are the result. Second, mills are seeing more and more logs that do not meet quality specifications, as loggers attempt to dump low-quality stems that would typically go into low-grade markets. Mill profits are reduced either if the mill owner chooses to accept and saw these logs, or if he has to spend additional time sorting incoming loads and disposing of rejected logs.

In the longer term, potential impacts on the sawmill industry are even more severe. A landowner's ability to manage for the future production of quality sawlogs is dependent on having current markets for low-grade timber. If low-grade markets disappear, the viability of New Hampshire's sawmill industry will be jeopardized.

Loss of Markets for Sawmill Residues: Sawmills also rely on pulp mills and wood-energy facilities to dispose of the chips that are a byproduct of lumber manufacture. Sawmills cannot afford to dispose of these materials as a waste, with associated tipping fees, and so are absolutely reliant on the continuing existence of markets where they can dispose of chips at no cost or for a small positive return. In the short term, the loss of the Berlin pulp mill has made the existing wood-energy market even more important. And the current Berlin situation is a likely harbinger of things to come. With pulp mill demand on a regional basis unlikely to show any positive growth, the wood-energy market for mill residues will remain critical to the economic viability of New Hampshire's sawmills.

Environmental Impacts of Wood-fired Power

An important issue regarding wood-fired electricity is its environmental comparison with other forms of electricity production. Among the key areas of comparison are the following:

Sulfur Dioxide (SO₂) Emissions: Emissions from wood-fired electricity (expressed on a per kilowatt-hour basis) are several orders of magnitude less than emissions from New Hampshire's coal- or oil-fired generating plants (less than 0.0002 lbs/kWh, compared to 0.01 to 0.025 lbs/kWh for coal and oil).

Nitrogen Oxides (NO_x) Emissions: Emissions from wood-fired electricity are equivalent to emissions from coal- and oil-fired plants (approximately 0.0003 to 0.0004 lbs/kWh).

Mercury Emissions: Based on best available estimates, mercury emissions from wood-fired power (on a per kilowatt-hour basis) are about one-tenth as large as emissions from coal-fired electricity, and roughly equivalent to emissions from oil-fired power.

Dioxin Emissions: The February 2001 *New Hampshire Dioxin Reduction Strategy* identified wood-fired boilers, particularly wood-fired electricity generators, as major sources of dioxin emissions in the state. Because no stack testing for dioxin had been conducted in New Hampshire at the time, DES used generic emission models based on 1980's California biomass plants to reach this conclusion. Subsequently, stack testing at one of New Hampshire's wood-energy plants has documented dioxin emissions much less than the rates postulated by DES, and other evidence (e.g., stack tests from other plants outside of New Hampshire) also suggests that actual dioxin emissions are far less than those presented in the original DES report. Recognizing this fact, DES now hopes to sanction additional testing at New Hampshire facilities, and will re-evaluate the conclusions of its *Dioxin Reduction Strategy* as appropriate.

Greenhouse Gas Emission / Climate Change: Biomass energy can play an important role in reducing greenhouse gas emissions. All fuels burned to produce electricity produce carbon emissions (30 to 50 pounds of carbon per million Btu of fuel consumed). But with wood-fired power, the carbon sequestered in biomass growth balances carbon emissions, and the net greenhouse gas impact of biomass electricity production is zero. According to a climate change action plan developed by the State of Maine, encouraging renewable power and promoting sustainable forest management (also a benefit of wood-fired electricity) are two of the most effective state-level actions that can be taken to address climate change.

Sustainable Forest Management: As noted above, the wood-fired electricity industry is a cornerstone of sustainable forest management in New Hampshire. Supported by the low-grade wood markets represented by wood-fired power, the State can promote and reap benefits from sustainable forestry initiatives that stretch into the indefinite future. Absent this market, the capability to support sustainable forestry practices in New Hampshire becomes problematic.

Energy Sustainability: Equally important, wood-fired electricity is a permanently sustainable energy source. Properly managed, New Hampshire's forests can provide a source of energy (as well as high value-added forest products) for the indefinite future. This promise is in stark contrast to the outlook for all forms of fossil fuel-fired electricity production, which represent a one-time use of irreplaceable resources. The extractive technologies used to provide coal, oil, and natural gas also have significant environmental impacts (which are masked only by the fact that they occur in locations far from New Hampshire).

Financial Projections for Wood-fired Power in New Hampshire

The most crucial question regarding the future of wood-fired power in New England is whether wood-fired plants can operate profitably selling power in an unregulated market. If they can, then little or no policy intervention may be required to promote their continued operation. If they cannot, then it may be imperative to identify and implement policies to assure that they continue to operate.

Figure ES-1 provides a summary profit and loss projection for a "generic" wood-fired electric generating plant in New Hampshire. This is a 15 MW plant operating at a 95% annual capacity factor (New Hampshire's six operating plants have capacities of 11, 13.8, 13.8, 15, 15, and 20 MW – see above). Because none of New Hampshire's plants has publicly divulged its detailed operating cost information, this projection has been developed based on information gathered from similar plants in other jurisdictions, limited information that has been released by the New Hampshire plants or is otherwise available in the public record, and contacts with individuals knowledgeable about wood-fired plant operations in this state.

Among the critical assumptions underlying the projections in Figure ES-1 are

- Electricity sales revenues of \$0.04/kWh. This is based on recent and current (1999-2001) open market sales data in New England, and projections from the U.S. Energy Information Administration
- A “base case” fuel price of \$18.00/ton, which reflects the mean statewide average for whole-tree chips delivered to wood-fired plants over the past several years.
- Capital costs based on purchase of an existing plant for \$2.5 million, amortized over 10 years at a 7% interest rate.

Items such as labor force, labor costs, and property taxes are based on New Hampshire data.

Figure ES-1					
Pro Forma Profit and Loss Projection, 15 MW Wood-Fired Electric Generating Plant in New Hampshire, Base Case					
			Total	\$/kWh	Percent
REVENUES					
Revenues from electricity sales					
	KWh	Price			
	125,000,000	\$0.040	\$5,000,000	\$0.0400	100.00%
COST OF GOODS SOLD					
	Fuel Tons	Price			
	225,000	\$18.00	4,050,000	0.0324	81.00%
	Production Labor (fully loaded)		693,750	0.0056	13.88%
	Utilities (production)		300,000	0.0024	6.00%
	Maintenance		350,000	0.0028	7.00%
	TOTAL COST OF GOODS SOLD		5,393,750	0.0432	107.88%
GROSS PROFIT			(393,750)	(0.0032)	-7.88%
EXPENSES					
OPERATING EXPENSES					
	Non-Production Labor (loaded)		281,250	0.0023	5.63%
	Utilities (non-production)		125,000	0.0010	2.50%
	Property Taxes		225,000	0.0018	4.50%
	Supplies and Services		400,000	0.0032	8.00%
	Total Operating Expenses		1,031,250	0.0083	20.63%
OTHER EXPENSES					
	Principal and Interest		355,944	0.0028	7.12%
	Income & Other Taxes				
	Total Other Expenses		355,944	0.0028	7.12%
	TOTAL OP. AND OTHER EXPENSES		1,387,194	0.0111	27.74%
NET PROFIT			(1,780,944)	(0.0142)	-35.62%

For a plant typical of the six operating wood-fired facilities in New Hampshire, Figure ES-1 projects total costs to generate wood-fired electricity of approximately \$0.0542 per kilowatt-hour

(with minimal debt service and no profit). Against projected sales revenues of \$0.04 per kilowatt-hour, this cost structure implies that wood-fired electricity can be produced in New Hampshire at a *deficit* of approximately 1.4 cents per kilowatt-hour, or a net operating loss of approximately \$1.8 million per year for a plant that generates 125 million kilowatt-hours annually.

Sensitivity to Economic Variables. Tables ES-3, ES-4, and ES-5 present the sensitivity of plant profit and loss projections to the three major variables potentially subject to public policy intervention:

- Electricity sales price (Table ES-3): Each one-half cent increase in electricity price equates to \$625,000 in additional revenues, and the “generic” plant breaks even at an electricity sales price of \$0.0542/kWh.
- Fuel cost (Table ES-4): Each one-dollar reduction in the net delivered price of fuel to a wood-fired plant results in an increase of approximately \$225,000 in revenues. With all other costs and revenues held constant, a plant would break even with a wood cost of \$10.08/ton.
- Capital cost (Table ES-5): Using a 10-year amortization period and a 7% interest rate, each \$1.0 million increase or decrease in the capital cost generates a \$142,000 impact on annual profit or loss. Under the base case scenario, a plant would operate at a deficit of over \$1.4 million per year even if its capital cost was reduced to zero.

Table ES-3							
Sensitivity of Wood-Fired Electricity Annual Profit (Loss) to Electricity Sales Price							
	Sales Price of Electricity (\$/kWh)						
	\$0.040	\$0.045	\$0.050	\$0.055	\$0.060	\$0.065	\$0.070
Plant Profit or (Loss)	(1,780,944)	(1,155,944)	(530,944)	94,056	719,056	1,344,056	1,969,056

Table ES-4								
Sensitivity of Wood-Fired Electricity Annual Profit (Loss) to Fuel Cost								
	Cost of Wood Chip Fuel (\$/Ton)							
	12.00	\$13.00	\$14.00	\$15.00	\$16.00	\$17.00	\$18.00	\$19.00
Plant Profit or (Loss)	(430,944)	(655,944)	(880,944)	(1,105,944)	(1,330,944)	(1,555,944)	(1,780,944)	(2,005,944)

Table ES-5								
Sensitivity of Wood-Fired Electricity Annual Profit (Loss) to Capital Cost of Plant Purchase								
	Capital Cost of Plant (Million \$\$)							
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5
Profit or (Loss)	(1,425,000)	(1,496,189)	(1,567,378)	(1,638,566)	(1,709,755)	(1,780,944)	(1,852,133)	(1,923,321)

These results imply that the most effective policies to improve the prospects for sustaining New Hampshire’s wood-fired generating industry will be directed to increasing the revenues received from electricity sales, or to decreasing the cost of fuel. Policies intended to reduce the costs of acquiring and owning wood-fired generating capacity will have much less impact on the financial viability of the industry.

Benefit: Cost Assessment of Sustaining the State's Wood-fired Energy Industry

The financial projections presented in Figure ES-1 imply that, in an entirely unregulated market, a single wood-fired plant typical of those in New Hampshire would operate at an annual deficit of approximately \$1.8 million. As a first order approximation, therefore, the “above market” financial assistance required to keep this industry alive in New Hampshire is approximately \$10.8 million per year – \$1.8 million/year for each of six plants.

The benefits of this assistance far outweigh the cost. The direct economic benefits of wood-fired power in New Hampshire are approximately \$38,550,000 per year, yielding a benefit:cost ratio of 3.6:1. The total benefits of the industry, conservatively estimated, are approximately \$95,000,000 per year, yielding a benefit: cost ratio of 8.9:1. The number of jobs directly supported by the industry is approximately 500 – about 125 directly employed by the plants, and some 375 employed in New Hampshire's logging industry to provide the 1.3 million tons of raw materials consumed by the plants.

This study has not attempted to quantify in monetary terms the benefits of wood-fired power in other areas, but they are large and manifold – in forest management benefits, conservation of open space, and direct benefits to New Hampshire's \$475 million per year sawmill industry. Nor has this study attempted to attach monetary value to environmental benefits associated with energy sustainability, greenhouse gas reduction, and reduction in other emissions. But clearly, these add to the already large multiplier by which the benefits of wood-fired power outweigh whatever costs would be involved to keep the industry functioning.

Policies to Promote Continued Production of Wood-fired Power

Ten potential policies are available to promote the continued viability of New Hampshire's wood-fired power industry (Table ES-6). They fall into two general categories: (1) Policies that tend to assure that prices paid for wood fired power are sufficient to allow continued operation of the industry; and (2) Policies that reduce the cost of fuel for the plants. These policies can also be differentiated by whether they are planned and implemented at the state or federal level.

Table ES-6 Overview of Policies to Promote Continued Production of Wood-Fired Power		
Level of Implementation	Policy Goal	
	Assure Price Paid for Output is Sufficient for Continued Operation	Reduce Fuel Costs
State Government	1. Renewable Energy Portfolio Standard 2. System Benefits Charge 3. State Tax Subsidy 4. Promotion of “Green Power” Marketing	7. Subsidy to Whole Tree Chip Purchases 8. Prohibition of Open Burning of Clean Wood Waste 9. Disposal Ban on Clean Wood Waste 10. Promotion of Regional Policies to Capture Clean Wood
Federal Government	5. \$0.015/kWh Federal Income Tax Incentive 6. \$0.015/kWh Federal Incentive Payment to Qualifying Wood-Energy Generators	

At least six policies could be implemented that would have the direct or indirect impact of increasing the price paid to the plants for their output. Four of these are policies that can be implemented at the state level. Two are policies that rely on federal action, but are based on legislation already under consideration by the U.S. Congress. In these cases, the state could take action through its Congressional delegation to help assure their ultimate passage in a form that will assist New Hampshire’s wood-fired power industry.

1. Renewable Energy Portfolio Standards (RPS). This is a state-implemented regulatory requirement that any firm selling electricity to consumers in New Hampshire must derive a proportion of that electricity from renewable sources. It has been considered in a number of states, and RPS legislation was introduced in the New Hampshire House in 2001 (although it now appears unlikely to be considered as originally introduced). An RPS could probably be structured that assures continued operation of New Hampshire’s wood-fired power industry with a ratepayer impact of about \$0.002 per kilowatt-hour, or about 2% of current electricity rates.

Advantages of this option are its simplicity, ease of verification, negligible oversight requirements, and minimal ratepayer impact. It’s principal disadvantage is that, unless carefully crafted, it might not provide sufficient assurance of an income stream to stimulate long-term investment in wood-fired power.

2. System Benefits Charge. A System Benefits Charge (SBC) is a per kilowatt-hour surcharge on electricity rates designed to fund “public benefit programs”, which could include wood-fired power. An SBC directed to sustaining the wood-fired industry could be implemented through legislation and regulatory action by the NH PUC. An SBC sufficient to maintain the state’s wood-fired power industry would probably have a ratepayer impact of \$0.0015 to \$0.0020 per kilowatt-hour, or about 1.5-2% of current electricity rates.

Advantages of this option are its simplicity and flexibility, and the fact that it can be tuned over time to provide a prescribed level of profit to the wood-fired plants. This is also a principal disadvantage, in that the SBC demands ongoing regulatory review of the wood plants' profit-and-loss statements to assure that the SBC is neither too high (generating excess profits) nor too low (jeopardizing continued operation). An SBC also amounts to a direct subsidy of wood-fired power, unlikely to gain wide support in New Hampshire.

- 3. State Tax Subsidy to Wood-Fired Electricity.** The simplest of several possible state tax-based subsidies would: 1) Mandate purchase by utilities of wood-fired power, at a price sufficient to keep wood-fired plants in operation; 2) Calculate the excess price paid by utilities for wood-fired power compared to the open market price otherwise paid for the same amount of electricity; 3) Reduce utilities' state tax liability (Business Profits Tax or other tax) by a sum equivalent to all or a fraction of excess payments to wood-fired generators.

An advantage of this option is that it spreads the cost of keeping a viable wood-fired power industry over all taxpayers in the state. Its multiple disadvantages include administrative complexity and cost, the fact that it supports wood-fired power at the expense of general fund revenues, and the fact that none or only a few of the wood-fired plants are likely to generate sufficient profits in an unregulated market to take advantage of the subsidy.

- 4. Non-Regulatory Incentives to Promote Marketing of "Green Power".** Electricity providers would be required to offer "packages" that include wood-fired electricity, along with packages that do not include wood-fired electricity. Green power would be promoted to consumers, who would have the choice of selecting green power from among other options offered.

The major advantage of this option is its market basis – wood-fired power would be supported by those who believe in its value, and would not have to be supported by those who do not. The major disadvantage is that this is unlikely to keep New Hampshire's wood-fired power industry alive. In jurisdictions where it has been implemented, green power marketing has attracted only a few percent of electricity customers, and there is no evidence to suggest that sufficient demand would be generated in New Hampshire to sustain the wood-fired power industry.

- 5. Federal Tax Incentive for Qualifying Renewable Resources.** The U.S. Congress will take up legislation in 2002 that will include a \$0.015/kWh credit against federal income taxes for new or existing wood-fired power plants.

Implementation of this option will require passage of federal legislation, and New Hampshire can influence this outcome only by working through its Congressional delegation. If passed, however, this option offers significant support for New Hampshire's wood-fired power industry, probably sufficient to keep most or all of its plants operational, at little to New Hampshire or its ratepayers since the tax credit would be paid for at the federal level.

- 6. Federal Direct Payment Incentive for Qualifying Renewable Resources.** Energy legislation passed by the U.S. House of Representatives (the Securing America's Future Energy [SAFE] Act of 2001) includes a \$0.015/kwh subsidy through 2023 for biomass-generated electricity from facilities owned by non-profit cooperatives, state or municipal governments, and certain other non-utility owners.

The principal disadvantage of this legislation is its limitation to plants under a narrow range of ownership structures, none of which are currently in place in New Hampshire. It is likely, however, that qualifying ownership entities could be organized to take over at least a subset of New Hampshire's wood-fired plants as their rate orders expire or are bought out. This

option is also subject to annual Congressional appropriation, and there is no guarantee that appropriations would be sufficient to sustain payments to New Hampshire plants.

Of the four policies that are available to reduce fuel costs for wood-fired power, three can be implemented by independent state action in New Hampshire, while the fourth would require coordinated action by a number of states.

7. *Subsidy to Whole Tree Chip Purchases.* The State could reduce the cost of fuel to wood-fired power plants by providing direct payments either to the plants or to loggers, with the goal of bringing the cost of fuel into the range that allows breakeven or profitable production of wood-fired power.

An advantage of this option is that it provides support to New Hampshire's loggers, who are the foundation of the state's entire forest products industry. Significant disadvantages include administrative complexity, the need to continually re-evaluate the appropriate level of subsidy, and the difficult issue of identifying a funding source for such a subsidy.

8. *Prohibition of Open Burning of Clean Wood Waste in New Hampshire.* According to the N.H. Department of Environmental Services (DES), over 100 of New Hampshire's 223 municipalities continue to burn clean wood waste in open burn piles. If this practice were prohibited, this wood could become a low-cost source of fuel for wood-fired power plants. Legislation and regulation would be required to achieve this end, potentially including new regulation that would sanction the combustion of municipal wood waste at wood-energy facilities.

This option could simultaneously generate low-cost fuel for wood-fired power, and eliminate the environmental impacts associated with open burning. It could be complex and expensive to implement, however, and might run afoul of the State's prohibition of unfunded municipal mandates.

9. *Disposal Ban on Clean Wood Waste.* It is estimated that clean wood waste from pallets plus construction and renovation activities could provide 10% or more of the fuel required for wood-fired power generation at current levels. Banning disposal of clean wood from these sources could simultaneously reduce by several percent the volume of waste landfilled in New Hampshire, and provide a source of low-cost fuel for wood-fired power. Legislation and implementing regulations would be required.

Conservation and re-use of an in-state resource that is currently wasted is the principal advantage of this option. Cost, the complexity of sourcing materials from thousands of job sites, and concern about its ultimate effectiveness are major disadvantages.

10. *Promotion Of Regional Policies To Capture Clean Wood Waste.* States throughout the Northeast face common problems related to high tipping fees for waste disposal. Clean construction and renovation wastes, plus manufactured items such as pallets, represent a significant component of the waste stream that could be captured and used for energy production. New Hampshire could work in concert with other states to promote policies to divert clean wood from disposal, with states such as Connecticut and Massachusetts as major sources of such materials, and New Hampshire's wood-fired power plants as a market.

This may be a viable and valuable long-term strategy, but its complexity and the need for significant interstate coordination suggest that it is unlikely to be capable of having an impact on New Hampshire's wood-fired industry in the short- to mid-term.

Conclusions and Recommendations

The principal conclusion of this analysis is clear:

The benefits of maintaining the wood-fired power industry in New Hampshire outweigh the costs of any direct support required to achieve this goal by a factor far greater than ten-to-one.

Among possible policies to support wood-fired electricity, four stand out as the most practicable, least cost options to assure the future viability of wood-fired power in New Hampshire. These are:

Renewable Energy Portfolio Standards. This has the significant advantages that it can be implemented at the state level, that it is straightforward and simple to implement and monitor, and that it relies on market forces to establish the price paid to sustain the wood-fired power industry in New Hampshire.

Federal Tax Incentive for Qualifying Renewable Resources. New Hampshire policy makers should work with the State's Congressional delegation to assure implementation of this option, which has the significant advantage that it would support New Hampshire's wood-fired power industry as part of a coordinated national policy to sustain renewable energy.

Federal Direct Payment Incentive for Qualifying Renewable Resources. This is another policy that would integrate New Hampshire policy goals with national energy policy. The cooperative ownership structures encouraged by this policy might also provide a means to unify multiple partners from New Hampshire's forest industry to support wood-fired power as a vital component of the state's forest-based economy.

Prohibition of Open Burning of Clean Wood Waste in New Hampshire. This option, on its own, is not likely to provide sufficient support to sustain the wood-fired power industry in New Hampshire. But it would reduce the amount of support required from other sources, would provide demonstrable environmental benefits in eliminating uncontrolled combustion of a valuable fuel resource, and would provide an immediate demonstration of the State's commitment to assist the wood-fired power industry through sensible policy options.

In the longer term, another attractive policy option is to support regional policies that prohibit disposal of clean wood wastes, with New Hampshire's wood-fired plants serving as a market for wood fuel generated throughout New England. Because of its complexity, however, this option is not capable of immediate impact on the wood-fired power industry.

SECTION ONE

INTRODUCTION

1.1 Current Situation

Markets for low-grade and underutilized wood are critical to the practice of good forestry and the efficient operation of the forest products industry in New Hampshire. These markets provide an outlet for wood that cannot be used for the manufacture of lumber, but that are removed during forestry operations to allow other, better quality trees to grow into high value sawlogs. A viable market for low-grade wood enhances the future of the state's forest products industry, allows for the practice of sustainable forest management, and increase the economic viability of privately owned forestland in New Hampshire.

Additionally, markets for low-grade wood also provide an outlet for sawmill residue that is generated during the manufacture of lumber. Sawmills in New Hampshire generate between 400,000 and 600,000 tons of residue annually. In order to operate efficiently and economically, sawmills must be able to sell this residue or landfill it. In this respect, low-grade markets also serve as a critical component of the state's robust and growing sawmill industry.

The importance of markets for low-grade wood has been recognized in New Hampshire public policy for decades. Most recently this has been noted in the New Hampshire Forest Resource Plan (1996), Good Forestry in the Granite State (1997), the Final Report of Governor Shaheen's Forest Industry Task Force (1997), and legislation regarding the state's wood-to-energy facilities.

Traditional markets for low-grade wood and sawmill chips include pulp and paper manufacturing and, for the past two decades, wood-fired power plants.

The manufacture of pulp and paper has long been an anchor of New Hampshire's forest industry, and provides a market for an estimated 2.8 million tons of low-grade wood from New Hampshire each year. Until recently, Pulp and Paper of America's mills in Berlin and Gorham accounted for over 40% of this total. These mills are presently idled, the owner of the mills – American Tissue Company – is in bankruptcy proceedings, and their future is uncertain.

New Hampshire's wood-fired power industry developed in the 1980's. Following the energy crisis of the mid 1970's, both state and federal public policy encouraged construction of renewable and diversified sources of electricity. In New Hampshire, this resulted in construction of eight wood-fired energy facilities, six of which remain operational today. These six facilities use 1.3 million tons of wood annually -- primarily whole-tree chips. In the fall of 2001, the New Hampshire Public Utilities Commission approved the termination of "rate orders" – in effect contracts that assure operation of the facilities – for Bio Energy in Hopkinton and Whitefield Power & Light. Future operation of these facilities is uncertain, though both entered into short-term agreements with the New Hampshire Timberland Owners Association that should keep them operating for the near future.

The remaining wood-fired facilities have "rate orders" to sell their power to Public Service of New Hampshire at a specified price. These rate orders expire between 2006 and 2008. The operation of these facilities, and their existence as markets for low-grade wood from New Hampshire's forests after the expiration or termination of these rate orders is highly uncertain.

1.2 Identifying and Evaluating Alternative Markets for Low-Grade Wood

Recognizing the importance of low-grade wood markets to New Hampshire's forest products economy, the New Hampshire Department of Resources and Economic Development commissioned a study with the goal of identifying and beginning the process of implementing one or more options to sustain these markets. The project has proceeded in two phases. The first phase evaluated a number of possible markets for low-grade wood, (using evaluation criteria that included, among others, potential market size, technical feasibility, economic feasibility, and environmental and social impacts) and identified the single option most likely to provide a market to replace the anticipated loss of several wood-fired energy plants. The second phase encompassed a detailed technical and financial analysis of this "preferred" option, which was planned to provide the foundation for economic development activity aimed at successfully promoting development of this option in New Hampshire.

1.2.1 Phase 1 – Evaluation of Potential Low-Grade Wood Markets

Phase 1 of this study is documented in the *Phase I Final Report: Use of Low Grade and Underutilized Wood Resources in New Hampshire* (NH Dept of Resources and Economic Development, January 2001, http://www.nhdf.com/publications/div_publications.htm). In order to identify potential new markets for low-grade wood in New Hampshire, a total of fourteen markets that offered the promise of new or expanded use of low-grade wood were surveyed. These included:

- Pulp and paper manufacturing
- Fuel pellets
- Wood chip export
- Small-scale gasification
- Process heat / co-location
- Ethanol and biochemicals
- Co-firing with wood at the PSNH Merrimack coal-fired electricity plant
- Firewood
- Animal bedding
- Landscaping mulch
- Densified logs
- Lumber from small diameter material
- Solid wood composites (oriented strand board and medium density fiberboard)

After an initial technical and economic screening, six of these were analyzed in depth. For each potential new market the amount of wood that could be consumed by the market and current technological and economic forces that would impact the viability of the market were thoroughly researched.

1. Oriented Strand Board (OSB): Replacing plywood in many applications, OSB is a structural panel of roundwood flakes bonded together using resins. A modern OSB plant could consume almost 500,000 tons of wood annually, though because of flake specifications could not use sawmill residue. While OSB consumption is expected to grow over the next decade, existing and planned capacity significantly exceed demand. A total of thirteen new OSB facilities are expected to be constructed between now and 2005, adding to an already glutted market. For this reason, it was determined that OSB is not a viable potential market for low-grade wood in New Hampshire.
2. Ethanol and Bio-chemicals: Ethanol and other bio-chemicals can be derived from wood, and can utilize roundwood and mill residue as feedstocks. The United States Department of Energy is presently working with "bio-ethanol" projects that produce 20 million gallons per year (GPY), and believes that bio-ethanol is approaching economic viability. A 50 million GPY facility, a size

anticipated in the near future, would use 2,000 bone-dry tons of wood daily, or roughly 1 million green tons each year. However, wood and mill residue are economically unattractive feedstocks for such operations, which can utilize almost any biologically based material as a raw material. Wood, which presently costs over \$30 per dry ton, would compete with other feedstocks such as agricultural waste, municipal solid waste, and construction waste, which have much lower or even negative procurement costs.

3. Chip Export: Exporting paper chips out of the Port of Portsmouth to foreign or domestic markets has been discussed and researched for at least a decade, though no chip exports have occurred to date. Chip exports could provide a market for up to a half-million tons of low-grade wood, including sawmill residue, annually. But several factors combine to eliminate this as a viable potential market for New Hampshire chips. Japan is by far the largest importer of paper chips, but is very distant from New Hampshire by shipping lanes, much further than from competing sources of chips. This fact, combined with a strong dollar that makes export of low-value commodities nearly impossible, suggest that chip exports will not provide a stable market for low-grade wood in the foreseeable future.
4. Co-Firing with Coal: Supplementing wood in a coal-fired boiler is referred to as “co-firing”, and is used in many coal-fired boilers across the nation. Co-firing with wood at a rate of 5-7% of BTU value in a facility the size of PSNH’s Merrimack Station would use roughly 270,000 tons of wood annually. Co-firing has been used to achieve reductions in emissions of SO₂ and NO_x in other coal-fired boilers, including cyclone boilers of the type installed at Merrimack, and wood is cost competitive with coal as a Btu source. Although a potential long-term option, co-firing at Merrimack is impractical in the near to mid-term, however. PSNH’s pending sale of Merrimack Station (as part of its divestiture of its generating assets) eliminates any incentive the utility might have to investigate co-firing – an investigation that in any event would be expensive and time-consuming – and the utility would derive no benefit from possible emission reductions. Nor is there any guarantee that co-firing will in fact be technically feasible at Merrimack Station. A future owner might be encouraged to investigate this option, but until the plant is sold it does not merit serious consideration.
5. Pulp & Paper Manufacturing: The pulp and paper industry has long served as one of the anchors of the Northeast’s forest industry, and is the largest market for low-grade wood in New Hampshire. However, North American paper production is and is projected to remain flat, as the industry invests the bulk of its resources in expansions in Latin America and Asia, where raw material (tree and other organic fiber) growing cycles are faster, labor and raw material costs are less, exchange rates are favorable, and environmental restrictions are less stringent. Given these factors, it is unlikely that this market will see any meaningful increases in the near future, particularly in the Northeast.
6. Medium Density Fiberboard (MDF): MDF is a wood-based composite panel used in non-structural applications, such as furniture and cabinets. A modern MDF plant would use roughly 400,000 tons of wood annually, including a significant portion of mill residue and a variety of tree species found in New Hampshire. The market for MDF is growing rapidly, in both the U.S. and worldwide, and manufacturing facilities are being built throughout North America to meet anticipated demand.

The results of Phase 1 indicated that, of all markets analyzed, Medium Density Fiberboard is the most likely to provide an economically viable market for a significant amount of low-grade wood in New Hampshire. For this reason, a full feasibility study was conducted on this potential market in Phase 2 of the study.

1.2.2 Phase 2 – Medium-Density Fiberboard: Feasibility Analysis

Phase 2 of the study comprised a detailed feasibility assessment for Medium Density Fiberboard (MDF). Its goal was to provide economic and technical analysis in sufficient detail to support efforts to attract an MDF manufacturer to locate in New Hampshire. This work is documented in *Phase II of a Project: Feasibility Analysis of Medium Density Fiberboard Manufacturing in New Hampshire* (NH Dept of Resources and Economic Development, July 2001).

The manufacture of MDF has grown rapidly in the United States and worldwide in the past 15 years. MDF is manufactured by first pulping roundwood or mill chips to release individual wood fibers (in a semi-mechanical process analogous to the corresponding operation in the pulp and paper industry), drying the fibers, coating them with a synthetic (urea formaldehyde) resin, and then pressing the fibers into a panel. Panels are manufactured between 1/8” and 1-1/2” thick, and four or five feet in width. With the development of continuous pressing processes, panels can be sawn to practically any length, but are most often marketed at eight feet and twelve feet. Because of its fine texture, MDF surfaces and edges can be readily machined, and provide an excellent substrate for paints, veneers, and other surface coatings. On the strength of its cost and technical characteristics, MDF has captured a large and growing market share formerly held by solid wood products in the furniture and related industries.

MDF production is a capital-intensive operation, requiring substantial investment and economies of scale in order to achieve acceptable profit. The facility modeled for New Hampshire, similar in size to other facilities now being developed in the U.S., would utilize 420,000 tons of roundwood and sawmill residue each year in order to produce 130 to 150 million square feet (3/4” basis) of MDF.

A facility of this size would require substantial energy – in the form of heat and electricity – equivalent to the dedicated output of a 10-megawatt (MW) power plant. Because of the comparatively high cost of electricity in New Hampshire, as well as the need to dispose of bark and other wood waste, a 25 MW wood-fired electric generating plant was modeled as a necessary part of the MDF facility. The excess electricity generated (beyond the plant’s own 10 MW requirements) would be sold into a competitive marketplace, providing an additional source of revenues. (The possibility of co-locating an MDF facility with one of New Hampshire’s existing wood energy facilities was evaluated, but was determined not to be feasible because of very specific requirements for use of thermal energy and emissions controls needed for an MDF plant.)

Total capital costs for an MDF facility of this size would be \$132 million for the MDF production operations, plus \$21 million for electric and thermal energy generation. Annual operating costs for this facility would be roughly \$38 million for raw materials, labor, administration and other expenses. Income, based on projected MDF and wholesale electricity sales prices, is projected to equal approximately \$54 million per year.

The analysis reached the conclusion that a facility of this size, although profitable, would not generate sufficient levels of profit to attract a developer to invest in a New Hampshire plant. Under reasonable economic assumptions, the facility described above generates a projected Return on Investment of 11.5% and an Internal Rate of Return (IRR, a measure of the quality of investment) of 9.35%. These values are below the returns required by the industry for investment in new MDF capacity. The industry expectation for IRR is between 14% and 16%.

Three factors are primarily responsible for the fact that MDF is not financially attractive in New Hampshire. First is New Hampshire’s high cost of electricity. Industrial electricity rates in New

Hampshire are roughly twice as high as rates in much of the southern U.S., where much of new MDF capacity is being developed. Even with cogeneration, the cost-revenue balance associated with electricity is a major drag on MDF's economic performance in this state. Second is the high cost of wood. The delivered price of MDF-ready chips in New Hampshire is approximately \$18.00-\$20.00 per ton, which is about 20% higher than the cost of equivalent forest products in the southern U.S. Third is New Hampshire's distance to end use markets for MDF (located primarily in the southern U.S. and Canada), which imposes a significant freight penalty, coupled with an unfavorable exchange rate, which makes it difficult for American products such as MDF to penetrate Canadian markets.

Phase 2 of the analysis concluded, therefore, that although MDF is the most viable potential market for low-grade wood in New Hampshire, it is in fact highly unlikely that a developer of MDF capacity could be attracted to the state in the near future.

1.3 Introduction to Phase 3: Alternatives to Sustain Wood-Fired Power in N.H.

The conclusion of Phases 1 and 2 of the project is clear:

In the foreseeable future, no other market exists to replace wood-fired electricity as an outlet to consume low-grade wood in New Hampshire

More generally, the results of the MDF feasibility analysis, and the protracted uncertainty experienced by the state's pulp and paper industry over the past two to three decades, document that it is difficult for New Hampshire to compete in national and global commodity markets with manufactured products based on low-grade wood. This is particularly true for industries requiring new facilities, or significant re-investment into existing facilities. National and global economic pressures are pushing these industries to regions where energy, labor, and/or raw material costs are more favorable than they are in New Hampshire.

Based on this conclusion, DRED initiated Phase 3 of the study. The goal of Phase 3 goal has been to fully document the environmental and economic costs and benefits associated with wood-fired electricity in New Hampshire, and to develop and analyze policy options that the state can employ to sustain this industry and its associated market for low-grade wood .

1.4 Overview: The Current Situation of Wood-Fired Power in New Hampshire

New Hampshire has eight wood-fired power plants, two of which are closed (Table 1-1). These plants are located throughout the state (Figure 1-1), and in 2000 provided a market for roughly 1.3 million tons of wood, with an estimated 94% derived from logging operations and sawmill residue. These plants range in size from 4 megawatts to 20 megawatts.

When they came on line, all of these plants had long-term "rate orders" that guaranteed the purchase of their output at fixed prices for a fixed period of time. The plants were provided with such guaranteed purchases under federal and state laws, because they provided electricity, generated using renewable resources, at costs lower than the regulated utility was forecasting at the time the rate orders were initiated.

Some of these rate orders have been terminated by mutual agreement, or "buyout", of the utility (Public Service Company of New Hampshire) and the wood-fired power plant. The remaining rate orders are set to expire between 2006 and 2008.

The first two buyouts occurred in 1994, with the closure of the Timco and Alexandria facilities. These buyouts resulted in the closure of facilities, and placed severe restrictions on future output of these facilities. Future sale of power from either of these closed facilities must be to customers within very close proximity to the facilities, or to customers outside of the PSNH service territory.

Following these buyouts, the New Hampshire passed legislation intended to protect the remaining market for low-grade wood from additional buyouts. In 1995, the legislature passed SB 790, which prohibited further buyouts off wood-fired power plants. This limitation was modified in 1998, with the passage of HB 485, to allow limited buyouts, subject to restrictions. These restrictions have the effect of safeguarding two-thirds of the market for low-grade wood provided by these facilities from buyouts. The legislative restrictions on buyouts or other reduction in purchase of power from wood-fired power plants are contained in Appendix B.

In 2001, the NH Public Utilities Commission considered and eventually approved the buyout of rate orders for Bio Energy and Whitefield Power and Light. As part of the hearing process, the New Hampshire Timberland Owners Association entered into agreements with both of these facilities that could keep the facilities operating for up to three more years. These agreements allow for the facilities to use some percentage of fuel from non-forest sources, so the continued operation of these facilities will not necessarily continue their purchases of low-grade wood. A buyout proposal was also filed for Hemphill Power & Light, but was withdrawn by the parties prior to consideration by the NH Public Utilities Commission.

New Hampshire's six operating wood-fired power plants provide a market for roughly 1.3 million tons of low-grade wood annually, 97% of which comes from either in-forest chipping or sawmill residue (Figure 1-2).

**Table 1-1
Wood-fired Power Plants in New Hampshire**

Facility	Town	Size	Status
Bio Energy	Hopkinton	11 MW	Rate order buyout 2001
Bridgewater Power	Bridgewater	15 MW	Rate order expires August 31, 2007
Alexandria Power	Alexandria	15 MW	Closed in 1994, restrictions on future power sales
Hemphill Power & Light	Springfield	13.8 MW	Rate order expires November 30, 2007
Pinetree Power – Bethlehem	Bethlehem	15 MW	Rate order expires November 30, 2006
Pinetree Power – Tamworth	Tamworth	20 MW	Rate order expires March 31, 2008
Timco	Pittsfield	4 MW	Closed in 1994, restrictions on future power sales
Whitefield Power & Light	Whitefield	13.8 MW	Rate order buyout 2001

Figure 1-1
Location of Wood Fired Power Plants in New Hampshire

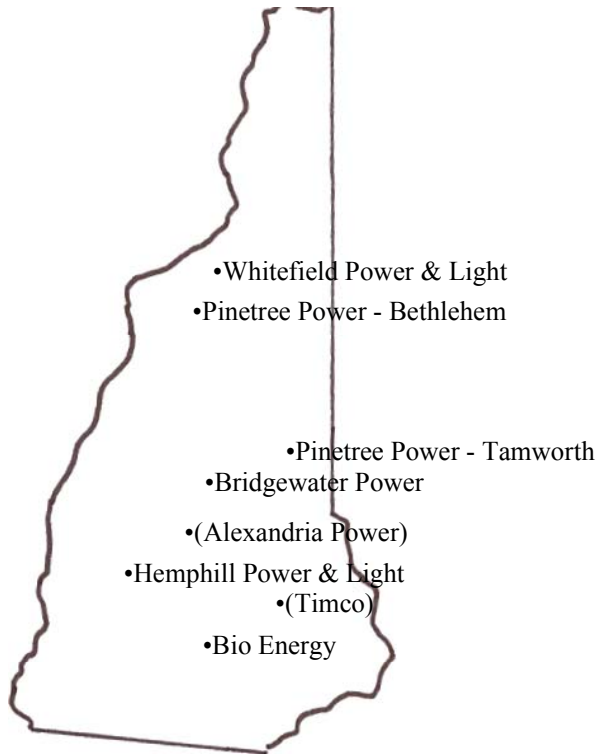
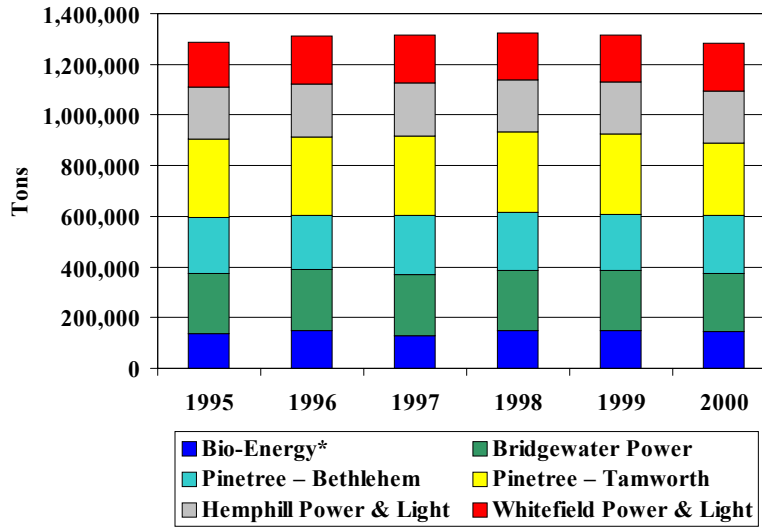


Figure 1-2

Tons of Wood Burned, New Hampshire Wood-Fired Power Plants, 1995 - 2000

Source: NH Department of Environmental Services



	1995	1996	1997	1998	1999	2000
Bio Energy*	136,719	148,121	127,076	148,589	149,720	145,557
Bridgewater Power	239,181	241,141	241,207	236,342	236,750	229,320
Pinetree – Bethlehem	220,928	216,136	234,677	229,901	222,175	226,600
Pinetree – Tamworth	306,488	308,094	314,218	318,524	316,530	286,178
Hemphill Power & Light	206,555	210,689	211,023	203,575	203,877	207,577
Whitefield Power & Light	178,300	187,609	186,159	187,508	186,959	187,392
Total	1,288,171	1,311,790	1,314,360	1,324,439	1,316,011	1,282,624

* Note: Bio Energy’s fuel consists of roughly 70% forest residue (whole tree chips and sawmill residue) and 30% urban wood (ground pallets). All other plants use forest residue exclusively.

SECTION 2

BENEFITS OF MARKETS FOR LOW-GRADE WOOD CREATED BY WOOD-FIRED POWER PLANTS

This details the economic and environmental benefits provided by wood-fired energy in New Hampshire. These benefits include the direct and indirect economic impact of the wood-fired power plants, their support for the state's entire forest industry, their contribution to the conservation of open space statewide, emissions benefits when compared with other New Hampshire electricity generation, and their role in mitigating climate change.

In addition to Section 2, below, INRS and DL had a white paper prepared to review the forestry benefits of markets for low-grade wood. This information was used throughout the report, and is contained in its entirety in Appendix D.

2.1 Economic Impact of Wood-Fired Power Plants

New Hampshire's six operating wood-fired power plants provide a market for roughly 1.3 million tons of whole-tree chips and mill residue each year. These plants have a significant economic impact statewide, as well as in the communities where they are located. In the six municipalities with operating facilities, the plants are sources of employment, and members of the business and civic community. These plants purchase whole-tree chips and mill residue throughout the state and region, and the economic impact of this activity is felt in woodlots and sawmills of every county in the state.

The following information quantifies the direct and indirect economic impact of the six operating power plants – Whitefield Power & Light, Hemphill Power & Light, Bridgewater Power, Pinetree Power – Tamworth, Pinetree Power – Bethlehem, Bio Energy. For all plants except Bio Energy, the entire economic impact is considered in this analysis. For Bio Energy, the economic impact analysis is limited to the impact of the 70% of fuel that comes from whole tree chips or sawmill residue.

The following information is based upon economic models created using published reports, filings in the Public Utilities Commission of New Hampshire and other states, and conversations with suppliers and plant managers of biomass power facilities. All economic figures presented are annual.

2.1.1 Direct Economic Impact

Direct economic impact describes the payments made and jobs created as a result of spending by the six operating wood-fired power plants. It does not refer to the impact this spending has through its suppliers, or through the secondary economic activity this activity creates.

Employment: The wood-fired power plants employ an estimated 125 individuals. This includes wood handling staff, round-the clock production personnel, plant management, and support staff.

Payroll: The approximately 125 employees of these plants receive an average compensation package – inclusive of wages and benefits – of \$45,000. The estimated total payroll for these facilities is \$5,600,000.

Property Taxes: Plants either pay property taxes, or have payment-in-lieu-of-taxes expenses, to the host community. With the re-valuation of the plants anticipated as a result of the implementation of the statewide property tax, a number of plants indicated they are concerned that their assessment, and thus their overall taxes, will increase in future years. Presently, the plants pay an estimated \$1,350,000 in property tax payments.

Maintenance: Annual expenditures associated with replacement parts, operating supplies, routine maintenance and major repairs is estimated to be \$2,100,000. It should be noted that a number of industry sources familiar with the power plants expressed concern that as the facilities approach the termination of their rate orders, owners are spending less on major repairs – instead opting to make repairs designed to last the remainder of the rate order. If this is true, and we were unable to confirm that it is, this raises operation concerns about the ability of the plants to operate past their rate orders. The best way to address this issue may be to provide an expectation that there will be an economically viable market for this power following the termination of rate orders.

Utilities Supplies, Services and Other Expenses: Utilities for the plants, as well as other miscellaneous expenses including legal and accounting services, state and federal taxes other than property taxes, and membership in necessary business trade associations account for an estimated \$ 4,950,000 in expenditures.

Fuel: Purchase of wood to fuel the power plants represents the single largest expense for the facilities. At \$18 per ton, a figure discussed at length in section 3.1, wood costs represent \$24,300,000 in expenses.

Total: Based on the above information, the total direct economic impact of the six wood-fired power plants is \$38,550,000. This means that for each megawatt (MW) of wood-fired energy capacity using forest-derived fuel, there is a direct economic impact of roughly \$400,000.

2.1.2 Total Economic Impact

Total economic impact describes the combined direct and indirect economic impact derived from operation of the wood-fired power plants. This includes the expenditure of money by suppliers as a result of their relationship with the plants, as well as the impact of this money circulating in the local economy. In the case of these wood-fired power plants, use of an appropriate multiplier is critical to capture the true impact the plants have through their fuel purchases.

Total economic impact is estimated using a “multiplier”, which describes the circulation of money in the economy as a result of expenditures by a firm. Multipliers are specific to industries, geographic locations, and other factors, and are derived using input-output models. A review of the literature did not show an accepted multiplier specific to wood-fired energy. As a result, several accepted and published multipliers for timber harvesting and wood product manufacturing were located, and present this range.

Multiplier	Author(s)	Industry
1.84	Jankowski and Moazzami	Pulp and paper manufacturing
2.10	Hardy Stevenson and Associates	Local forest industry
2.95	University of Maryland	Timber harvesting and management
3.00	Testimony in the NHPUC Docket No. DE 01-089	General economic activity
3.83	University of Maryland	Primary wood product manufacturing

Based upon these multipliers, it can be estimated that the economic impact of the five listed wood-fired power plants is between \$69 million and \$143 million annually.

It can also be estimated that these five wood-fired power plants are responsible for the creation of between 213 and 444 jobs, or between 2.4 and 5.0 jobs per megawatt (MW) of generating capacity. Assuming most of these jobs, are related to logging and trucking, this represents between 10% and 21% of the state’s logging workforce.

Due to the fact that most costs are associated with purchase of fuel for the wood-energy plant, and production of fuel is a labor-intensive activity, the number of jobs supported is likely at the high end of this range. It should be noted that, because of the location of the wood-fired power plants and their suppliers, these jobs are located in rural areas of the state, where unemployment rates tend to be higher than the statewide average.

Because the range of total economic impact is relatively large, we have made a good faith attempt to estimate more precisely the actual economic impact of these facilities. In order to do this, distinct multipliers were assigned to different portions of economic activity, based upon the similarity of those activities to activities described for the above multipliers. For all operations and maintenance activities above (payroll, property taxes, parts, supplies, maintenance, utilities and other expenses), the multiplier of 1.84 was used. This is because these activities are most similar to expenses and activities associated with operation of a pulp and paper mill. For the purchase of fuel, the multiplier used in Maryland for timber harvesting and management, 2.95, was used. This is because fuel purchase is truly the purchase of wood from a timber harvesting operation (or in some cases a sawmill). Using this methodology, it is estimated that the listed wood-fired power plants have a \$96 million economic impact upon the state of New Hampshire, or a little over \$1 million for each megawatt (MW) of wood-fired energy capacity using forest-derived fuel in New Hampshire.

2.2 Importance of Low-Grade Wood Markets to the New Hampshire Forest Industry

New Hampshire's forest industry is the third largest sector of the state's manufacturing economy in terms of value of shipments, and fourth largest sector of the state's manufacturing economy in terms of both employment and payroll. Its importance is magnified by the fact that forest industries are located predominantly in rural areas of the state, where other industries often do not have a significant presence.

A 2001 publication from the North East *State* Foresters Association shows that New Hampshire has 9,325 individuals employed in forest-based manufacturing. In a 1999 report commissioned by the Society for the Protection of New Hampshire Forests, *The Economic Impact of Open Space in New Hampshire*, showed that the forest industry as a whole has a \$1.2 billion direct economic impact upon the state, and a \$3.9 billion economic impact when indirect impacts are considered. According to this report, forestry and the forest industry comprise the largest sector of the state's \$8.2 billion open space dependent economy, ahead of open space related tourism.

The forest industry in New Hampshire includes over thirty thousand private landowners with ten or more acres -- owning roughly four million acres of forestland (or nearly two-thirds of the State's land area), an estimated 1,400 loggers, over 300 licensed foresters, roughly 100 sawmills, three major paper mills and six wood-fired power plants. Strong markets for low-grade wood are critical to every sector of the state's forest industry, and important for the conservation of open space statewide.

At present, New Hampshire's forest industry is experiencing a crisis in the market for low-grade wood. The Pulp and Paper of America mill in Berlin, traditionally a consumer of roughly one million tons per year of low-grade wood, closed in the fall of 2001 and its owner, American Tissue, is presently in bankruptcy proceedings. Finch, Pruyn & Company, a paper mill in Glens Falls, New York and traditional market for some sawmills and loggers in southwestern New Hampshire, is not presently making pulp and thus not purchasing pulpwood. Following the approval of rate-order buyouts for Whitefield Power & Light and Bio Energy in Hopkinton, uncertainty surrounds the continued operation of these two facilities.

The current crisis in markets for low-grade wood, coupled with uncertainty about the future of these markets, is impacting all aspects of the New Hampshire forest industry, and its effects are being felt statewide.

2.2.1 Importance to Timber Sales

A surplus of commercially undesirable species and low quality trees exists in New Hampshire's forests. Analysis of the USDA Forest Service Forest Inventory and Analysis by the NH Division of Forests and Lands indicate that between 37% and 44% of the standing timber volume in the state is considered "low-grade" (timber that is non-sawlog or non-veneer quality).

Low-grade wood is removed during every timber harvest in the state. Depending upon the stand quality and the silvicultural prescription (selection cut, clearcut, etc.), the amount of low-grade wood removed can vary widely. Loggers and foresters around the state report that -- depending upon the forest type, stand conditions, and other factors -- between 20% and 80% of the volume removed during a timber harvest is sent to low-grade -- either pulpwood or biomass -- markets. Research from the USDA Forest Service's Bartlett Experimental Forest on the White Mountain National Forest indicate the following percentage of low-grade wood by harvest type:

Harvest Type	% Low-grade (volume)
Selection cut	55 %
Patch cut	57 %
Diameter limit	30 %
Clearcut	41 %

Finding a market for this wood is becoming increasingly difficult. As a direct result of this, many landowners are deferring timber sales, hoping that the market for low-grade wood will rebound. Speaking to New Hampshire Public Radio, consulting forester Richard Boulanger said:

“Most of our clients are concerned about long-term management and improving their forest as well as obtaining income. And with the roundwood pulp market and what we assume will be a glut on the fuel chip market we simply can’t do good silviculture, so we’re going to delay everything for at least one winter season.”

Boulanger is not alone in delaying timber sales. One firm that manages roughly 20,000 acres of forestland in New Hampshire for a variety of clients is scaling back on the amount of logging they are doing. This firm has placed roughly one-third of its jobs on hold, and has stopped some jobs in southern New Hampshire. This firm is operating pulpwood sales at a loss, something their clients cannot sustain. Loss of the existing market for low-grade wood provided by the wood-fired power plants would make the current situation even worse.

Another consulting forester based in central New Hampshire indicated that he could not justify doing a pulpwood or biomass chips sale under the current economic conditions, and has two clients that are waiting for the market to stabilize before having logging jobs. He indicated that he currently has extremely limited access to markets for low-grade wood, certainly not enough to properly manage the roughly 6,000 acres he is responsible for.

2.2.2 Importance to Conservation of Open Space

The loss of low-grade markets has impacted not only the timing of timber sales, but also the value of forestland property. Without markets for low-grade wood such as pulpwood and biomass chips, the value of forestland can fall substantially. Many landowners have experienced this impact, with the most extreme case in the largest single parcel of private land in the state, the “Connecticut Lakes Headwaters Parcel”. This land, which International Paper is in the process of selling, comprises 171,500 acres in Pittsburg, Clarksville and Stewartstown. According to David Houghton of the Trust for Public Land (the anticipated buyer of the parcel) the property has lost significant value, “in the millions [of dollars]”, because of the loss of the Berlin pulpwood market coupled with uncertainty over future markets for low-grade wood.

Assuming that the property has lost between one and three million dollars, a figure suggested by observers of the sale, this means the parcel has lost between nearly \$6.00 and \$17.50 per acre of value because of loss of the market for low-grade and continued uncertainty over future markets. If a similar loss has occurred over all 4,799,300 acres of timberland in the state of New Hampshire, the total loss in value would range from \$28 million to \$84 million statewide. Because 83 percent of the forestland in New Hampshire is held privately – with the great majority of that owned by non-industrial private landowners – this loss is born largely by individual landowners.

While it is true that the wood-energy plants in New Hampshire continue to provide a market for low-grade wood, there is considerable uncertainty about the future of this market, particularly after the expiration or termination of rate orders. Because timber is a slow-growing crop, many forest landowners look to markets years, if not decades, in the future. For many landowners, and thus for the forest industry that relies upon them, the future uncertainty over markets for low-grade wood has a very real impact today.

The ability of individuals and firms to own and manage land for the long-term is the cornerstone of New Hampshire's land conservation efforts. The open space that is an integral part of the state's character, quality of life and economy relies heavily upon continued markets for forest products. David Publicover, Senior Staff Scientist for the Appalachian Mountain Club, has stated:

“I think there's a lot of people who want to be managing their forests for timber production. They understand the value of open space, but it's also an investment. They're not willing to do it if they essentially have to subsidize those public values. A lot of people want to hold these lands but if they're losing money at it they may have no choice but to sell. The loss of the low-grade market may push a lot of landowners from one side of that equation to the other.”

As the loss of low-grade markets for forest products threatens the ability of landowners to own and manage forestland with the reasonable expectation of a profit, the conservation of open space and privately held forestland is threatened as well.

2.2.3 Importance to Land Management

The ability of land managers to access low-grade markets is critical to the practice of good forestry. Access to markets for low-grade wood, including the 1.3 million ton market provided by the state's six wood-energy facilities, allows landowners to harvest where lesser quality trees, allowing the remaining higher quality trees to grow more rapidly and achieve higher value as sawlogs and veneer logs..

There is ample testimony to this fact. Northam Parr, Forest Resource Educator with UNH Cooperative Extension, notes, “In forestry any harvest should improve the forest. That's hard to do unless you can remove profitably the low material grade trees that chokes a lot of our forests, particularly in hardwood stands.”

Similarly, Charles Niebling, Director of Policy and Land Management for the Society for the Protection of New Hampshire Forests, notes that markets for low-grade wood are critical to their forest management. The Forest Society, which recently had their 34,000 acres of forestland independently certified as “well managed” under the Forest Stewardship Council's (FSC) green certification program, has found current markets for low-grade wood to be a problem. Niebling indicates that at present, there are several properties where they have delayed logging activity because of the state of the low-grade market. This has been most true on jobs where the logging acts as an investment in the future forest (e.g. pre-commercial thinning), where large volumes of low-grade wood are removed, resulting in high per-unit costs and low revenue.

While the Forest Society and others are delaying some harvests, others are not. One result of the loss of markets for low-grade wood is “high-grading”, a practice that *Good Forestry in the Granite State* defines as “an exploitive logging practice that removes only the best, most accessible and marketable trees in a stand.” While maximizing short-term profits, high-grading

significantly decreases stand quality, reduces future management options, and draws down the number of high-value sawlog and veneer logs that will be available from the stand. Procurement foresters, who visit a large number of logging jobs around the state, report a significant increase in high-grading, with one procurement forester observing ten times as much high-grading as he has in past years.

2.2.4 Importance to Wildlife Habitat

Preservation and enhancement of wildlife habitat is another aspect of land management that will suffer in the absence of markets for low-grade wood. For example, David Publicover, Senior Staff Scientist for the Appalachian Mountain Club notes that:

“If there’s no market for this low-grade, small diameter wood, then if people want to get an economic return off their land then they’re much more likely to cut the higher value, larger diameter material, because that’s the only material there’s a market for. That going to have very serious impact on wildlife habitat. Bears, raccoons, fishers, hawks, owls, and eagles are among the species that den or nest in big trees. And lots of animals use these big trees when they die and fall over. Salamanders, insects, and small mammals lives in or under the dead, rotting logs, and they provide an important link in the food chain.”

The loss of the low-grade wood market also means that land managers will have difficulty creating early successional habitat, which John Lanier of the New Hampshire Department of Fish & Game notes is in short supply in the southern two-thirds of the state. Leighland Prout, a biologist with the White Mountain National Forest, recently stated:

“... when you cut a stand, you can get this big regrowth of a lot of different types of vegetation, shrubs and trees and grass, and all of that can support a much larger diversity of wildlife, which in the end is what we’re looking for...A lot of the popular game species in New Hampshire like deer, moose, grouse, all rely heavily on openings or regenerating stands, mostly for foraging, but also for cover especially some of the songbirds look to that shrubby regrowth because it’s very dense and thick it provides good cover.”

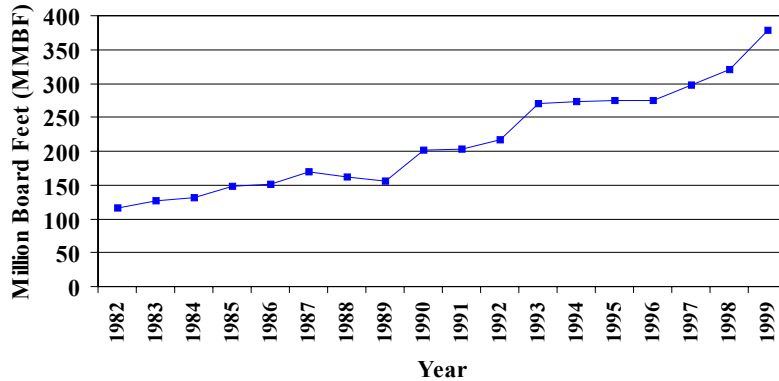
The lack of markets for low-grade wood threatens the ability of land managers to create this important habitat, upon which biologists estimate 90% of the vertebrate species on the White Mountain National Forest depend.

2.2.5 Importance to Sawmill Procurement

As New Hampshire forests mature and lumber markets demand more material, sawmills in New Hampshire have increased their production, tripling output from the early 1980’s to the present (Figure 2-1)

Figure 2-1

New Hampshire Sawmill Production 1975 - 1999



It is no coincidence that the growth of the New Hampshire sawmill industry has paralleled the growth of wood-fired power in New Hampshire. By providing a market for low-grade forest products, New Hampshire's wood-fired power plants have encouraged increased harvesting and sawlog production throughout the state – by improving the economics of timber harvesting, increasing the total size of timber markets, and encouraging forest management practices that enhance production of high quality sawlogs. Shrinking markets for low-grade wood can be predicted to inflict both immediate and long-term damage on this currently vibrant and growing industry.

Timber sales that are deferred or canceled have a direct and immediate impact on New Hampshire's sawmill industry. Mills statewide currently face a shortage of logs because logging operations have been curtailed. Many of the logs they are able to purchase are of lower quality than they normally procure, and there is upward pressure on prices. According to a procurement forester working for a large white pine mill in central New Hampshire, it is obvious that landowners are delaying timber sales. During the past autumn, traditionally a strong time for timber sales, this forester observed the lowest amount of stumpage on the market in a decade. Procurement foresters for other sawmills confirm this observation, and note that it is expected to get worse if biomass power plants close or stop using chips derived from forestry operations.

Other mills statewide report a tougher time getting logs, as fewer timber sales are on the markets and loggers are carefully selecting jobs where they can sell all of the stems. The general manager of a large mill in southwestern New Hampshire indicates that the low-grade market situation has impacted sawmill operations in this region. Like other mills, he is seeing log deliveries with more and more logs that don't meet specifications for quality, a situation attributed to the fact that loggers do not have access to markets for low-grade wood, and are trying to sell it to the sawmill. Unfortunately, there is virtually no demand for the lower grades of lumber that these lower quality stems would provide. The need to sort, handle, and discard these unacceptable logs imposes additional costs on the mill.

The problems already witnessed by the state's sawmills may be only a foretaste of things to come. Loggers around the state depend upon the markets for wood provided by biomass power plants. Mill operators are concerned that many of their suppliers may go out of business if low-grade markets do not improve. One large hardwood mill in southern New Hampshire has seen its largest single supplier cease operations as a result of the loss of markets for low-grade wood in Berlin, and fears that a number of other suppliers are nearing bankruptcy. Many of the largest and most stable logging firms in southern New Hampshire are heavily involved in chipping for wood-energy plants, and this hardwood mill believes that its suppliers, and thus the mill and its over 50 employees, would be "dead in the water" without the markets provided by the wood-energy plants. As less harvesting occurs, and as fewer suppliers remain in operation, sawmills fear it will become increasingly difficult to purchase logs on the open market. Without these logs as raw materials available at a fair price, sawmills will be unable to operate.

2.2.6 Importance to Sawmill Operations

In addition to procurement issues, sawmills rely upon pulp mills and wood-energy facilities to consume chips that are a by-product of sawmill production. When round logs are sawed into rectangular boards, the wood that is sawed off is chipped and sold to these low-grade markets. Based upon interviews conducted with sawmills as part of Phase 2 of this project, New Hampshire sawmills produce between 1,005 and 1,583 tons of chips for each million board feet of sawmill production. New Hampshire's 1999 sawmill production was 378 million board feet – implying generation of almost 400,000 to nearly 600,000 tons of chips. These mills need a chip market in order to continue production.

Information provided to INRS and DL during Phase II of this project suggest that, prior to the closing of the paper mill in Berlin, three-fourths of the chips produced by New Hampshire sawmills went to pulp mills throughout New England. The remaining one-fourth of the chips produced were sold to biomass power plants. With the closing of the paper mill in Berlin, a number of additional sawmills have indicated they are now sending their chips to biomass power plants. For most mills interviewed, the price paid for sawmill chips does not allow for any meaningful profit on this product, but does allow them to cover trucking costs. Mills noted time and again that without an outlet for their sawmill chips, they will be unable to continue production of lumber. Further, any increase in the price they must pay to dispose of chips, or to haul chips to distant markets (for example, some New Hampshire sawmill chips have been marketed to pulp mills in eastern New York), has a direct impact on sawmill profitability.

Several mills interviewed for this project noted explicitly that their inability to sell chips was preventing expansion of sawmill operations. For example, one sawmill in southern New Hampshire seriously considered adding a night "half-shift", which would have provided roughly fifteen jobs in a rural area of the state. This mill was unable to add the shift because it had no viable market for the chips it would have generated.

2.2.7 Importance to Loggers

The logging industry is the critical link between landowners, foresters, sawmills, and other forest product markets. New Hampshire's logging industry currently employs approximately 1,400 individuals working full-time cutting and hauling timber, and hundreds more who derive part-time employment from logging and directly related activities.

New Hampshire loggers and logging contractors have made substantial investments in equipment for harvesting, skidding, processing and trucking, and are highly leveraged. Prices for skidders, chippers, and other harvesting equipment run into hundreds of thousands of dollars, and it is not uncommon for individuals managing a four-person operation to have debt of over \$1 million.

This industry cannot sustain the loss of low-grade wood markets or significant downward pressure on low-grade wood prices. As noted in Section 2.2.1, as much as 80% of the volume harvested in a given logging operation can be low-grade material. In almost all cases, the price paid to landowners for low-grade wood represents a breakeven value to the logger, who derives whatever profit he makes from the cutting and sale of sawlogs and veneer logs. If demand for low-grade wood drops (as it has done in the wake of the Berlin mill closure), prices will be pushed down as well. With low-grade wood representing half or more of total volume, even a dollar or two per ton reduction in low-grade prices can threaten the financial viability of almost any logging concern in the state.

This is not a situation that affects only smaller firms. To the contrary, New Hampshire's largest and most established firms are typically among the most highly leveraged, and have made the greatest investment in equipment capable of harvesting low-grade wood. In the event of the loss or significant contraction of low-grade markets, it will be the larger firms, with the greatest employment and economic impact in the state, who suffer most.

An equally pernicious impact as low-grade markets diminish will be pressure on the logging industry to cut corners in all aspects of their operations. Perhaps the most serious will be the pressure to "high grade" – taking only the most valuable stems to maximize short-term profit at the expense of future values. But foresters, loggers and regulators have also noted that pressure on loggers' profits will also almost certainly lead to an increase in violations of timber harvesting and wetland laws, overweight trucking, and violation of worker's compensation regulations.

2.3 Comparative Environmental Impacts of Wood-fired Power

Enhanced conservation and forest management opportunities are among the major environmental benefits associated with wood-fired power – benefits for which there is no comparison with other forms of electric power generation. An important issue regarding wood-fired energy is its environmental comparison with other types of electrical generation in areas where they are directly comparable. The most important of these is emissions.

Biomass fuels provide a number of air emissions benefits compared with coal or oil fired electricity generation. In the *New Hampshire Dioxin Reduction Strategy* (February 2001) the New Hampshire Department of Environmental Services noted of wood-fired energy:

“These facilities, when viewed in context of total environmental impacts, emit less sulfur dioxide, mercury, and greenhouse gasses per unit of energy produced than power plants burning coal or oil.”

The following information compares emission of certain pollutants from wood, fossil fuel (coal and oil), and natural gas fired power plants. All information for wood and fossil fuel fired plant emissions was calculated using emissions data from the NH Department of Environmental Services and electrical generation data provided by the Federal Energy Regulatory Commission or, in the case of Bio Energy, the plant itself. Emissions values for natural gas fired power are NH Department of Environmental Services estimates, because no major gas-fired facilities are operational in New Hampshire. Emissions are listed in pounds per kilowatt hour (lbs/kWh) to provide a standard measurement of pollution per amount of output.

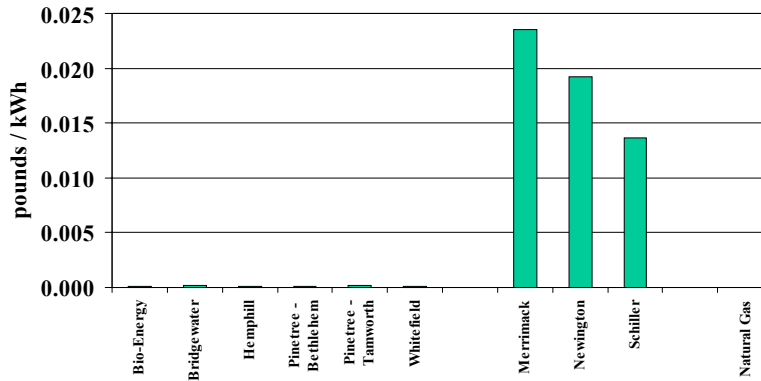
2.3.1 Sulfur Oxides

Sulfur oxides (SO_x) are emitted from industrial, institutional and utility boilers; petroleum refineries, smelters, paper mills, and chemical plants. It is a criteria pollutant that the state is required to track under the Clean Air Act. It is of concern to human and environmental health officials because it may cause breathing problems and permanent damage to lungs and is an ingredient in acid rain which can damage trees, lakes, and metals and reduce visibility.

Sulfur emissions from wood-fired power plants are several orders of magnitude less than emissions from coal- and oil-fired power. In 1999, sulfur emissions from wood-fired power plants ranged from 0.00011 to 0.00015 lbs/kWh of generation and fossil fuel plant emissions ranged from 0.01368 to 0.02349 lbs/kWh. According to NHDES, there have not been meaningful reductions on a per kilowatt-hour basis of SO_x from either wood-fired or fossil fuel plants since that time. Natural gas is anticipated to emit SO_x at a rate of 0.00001 lbs/kWh.

Figure 2-2

Emissions of SO_x for NH Wood-fired and Fossil Fuel Power Plants
1999



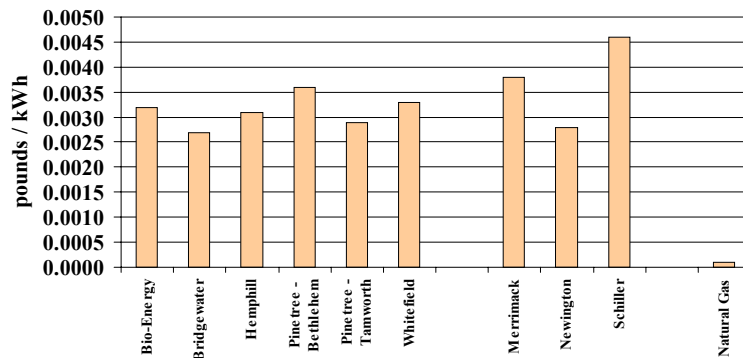
2.3.2 Nitrogen Oxides

Nitrogen Oxides (NOx) are also a criteria pollutant that the state is required to track under the Clean Air Act. NOx causes respiratory illnesses and lung disease and is an important component of smog. NOx can harm humans and vegetation when concentrations are sufficiently high, and may cause lung damage and illnesses of breathing passages and lungs.

NOx emissions from wood-fired power are roughly equivalent to emissions from coal- and oil-fired electricity. In 1999, NOx emissions from wood-fired power plants ranged from 0.0027 to 0.0036 lbs/kWh of generation. These are compared to 2000 emissions from PSNH's Merrimack and Schiller Stations, which were retrofitted with new NOx emission controls in 1999. The 2000 fossil fuel plant emissions of NOx ranged from 0.0028 to 0.0046 lbs/kWh. NOx emissions from natural gas are expected to be roughly 0.0001 lbs/kWh.

Figure 2-3

Emissions of NOx for NH Wood-fired and Fossil Fuel Power Plants
1999 (wood plants), 2000 (fossil plants), and estimates (natural gas)



2.3.3 Mercury

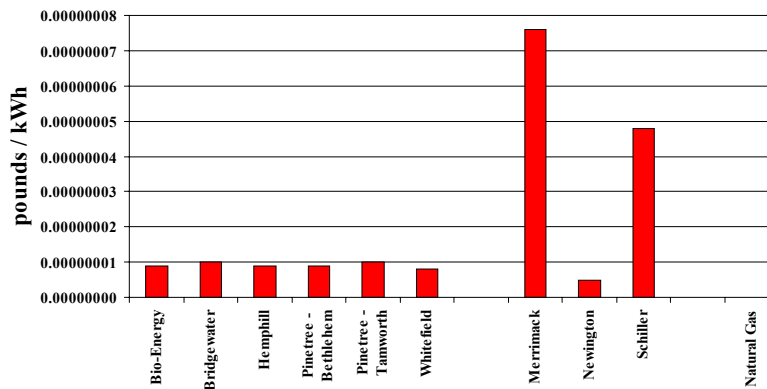
According to the *New Hampshire Mercury Reduction Strategy*, “mercury contamination in the environment is a significant public health and environmental problem”. As a persistent, bioaccumulative, toxic pollutant, mercury becomes part of the food chain and has numerous harmful effects in plants, birds, mammals and humans. According the *Mercury Reduction Strategy*, “mercury exposure in humans can lead to a variety of negative health effects including neurotoxicity, kidney toxicity, gastrointestinal toxicity, genetic toxicity, cardiovascular toxicity, dermal toxicity, developmental toxicity and even death.”

(It should be noted that the information on mercury is not based on stack testing at either the wood or fossil fuel fired plants. It is based upon input-output models, and the emissions data provided by NHDES is the best information available at this time. However, there is a high degree of uncertainty around this data, and testing is ongoing at coal-fired power plants to better assess actual mercury emissions.)

On a per-kilowatt-hour basis, mercury emissions from wood-fired power are estimated to be 70% to 90% less than emissions from coal-fired power. In 1999, estimated mercury emissions from wood-fired power plants ranged from 0.000000008 to 0.000000010 lbs/kWh of generation and coal-fired plant emissions ranged from 0.000000048 to 0.000000076 lbs/kWh. Natural gas is anticipated to have negligible emissions of mercury.

Figure 2-4

Emissions of Mercury for NH Wood-fired and Fossil Fuel Power Plants
1999



2.3.4 Dioxin

Dioxin is a family of chemical compounds that are considered persistent bioaccumulative biotoxins. According to the DES report, “dioxin is considered to be a very potent toxicant that has the potential to produce a number of adverse effects in humans including reproductive and developmental disorders, suppression of the immune system, and cancer.”

Released in February, 2001 the NH Department of Environmental Service’s *New Hampshire Dioxin Reduction Strategy* the NH Department of Environmental Services identified wood-fired boilers, particularly those used to generate electricity, as major sources of dioxin emissions in the state. Because no stack test for dioxin had been conducted on New Hampshire biomass plants, DES used models to determine emissions from these plants. Based upon EPA emissions models derived from California biomass plants, this report estimated that 20.3% of the dioxin emitted in New Hampshire comes from wood-fired boilers.

Prior to and following the release of this report, the wood-fired power plants and the broader forest industry in New Hampshire challenged the accuracy of this model, noting that the fuel sources used for some of the biomass plants in California were significantly different than the whole-tree chips and sawmill residue typically used in New Hampshire plants.

In February of 2001, a dioxin and furan emissions test was conducted on the Pinetree Power facility in Bethlehem, New Hampshire. The results of this test were provided to the DES Air Resources Division in May, 2001. This test shows dioxin emissions at levels much lower than the EPA models, and has caused DES to re-evaluate its earlier findings and recommendations on wood-fired boilers. In December of 2001, DES released the following statement as part of an addendum to its dioxin reduction strategy.

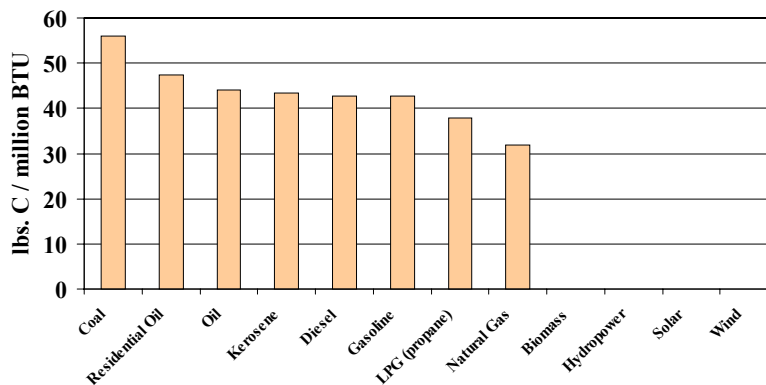
Wood-fired Boilers and Power Plants: The [*New Hampshire Dioxin Reduction*] *Strategy* also identified large wood-fired boilers and electric power plants as a likely major source of dioxin in New Hampshire. Because no dioxin test data from New Hampshire wood-fired boilers and electric power plants existed, dioxin releases from these facilities were initially estimated in the *Strategy* using generic EPA emission factors. These factors were compiled from the results of testing conducted at similar facilities burning wood and biomass material in California in the 1980’s. Since publication of the *Strategy*, however, a dioxin emissions test was carried out privately at one of New Hampshire’s larger wood-fired boilers. Although DES did not receive prior notice of this test – and was therefore unable to witness and validate its results – the test results and supporting data were later provided to DES. The test results indicate that dioxin emissions from wood-fired boilers may be much lower than initially estimated in the *Strategy*. If future DES-sanctioned testing confirms these encouraging preliminary results, DES will re-evaluate the dioxin contribution from wood-fired boilers, and shift the focus of future dioxin reduction efforts to other, larger emission sources.

2.4 Benefits Associated with Carbon Sequestration and Climate Change

Biomass energy can play an important role in reducing greenhouse gas emissions. All fuels burned to produce electricity produce carbon emissions (30 to 55 pounds of carbon per million Btu of fuel consumed). But with wood-fired power, carbon emissions are balanced by the carbon sequestered in biomass growth, and the net greenhouse gas impact of biomass electricity production is zero (Figure 2-8). This is so because carbon is absorbed from the atmosphere as trees grow, and stored in the woody stem. The carbon is released when wood is burned to produce electricity, but this release is balanced by the uptake and storage of carbon as a new generation of trees are grown to provide biomass fuel. According to a climate change action plan developed by the State of Maine, encouraging renewable power and promoting sustainable forest management are two of the most effective actions that can be taken at the state level to address climate change.

Figure 2-5

Net Carbon Emissions From Electricity Production
By Fuel Type



Source: State of Maine Climate Change Action Plan

Fuel	Emissions (lbs. C / million BTU)
Coal	56.0
Residential Oil	47.4
Oil	44.0
Kerosene	43.5
Diesel	42.8
Gasoline	42.8
LPG (propane)	37.8
Natural Gas	31.9
<i>Biomass (sustainable harvest and regrowth)</i>	<i>0.0</i>
Hydropower	0.0
Solar	0.0
Wind	0.0

Note: Biomass releases about 42.8 pounds of carbon for each 100 pounds of dry wood combusted, but an equal amount of carbon is sequestered over a 60 – 100 year re-growth period.

Source: *State of Maine Climate Change Action Plan*

SECTION THREE

FINANCIAL PROJECTIONS FOR WOOD-FIRED ELECTRICAL GENERATION IN NEW HAMPSHIRE

Looking to promote the continued operation of New Hampshire’s wood fired electric plants, and potentially to reactivate its two mothballed facilities, the most crucial question is whether these plants can operate profitably in an unregulated electricity marketplace.

The most readily observable evidence is contradictory. On the one hand, owners of the two mothballed facilities have not attempted to operate without guaranteed rate orders, suggesting that profitable operation is not possible without this guarantee. On the other hand, the current owners of two plants (Bio Energy in West Hopkinton and Whitefield Power & Light in Whitefield) have made commitments to continue operations after buy-out of their rate orders, suggesting that continued operation may not cause significant economic losses. This situation is complicated by the fact that Bio Energy and Whitefield Power & Light both agreed to continued operation, under specified terms, in order to assure approval of their buyout before the NH Public Utilities Commission. Bio Energy’s situation is further complicated, however, by the plant’s use of urban wood waste fuel, presumably at a substantial discount to the cost of low-grade forestry chips.

To project whether New Hampshire’s plants can produce and sell electricity profitably in an unregulated marketplace, Innovative Natural Resource Solutions LLC and Draper/Lennon, Inc (INRS and DL) developed *pro forma* profit and loss projections for wood-fired electricity generation in New Hampshire. These include estimates of the capital and operating costs of running a “generic” 15 MW plant in New Hampshire, coupled with revenue projections from the sale of the approximately 130 million kilowatt-hours per year of electricity generated by such a plant. These estimates are based upon best available data, and assume operation in the absence of a guaranteed rate order.

3.1 Capital and Operating Costs

None of New Hampshire’s plants has publicly divulged operating cost data. Although this information may have been provided to the New Hampshire Public Utilities Commission as part of the PUC’s many dockets related to wood-fired electricity, it remains confidential business information in the PUC’s hands, and was not available for this analysis. Absent this direct information, INRS and DL used primary and secondary information from a number of sources, including published data from wood-fired electricity producers in other states, contacts with industry experts, and contacts with operators of several of the New Hampshire facilities, to develop and verify estimates of the cost of operating a wood-fired plant in New Hampshire. To the maximum extent possible, this information was refined to reflect the specifics of operating a wood-fired plant in New Hampshire – for example, by using historical New Hampshire wage and salary data, and New Hampshire property tax data.

3.1.1 Operating Costs

Table 3-1 summarizes DL and INRS’s estimates of the cost to operate a 15 MW wood-fired power plant in New Hampshire, exclusive of fuel costs. Total operating costs to equal approximately \$2.375 million per year.

Table 3-1 Costs to Operate a 15MW Wood Fired Electric Generating Plant in N.H.		
Element	Cost	
	\$/Yr	\$/kWh
Payroll (Fully Loaded)	975,000	\$0.0079
Property Taxes	225,000	\$0.0018
Supplies and Services	400,000	\$0.0032
Maintenance	350,000	\$0.0028
Utilities, Production	300,000	\$0.0024
Utilities, Other	125,000	\$0.0010
Total	2,375,000	\$0.0190

Of this sum, the largest component is labor costs, at \$975,000/year. Table 3-2 summarizes typical labor requirements and costs for a 15MW wood-fired plant. Total employment is about 20-22, with fifteen or sixteen production employees, plus five to six non-production staff.

**Table 3-2
Estimated Labor Requirements and Costs, 15MW Wood-Fired Electric Plant**

Employee	Number	Base \$	Load Pct	Load \$	Total \$
Production (4/shift)	12	30,000	25%	7,500	450,000
Supervisor (1/shift)	3	45,000	25%	11,250	168,750
General Manager	1	60,000	25%	15,000	75,000
Subtotal, Production	16				693,750
Financial Manager	1	50,000	25%	12,500	62,500
Administration	2	27,500	25%	6,875	68,750
Maintenance	3	40,000	25%	10,000	150,000
Subtotal, Non-Production	5				281,250
Total	21				975,000

Utilities and maintenance costs follow in magnitude. The estimated utility cost of \$425,000 includes electricity that is consumed by the plant itself, plus water and wastewater management. Maintenance costs of approximately \$350,000 include upkeep of the materials handling, boiler, and electric generating systems, general plant upkeep, and maintenance of water treatment and emissions control equipment. Supplies and services account for an additional \$400,000 in expenses. They include operating and office supplies, overhead costs such as insurance, plus an allowance for outside services such as accounting, legal, and engineering. Property taxes, estimated at \$225,000 per year for a generic plant, represent the approximate mean of actual costs incurred by New Hampshire’s operating wood-fired facilities.

3.1.2 Fuel Costs

Fuel costs are a critical determinant of the profitability of wood-fired electricity. In a base case financial projection, DL and INRS used a fuel cost of \$18.00/ton, reflective of the current and historic average price of wood chip fuel in New Hampshire (see Appendix C). The sensitivity of profitability estimates to changes in this value is discussed in Section 3.4.

3.1.3 Capital Costs

The capital cost to an operator of a wood-fired plant is another critical determinant of its potential profitability. The turnkey capital cost for a new wood-fired plant in the 15MW range is approximately \$20 million. The capital cost to a current owner/operator of one of New Hampshire’s plants can be equated to zero, based on the reasonable assumption that the capital costs of all of these plants have been fully paid off at the time the rate order is terminated or expires. The capital cost for a new owner of one of these plants, obviously, would fall between these end points.

Although two New Hampshire plants (the Whitefield Power and Light facility in Whitefield, and the Hemphill Power and Light facility in Springfield) have recently changed hands, sales prices in these transactions do not provide a benchmark from which to predict prices in future plant sales. For one thing, these sales were part of a much larger, multiple-plant transaction between the AES Corporation (a multinational developer of independent electric plants) and the Thermo Ecotek Corporation, their former owner. The companies have not divulged the price paid for individual properties under this transaction. Further, because the Whitefield and Hemphill purchases were linked to transactions of other, more valuable properties, their price would not necessarily reflect the stand-alone value of these plants. More important, however, these plants were sold with their rate orders still intact, and the rate orders (with their guaranteed income stream) are by far the largest component of the value of these plants – much larger than their now fully depreciated capital cost.

Absent precedent from actual sales, INRS and DL consulted a number of industry experts, including parties directly involved with New Hampshire’s independent wood-fired plants, to estimate the likely purchase price of an existing wood-fired plant in the state. Estimates all ranged below twenty cents on the dollar, or \$4 million for a plant with an as-built capital cost of \$20 million. Most estimates were closer to ten to fifteen cents on the dollar, or about \$2 to \$3 million, for a plant with no rate order attached.

In a sense, the cost to purchase one of these plants in a future transaction will be a residual value. Facing an unregulated electricity market, a new owner would first calculate his/her potential profits based on projected electricity sales revenues minus projected operating costs. The difference between these values is the pool of money available for profit and capital cost payments, and would determine how much a new owner would be willing to pay for an existing plant. On an annualized basis, an owner would be willing to pay only the amount that would allow him/her first to pay all operating costs, and then meet profitability targets. The purchase price (expressed as an annualized cost) would be the residual value. Put as an equation:

$$\text{Purchase Price (annualized)} = (\text{Projected Revenues}) - (\text{Operating Costs}) - (\text{Profit Target})$$

The purchase price would be further discounted by the buyer’s perception of risk in an unregulated electricity market. That is, with no guarantee that revenues will meet projections (or that costs will not be subject to pressure to move higher than projections), the buyer would insist on a further purchase price reduction to account for the risk level of his/her investment in an unregulated power production facility.

The seller, of course, will also be involved in establishing a purchase price. But the seller faces a much simpler equation. A seller should be willing to dispose of a plant for any value greater than its scrap value, which is typically much less than ten cents per dollar of original investment. In our base case, INRS and D/L have used a value of 12.5 cents on the dollar, or \$2 million, as a first estimate of the purchase price for a “generic” existing wood-fired plant in New Hampshire. But we recognize that this is only a plug-in value, and that the actual purchase price for any of the existing plants will ultimately be determined by the more important balance between revenues, fuel and operating costs, profit, and risk, which are explored in Section 3.4.

3.2 Revenues from Electricity Sales

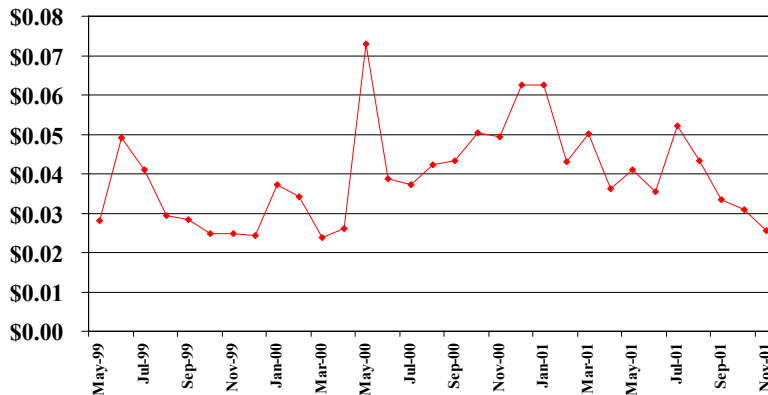
More than any cost element, sales revenues are the most important factor determining the potential profitability of wood-fired electricity in New Hampshire. Because of the volatility of

electricity prices and price projections in the uncharted territory of an unregulated market, revenues are also the most problematical income statement component to predict.

INRS and DL examined electricity prices for unregulated power production from two perspectives. The first is historic data from ISO New England (ISO-NE). ISO-NE is the “independent system operator” which is responsible for managing the New England region's electric bulk power generation and transmission systems and administering the region's open access transmission tariff – that is, the prices paid to independent generators who supply electricity to the New England electric grid. A bid system managed by ISO-NE sets the “electricity clearing price,” or ECP, which is the price ultimately paid to unregulated generators for power supplied into the New England grid. The average monthly ECP provides the best estimate of the per kilowatt-hour price that would be paid to an independent, unregulated wood-fired generator (or any other independent generator of baseload power) under current market conditions. Figure 3-1 and table 3-3 summarize the monthly average ISO-NE ECP from 1999 through November 2001. Over this 30-month period, the average monthly ECP has ranged from \$0.024/kWh to \$0.073/kWh, with a mean value of \$0.039/kWh over the period. Assuming a continuation of past trends, this is one reasonable estimate of the price paid for unregulated electricity from an independent New Hampshire generator.

Figure 3-1

ISO New England Monthly Average Electricity Clearing Prices, 1999-2001



**Table 3-3
ISO New England Monthly Average Electricity
Clearing Prices, 1999-2001**

Year	Month	Price (\$\$/kWh)
1999	May	\$0.0282
1999	June	\$0.0492
1999	July	\$0.0411
1999	August	\$0.0293
1999	Sept	\$0.0284
1999	Oct	\$0.0248
1999	Nov	\$0.0249
1999	Dec	\$0.0243
2000	Jan	\$0.0372
2000	Feb	\$0.0342
2000	Mar	\$0.0239
2000	Apr	\$0.0262
2000	May	\$0.0728
2000	June	\$0.0388
2000	July	\$0.0371
2000	August	\$0.0422
2000	Sept	\$0.0432
2000	Oct	\$0.0503
2000	Nov	\$0.0493
2000	Dec	\$0.0625
2001	Jan	\$0.0626
2001	Feb	\$0.0430
2001	Mar	\$0.0502
2001	Apr	\$0.0363
2001	May	\$0.0410
2001	June	\$0.0354
2001	July	\$0.0522
2001	August	\$0.0433
2001	Sept	\$0.0335
2001	Oct	\$0.0310
2001	Nov	\$0.0256
Maximum		\$0.0728
Minimum		\$0.0239

DL and INRS also examined national and regional electricity price trends and forecasts. The U.S. Department of Energy’s Energy Information Administration (EIA) compiles historical statistics and forecasts of electricity prices by state and region. Table 3-4 summarizes EIA’s data and projections for prices paid to electricity generators (averaged across the country) from 1999 through 2010. This projection rises from \$0.041/kWh to \$0.046/kWh from 1999 to 2001, and then falls slowly to a value of \$0.037/kWh by 2010. This is consistent with estimates supplied by New Hampshire’s Governor’s Office of Energy and Community Services, which predicts regional wholesale electricity prices of \$0.036/kWh to \$0.040/kWh for the next few years.

Table 3-4 U.S. DOE Energy Information Administration Forecasts of Prices Paid to Generators, 2001-2010 (\$\$/kWh)										
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
\$/kWh	\$0.046	\$0.042	\$0.040	\$0.040	\$0.039	\$0.038	\$0.038	\$0.037	\$0.037	\$0.037

For a base case analysis, INRS and DL used a value of \$0.040/kWh to predict revenues to an independent wood-fired electricity generator in New Hampshire. The profitability of any independent electricity generator is very much dependent on this value, as discussed in detail in Section 3.4.

3.3 Pro Forma Profit and Loss Projections, Base Case

Figure 3-2 presents an inclusive profit-and-loss projection for a 15MW wood-fired power plant in New Hampshire. Operating at an annual 95% capacity factor (typical for a plant dispatched for baseload power), a 15MW plant would generate 125,000,000 kWh per year. At a sales price of \$0.04/kWh, this would provide \$5,000,000 in revenues.

Figure 3-2
Pro Forma Profit and Loss Projection, 15 MW Wood-Fired Electric Generating Plant in New Hampshire, Base Case

	Total	\$/kWh	Percent
REVENUES			
Revenues from electricity sales			
kWh		Price	
125,000,000	\$5,000,000	\$0.0400	100.00%
COST OF GOODS SOLD			
Fuel Tons		Price	
225,000	4,050,000	\$18.00	81.00%
Production Labor (fully loaded)	693,750	0.0056	13.88%
Utilities (production)	300,000	0.0024	6.00%
Maintenance	350,000	0.0028	7.00%
TOTAL COST OF GOODS SOLD	5,393,750	0.0432	107.88%
GROSS PROFIT	(393,750)	(0.0032)	-7.88%
EXPENSES			
OPERATING EXPENSES			
Non-Production Labor (loaded)	281,250	0.0023	5.63%
Utilities (non-production)	125,000	0.0010	2.50%
Property Taxes	225,000	0.0018	4.50%
Supplies and Services	400,000	0.0032	8.00%
Total Operating Expenses	1,031,250	0.0083	20.63%
OTHER EXPENSES			
Principal and Interest	355,944	0.0028	7.12%
Income & Other Taxes			
Total Other Expenses	355,944	0.0028	7.12%
TOTAL OP. AND OTHER EXPENSES	1,387,194	0.0111	27.74%
NET PROFIT	(1,780,944)	(0.0142)	-35.62%

The total direct cost – the “cost of goods sold – to generate this power would be approximately \$5,400,000, or \$0.0432/kWh. Fuel costs (at \$18.00 per ton) are by far the largest component of this cost. At \$4.05 million, the cost of fuel alone consumes over 80% of revenues from electricity sales. Labor and other direct production costs total approximately \$1.35 million – labor approximately \$700,000, maintenance approximately \$350,000, and utilities approximately \$300,000. With this cost and revenue structure, the plant operates at a deficit of approximately \$400,000 per year, or nearly 8% of revenues, before indirect costs are accounted for.

Indirect costs total another \$1.4 million, \$0.011/kWh, or 28% of revenues. Of this total, \$1.03 million are represented by operating expenses including salaries for management and administrative staff (\$280,000), non-production utilities (\$125,000), supplies and services

(\$400,000), and property taxes (\$225,000). Another \$355,000 are annualized capital costs for purchasing the plant, assuming a purchase of \$2.5 million amortized over 10 years at a 7% interest rate.

With this cost structure, the total cost to operate a wood-fired plant in New Hampshire is approximately \$6.8 million per year, or \$0.0542/kWh. Against a projected electricity sales price of \$0.040/kWh, this implies that a plant would operate at a loss of over 35 percent – approximately \$1.8 million per year, or over 1.4 cents per kilowatt-hour.

It should be noted that this analysis does not include expenses associated with taxes, either federal or state, on corporate income or business profits. This is because, as the analysis shows, a wood energy facility operating without a rate order or other public policy intervention does not generate a profit, and thus would presumably not be subject to these taxes.

Simply put, wood-fired electricity cannot be expected to operate as a profit-making enterprise in New Hampshire without some sort of intervention to decrease costs or increase revenues.

3.4 Sensitivity to Revenue and Cost Projections

D/L and INRS performed a series of sensitivity analyses to identify the areas where the profitability of wood-fired electricity generation would be most sensitive to possible policy and/or economic intervention.

The income statement presented in Figure 3-2 can be broken down into four major components – revenues, fuel costs, capital costs, and operating costs. Intervention in any one of these – that is, action to increase revenues, or to decrease any of the three cost components – could be undertaken to improve the bottom line performance of wood-fired electricity in New Hampshire.

Of the four, operating costs are the least subject to improvement. In general, the owners of New Hampshire's plants can be expected to have optimized operating costs as part of their general management oversight in the fifteen to twenty years in which these plants have been operating, and there should be little room for further reduction in such items as production and management salaries, utilities, maintenance, and supplies. Presumably, property taxes could be forgiven in whole or in part as a local and state incentive to improve the profitability of wood-fired electricity, but even 100% property tax forgiveness would reduce a \$1.8 million operating deficit by only \$225,000, or 12.5%. Because of the fact that these costs are relatively inflexible, we did not conduct sensitivity analysis in this area.

Sensitivity to Electricity Sales Revenues. In absolute and proportional terms, the profitability of wood-fired electricity in New Hampshire is more sensitive to electricity sales revenues than to any other variable. Table 3-5 summarizes the projected profit or loss for a New Hampshire wood-fired plant as the electricity sales price is raised in half-cent increments from a base case of \$0.040/kWh. Each one-half cent increase in electricity price equates to \$625,000 in additional revenues, and the plant breaks even at an electricity sales price of \$0.0542/kWh.

Table 3-5							
Sensitivity of Wood-Fired Electricity Annual Profit (Loss) to Electricity Sales Price							
	Sales Price of Electricity (\$/kWh)						
	\$0.040	\$0.045	\$0.050	\$0.055	\$0.060	\$0.065	\$0.070
Plant Profit or (Loss)	(1,780,944)	(1,155,944)	(530,944)	94,056	719,056	1,344,056	1,969,056

Sensitivity to Fuel Cost. Consuming 80% of revenues under the base case scenario, the cost of wood chip fuel also has a major impact on the profitability of wood-fired electricity. The value of \$18.00/ton represents a historic average of forest-derived wood chip costs in New Hampshire, and is probably not much subject to manipulation. The possibility exists, however, to reduce this cost by bringing in clean urban wood waste, which can be had at a significantly lower per-ton cost (and in some cases as a revenue generating item) (see Section 3.5). If this can be done, each one-dollar reduction in the net delivered price of fuel to a wood-fired plant results in an increase of approximately \$225,000 in bottom line profit (Table 3-6). With all other costs and revenues held equal, a plant would break even with a wood cost of \$10.08/ton.

Table 3-6								
Sensitivity of Wood-Fired Electricity Annual Profit (Loss) to Fuel Cost								
	Cost of Wood Chip Fuel (\$/Ton)							
	12.00	\$13.00	\$14.00	\$15.00	\$16.00	\$17.00	\$18.00	\$19.00
Plant Profit or (Loss)	(430,944)	(655,944)	(880,944)	(1,105,944)	(1,330,944)	(1,555,944)	(1,780,944)	(2,005,944)

Sensitivity to Capital Cost. As discussed above, the buyer of an existing wood-fired plant should be willing to pay a purchase price that (when annualized) would allow him or her to cover all operating costs and meet required profitability targets. Table 3-7 explores the sensitivity of profitability to plant purchase price. Using a 10-year amortization period and a 7% interest rate, each \$1.0 million increase or decrease in the capital cost generates a \$142,000 impact on annual profit or loss. Under the base case scenario used in this analysis, a plant would operate at a deficit of over \$1.4 million per year even if its capital cost was reduced to zero.

Table 3-7								
Sensitivity of Wood-Fired Electricity Annual Profit (Loss) to Capital Cost of Plant Purchase								
	Capital Cost of Plant (Million \$\$)							
	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5
Profit or (Loss)	(1,425,000)	(1,496,189)	(1,567,378)	(1,638,566)	(1,709,755)	(1,780,944)	(1,852,133)	(1,923,321)

Sensitivity to Combined Variables. Tables 3-8 and 3-9 and 3-10 present the sensitivity of plant profits to combinations of two variables. With the linear financial model used in this analysis, the impact of manipulating two variables simultaneously is simply the sum of manipulating each of the variables on its own. Nevertheless, from a policy perspective, the possibilities and implications of intervening in more than one cost or revenue line item could be important.

Table 3-8 presents the joint sensitivity of plant profits to electricity sales price plus wood cost, and shows that any steps taken to reduce wood costs by even a dollar or two per ton would significantly reduce the electricity price intervention required to make a plant profitable. For example, if wood could be procured for \$15.00/ton, a plant would be profitable with electricity selling at \$0.049/kWh – that is, the required sales price intervention would be only 65% of that required if wood costs cannot be reduced.

Table 3-8								
Sensitivity of Wood-Fired Electric Plant Profits to Electricity Sales Price and Wood Fuel Cost								
Wood Cost (\$/Ton)	Sales Price of Electricity (\$/kWh)							
	\$0.040	\$0.045	\$0.050	\$0.055	\$0.060	\$0.065	\$0.070	\$0.075
\$12.00	(430,944)	194,056	819,056	1,444,056	2,069,056	2,694,056	3,319,056	3,944,056
\$13.00	(655,944)	(30,944)	594,056	1,219,056	1,844,056	2,469,056	3,094,056	3,719,056
\$14.00	(880,944)	(255,944)	369,056	994,056	1,619,056	2,244,056	2,869,056	3,494,056
\$15.00	(1,105,944)	(480,944)	144,056	769,056	1,394,056	2,019,056	2,644,056	3,269,056
\$16.00	(1,330,944)	(705,944)	(80,944)	544,056	1,169,056	1,794,056	2,419,056	3,044,056
\$17.00	(1,555,944)	(930,944)	(305,944)	319,056	944,056	1,569,056	2,194,056	2,819,056
\$18.00	(1,780,944)	(1,155,944)	(530,944)	94,056	719,056	1,344,056	1,969,056	2,594,056
\$19.00	(2,005,944)	(1,380,944)	(755,944)	(130,944)	494,056	1,119,056	1,744,056	2,369,056
\$20.00	(2,230,944)	(1,605,944)	(980,944)	(355,944)	269,056	894,056	1,519,056	2,144,056
Values in table are projected annual profit or (loss) for a 15MW wood-fired power plant								

Table 3-9 presents a similar two-way analysis for electricity revenues plus capital costs. Proportionately, the impact of reducing capital costs is much less than the impact of reducing fuel costs. Even if capital costs are eliminated entirely, electricity price intervention of over \$0.01/kWh is still required to eliminate projected operating deficits.

Table 3-9								
Sensitivity of Wood-Fired Electric Plant Profits to Electricity Sales Price and Capital Cost								
Capital Cost	Sales Price of Electricity (\$/kWh)							
	\$0.040	\$0.045	\$0.050	\$0.055	\$0.060	\$0.065	\$0.070	\$0.075
\$0	(1,425,000)	(800,000)	(175,000)	450,000	1,075,000	1,700,000	2,325,000	2,950,000
\$500,000	(1,496,189)	(871,189)	(246,189)	378,811	1,003,811	1,628,811	2,253,811	2,878,811
\$1,000,000	(1,567,378)	(942,378)	(317,378)	307,622	932,622	1,557,622	2,182,622	2,807,622
\$1,500,000	(1,638,566)	(1,013,566)	(388,566)	236,434	861,434	1,486,434	2,111,434	2,736,434
\$2,000,000	(1,709,755)	(1,084,755)	(459,755)	165,245	790,245	1,415,245	2,040,245	2,665,245
\$2,500,000	(1,780,944)	(1,155,944)	(530,944)	94,056	719,056	1,344,056	1,969,056	2,594,056
\$3,000,000	(1,852,133)	(1,227,133)	(602,133)	22,867	647,867	1,272,867	1,897,867	2,522,867
\$3,500,000	(1,923,321)	(1,298,321)	(673,321)	(48,321)	576,679	1,201,679	1,826,679	2,451,679
\$4,000,000	(1,994,510)	(1,369,510)	(744,510)	(119,510)	505,490	1,130,490	1,755,490	2,380,490
\$4,500,000	(2,065,699)	(1,440,699)	(815,699)	(190,699)	434,301	1,059,301	1,684,301	2,309,301
\$5,000,000	(2,136,888)	(1,511,888)	(886,888)	(261,888)	363,112	988,112	1,613,112	2,238,112
\$10,000,000	(2,848,775)	(2,223,775)	(1,598,775)	(973,775)	(348,775)	276,225	901,225	1,526,225
\$20,000,000	(4,272,550)	(3,647,550)	(3,022,550)	(2,397,550)	(1,772,550)	(1,147,550)	(522,550)	102,450
Values in table are projected annual profit or (loss) for a 15MW wood-fired power plant								

Table 3-10 provides a two-way analysis of sensitivity to wood costs and capital costs. As expected, because these variables individually have a smaller impact on profitability than does electricity sales revenue, their combined impact is also smaller. For example, even if capital costs were reduced to zero, wood cost would still have to be brought down to below \$12.00/ton to allow breakeven operation.

**Table 3-10
Sensitivity of Wood-Fired Electric Plant Profits to Wood Fuel Cost and Capital Cost**

Capital Cost	Wood Fuel Cost (\$/Ton)							
	\$11.00	\$12.00	\$13.00	\$14.00	\$15.00	\$16.00	\$17.00	\$18.00
\$0	150,000	(75,000)	(300,000)	(525,000)	(750,000)	(975,000)	(1,200,000)	(1,425,000)
\$500,000	78,811	(146,189)	(371,189)	(596,189)	(821,189)	(1,046,189)	(1,271,189)	(1,496,189)
\$1,000,000	7,622	(217,378)	(442,378)	(667,378)	(892,378)	(1,117,378)	(1,342,378)	(1,567,378)
\$1,500,000	(63,566)	(288,566)	(513,566)	(738,566)	(963,566)	(1,188,566)	(1,413,566)	(1,638,566)
\$2,000,000	(134,755)	(359,755)	(584,755)	(809,755)	(1,034,755)	(1,259,755)	(1,484,755)	(1,709,755)
\$2,500,000	(205,944)	(430,944)	(655,944)	(880,944)	(1,105,944)	(1,330,944)	(1,555,944)	(1,780,944)
\$3,000,000	(277,133)	(502,133)	(727,133)	(952,133)	(1,177,133)	(1,402,133)	(1,627,133)	(1,852,133)
\$3,500,000	(348,321)	(573,321)	(798,321)	(1,023,321)	(1,248,321)	(1,473,321)	(1,698,321)	(1,923,321)
\$4,000,000	(419,510)	(644,510)	(869,510)	(1,094,510)	(1,319,510)	(1,544,510)	(1,769,510)	(1,994,510)
\$4,500,000	(490,699)	(715,699)	(940,699)	(1,165,699)	(1,390,699)	(1,615,699)	(1,840,699)	(2,065,699)
\$5,000,000	(561,888)	(786,888)	(1,011,888)	(1,236,888)	(1,461,888)	(1,686,888)	(1,911,888)	(2,136,888)
\$10,000,000	(1,273,775)	(1,498,775)	(1,723,775)	(1,948,775)	(2,173,775)	(2,398,775)	(2,623,775)	(2,848,775)
\$20,000,000	(2,697,550)	(2,922,550)	(3,147,550)	(3,372,550)	(3,597,550)	(3,822,550)	(4,047,550)	(4,272,550)

Values in table are projected annual profit or (loss) for a 15MW wood-fired power plant

3.5 Consuming “Urban” Wood as an Option to Reduce Fuel Costs

Section 3.4 identified fuel costs as one of the two areas that might be able to be manipulated by policy tools to improve the overall economics of wood-fired electricity in New Hampshire. One option to do so is simply to subsidize the cost of fuel derived from low-grade forest resources (see Section 5.10). A second option is to supplement forest-derived wood chips with “urban” wood fuels – that is, wood generated as waste from other economic activities that could be diverted to fueling wood-fired electricity. Urban wood fuel has two advantages compared to forest-derived chips. It is drier, and so provides greater Btu value per ton. And more important, it is less expensive. The majority of urban wood is currently disposed of, with generators paying a “tipping fee” of as much as \$100+ per ton in Massachusetts and southern New England. If urban wood can be diverted to wood-fired electricity, procurement costs (before processing) should be zero or even negative. Although processing will add some cost back into this fuel (for chipping, quality control, etc.), the net impact of using urban wood would be a significant benefit to a wood-fired generator (Table 3-11).

Urban Wood as Percent of All Fuel	Net Fuel Cost as Cost of Urban Wood Fuel Increases from –5.00 to \$10.00 per ton			
	–\$5.00	\$0.00	\$5.00	\$10.00
10%	\$15.70	\$16.20	\$16.70	\$17.20
20%	\$13.40	\$14.40	\$15.40	\$16.40
30%	\$11.10	\$12.60	\$14.10	\$15.60
40%	\$8.80	\$10.80	\$12.80	\$14.80
50%	\$6.50	\$9.00	\$11.50	\$14.00

Note:
Values in table are the net cost of all fuel used by a wood-fired plant as the proportion of urban wood increases (reading down) and the cost of urban fuel increases (reading left to right). E.g., if a plant uses 30% urban wood at a cost of \$0.00 per ton, the net cost of all fuel to the plant is \$12.60/ton. The cost of whole-tree chips is assumed to equal \$18.00 per ton – the base case in D/L and INRS’s financial analysis.

There are technical and policy limitations on the quantity of wood fuel that can or should be consumed by New Hampshire’s electricity generators. Because of its low moisture, urban wood will affect the operating characteristics of any wood-fired boiler. Technically, each New Hampshire plant would have to find the balance of urban and whole-tree chips that optimizes overall financial and operating performance. To date, only one plant (Bio Energy) has invested in this exercise. From a policy perspective, replacement of too large a fraction of whole-tree chips could begin to compromise the objective of sustaining markets for low-grade forest products

3.5.1 Sources and Types of Urban Wood Fuel

There are four major sources of “urban” wood fuel. Three are potential fuel sources for wood-fired electricity. These are (1) Pallets; (2) Clean wood waste from residential and light commercial construction and renovation; (3) “Source separated” wood from construction and

demolition projects. Sources and quantities of these wastes are discussed in general terms in Sections 3.5.1.1 through 3.5.1.3. Section 3.5.2 discusses issues relevant to sourcing these waste streams as wood-energy fuel in New Hampshire.

(Wood segregated from mixed construction and demolition debris is the fourth source of “urban” wood fuel. But in no reasonable management scenario can this be sorted and cleaned to be acceptable wood-energy fuel under New Hampshire law and regulation, so it is not considered further in this analysis.)

3.5.1.1 Pallets

U.S. companies purchase approximately 500 to 600 million pallets each year. Of this total, about three-fourths are new, and about one-fourth are used pallets that have been recovered and repaired. Nationwide, pallet production consumes about 4.5 billion board feet of solid hardwood lumber annually, plus about 1.75 billion board feet of softwood lumber.

Total disposal of pallets in landfills in the U.S. has been estimated to equal 185 million pallets per year. With an approximate weight of 55 lbs/pallet, this represents approximately 5.1 million tons of pallets disposed of. According to a survey by Araman, the northeastern U.S. (New England plus NY, PA, NJ, MD, DE) accounts for about seven percent of this total, or about 360,000 tons of pallets landfilled annually.

Pallet recycling is widespread. There are over 120 pallet recyclers and manufacturer-recyclers in New England (Table 3-12), and nearly 500 such firms in the northeastern U.S. (The large majority of these firms are recyclers only, but most manufacturers also refurbish, resell, and/or recycle pallets in secondary markets.) Used pallets are sorted and directed to one of three primary end uses with declining value: as-is resale; resale after refurbishment; and recycling for wood recovery. A small number of pallets are dismantled to provide raw materials for refurbishing operations.

State	Number	State	Number
Maine	16	New York	109
New Hampshire	19	Pennsylvania	187
Vermont	7	New Jersey	41
Massachusetts	45	Maryland	19
Connecticut	26	Delaware	4
Rhode Island	9		
Total New England	122	Total Mid-Atlantic	360
		Total Northeast	482

Source: U.S. Census Bureau, County Business Patterns, 1999

A large number of pallets are also disposed of directly to end markets by large generators (primarily large corporations with significant shipping and receiving functions). Most of these pallets are either disposed of or destructively recycled.

Pallets that reach the hands of recyclers but cannot be resold or refurbished are almost always ground or chipped. Chips from recycled pallets are marketed to one of a number of end uses, including mulch, animal bedding, compost, landfill cover, furnish for particleboard, and boiler or wood-to-energy fuel.

3.5.1.2 Clean Construction Wastes

Clean construction wastes consist of untreated, unpainted dimensional lumber and manufactured wood products (e.g., plywood, OSB) that are segregated for recycling during the construction process. Their primary sources are residential construction and renovation and light commercial construction and renovation.

Residential new construction generates about 1.5 to 2.0 pounds of wood waste per square foot of floor space (3,000 to 4,000 pounds for a 2,000 sq ft home, or 7,500 to 10,000 pounds for a 5,000 sq ft home). Almost all of this consists of trim from dimensional lumber, plywood, oriented strandboard, and other manufactured wood panels. Wood-framed commercial construction can be expected to generate similar quantities. Nationally, the total quantity of wood waste from new residential construction has been estimated at approximately 2.5 million tons/year, and the quantity from non-residential new construction at 1.5 to 2.0 million tons/year.

It is not possible to generalize quantities of clean wood from residential and commercial renovation on a per square foot basis, because of the diversity of projects encompassed by the term “renovation.” Nationwide, however, it is estimated that the total quantity of wood waste from renovation projects is 5 to 10 times the quantity from new construction, or as much as 25 million tons per year. The fraction of this waste stream potentially useful as wood-energy fuel includes only that derived from new and replacement construction activity; because of its uncertain origin and composition, wood from the demolition phase of a renovation project is classified as a “source separated” waste.

The common characteristic of all clean wood wastes is that they are easily identified, they are generated during specific phases of a construction or renovation project, they are uncontaminated with other building and furnishing materials, and they are easily separated from all other wastes generated during a construction/renovation project.

3.5.1.3 Source-Separated Wood Wastes

“Source-separated” wood wastes consist of wood derived and separated from other wastes in demolition and reconstruction projects. Source-separated wood possibly useful as wood-energy fuel includes untreated dimensional lumber, plywood, and wood panel products, plus the majority of surface-treated (i.e., stained and painted) lumber, plywood, and other panels; it specifically *excludes* all pressure-treated and creosoted products, and products of which the origin and composition cannot be reasonably well documented.

The composition of materials derived from demolition obviously mirrors the composition of materials in new construction, with the significant caveat that a large fraction of wood products cannot practically be separated from the mixed debris characteristic of demolition. Potentially recoverable wood may be only 15-20 percent of all waste from residential or commercial demolition, compared to about 40 percent of the waste from new construction. Nationally, the total quantity of source-separated wood waste can be approximated at 6 to 10 million tons/year.

3.5.2 Quantities of Wood Waste Generated in New England

Table 3-13 summarizes D/L’s and INRS’s estimates of the total quantities of “urban” wood generated in the northeastern United States, including state-by-state estimates for New

Hampshire, Massachusetts, and Vermont – the most logical procurement area for wood-fired plants in New Hampshire. (Maine already has extensive infrastructure to provide these types of fuels to its own population of wood-fired boilers, so we exclude Maine as a possible source of fuel for New Hampshire plants.) Table 3-13 also compares the estimated quantities of urban wood generated to the total quantity of whole tree chips currently consumed by New Hampshire’s wood-fired generators, which is 1,300,000 tons/year.

Table 3-13					
Quantities of “Urban” Wood Generated in the United States					
Region	Quantities of “Urban” Wood Waste by Type (Tons/Year)				
	Pallets	Clean Wood, New Construction	Clean Wood, Renovation	Source-Separated Wood	Total
United States	5,100,000	4,250,000	20,000,000	8,000,000	37,350,000
Northeast	360,000	1,074,514	5,056,537	2,022,615	8,513,666
New England	85,031	253,799	1,194,346	477,739	2,010,915
New Hampshire	6,038	18,021	84,806	33,922	142,787
Massachusetts	40,000	119,390	561,837	224,735	945,963
Vermont	3,019	9,011	42,403	16,961	71,393
Current Demand, New Hampshire Wood-Fired Generators					1,300,000
Notes:					
“Northeast” includes New England plus NY, PA, NJ, MD, DE					
Quantities of wood from Northeastern states based on national estimates; estimated based on proportion of state’s Gross State Product to U.S. Gross Domestic Product					

Several conclusions can be drawn from this table:

- If it could be tapped, “urban” wood from a reasonable procurement radius has the capability to supply a meaningful fraction of the fuel required by New Hampshire’s wood-fired generators.
- The largest single source of “urban” wood fuel is generated from residential and commercial renovation projects, followed by source-separated wood from construction and demolition, clean wood from new construction, and pallets.
- The relative size of urban wood stockpiles is roughly the reverse of their ease of procurement. That is, pallets and clean wood from new construction are the simplest types of wood waste to segregate, but are the smallest sources. Source-separated wood and wood from renovation projects are larger sources, but are more difficult to segregate and manage for quality.

3.5.3 Procurement of “Urban Wood” as Fuel

Unfortunately, several barriers stand between the identifiable supplies of urban wood and their delivery to New Hampshire wood-fired generating plants as fuel.

The first is separation from other wastes. No law or policy exists in any New England state that mandates or encourages the separation of re-usable wood from other wastes. As a result,

essentially 100% of the wood wastes generated from construction and demolition projects throughout New England – and throughout the United States – continue to be discarded.

Pallets are a partial exception, in that a thriving recycling market does exist. However, most evidence suggests that even the majority of used pallets end up in landfills. And even among pallets that are ultimately chipped, most are marketed locally for mulch or other landscaping uses.

The second major barrier is logistics and transportation costs. Because they cannot be efficiently compacted, construction wastes are notoriously costly to haul. Whatever monetary savings a generator might realize by segregating wood wastes for use as fuel can rapidly be overshadowed by 200+-mile round-trip haul cost to take a few tons of scraps to a New Hampshire wood-fired plant site. For example, the cost to haul a 4-ton load of wood scraps from a construction site in Boston to a wood-fired plant in Bridgewater or Tamworth would be approximately \$225-\$250, or \$55-\$60 per ton.

This problem could be addressed if wood wastes were processed at a central location close to the sites where they are generated, and then hauled as chips to the wood-fired plants. Transportation costs in this case would decrease by a factor of three or four. This solution is unlikely, however, for at least two reasons. First, without a government-imposed mandate to separate wood wastes, it is difficult to envision a business being successfully organized to procure and re-market wood from dozens or hundreds of disparate generators. It is equally difficult to envision one of New Hampshire's wood-fired operators setting up such an operation in Massachusetts or further south, in the urban/suburban areas likely to generate significant quantities of urban wood waste. (At least one New Hampshire operator has investigated and rejected the possibility of such an operation as economically infeasible.) Second, quality control becomes a major issue with a remote processing facility. In any procurement scenario, the wood-fired plants must be able to enforce strict controls on the quality of urban wood accepted as potential fuel. These can become difficult or impossible to enforce at a remote processing location, especially one operated by a third party.

A major barrier relevant to source-separated wood waste is its regulatory classification in New Hampshire. Any wood-energy facility proposing to consume source-separated wood waste would be classified as a solid waste incinerator under New Hampshire law and regulation, and would have to be permitted as such. Although one New Hampshire facility (Bio Energy in West Hopkinton) has submitted a solid waste permit application to burn source-separated wood (supplementing the clean wood wastes it already consumes), INRS and D/L do not consider this a likely, or necessarily a laudable strategy to replicate at other wood-fired plants in the state.

3.5.4 Conclusions Regarding Limited Use of Urban Wood

In the short term, sourcing “urban” wood is not an economically or practically viable option to lower fuel costs for New Hampshire's wood-fired generators. In the long term, however, the barriers to sourcing urban wood fuel can be addressed. The simplest and most direct step to do so is to ban the landfill or incineration of pallets and clean wood waste, and to provide startup support to establish central (or mobile) processing facilities capable of producing quality wood chip fuel. Unfortunately for New Hampshire's wood-fired plants, the most meaningful steps required to achieve this end cannot be taken in New Hampshire, because the state simply does not generate enough wood waste to have a meaningful impact on overall wood fuel prices. The state, can, however, be active in supporting policy steps elsewhere in New England and the Northeast, offering its wood-fired electricity plants as a market for clean wood chips generated elsewhere in the region.

A preliminary step toward this goal could be to ban the open burning of clean wood wastes by New Hampshire's communities. Although precise tonnage figures are not available, the N.H. Department of Environmental Services estimates that over 100 of New Hampshire's 223 municipalities continue to burn clean wood waste in local burn piles. Given that local specifications for wood consumed in these piles are equivalent to a specification for clean wood waste (dimensional lumber and panels, brush and stumps, incidental quantities of painted and stained wood), there is little environmental risk in such a policy, and possibly significant environmental benefit in transferring combustion of these wastes into the controlled, and emission-controlled setting of a wood-fired boiler.

It should be emphasized that while urban wood can help reduce fuel costs for wood energy facilities, this displaces a market for low-grade wood derived from forestry or sawmill activities. If the state pursues urban wood as part of a feedstock, it may wish to consider limitations on the percentage of urban wood a facility can use – thus assuring a continued market for forest-derived low-grade wood. There may also be technical and practical limitations to the amount of low-grade wood a facility can use, specific to each location.

SECTION FOUR

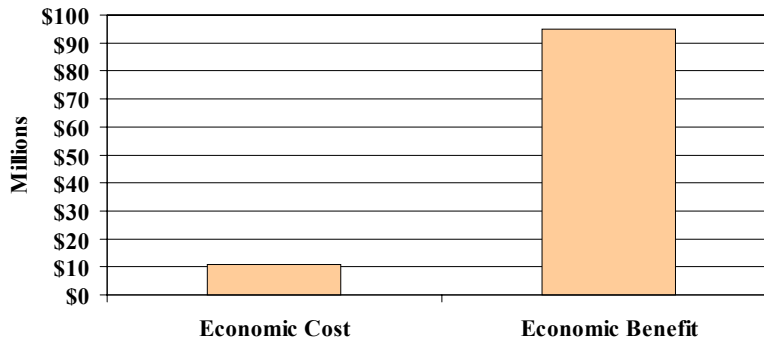
BENEFIT AND COST ANALYSIS OF WOOD-FIRED POWER

The financial projections presented in Figure ES-1 imply that, in an entirely unregulated market, a single wood-fired plant typical of those in New Hampshire would operate at an annual deficit of approximately \$1.8 million. As a first order approximation, therefore, the “above market” financial assistance required to keep this industry alive in New Hampshire is approximately \$10.8 million per year – \$1.8 million/year for each of six plants.

The benefits of this assistance far outweigh the cost. The direct economic benefits of wood-fired power in New Hampshire are approximately \$38,550,000 per year, yielding a benefit: cost ratio of 3.6:1. The total benefits of the industry, conservatively estimated, are approximately \$95,000,000 per year, yielding a benefit: cost ratio of 8.9:1. The number of jobs directly supported by the industry is approximately 500 – about 125 directly employed by the plants, and some 375 employed in New Hampshire’s logging industry to provide the 1.3 million tons of raw materials consumed by the plants.

Figure 4-1

Costs and Benefits of Supporting Wood-fired Electricity in New Hampshire



Note: This does not include benefits associated with forest management, open space conservation, the state’s sawmill industry, emission reductions, climate change mitigation, or energy sustainability

This study did not quantify the economic benefits associated with emissions reductions, climate change, waste disposal of sawmill residue, or energy sustainability. Other published literature indicates that these activities alone account for \$0.114 / kWh of non-electric benefit.

More importantly to New Hampshire, this study did not attempt to put a monetary value on the importance of the market created by wood energy plants, though its importance to the forest industry and the state is enormous. The market for 1.3 million green tons of chips annually is one of the state’s largest markets for low-grade wood. This market allows landowners to use best forest practices when managing their land, contributes to the creation of wildlife habitat, and supports private ownership of open space throughout the state. Markets for low-grade wood are a

critical component of the state's \$8.2 billion open space economy. These markets are also critical for the state's sawmill economy that relies upon wood energy plants both to support the infrastructure of the timber harvesting industry, and to provide an outlet for sawmill residue.

While these many benefits were not quantified, a conservative review of the economic impact of the six wood-fired power plants demonstrates the enormous continued economic benefit that can be provided to the State with modest investment. When coupled with the numerous benefits derived for the state's environmental health and forest industry, the modest investment required to keep the wood-fired power plants operational is clearly justified by the enormous return..

SECTION FIVE

POLICY OPTIONS THAT ENCOURAGE CONTINUED OPERATION OF WOOD-FIRED POWER PLANTS

Sections 1 through 4 of this analysis have documented the economic and environmental benefits of sustaining the wood-fired power industry in New Hampshire, and have estimated the level of support required to achieve this goal. The financial analysis presented in Section 3 points to the two areas where policy intervention can be most effective to allow wood-fired power to be produced on at least a breakeven basis: (1) Policies that assure that the price paid for wood-fired electricity is sufficient for continued operation of the plants; and (2) Policies that reduce fuel costs. While it is clear that the State will not revert to a regulated utility marketplace where either input or output prices are set by contract and/or administrative action, there are numerous policy options that can achieve the goal of supporting the wood-fired power industry with less prescriptive intervention. These are summarized in Table 5-1. (It should be noted that all of these policy options are intended only for facilities that have terminated or expired rate orders. There is no indication that wood-fired power plants need to either reduce costs or enhance revenues in order to earn a profit while their rate orders are in place.)

Table 5-1 Overview of Policies to Promote Continued Production of Wood-Fired Power		
Level of Implementation	Policy Goal	
	Assure Price Paid for Output is Sufficient for Continued Operation	Reduce Fuel Costs
State Government	1. Renewable Energy Portfolio Standard 2. System Benefits Charge 3. State Tax Subsidy 4. Promotion of “Green Power” Marketing	7. Subsidy to Whole Tree Chip Purchases 8. Prohibition of Open Burning of Clean Wood Waste 9. Disposal Ban on Clean Wood Waste 10. Promotion of Regional Policies to Capture Clean Wood
Federal Government	5. \$0.015/kWh Federal Income Tax Incentive 6. \$0.015/kWh Federal Incentive Payment to Qualifying Wood-Energy Generators	

At least six policies could be implemented that would have the direct or indirect impact of increasing the price paid to the plants for their output. Four of these are policies that can be implemented at the state level. Two are policies that rely on federal action, but are based on legislation already under consideration by the U.S. Congress. In these cases, the state could take action through its Congressional delegation to help assure their ultimate passage in a form that will assist New Hampshire’s wood-fired power industry.

Four additional options have the impact of reducing the cost of fuel for wood-fired power generation. As noted in Section Three, reducing fuel costs, by itself, is unlikely to yield sufficient savings to sustain wood-fired power generation as a breakeven or profit-making enterprise. But policies that tend to reduce fuel costs can be a valuable complement to policies that enhance electricity sales revenues, and can promote other environmental and waste management goals of importance to the state and region.

5.1 Renewable Energy Portfolio Standards

Summary: A renewable portfolio standard, or RPS, is a regulatory requirement that any firm selling electricity to consumers in New Hampshire must derive a proportion of that electricity from renewable sources. An RPS can be more or less prescriptive – that is, it can precisely specify the quantities and types of generation included in the renewable portfolio, or it can establish more general guidelines that leave electricity providers considerable leeway to select the quantities and sources of renewable power they provide.

Steps Required for Implementation: Legislation is required to enact an RPS. A legislatively enacted RPS can achieve the goal of ensuring continued operation of New Hampshire’s wood-fired plants in one of two ways -- directly, by establishing fixed kilowatt-hour purchase requirements for wood-fired electricity, or indirectly, by establishing more general RPS requirements that are high enough to have the practical impact of guaranteeing continued operation of the wood-fired plants.

Legislation has already been considered in New Hampshire that follows the second, indirect, approach. House Bill 718 (2001 legislative session), as introduced, defined two classes of renewable electricity generators, and set RPS targets by generator class for all electricity sold in New Hampshire. The House Science, Technology and Energy Committee eventually rejected HB 718 as introduced “because of the concerns such a policy would have had on the price of electricity in New Hampshire.”

Financial Impact, State: None

Financial Impact, Ratepayers: The rate impact of an RPS depends on the sources and prices of renewable power utilized. If the majority of power is supplied by hydroelectric facilities, for example, the impact should be neutral or favorable to ratepayers. If the majority of renewable power were supplied by wood-fired plants, the impact could be moderately unfavorable to ratepayers. INRS and DL estimate that in the most unfavorable ratepayer scenario, where 100% of an RPS consisted of wood-fired power at a price sufficient to sustain operations at all six plants, the impact on ratepayers would be at most two to three percent.

Advantages:

- Non-prescriptive, market-based. Renewable electricity provided by the least-cost providers. Provides an incentive for efficient, low-cost operations.
- May promote competition to purchase power from the existing wood-fired plants, providing relatively strong and stable revenues for wood-fired electricity producers.
- Flexible. Can be fine-tuned to achieve different policy ends over time.
- No cost to the state.
- Controlled by the state. Does not depend on federal or other action.

Disadvantages:

- Non-prescriptive. May not provide sufficient guarantee of adequate long-term revenue stream to encourage investment in continued operation of wood-fired plants.
- May result in increased electric rates to consumers.

Discussion: RPS requirements can be an effective means to assure continued operation of wood-fired generators in New Hampshire.

Renewable resources identified in HB 718 currently generate about 16% of the electricity used in New Hampshire, or about 1,550,000 MWH per year. Of this total, about half, or about 750,000 MWH per year, comes from the independent wood-fired facilities. Almost all of the remainder comes from hydroelectric plants. New Hampshire has a total capacity of about 210 MW of hydroelectric power – about 125 MW in facilities less than 12 MW (“Class I” facilities according to definitions established by HB 718), and about 85 MW in facilities between 12 and 25 MW (“Class II” facilities) – compared to about 90 MW in the six operating wood-fired plants.

Because hydroelectric facilities operate at a much lower and more unpredictable fraction of their potential capacity than wood-fired plants, electricity suppliers seeking to comply with such a standard would almost certainly attempt to secure the bulk of their renewable portfolio from the wood-fired plants. With multiple suppliers presumably competing to provide electricity in an unregulated market, the demand for renewable capacity may ultimately be greater than the sum of the capacities of the currently operating plants. This should provide secure and stable demand that would encourage long-term investment in continued operation of these facilities. This will be particularly likely if other, surrounding states also implement renewable portfolio standards, as has been done in Maine, Massachusetts and Connecticut.

If the goal of RPS legislation is to guarantee operation of the wood-fired power plants, legislation would be most effective by incorporating language specifically to achieve this end -- for example, by including a kilowatt-hour purchase target from New Hampshire wood-fired generators. RPS legislation geared to promoting markets for low-grade forest resources could also specify the percentage of wood fuel procured from in-state sources.

More generally, however, the possibility of successfully implementing an RPS in New Hampshire would benefit most from the wide distribution of information to document the economic and environmental benefits of wood-fired electricity. Without such information, it is by no means certain that the legislature or ratepayers will ultimately be receptive to any RPS requirement at all. It *is* certain that there will be resistance to an RPS (particularly one as relatively aggressive as that proposed in HB 718, or one targeted more specifically to wood-fired electricity).

5.2 System Benefits Charge

Summary: A System Benefits Charge (SBC) is a per kilowatt-hour surcharge on electricity rates designed to fund “public benefit programs” as defined by the NH Public Utilities Commission (PUC) under enabling New Hampshire law. A System Benefits Charge could be structured to provide a payment to New Hampshire’s wood-fired electricity producers to bring their total revenues to a level that would make continued operations profitable.

Steps Required for Implementation: At a minimum, this would require action initiated by the NH PUC. Given the complexity of the issue, the controversy that has surrounded wood-fired electricity in New Hampshire, and the further controversy that can be predicted if an SBC is proposed to support wood-fired power, it is almost certain that legislative action would be

required to initiate this option. If implemented, the SBC would take the form of a per kilowatt-hour charge on all electricity sold in the state, with the proceeds passed on to wood-fired generators in the form of a per-kilowatt-hour payment, or on another basis established by the PUC or legislature.

Financial Impact, State: The state would incur costs to administer the SBC. Presumably these would be paid from the SBC itself, so that the net financial impact on the state would be zero.

Financial Impact, Ratepayers: The SBC would amount to a subsidy paid by all electricity consumers to provide for continued operation of the wood-fired power plants. Its cost to ratepayers would be dependent on the size of the payments to wood-fired generators, and on the proportion of total New Hampshire electricity sales supported by the SBC payments. Expressed on a per kilowatt-hour basis, the SBC would be much smaller than the payment to generators. For example, if wood-fired generators supplied 10% of all of the electricity sold in New Hampshire, a \$0.001/kWh (one-tenth of a cent per kWh) SBC (about one percent of current electricity rates) would be sufficient to provide a \$0.01/kWh (one cent per kWh) subsidy to wood-fired power.

Advantages:

- Auditable. Could be designed and implemented in a manner requiring wood plants to divulge their capital and operating costs, and limiting SBC payments to provide them with a predetermined level of profitability.
- Flexible. Unlike a fixed subsidy, can be tuned over time to provide constant level of profitability.
- Can be specifically targeted to wood-fired electricity.
- Could be linked to other “public benefit” requirements, e.g. provisions making funds available only to plants under certain ownership structures, restrictions on wood sources, etc.
- No direct cost to the state.
- Spreads cost of supporting wood-fired electricity equitably over all consumers of electricity in NH.
- Controlled by the state. Does not depend on federal or other action.

Disadvantages:

- Requires NH legislative action.
- Probability of opposition from multiple sources (legislators, business community, other ratepayers) to subsidy for wood-fired power.

Discussion: System benefits charges are set by the NH PUC in the tariffs it establishes with each company providing electricity to New Hampshire customers. SBCs are a relatively new regulatory construct which replace a variety of separate charges formerly incorporated into utility rates (for example, “conservation charges,” “interim energy assistance charges,” and others). SBCs have been established by the PUC for some but not all of the electricity providers operating in New Hampshire.

Support for wood-fired electricity is clearly within the legislative bounds established for SBCs in New Hampshire, which include “programs for low income customers, energy efficiency programs, ... support for research and development, and investments in commercialization strategies for new and beneficial technologies” (RSA 374-F:3-VI). It is unclear, however, whether legislative support could be developed for such a direct subsidy to wood-fired electricity.

If utilized, however, the SBC provides an excellent approach to leverage ratepayer dollars to support wood-fired electricity. For example, DL and INRS calculate that the cost of producing wood-fired electricity in New Hampshire is about \$0.014/kilowatt-hour more than expected revenues (see Section 3.3). With wood-fired generators producing somewhat less than 10% of all electricity used in New Hampshire, the SBC required to close this financial gap would be roughly \$0.001/kilowatt-hour. On an average residential rate of about \$0.09/kWh, this amounts to an increase of about one percent.

5.3 State Tax Credit for Purchase of Wood-Fired Electricity

Summary: The simplest of several possible state tax-based subsidies would:

- 1) Mandate purchase by utilities of wood-fired power, at a price sufficient to keep wood-fired plants in operation;
- 2) Calculate the excess price paid by utilities for wood-fired power compared to the open market price otherwise paid for the same amount of electricity;
- 3) Reduce utilities’ state tax liability (Business Profits Tax or other tax) by a sum equivalent to all or a fraction of excess payments to wood-fired generators.

Steps Required for Implementation: Legislation and subsequent regulation and administrative action would be required to enact this option. The legislation would:

- 1) Establish a mechanism to determine and periodically adjust the “supported” price paid for wood-fired electricity (i.e., the price required to keep the wood-fired plants operating);
- 2) Mandate utility purchases of wood-fired power at the “supported” price;
- 3) Establish a mechanism for determining the amount of excess payments by utilities for wood-fired power (i.e., the difference between the supported price of wood-fired power and the market price otherwise paid);
- 4) Identify the business tax source from which subsidies for wood-fired power purchases would be taken;
- 5) Determine the proportion of excess payments for wood-fired power that would be repaid by subsidy, the proportion (if any) that would be borne by ratepayers, and the proportion (if any) that would be uncompensated to utilities;
- 6) Identify the state tax(es) against which credits would be taken;
- 7) Assign administrative responsibility for establishing and managing the program (calculating excess payments by utilities, calculating tax implications, managing and verifying utility credit and tax claims, etc.)

Financial Impact, State: The state would lose whatever tax revenues are credited to utilities to compensate their “excess” payments for wood-fired electricity. The state would incur substantial additional costs to administer this program.

Financial Impact, Ratepayers: Ratepayers could be required to bear none or some of the costs of supported price purchases from the wood-fired facilities. If utilities were allowed a 1:1 write-off of state tax liabilities against the excess cost of wood-fired power purchases, ratepayers would bear no impact. If, however, the compensation to utilities against tax liabilities is less than 100% of the excess cost of wood-fired power, then the gap would presumably be made up through increased rates.

Advantages:

- Spreads cost of supporting wood-fired electricity across all NH taxpayers, not only electric customers.
- Auditable. Could be designed and implemented in a manner requiring wood plants to divulge their capital and operating costs, and limiting compensation to provide them with a predetermined level of profitability.
- Flexible. Can be tuned over time to provide constant level of profitability to wood-fired plants.
- Can be specifically targeted to wood-fired electricity.

Disadvantages:

- Administratively complex. Achieves essentially the same end as a System Benefits Charge, but with much more complexity.
- Reduces general fund revenues.
- Certain to provoke spirited opposition from utilities and the business community.
- Unlikely that wood-fired generators operating in an unregulated market would produce sufficient profits to take advantage of this incentive.

Discussion: By a wide margin, this is the most complex of the options available to provide financial support to wood-fired generators. It accomplishes the same goal as a System Benefits Charge – namely a per kilowatt-hour incentive to produce wood-fired power – but uses a much more complex mechanism. Its principal advantage compared to the SBC is that it spreads the cost of this subsidy across all taxpayers in the state, not only electricity users. But given that virtually every taxpaying resident and business in the state is also an electricity consumer, this may hardly be a point of differentiation.

Its base in general fund revenues is also a major disadvantage of this option. Serious opposition to this or any other state tax-based incentive for wood-fired power can be expected, especially with the state facing structural budget deficits stretching indefinitely into the future.

5.4 Non-Regulatory Incentives to Promote Marketing of “Green Power”

Summary: This is, in essence, a voluntary Renewable Portfolio Standard. Electricity providers selling in New Hampshire would be required to offer “packages” of power that include wood-fired electricity, along with, and in competition with, packages of power that do not include wood-fired electricity. These green power packages would be market priced – that is, if wood-fired power costs more than power from other generators, then the green package would be priced higher than non-green power. The electricity providers would promote green power to consumers, who would have the choice of selecting green power from among other generation packages offered.

Steps Required for Implementation: Legislation and subsequent PUC action would be required to enact this option. The legislation would:

- 1) Define green power in a way that specifically includes wood-fired electricity from New Hampshire generators;

- 2) Require providers of electricity in New Hampshire to offer consumers a choice of this green power along with other competing sources of electricity.

Financial Impact, State: None

Financial Impact, Ratepayers: Dependent on implementation and ratepayer choice. Any ratepayer could choose not to consume green power, and so would bear no cost to support wood-fired electricity. The impact on ratepayers who do choose green power would depend on the structure of providers' green power portfolios, which would in turn depend on the authorizing legislation. In general, green power can be expected to be more expensive than non-green options under current market conditions, and green power from wood-fired plants can be expected to be somewhat more expensive than green power from other sources, particularly hydroelectricity (see *Discussion*).

Advantages:

- Voluntary, market-based, non-regulatory program.
- Consumers who support continued operation of wood-fired power plants have the opportunity to support this goal. Consumers who do not share this goal are not required to support wood-fired power.

Disadvantages:

- Based on experience to date, this option is unlikely to stimulate sufficient demand to keep the wood-fired plants operating.
- No wood-fired operator is likely to keep operating absent a stronger guarantee of consumption of his/her output.
- Market signals to consumers do not include the multiple benefits of keeping wood-fired plants operating in New Hampshire.

Discussion: Green power marketing was discussed at some length in the Phase I Final Report of this project, with the conclusion that this option is unlikely to sustain adequate demand for the output of New Hampshire's existing wood-fired power plants. This conclusion is unchanged.

There are several reasons. Most important, even where electricity markets have been deregulated, there is little evidence that most consumers are really paying attention. When they are available, the majority of residential consumers are sticking with the power packages offered by their historic service providers, or with the "default" or "transition" packages offered to consumers who fail to choose an alternative. (This has been the overwhelming experience in New Hampshire's retail competition pilot program, even though participants in the pilot were self-selected in part on the basis of their inclination to choose an alternative electricity provider.)

Furthermore, in jurisdictions where green power has been offered as a choice contrasted to non-green electricity, demand has not been particularly strong. Evidence from Pennsylvania (where green power has been most widely available in competition with other, non-green power) suggests that about 20% of residents who choose to switch electricity providers are selecting a green option. The proportion of business and industrial consumers who choose green power is much smaller. While 40% to 80% of consumers who respond to customer choice surveys indicate their willingness to pay a premium for green or renewable power, the proportion who have actually chosen to do so is far, far less.

Price is another issue. In states where green power options have not been subsidized, green power packages have typically been priced at a premium of about one to three cents per kilowatt-hour above the price of non-green options. If this experience is repeated in New Hampshire, where consumers are already quite sensitive to high electricity rates, it can be predicted that green power will win few converts among residential consumers, much less among business and industrial users of electricity. The price premium for voluntary green power packages can also be contrasted to the premium represented in Renewable Portfolio Standards or System Benefits Charges, which amount to one or two *tenths* of a cent per kilowatt-hour.

In summary, in the short term green power appears to have no more than a niche market, capable of attracting a few percent of residential electricity consumers, fewer still among business and industrial customers. At most, green power might attract a percent or two of New Hampshire's total demand for electricity. Even if electricity providers offered a 100% wood-fired product, this is far, far less than the demand required to keep the wood-fired plants operating.

The long-term outlook for green power is not really predictable, but is not much more hopeful. There is little evidence to suggest that, without active and continuing engagement from the legislature, PUC, and electricity providers, marketing of "green power" will evolve into a tool capable of ensuring the economic viability of wood-fired electricity in New Hampshire.

5.5 Federal Tax Incentive for Qualifying Renewable Resources

Summary: Legislation will be taken up by the U.S. Congress in 2002 that will include a \$0.015/kWh credit against federal income taxes for new or existing wood-fired power plants.

Steps Required for Implementation: Implementation of this option will require passage of federal legislation, and New Hampshire can influence this outcome only by working through its Congressional delegation.

Financial Impact, State: None

Financial Impact, Ratepayers: None

Advantages:

- No direct state action required
- No cost to State or to New Hampshire ratepayers
- \$0.015/kWh should be more than sufficient to allow profitable continued operation of wood-fired plants in New Hampshire, and possibly to promote re-opening of one or both mothballed facilities.
- Compared to federal incentive payments, does not require specific ownership structures. Available to current or any future owner of N.H. biomass facilities.
- Compared to federal incentive payments, does not require funding through annual appropriation.

Disadvantages:

- Appears unlikely that N.H. generators would generate sufficient income in an unregulated electricity market to take full or even partial advantage of this credit.

(Depending on implementation, however, the credit could be made available to parent firms of local generating companies.)

- This tax provision faces challenges to passage. A similar provision, Section 107 of S. 1792, was proposed in 1999, and eventually dropped during a Committee of Conference. Biomass power industry representatives are not confident of passage.

Discussion: This federal legislation would extend and expand to all new biomass-fired electricity producers an existing federal income tax credit that is now available only to “closed loop” biomass energy producers (i.e., producers whose fuel crop is grown specifically for the production of biomass-fired electricity). It would allow the owner of a biomass plant to take a \$0.015 write-off against federal income taxes for each kilowatt-hour of electricity produced and sold.

Unless written in a manner that allows use of the credit by corporate parents, this credit might be of limited utility in New Hampshire. For a plant generating 130,000,000 kilowatt-hours per year (the approximate average of New Hampshire’s operating wood generators), the maximum annual value of the tax credit would equal \$1.95 million. A plant could take advantage of this maximum credit only if its federal income tax liability reached this level. If its income tax was less, the value of the credit would be less. The financial analysis carried out for this study (see Section Three) suggests that, in an unregulated market, none of New Hampshire’s plants will yield profits that would generate a tax liability of \$1.95 million, and therefore none could take advantage of the credit.

This drawback might be overcome if a plant were owned by a larger organization, which could use credits from New Hampshire to offset taxes on profits from operations in other states. But it is by no means certain that profits from a New Hampshire plant would be sufficient to attract investment from such an outside organization, even accounting for the financial impact of the credit. To rely on this outcome would be a policy of dubious merit.

5.6 Federal Direct Payment Incentive for Qualifying Renewable Resources

Summary: Energy legislation passed by the U.S. House of Representatives (the Securing America’s Future Energy, or SAFE, Act of 2001, passed on August 2, 2001) includes a \$0.015/kwh subsidy through 2023 for biomass-generated electricity from facilities owned by non-profit cooperatives, state or municipal governments, and certain other non-utility owners. Funding for the program is subject to annual appropriation. This legislation extends an existing, very similar incentive payment program that is scheduled to expire in 2012. The legislation is scheduled to be taken up by the U.S. Senate in February 2002.

Steps Required for Implementation: Three steps are required. The first is passage by the U.S. Senate and signature by the President. The second is appropriation by Congress, on an ongoing basis, of adequate funding to make the incentive payments. The third is formation in New Hampshire of ownership organizations that can take advantage of this incentive payment, and their purchase of one or more of the existing wood-fired plants.

Financial Impact, State: None

Financial Impact, Ratepayers: None

Advantages:

- No direct state action required

- No cost to State or to New Hampshire ratepayers
- \$0.015/kWh should be sufficient to allow profitable continued operation of wood-fired plants in New Hampshire, and possibly to promote re-opening of one or both mothballed facilities.
- Cooperative or government ownership organizations may not require as high rates of return as private owners, encouraging transfer of currently operating plants to such organizations.

Disadvantages:

- Has yet to be considered or passed by the U.S. Senate.
- Available only to specified cooperative or government ownership organizations, not to current plant owners.
- Dependent on annual Congressional appropriations.

Discussion: If enacted, this direct incentive appears to be a simple and elegant approach to allow New Hampshire’s wood-fired plants to continue operating. The financial analysis in carried out for this project (see Section Three) suggests that the wood-fired plants are about \$0.014/kWh away from profitable operation in an unregulated market. This \$0.015/kWh incentive payment would more than bridge this gap.

One barrier to application of this option is its requirement that qualifying plants be owned by a government entity or by a tax-exempt cooperative. DL and INRS believe, however, that such cooperatives could be organized to purchase most or all of the wood-fired plants in the State, with cooperative members drawn from the many constituencies who have an interest in seeing these plants remain open (e.g., landowners, foresters and loggers, government and quasi-government organizations, charitable and socially responsible investors). The cooperatives could either operate the plants directly or retain a qualified professional operator.

A second and perhaps more intractable barrier is the requirement that funds for these incentive payments must be appropriated annually. If a plant would not be profitable without the incentive payments, no sensible investor would commit to purchasing and operating a plant if this income stream was not guaranteed over the life of his/her investment. The most recent federal appropriation to fund the existing biomass incentive payment program is \$4 million per year, far from sufficient to sustain breakeven operation at the six New Hampshire facilities. (DL and INRS were not able to ascertain, however, whether the current \$4 million appropriation was less than, equal to, or greater than potential demand for the incentive payments – demand that is severely constrained by the limitations on ownership structures that qualify for the payments.)

5.7 Prohibition of Open Burning of Clean Wood Waste in New Hampshire

Summary: According to the N.H. Department of Environmental Services (DES), over 100 of New Hampshire’s 223 municipalities continue to burn clean wood waste in open burn piles. If this practice were prohibited, this wood could become a low-cost source of fuel for wood-fired power plants.

Steps Required for Implementation: Legislation and implementing regulation by NHDES. Additional assistance might be needed to help develop the infrastructure required to process and deliver wood from municipalities to wood-fired plants.

Financial Impact, State: None

Financial Impact, Ratepayers: None

Advantages:

- Wood accepted for combustion by NH municipalities generally meets high quality specifications (no pressure-treated or creosoted wood, limited proportion of painted and stained wood, etc.), and should be acceptable for combustion at wood-fired plants
- Environmental benefits associated with controlled combustion of wastes now burned without any controls.
- Diverts an in-state resource that is now wasted to promote continued production of wood-fired power.

Disadvantages:

- Reduces the market for forest-derived low-grade wood
- Requires legislation and regulation.
- Might contravene New Hampshire's prohibition of unfounded mandates imposed on municipalities.
- Uncertain reaction from NHDES and municipalities.
- Requires development of infrastructure to process and haul wood from multiple local points of generation.
- Uncertain regulatory status for wood-fired plants. Could require additional permitting, or modification of NHDES permit regulations, to allow combustion of municipally-derived wood wastes.
- No quantitative estimates are available of the amount of clean wood burned by NH municipalities. Uncertain that this tonnage would have a significant impact on the quantity of other materials needed for wood-fired power, or on total fuel costs.

Discussion: Clean wood is now burned in open piles by the majority of New Hampshire municipalities. This wood consists mainly of brush, but also includes some dimensional lumber, plywood, pallets, and similar items. Specifications imposed by the NHDES require rejection of painted, stained, and treated wood, but some amounts of these wastes inevitably are accepted and burned. No tonnage estimates are available, but DES estimates that over 100 of New Hampshire's 223 municipalities continue the practice of open burning.

Wood-fired power plants can burn source-separated materials like pallets under a permit-by-rule, without additional permitting. It is unclear, however, that they could burn mixed wood wastes such as those typically directed to burn piles; additional permitting, or a modification of existing air quality or waste management regulations, could be required. From an environmental perspective, combustion of clean wood waste in the controlled environment of a wood-fired boiler would be undeniably preferable to open burning, and one would expect DES's cooperation to effect whatever regulatory changes are needed.

Processing and transporting clean wood from municipal transfer stations around the state presents logistical challenges, and new infrastructure would have to be developed. At least one private firm in New Hampshire already operates mobile processing equipment for wood waste, however, which it uses to prepare wood for transportation and combustion in wood-fired facilities across in Maine. This or another firm could be encouraged to fill this role in New Hampshire, or the wood-fired plants, acting alone or in concert, could organize processing and transportation capabilities.

5.8 Disposal Ban on Clean Wood Waste

Summary: New Hampshire could ban the disposal in landfills and incinerators of all clean wood wastes suitable as fuel for wood-fired power producers.

Steps Required for Implementation: Legislation and implementing regulation by NHDES. Additional assistance might be needed to help develop the infrastructure required to process and deliver wood from municipalities and construction and demolition sites to wood-fired plants.

Financial Impact, State: None

Financial Impact, Ratepayers: None

Advantages:

- Diverts an in-state resource that is now wasted to promote continued production of wood-fired power.
- Conserves landfill capacity.

Disadvantages:

- Reduces the market for forest-derived low-grade wood
- Difficult and expensive logistics to source wood from hundreds or thousands of generation points.
- Difficult to ensure quality of wood generated at thousands of job sites.
- Most job sites generate very small quantities of wood waste – a few pounds to a few hundred pounds. It would be very difficult and expensive to procure wood wastes from any but the largest job sites.
- Would supply much less than 10% of the fuel required by existing wood-fired power producers.
- Significant time required to implement this option. Probably cannot be implemented quickly enough to have an impact on plants now undergoing rate order buyout.

Discussion: New Hampshire generates an estimated 108,000 tons per year of clean wood waste (pallets plus scraps from construction and renovation), almost all of which is currently disposed of. This wood could supply over 10% percent of the fuel required for power production by the New Hampshire's six wood-fired power plants. (On a tonnage basis, 108,000 tons is less than 10% of current fuel requirements. But the Btu value of construction and demolition wastes is enhanced by their low moisture content, and they would replace whole-tree chips at a ratio more favorable than 1:1.)

Sourcing this wood for electric power production presents significant challenges, however, because of the very large number of sites where construction and renovation wastes are generated, and the relatively small quantities of wood wastes generated at each site. Practically, it would be feasible to source wood only from the relatively small number of jobs where wood wastes are generated in the hundreds or thousands of pounds. This limitation would significantly reduce the quantity of wood waste available for wood-fired power.

Quality control is another major issue. Practically, it is inevitable that segregated wood wastes would be contaminated with other materials, potentially including hazardous materials, which would be impossible to identify and remove once the wastes were processed or removed from the job site.

Wood-fired power plants can burn source-separated materials like pallets under a permit-by-rule, without additional permitting. It is unclear, however, that they can legally burn the mixture of wood products generated from construction and demolition; additional permitting, or a modification of existing air quality or waste management regulations, could be required. From an environmental perspective, combustion of clean wood waste in wood-fired boiler should be preferable to disposal, and one would expect DES's cooperation to effect whatever regulatory changes are needed.

Processing and transporting clean wood from multiple generation points around the state present significant logistical challenges, and new infrastructure would have to be developed. At least one private firm in New Hampshire already operates mobile processing equipment for wood waste, however, which it uses to prepare wood for transportation and combustion in wood-fired facilities across in Maine. This or another firm could be encouraged to fill this role in New Hampshire, or the wood-fired plants, acting alone or in concert, could organize processing and transportation capabilities.

5.9 Promotion of Regional Policies to Capture Clean Wood Waste

Summary: States throughout the Northeast face common problems related to high tipping fees for waste disposal. Clean construction and renovation wastes, plus manufactured items such as pallets, represent a significant component of the waste stream that could be captured and used for energy production. New Hampshire could work in concert with other states to promote policies to divert clean wood from disposal, with states such as Connecticut and Massachusetts as major sources of such materials, and New Hampshire's wood-fired power plants as a market.

Steps Required for Implementation: Requires legislation and implementing regulations in other states. May require legislation and/or regulation in New Hampshire to allow combustion in wood-fired power plants of clean wood from out-of-state.

Financial Impact, State: None

Financial Impact, Ratepayers: None

Advantages:

- Addresses a regional waste management issue.
- States such as Connecticut and Massachusetts generate clean wood in quantities that could offset a significant fraction of fuel requirements at NH wood-fired power plants.

Disadvantages:

- Reduces the market for forest-derived low-grade wood.
- Requires coordinated interstate policy development implemented over a period of years.
- Difficult and expensive logistics to source and process wood from thousands of generation points, and transport to NH wood-fired facilities.
- Difficult to ensure quality of wood generated at thousands of job sites.
- Most job sites generate very small quantities of wood waste – a few pounds to a few hundred pounds. It would be very difficult and expensive to procure wood wastes from any but the largest job sites.
- Significant time required for implementation. Cannot be implemented quickly enough to have an impact on plants now undergoing rate order buyout.

Discussion: Clean wood waste is a major contributor to the waste stream throughout the Northeast (see Section 3.5) and one of the least recycled. States around the region are attempting to develop policies to divert this waste stream from disposal. The Massachusetts Solid Waste Master Plan, for example, contemplates a ban on disposal of most construction and demolition wastes by 2010. A serious issue for planners in many states is to identify markets for these materials as they are removed from the waste stream

New Hampshire lawmakers and regulators could work with their counterparts elsewhere in New England to promote policies to recover clean wood waste and process it as fuel for wood-fired power. New Hampshire's wood-fired power industry could act as a market for clean wood generated in more populous Northeastern states. The necessary regional coordinating bodies already exist in organizations like the Northeastern Waste Management Officials Association (NEWMOA) and Northeast Recycling Council (NERC).

Serious issues would have to be addressed to implement this policy. Among the most important are logistics, quality control, and cost allocation. Logistically, infrastructure would need to be developed to collect wood waste from a large number of geographically scattered job sites, bring it to processing centers, and transport processed wood chips to New Hampshire power plants. Quality control would be a critical issue, to assure that off-specification wood and other contaminants are eliminated from wood fuel at the points of generation or processing. And the significant costs of managing this waste stream would have to be allocated equitably among all parties who benefit from its diversion and use as fuel.

5.10 Subsidy to Whole Tree Chip Purchases.

Summary: The State could reduce the cost of fuel to wood-fired power plants by providing direct payments either to the plants or to loggers, with the goal of bringing the cost of fuel into the range that allows breakeven or profitable production of wood-fired power.

Steps Required for Implementation: Legislation and subsequent administrative action would be required to implement this option. The legislation would have to address the size of the subsidy, the recipient (wood-fired power plants or loggers), the means of calculating and distributing the subsidy, and assignment of administrative responsibility.

Financial Impact, State: Subsidy payments represent a direct cost to the state, derived either from the General Fund, or conceivably from a funding source established for the expressed

purpose of supporting the wood-fired industry (this source would have to be identified in legislation). The state would incur substantial additional costs to administer this program.

Financial Impact, Ratepayers: None

Advantages:

- Provides support to New Hampshire's loggers, who are the foundation of the state's forest products industry.

Disadvantages:

- Administrative complexity and cost.
- Need to continually re-evaluate the level of subsidy and adjust subsidies accordingly.
- Loss of general fund revenues.

Discussion: The most straightforward means to decrease fuel prices for wood-fired power is simply to subsidize the price paid to loggers for whole tree chips delivered to the wood-fired plants. If the state determined, for example, that a delivered price of \$10.00 per ton were required to keep the plants operating, the state could opt to fund the difference between this price and the market price the plants would otherwise pay. The state could do so either by reimbursing the plants directly for the difference between the "target" price and the market price, or by mandating sales to the plants at the "target" price, and then compensating loggers for the difference between the "target" and market prices.

In either case, implementing this option would involve the state deeply both in the finances of the individual wood-fired power plants, and in markets for whole tree chips. It is questionable, at best, whether involvement in the industry at this level is either feasible or desirable policy. With thousands of shipments moving annually from hundreds of logging firms, this option would also be exceptionally complex to administer, and administrative costs would be correspondingly high.

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Appendix A – Information Resources, Individuals

The following individuals provided information for this report. Because information was derived from a variety of individuals and sources, no particular piece of information should be ascribed to a particular individual, unless specifically noted.

Ralph Arnold, Timco, Inc.
Allen Bouthillier, A.B. Logging & Trucking
Robert Bradbury, Landvest
Jack Bronnenberg, Bronnenberg Logging & Trucking
Hunter Carbee, NH Timberland Owners Association
Ken Colburn, NH Department of Environmental Services
John Conway, National Wooden Pallet and Container Association
Kevin Craig, National Renewable Energy Laboratory
Jim Cross, Whitefield Planning Group
Ross D’Elia, HHP
Russ Dowd, Pinetree Power - Tamworth
Kevin Evans, Dartmouth College Woodlands
Joe Fontaine, NH Department of Environmental Services
George Frame, Forester
Jeff French, Granite State Forest Products
Tom Frantz, NH Public Utilities Commission
Tim Frizzell, First Colebrook Bank
Charles Gadzik, Irving Woodlands LLC
David Houghton, Trust for Public Land
Ethan Howard, Manchester Water Works
Bruce Jacobs, Fountain Forestry
Robert Judd, US Biomass Power Producers Alliance
Norm Hansen, Monadnock Forest Products
Chip Kimball, Landowner
Scott Lake, Beaman Lumber
John Lanier, NH Department of Fish & Game
Bill Leak, USDA Forest Service – State & Private
Rick Lessard, North Country Lumber
B Manning, Durgin & Crowell Lumber
Adam Mock, Adam E. Mock Logging & Chipping
Stephen Mongan, Landvest
Mark Morgan, Recycling Coordinator, NH Department of Environmental Services
Charles Niebling, Society for the Protection of NH Forests
Mike O’Leary, Bridgewater Power & Light
Stephen Rhodes, Sustainable Forest Futures
Jack Ruderman, Governor’s Office of Energy and Community Service
Rick Rumba, NH Department of Environmental Services
Harry Smith, Bio Energy Corporation
Megan Smith, American Biomass Association
Frost Sobetzer, Wagner Forest Management
Jasen Stock, NH Timberland Owners Association
Dick Stone, Wheelabrator Industries
Sonny Strickland, NH Department of Environmental Services
John Tomilla, Tomilla Brothers Lumber
Craig Washburn, C.W. Timber

Van Webb, Harding Hill Tree Farm
Steve Winnett, Environmental Protection Agency
Don Winsor, HHP
Steve Wood, UNH Cooperative Extension
Brad Wyman, Forester

Appendix B – Legislative Restrictions on Buyouts of Wood-Energy Plants

362-A:4-c Consideration by the Commission

- I. The commission shall independently and expeditiously consider any mutually acceptable agreement for the buydown, buyout or renegotiation of any existing commission order providing for qualifying facility power sales or power purchase agreement regardless of the status of any other such pending renegotiations.
- II. The commission shall not approve any buy-out of a wood-fired qualifying facility prior to July 1, 2000. The commission shall not approve any buyout of a wood-fired qualifying facility until competition is certified to exist in at least 70 percent of the state pursuant to RSA 38:36. The commission shall not approve any renegotiation that places restrictions on selling the output of the qualifying facility in a competitive generation market pursuant to 374-F.
- III. The commission shall not approve any renegotiation of a commission order providing for power sales from a listed facility if, for any calendar year prior to 2006, that modification would reduce the total number of kilowatt hours being purchased annually at predetermined specified prices from all listed facilities to less than 80 percent of the base listed-facility kilowatt-hours for that calendar year.
- IV. In this section:
 - (a) “Base listed facility for calendar that year” means the total number of kilowatt hours which would have been purchased during the calendar year from all listed facilities if the renegotiated rate orders for all such listed facilities pending before the commission as of January 1, 1998 had been approved.
 - (b) “Buyout” means any modification of any existing commission order providing for power sales from a listed facility that:
 - (i) changes the termination date of that order to an earlier date, unless the modified termination date is not earlier than the termination date in the renegotiated buydown for that listed facility that was pending before the commission as of January 1, 1998, or
 - (ii) eliminated predetermined specified prices for any of the output of the facility covered by the rate order.
 - (c) “Listed facility” means any off the five wood-fired qualifying facilities having rate orders which, as of January 1, 1998 provide the right to sell at least 10 megawatts of capacity and associated energy to Public Service Company of New Hampshire.

Renumber sections 13-14 as 15-16 and insert new section 13-14 as follows:

13. Legislative Intent of Limits on Renegotiations on Wood-Fires Qualifying Facility Orders. The limits on renegotiations of wood-fired qualifying facility orders in RSA 362-A:4-c, as amended by this act, are intended to preserve an outlet for low-grade wood. If other markets are developed for low-grade wood, the legislature should reexamine these limits.

14. Legislative Findings Regarding Approval of Pending Renegotiated Arrangements. The legislature finds that with respect to the pending renegotiated arrangements for the remaining 6 wood-to-energy plants that were pending before the public utilities commission as of January 1, 1998:

- I. Significant net savings to customers will occur if these arrangements are promptly approved by the commission.
- II. Timely action is essential since significant losses of these savings will occur if approval is further delayed.
- III. It is in the public interest to clarify the recoverability of payments made pursuant to these arrangements by stating that payments made pursuant to these arrangements shall be as recoverable from customers as payments made pursuant to the rate orders they replace or modify. Nothing in this section is intended to provide any greater opportunity for cost recovery than is available under applicable regulation or law on the effective date of this act.

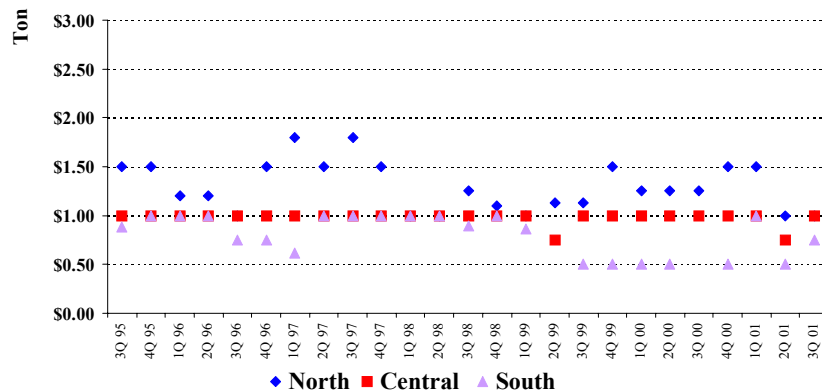
Appendix C—Cost of Production of Whole Tree Chips

While low-grade wood represents a substantial volume of wood from each harvest, its removal is generally not profitable for a landowner. The value in any harvest comes from sawlogs and veneer, but removal of the lower grade wood is necessary to the practice of good forestry. Landowners receive a nominal payment for biomass chips, generally between \$0.50 and \$1.50 per ton (Figure A-C-1). A number of timber purchasers indicated that even this payment is fictional, and subsidized by sale of higher value products (sawlogs and veneer) in a timber harvest.

Figure A-C-1

Whole Tree Chips, Stumpage Price

Source: NHTOA Quarterly Forest Products Market Report

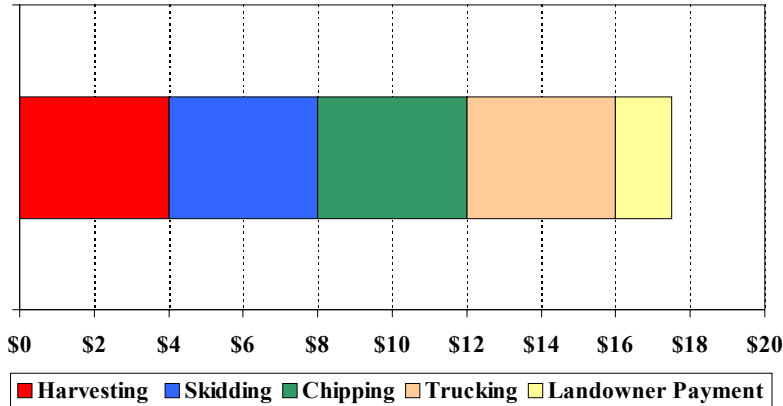


According to loggers interviewed, there is not profit in biomass chip production for them either. Loggers indicate that it costs roughly \$16 per ton to cut, skid, chip and truck whole tree chips to a wood-energy plant. While dependent upon the cost of fuel, labor, skidding distance, distance to market and operating conditions, several logging contractors provided information to show that each of these activities costs roughly \$4.00 per ton. (This account for equipment payments, payroll, fuel and other expenses necessary to harvest and transport forest products.) These expenses, coupled with a modest payment to the landowner for the stumpage leaves little – if any – room for profit. For this reason, it is expected that prices cannot decrease significantly from their present level.

Figure A-C-2

**Estimated Costs Associated with Production and Delivery of
Whole-tree Chips to Wood Energy Facility**

(Source: Interviews with New Hampshire Logging Contractors)



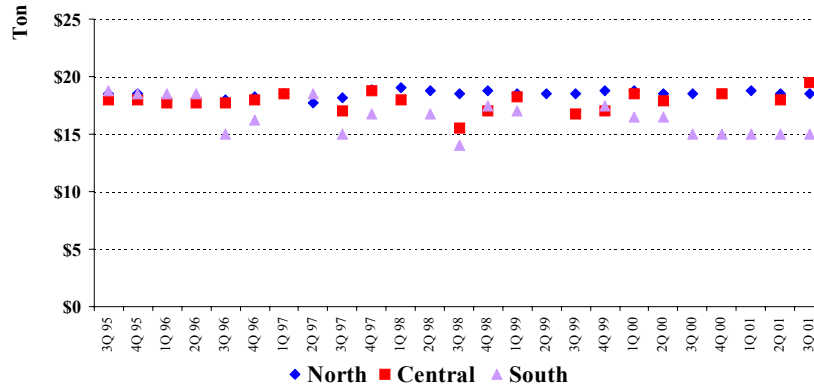
New Hampshire’s wood-fired power plants purchase their fuel on the open market, from a variety of suppliers. The price paid is set by the market, and may vary by time and location. However, delivered prices for whole-tree chip prices have remained remarkably stable over time, varying from \$14.00 to \$19.00 in the last six years. Within this range, whole tree chips have generally been purchased by wood-fired power plants at the higher end of this range.

Documents in the record of New Hampshire Public Utilities Commission Docket No. DE 01-089 indicates that the largest suppliers to Whitefield Power and Light were paid an average of \$18.50 to \$19.00 per green ton between 1996 and 2000, with an average price of \$18.83 per green ton during this time period. Figure A-C-3 shows reported prices for whole tree chips from 1995 to the present.

Figure A-C-3

Whole Tree Chips, Delivered Price

Source: NHTOA Quarterly Forest Products Market Report



If prices did decrease significantly, there is concern that loggers would be economically forced to cut corners. Industry members and regulators noted that this could lead to an increase in violations of timber harvesting and wetland laws, overweight trucking, and violation of worker's compensation regulations.

Loggers indicate that while production of biomass chips is an economic break-even proposition, it meets the demands of many landowners, allows for improved forestry practices, and allows them to find a market for the least marketable and least valuable products from a logging job. With the present oversupply of pulpwood, coupled with falling sawlog prices, logging contractors indicate that there is little -- if any -- profit in their operations. Because of this, they believe that they cannot significantly reduce their delivered price for whole-tree chips for a sustained period of time.

Appendix D –

MARKETS FOR LOW-GRADE WOOD AND FOREST MANAGEMENT

Bradford Wyman, Licensed Professional Forester # 42

Summary

This paper discusses the relationship between markets for low-grade primary wood products, such as pulpwood and chips, and the condition of our forests. We address the impact of low-grade markets, or their absence, on sustainability, added value, habitat, productivity and economic and biological diversity.

The bulk of the trees in our woods are unacceptable for higher grade products, or sawlogs, due to form, health or species. Without low-grade markets a forester has virtually no opportunity to practice the forester's trade of silviculture...to make choices, to manage the forest to meet sustainability, habitat, economic, watershed or recreational objectives. There will be no economical way to weed and thin the poorer trees from the stand. The marketplace will drive owners to high-grade the forest...to cut the best and leave the rest. This will lead to a diminution of stand diversity, habitat, timber quality, and genetic robustness...a loss of sustainability by any definition.

An insidious effect of high grading is negative genetic selection. Leaving the poorest trees to form the parent pool for the next generation will impoverish the gene pool, increasing the frequency of undesirable genes in the offspring population.

The dearth of low-grade markets will make it difficult for biologists to manage habitat for the early succession species as well as the older-growth inhabitants. We will be unable to sustain our current level of habitat diversity.

Biological diversity will be poorly served if we are unable to support the diversity of the manipulated forest. The absence of markets for low-grade wood will simply diminish management options, which will ultimately diminish biodiversity.

On the global scale, a thrifty biomass fuel market can make a small but meaningful contribution to the mitigation of our carbon loading to the atmosphere and diversify our sources of energy with biomass fuels.

Discussion

Sustainability, value-added, habitat, productivity, economic and biological diversity...these are the mantras of today's forestry community. This is the popularly adopted language of a public concerned with the present and the future of the economic and environmental status of New Hampshire's forest resource. However ill-defined they may be from one user to the next, these terms represent a persistent public understanding of the importance of the management systems we adopt for our forest resources. Anyone doubting this fundamental observation need only look to the level of debate and political and economic resources associated with the sale of 171,500 acres of International Paper Company forest lands in Coös County.

In 1997 the Berlin pulp mill provided a market for 455,000 cords of pulpwood annually... an amount equal to 82% of the 555,000 cords of pulpwood harvested in the state.¹ During the

winter of 2001, Pulp & Paper of America (PPA), owner of the Berlin mill and anchor of the North Country forest products economy, began defaulting on payments to its pulpwood suppliers. By September the company announced their corporate bankruptcy and the closure of the mill.

Concurrently, the New Hampshire Public Utilities Commission announced a plan for the buy-outs of several Public Service Company of New Hampshire contracts with their biomass energy suppliers. These buy-outs, coupled with an uncertain future for the remaining plants when their rate-orders expire, place the future operation of wood-fired electrical generators in question. Their combined consumption capacity of over 1.2 million tons of chips is greater than the one million tons of biomass estimated to be harvested in New Hampshire each year. This is an important outlet for low-grade wood which is not suitable for lumber or paper.^{ii, iii}

Let us examine some of the ways our forests are affected, or are likely to be affected, by the loss of low-grade wood/fiber markets in New Hampshire, and how they are related to the things about which our citizens care.

The key to this discussion is straightforward. Without low-grade markets a forester has no way to pay for the removal of the majority of the trees in the forest. With the ability to remove only the highest quality trees, one has virtually no opportunity to make choices, or manage the forest stand; to meet one’s objectives whether they involve sustainability, wildlife habitat, watershed improvement, commercial timber production, biological diversity or even some recreational goals. This is called the practice of silviculture.

The objective of silviculture is to control the density, composition, and structure of forest stands to enhance productivity. As described above, the silviculturalist manipulates tree growth by altering growing environments through treatments such as site preparation, weed control, thinning, improvement cuts, and final harvests. Doing so, of course, requires a thorough knowledge of forest ecology or silvics, but silviculture must also consider economics.^{iv}

According to the 1997 USDA Forest Inventory and Analysis^v just four percent of New Hampshire’s acceptable inventory of all trees on timberland is in the “preferred” category. More explicitly, the sawlog volume totals just 23.275 billion board feet, or 136.9 million cubic feet...only 1.5% of the standing volume in the state. These figures include all acceptable volume, which severely understates the sawlog potential in the younger ages. Nonetheless, harvest experience throughout the state indicates a hardwood sawlog yield of 15 – 25% and a softwood log yield of up to 60%. Excellent pine can yield up to 80 – 90%.

A harvesting study conducted on the Bartlett Experimental Forest over a 14 year period from 1950 – 1963^{vi} provides some examples of the volume of pulpwood generated by various harvesting regimes in a typical northern hardwood forest...

Table 1. – *Total Harvested Volume, in cunits, by product class and cutting method*

Product	Selection Cut	Patch Cut	Diameter Limit	Clearcut
Logs	1001	173	615	433
Pulpwood	1223	229	264	301
Total	2224	402	879	734

Percent Pulpwood	55	57	30	41
<i>Cunit – 100 cubic feet of solid wood</i>				

Selection Cut – Trees are individually chosen and marked for removal to meet stand improvement objective...weeding, thinning or regeneration of certain shade-tolerant species.

Diameter Limit Cut – All trees above a prescribed minimum butt diameter are removed, possibly with different limits for different species.

Clearcut (regeneration cut) – All trees are removed from the stand to create a new stand of shade-intolerant species. Depending upon markets and the equipment used, a sparse residual stand of small, defective trees might remain.

Patch Cut – Clearcuts conducted in patches of up to 3 – 5 acres to encourage seeding from residual surrounding stands. Wildlife biologists use this method to create edge, shrub, browse.

In 1950 – 1963 there were no biomass or chip markets. A clearcut, for example, left substantial numbers of small, deformed and defective trees standing. Furthermore, pulpwood specifications were more exacting, all of which would cause these figures to be under-stated by today's standards.

The question, then, is what happens in the woods if the forester must leave the low-quality stems in the stand?

Sustainability

Sustainability relates to all of the other facets of our forest resource issues. Whatever we seek from the forest, we wish to achieve it...or more likely them... in a sustainable fashion. We wish to enjoy the benefits of our forests without compromising the ability of our children and grandchildren to enjoy the same. It is essential that we enjoy the forest resources without impairing the ability of the forest to provide those resources indefinitely.

In examining the role of low-grade markets in the issues to follow, we shall see how forest resource sustainability is served by that market.

Productivity

Here's what award-winning Tree Farmer Thom Thomson, of Orford has to say...

On nearly every timber harvest in New Hampshire, 60 to 70% of all wood products are low-grade; chips, pulp, firewood and pallet. Only a small percent are grade logs and a fraction of that would be veneer if you're lucky.

As a forest landowner and tree farmer I manage my forest to harvest trees, but if I don't have a market for low-grade wood it will be almost impossible to manage in a sustainable manner. I'm afraid without the low-grade markets some may revert back to cutting techniques of the 1940's and 1950's called high grading or "cut the best and leave the rest." Fifty years later we can still see the negative effects of high grading in our forest. Many of us are still trying to deal with the

devastating Ice Storm of 1998 which damaged over one million acres in New Hampshire. Our family lost over 900 acres. Without low-grade markets it would be impossible to clean up our forest as we are doing today.^{vii}

Thomson raises the issue of high grading, which is perhaps the most frequently cited infraction against sustainability and productivity. If forest owners have no economical way to weed and thin the poorer trees from their inventory it will not only inhibit thrifty growth of the so-called crop, or marketable, trees, but when they are finally harvested those trees that are left will be only the poorer quality ones with no market at all.^{viii} The logical end to this process is a forest of diminished commercial value to the owner. The remaining trees will be of less marketable species (for example, beech instead of maple) and poor form and health.

A properly maligned form of high grading is the so-called diameter limit harvest.^{ix} In this instance the cutter takes all of the trees above a given diameter. Different species may be assigned different limits. While one may thus control the species composition either favorably or not, the effect on quality is dramatic. Refer back to Table 1, which clearly shows that the diameter limit cut yielded only 30% pulpwood, compared to the 41% pulpwood content of the stand. The missing 11% was left to drag down the quality of the residual stand.

A new, soon-to-be-published study by William Leak and Paul Sendak^x clearly illustrates the importance of practicing silviculture to improve productivity...

Three individual-tree selection harvests over a 48 year period in a northern hardwood stand in New Hampshire resulted in an increase in the percentage of volume in trees with grade 1 and 2 butt logs from 21% (1952) to 30% (2000) in beech and 40% (1952) to 65% (2000) in sugar maple and other hardwoods.

New Hampshire forest managers and policy makers already have this figured out...

- “Develop new markets to replace markets lost by the down-sizing of wood fired electrical generating plants for underutilized species and lower grades of timber”, Mission statement of Governor Shaheen’s Forest Industry Task Force, June 1997
- “Lack of low-grade markets...has resulted in many forests exhibiting timber quality well below the capacity of the soil and site.”, Good Forestry in the Granite State, June 1997
- “Markets for all forest products, especially low-grade wood, must be strengthened so that landowners can continue to manage the forest in a responsible manner” Good Forestry in the Granite State, June 1997
- “Markets for low-grade wood provide opportunities to improve the forest stands, and utilize abundant resources. With the recent loss of some wood-chip markets, there is concern about maintaining markets for low quality wood.” NH Forest Resource Plan, 1996

A more insidious effect of the high grading which is forced by the failure of the low-grade markets, is negative genetic selection.

Negative silvicultural selection, also known as high-grading, creaming, diameter-limit cutting, or logger's choice, is an effective way to change the genetic structure of a population. Leaving the poorest trees to form the parent pool for the next generation will ensure that the genes conditioning slow growth, maladaptation to the environment, and poor tolerance to stress-related insect and disease attack will be in high frequency in the offspring population.^{xi}

Aside from the issue of the quality of the stem of the tree itself, there is the concern about species mix. There are several species, our official State Tree, the White Birch, among them, which are known as “intolerants,” or pioneer species because of their love of sun. Others intolerants include aspen, yellow birch, and balsam fir. They do not regenerate well in the shade, requiring larger openings or clearcuts for their establishment. On the other hand, a forester wishing to discourage the propagation of a low quality tolerant, such as a stand of disease-ridden beech, might clearcut it to let in the sun.

As we saw in Table 1, 41% of the clearcut stand was pulpwood. In 1950 – 1963 the *only* low-grade market was pulpwood. A clearcut in that era still had a residual stand of small, poor quality trees which, by current standards would add considerably to the low-grade volume. There were no chip or biomass markets and pulpwood specifications were more exacting than they are today. It is true that the same market flexibility that offers foresters the opportunity to manage for productivity allows liquidators to conduct their nefarious business. However the absence of the low-grade markets will drive landowners to liquidate, or high grade, their merchantable higher quality growing stock.

Value Added

The addition of value to forest products through the vertical integration of the industry has been widely promoted as the key to a diverse, sustainable forest economy and release from the bonds of the pulpwood economy.^{xii, xiii, xiv}

This is a valid strategy to extract more value from the timber harvested from our forests before we export them from the state. As we have seen, however, to attempt to supplant our so-called “pulpwood economy” with vertical integration of the sawlog industry could hardly be sustainable. With no way to manage for improved quality our value-added industry would languish over time as our sawlog component petered out. The value added model cannot exist in a low-grade market vacuum.

A post script: pulpwood is an excellent example of a high added-value forest product. Fiber which is worth \$2 - \$5 per ton on the stump can sell for as much as \$150 - \$200 in the form of pulp or paper.

Habitat

There is very little literature on the relationship between low-grade markets and forest habitat. However, by examining available work on game and non-game habitat requirements in New Hampshire we can draw some fair conclusions based upon our discussion of forest productivity.

Wildlife managers attempt to understand the complexities of forest habitats by breaking them into a matrix of classes. For our purposes, consider the subset of four stand size classes: 1)

regenerating (seedling), 2) sapling, 3) small sawtimber, and 4) large sawtimber. There are 152 species of amphibians, reptiles, birds and mammals that occupy all four of these classes at one time or another. Furthermore, there are 26 species, including the American Kestrel, Bohemian waxwing, American Tree Sparrow and the Eastern cottontail, that use the regenerating class only during the year, and four species, including the Bald eagle, that use only large sawtimber forest habitat during the year.^{xv}

In our discussion of forest productivity we have seen how the absence of a low-grade market places economic constraints on harvesting anything but the limited volume of high-grade trees. The tendency, over time, is to reduce the size and number of openings to create regenerating (seedling) stand sizes. Meanwhile, the market for sawlogs will encourage forest owners to harvest only the largest and best trees, tending to reduce the acres of large sawtimber.

...some particular species will benefit from almost any forest practice. The key is to be aware of what is not benefiting from most or all practices – those are the species that become, *de facto*, the species of concern.

Clearcutting...selection cutting...Both produce habitats that are similar to those produced also by nature. Too much of either, though, in one place, can eliminate *other* habitats from the landscape that also are produced by nature (e.g., mature, closed-canopy forest).^{xvi}

Thus we conclude that the absence of low-grade markets will make it difficult for wildlife biologists to manage habitat for the early succession (regenerating) obligates, on the one hand, and the older-growth (large sawtimber)obligates on the other. The effect on the 152 species which are found in all four size classes during the year is less clear. It is unlikely that the retention of a heterogeneous mix of size classes will have adverse effects on them, though the loss of diversity likely to follow the loss of low-grade markets may well discourage some of them.

Biological Diversity

Certainly, students of biological diversity do not focus on timber harvesting as a tool of their trade. They are more apt to seek preserves of large acreages to shelter meaningful segments of the forest from the growth of human activities.

We clearly see a need for biodiversity conservation in New Hampshire. ...New Hampshire's biodiversity is influenced by four major factors: physical environment, ecological processes, evolution, and past and present human activities. The human influence...is very complex, but it is clear that humans have a disproportionately greater effect on biodiversity than other species.^{xvii}

Just the same, we are talking about diversity here. Irrespective of whatever preserves our society sets aside, biological diversity will be poorly served if we are unable to support the diversity of the manipulated forest as we have discussed in the contexts of forest productivity, forest stand genetics and wildlife habitat.

...we should keep in mind that ecological reserves are just one component of an overall strategy of land and natural resource management. Equally important are existing initiatives and programs to support and encourage good management of, for example, commercial timberland, wildlife populations, and watersheds.^{xviii}

As long as we accept ourselves as a component of our environment we must contemplate the effect of our actions, as well as our inaction, on biological diversity. The absence of markets for low-grade wood will simply diminish our management options. It is reasonable to suggest that, over time, it will diminish biodiversity.

Climate Change

The issue of climate change is somewhat beyond the scope of this paper. Nonetheless, it is certainly not beyond the scope of our societal concerns, nor is it irrelevant to the discussion of low-grade markets.

While the science is very complex and is still developing, it is now generally accepted that the CO₂ emission factor for biomass fuels is zero.^{xix} The underlying assumption is that, unlike petroleum, the biomass being consumed is being replaced at an equal or greater rate by growth. Gustavo Best, Secretary of FAO's Inter-Departmental Working Group on Climate Change says...

...(biomass fuel) does emit carbon when you get energy out of it. But when you grow more, that carbon is sequestered by being turned into plant matter. With fossil fuel that happens too, in theory, if you can wait a few million years.^{xx}

The implications almost speak for themselves. While we are diversifying our economy and our forest productivity, habitat and biodiversity, we can make a small but meaningful contribution to the mitigation of our carbon loading to the atmosphere and diversify our sources of energy with biomass fuels.

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