Biomass Fuel Availability

Berlin, New Hampshire

Prepared for:
Clean Power Development

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Table of Contents

Table of Figures

Table of Tables

Executive Summary

Innovative Natural Resource Solutions LLC (INRS) conducted an independent evaluation of the availability and pricing of Biomass for Clean Power Development's proposed biomass facility in Berlin, NH.

Coos County, New Hampshire has long served as the wood basket for forest industries, including two New Hampshire pulp mills that recently ceased operations on a permanent basis. The loss of these markets, coupled with increased interest in renewable energy generation in the state and region, has led to a focus on the opportunities for biomass energy production in Coos County.

In order to provide biomass fuel at an economically acceptable price, suppliers rely upon higher value markets – notably sawlogs and pulpwood – to help support the cost of timber harvesting operations. When a tree is felled, a number of products can be derived, including high value sawlogs and lower value pulpwood. On many logging jobs, the portions of the tree that do not meet the specifications of these higher value products can be chipped and used as biomass fuel. In order to remain economic, loggers involved in forest management operations need these other markets.

Recognizing this relationship, INRS used actual Report of Cut data for Coos County from 1998 – 2005 (the last year complete data is available for). Using this data, which reflects actual logging activity in Coos County, INRS estimates that enough biomass fuel is potentially available from additional residue chipping, combined with re-direction of some pulpwood to the biomass market, to generate nearly 30 MW of power production.

Interviews with local suppliers, conducted for this project by North Country Procurement, Inc. indicate that this volume of wood is likely available at $32 per green ton (delivered, assuming diesel costs at $3.50 per gallon).

INRS notes that there are a number of efforts publicly announced in Coos County that expect to use wood well in excess of the volumes noted above. In INRS' opinion, finding a supply of biomass to sustainably source these facilities would require an increase in biomass prices to levels that INRS considers economically unsustainable, importing wood from outside of the region (with the associated increase in trucking cost this will bring), improvements in the efficiency of biomass conversion technologies, or significant changes in harvesting patterns.

Introduction

This document serves as an independent assessment of wood availability, and factors influencing availability and pricing, for a proposed biomass energy facility in Berlin, New Hampshire. This facility would generate renewable electricity and would likely provide thermal energy to on-site or off-site users.

Innovative Natural Resource Solutions LLC (INRS) was hired by Clean Power Development to conduct research and develop this report. INRS has experience with the region's forest products industry and loggers, and has a strong working knowledge of existing and potential markets for biomass in the United States.

> *INRS believes the information contained in this report to be correct, based upon information sources we deem reliable. Given the dynamic nature of wood markets and biomass, INRS does not warrantee information in this report against all errors. This report contains some predictions, forecasts and forward-looking statements that are based upon the professional knowledge, experience and opinion of INRS. These predictions and forecasts are not guarantees of future events.*

Market Structure for Forest-Derived Wood

Whole–tree chips for use as biomass fuel are the by-product of timber harvesting for sawlogs and pulpwood. The economics and availability of biomass fuel rests upon the harvesting of higher-value products, with the tops, branches, off-spec wood and economically undesirable species potentially available as biomass fuel.

On timber harvesting operations, the loggers are generally looking to harvest sawlogs (for lumber) and pulpwood (for paper mills), both generally higher value products than biomass. However, much wood does not meet the rigid specifications for these higher value markets (for example, a length of tree may be crooked, have rot, or have a split in it). For this wood, as well as all tops and branches, loggers have two choices: they can return the wood to the forest and allow it to decay, or they can chip the wood that does not meet sawlog and pulpwood specifications. Many loggers practice a combination of these approaches.

In areas of New England where there is a viable biomass market, many loggers purchase portable whole tree chippers and chip vans (truck trailers designed to have chips blown in) in order to access this market. For firms engaged in land clearing, their need to remove most or all trees from a site makes a market for chips a necessary part of conducting their operations[1].

Loggers and landowners make their money from growing, harvesting and selling veneer, sawlogs and (to a much lesser extent) pulpwood. The health of these markets, particularly sawlogs, is what allows people the economic opportunity to conduct a timber harvesting operation. If these markets suffer a significant downturn, less biomass may be available in the marketplace because fewer individuals will conduct timber harvesting operations.

In general, when a single tree is harvested, a number of products can be derived[2].

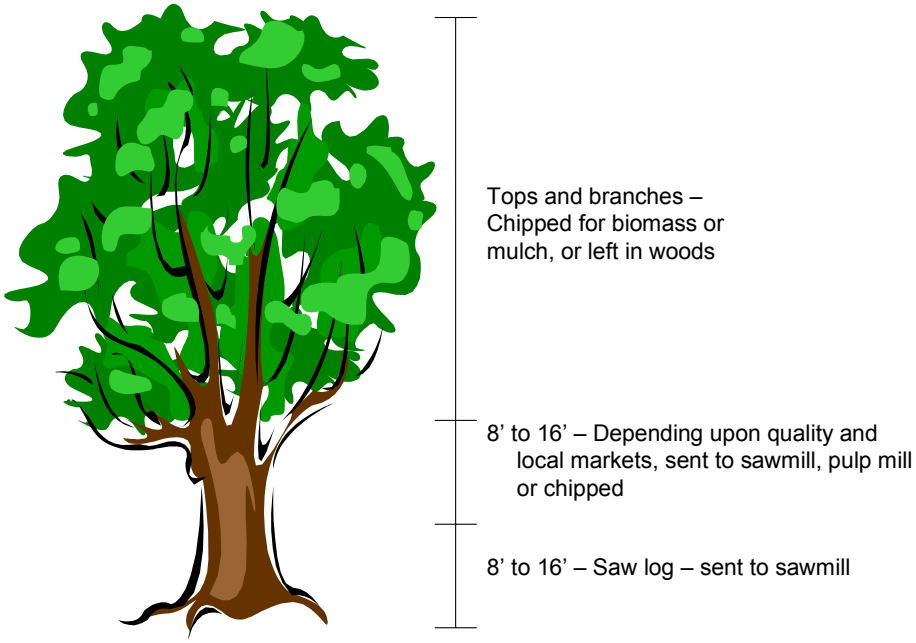
- The bottom length (generally eight to sixteen feet) is often straight with relatively few defects such as knots or branches. This section is generally a veneer log, sent to a market that slices or peels the log for plywood, or more commonly a sawlog, and is sent to a sawmill for lumber production.
- The next lengths (again, often eight to sixteen feet) may become a variety of products. If it is straight and has few defects, it is a veneer log or sawlog and will be sent to a sawmill. If it is smaller than the size sawmills require, or has a large number of defects (rot, knots, split, etc.), it will be sent to a pulp mill for paper manufacturing. If it is not straight (and thus cannot be cleanly debarked) it will be chipped for use in biomass production or mulch, or left in the woods if those markets are not economically available.
- The tops and branches can be chipped for biomass energy markets, chipped for mulch markets, or left in the woods.

[1] Land clearing activity in the area surrounding Berlin, NH is minimal, and land clearing wood is not expected to be a major source of supply at this location. Biomass chips from land clearing from other parts of New Hampshire and New England are expected to go to current or planned biomass facilities in the Southern part of the state, and the Berlin, NH facility should not count on receiving any meaningful volume of land-clearing wood.

[2] While this is a general description of the variety of products that can be derived from a single tree, it is important to note that the characteristics of an individual tree, combined with local markets, may make all or most of it unsuitable for lumber manufacturing, and then all of the tree would be used for pulp and chip markets, or left in the woods.

Figure 1 shows the sections of a single tree and the products derived[3]; figures 2 through 5 show parts of a New Hampshire logging operation that will produce whole-tree chips for a biomass power plant.

Figure 1. Schematic of Products Derived from a Single Tree



[3] *Note:* This tree is used for illustration purposes only. Forest-grown trees look significantly different than this diagram, generally with longer trunks and less "crown", or leafy top.

Figure 2. Log landing with slasher (left), chipper (right), and wood sorted by product.

Figure 3. Wood sorted for chipping.

Figure 4. Close-up of chipper on log landing.

Figure 5. Trailer for whole-tree chips, with opening for chipper to blow chips into.

Existing and Potential Competitors for Low-Grade Wood

Historically the North Country of New Hampshire has been home to two pulp mills – the Burgess Mill in Berlin (most recently owned by Fraser Papers) and small pulp mill owned by Groveton Paperboard in nearby Groveton. Both of these facilities have recently closed; with permanent measures taken that make re-start impossible.

However, markets for most low-grade wood – including pulpwood and biomass chips – remain in the North Country. There are two operating biomass power plants in Northern New Hampshire, and a large pulpwood processing yard, and a number of similar markets proximate to Berlin, NH. Figure 6 shows the location of major existing and planned facilities that utilize low-grade wood within a 30, 60 and 90 minute drive-time of Berlin. Table 1 through Table 5 provides details on these facilities.

Figure 6. 30, 60 and 90 Minute Drive Time, Berlin, NH

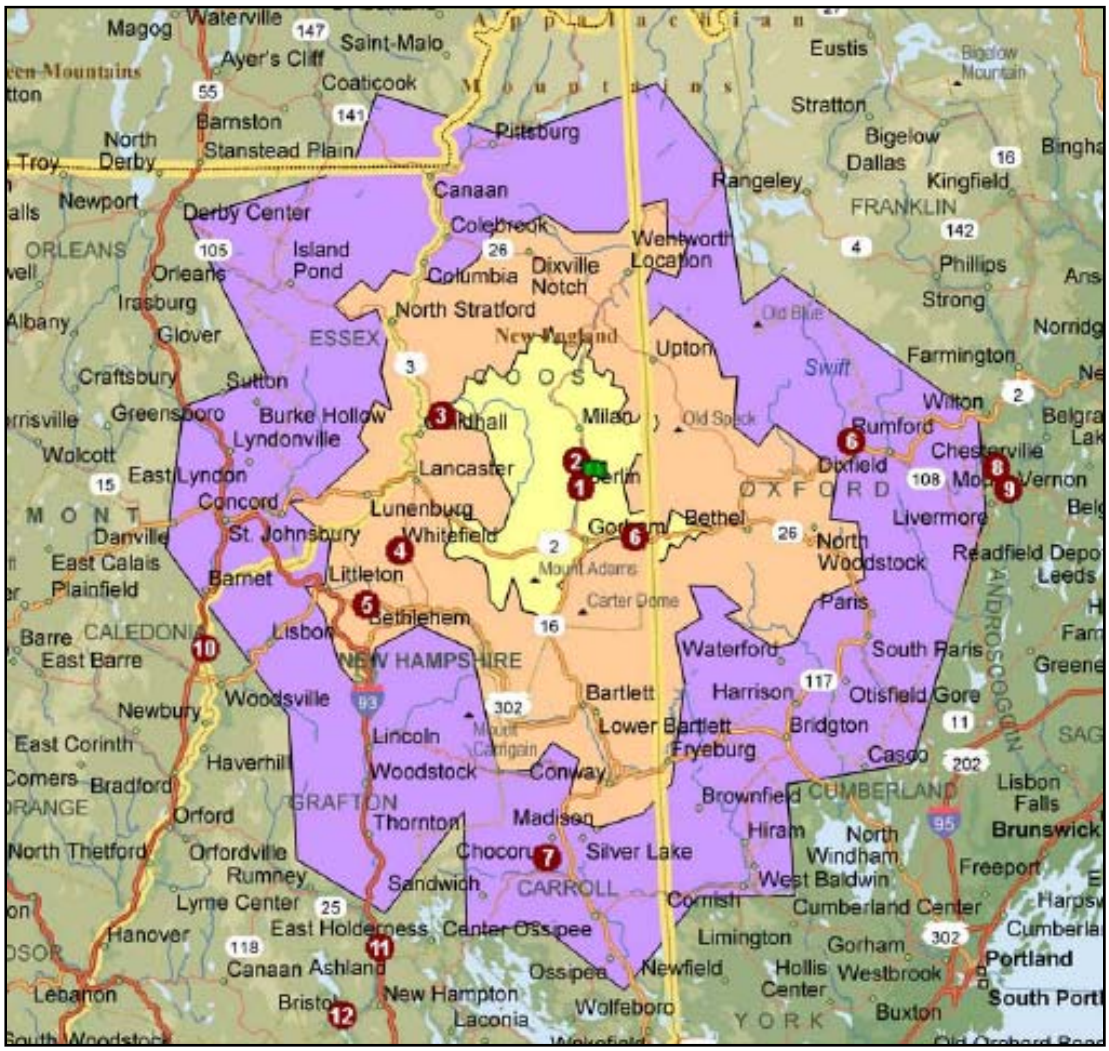


Table 1. Existing and Proposed Users of Low-Grade Wood, 30 Minute Drive Time

Facility 1	Laidlaw EcoPower – Berlin
Location	Berlin, NH
Status	Proposed
Product	Electricity (modest potential sale of thermal energy)
Owner	Laidlaw Energy & EcoPower
Size	~60 – ~70 MW
Fuel	Whole tree chips, sawmill residue, pallets
Annual Wood Use (est.)	Up to 750,000 tons
Assumption	Not constructed
Berlin – road miles	0 miles
Berlin – minutes	0 minutes
Notes	Laidlaw has reportedly entered the ISO-New England electricity queue, behind Clean Power Development's project. There is insufficient local biomass supply at what INRS considers an economic price to source the Laidlaw project as proposed. INRS does not believe that this project could be financed if Clean Power Development's Berlin project moves forward.

Facility 2	Greenova Wood Pellets
Location	Berlin, NH
Status	Proposed
Product	Wood Pellets
Owner	Woodstone / Greenova
Feedstock	Roundwood, with specifications similar to pulpwood
Annual Wood Use (est.)	Roughly 400,000 green tons
Assumption	Constructed
Berlin – road miles	0 miles
Berlin – minutes	0 minutes
Notes	The feedstock for this facility is expected to be similar to pulpwood, and as such will not compete directly with Clean Power Development's Berlin project for much of the supply. However, harvesting associated with this market may provide additional tops and branches for the biomass facility.

Facility 6	Carrier Chipping
Location	Shelburne, NH
Status	Operating
Product	Pulp chips for New Page – Rumford, ME
Annual Wood Use (est.)	Annual chipping capacity of roughly 450,000 green tons of pulp chips.
Status	Operating
Assumption	Continues operations at current level
Berlin – road miles	13 miles
Berlin – minutes	16 minutes

Table 2. Existing and Proposed Users of Low-Grade Wood, 60 Minute Drive Time

Facility 3	North Country Renewable Energy
Location	Groveton, NH
Status	Proposed
Product	Electricity, thermal energy, liquid fuels
Owner	Tamarack Energy & XGenesys Development
Size	45 to 75 MW (likely 68 MW)
Fuel	Whole tree chips, sawmill residue, pallets
Annual Wood Use (est.)	Up to 1.2 million tons
Assumption	Not constructed
Berlin – road miles	25 miles
Berlin – minutes	31 minutes
Notes	Tamarack Energy and XGenesys Development have announced that they have suspended development activity for this location, citing challenges related to transmission infrastructure. For purposes of this study, INRS assumes that this facility will not be constructed.

Facility 4	Whitefield Power & Light
Location	Whitefield, NH
Status	Operating
Product	Electricity
Owner	Marubeni Sustainable Energy, Inc
Size	16 MW
Fuel	Whole-tree chips, sawmill residue
Annual Wood Use (est.)	180,000 tons
Assumption	Continues operations at current level
Berlin – road miles	31 miles
Berlin – minutes	41 minutes

Facility 5	Pinetree – Bethlehem
Location	Bethlehem, NH
Status	Operating
Product	Electricity
Owner	Tractebel (www.Tractebelusa.com)
Size	17 MW
Fuel	Whole-tree chips and sawmill residue
Annual Wood Use (est.)	230,000 tons
Assumption	Continues operations at current level
Berlin – road miles	39 miles
Berlin – minutes	49 minutes

Table 3. Existing and Proposed Users of Low-Grade Wood, 90 Minute Drive Time

Facility 6	New Page – pulp and paper mill
Location	Rumford, ME
Status	Operating
Product	paper
Owner	New Page
Annual Wood Use (est.)	Estimated at ~1.1 million tons of pulpwood use annually, plus ~200,000 green tons of biomass fuel for production of thermal and electric energy
Status	Operating
Assumption	Continues operations at current level
Berlin – road miles	51 miles
Berlin – minutes	1 hour, 2 minutes
Notes	This facility gets pulp chips delivered from a remote chipping yard in Shelburne, NH – 13 miles (16 minutes) from Berlin, NH. This chipping facility has an annual chipping capacity of roughly 450,000 green tons of pulp chips.

Facility 7	Pinetree – Tamworth
Location	Tamworth, NH
Status	Operating
Product	Electricity
Owner	Tractebel (www.Tractebelusa.com)
Size	22 MW
Fuel	Whole-tree chips and sawmill residue
Annual Wood Use (est.)	300,000 tons
Assumption	Continues operations at current level
Berlin – road miles	55 miles
Berlin – minutes	1 hour, 9 minutes

Table 4. Other Existing and Proposed Users of Low-Grade Wood

Facility 8	Androscoggin Mill
Location	Jay, ME
Status	Operating
Product	Paper
Owner	Verso Paper
Annual Wood Use (est.)	Pulpwood estimated at 1.4 million tons annually Biomass fuel 245,000 green tons in 2003
Assumption	Continues operations at current level
Berlin – road miles	75 miles
Berlin – minutes	1 hour, 34 minutes

Facility 9	Boralex – Livermore Falls
Location	Livermore Falls, ME
Status	Operating
Product	Electricity
Owner	Boralex, www.boralex.com
Size	40 MW facility
Fuel	Whole tree chips, sawmill residue, construction & demolition debris (C&D may not continue)
Annual Wood Use (est.)	~350,000 tons per year, roughly half C&D debris
Assumption	Continues operation, move away from C&D as a fuel source
Berlin – road miles	77 miles
Berlin – minutes	1 hour, 39 minutes

Facility 10	Pinetree – Ryegate
Location	Ryegate, VT
Status	Operating
Product	Electricity
Owner	Tractebel (www.Tractebelusa.com)
Size	20 MW
Fuel	Whole-tree chips, wood chipped on-site and sawmill residue
Annual Wood Use (est.)	260,000 tons
Assumption	Continues operations at current level
Berlin – road miles	69 miles
Berlin – minutes	1 hour, 31 minutes

Facility 11	Bridgewater Power & Light
Location	Bridgewater, NH
Status	Operating
Product	Electricity
Owner	Privately held
Size	17 MW nameplate
Fuel	Whole-tree chips and sawmill residue
Annual Wood Use (est.)	225, 000 tons
Assumption	Continues operations at current level
Berlin – road miles	78 miles
Berlin – minutes	1 hour, 32 minutes

Facility 12	Alexandria Power
Location	Alexandria, NH
Status	Idle since 1994, re-start efforts likely
Product	Electricity
Owner	Indeck
Size	16 MW
Fuel	Whole-tree chips and sawmill residue
Annual Wood Use (est.)	200,000 tons
Assumption	Resumes operation at full capacity prior to commencement of operations by Clean Power Development in Berlin, NH
Berlin – road miles	89 miles
Berlin – minutes	1 hour, 44 minutes

Table 5 shows that, based on the information and assumptions above, the demand for low-grade wood (pulpwood and biomass) proximate to Berlin, NH is anticipated to be 5.1 million green tons annually, and could reach as high as 7.0 million green tons, counting only those projects that have been publicly announced.

Table 5. Existing and Proposed Low-Grade Wood Use near Berlin, NH

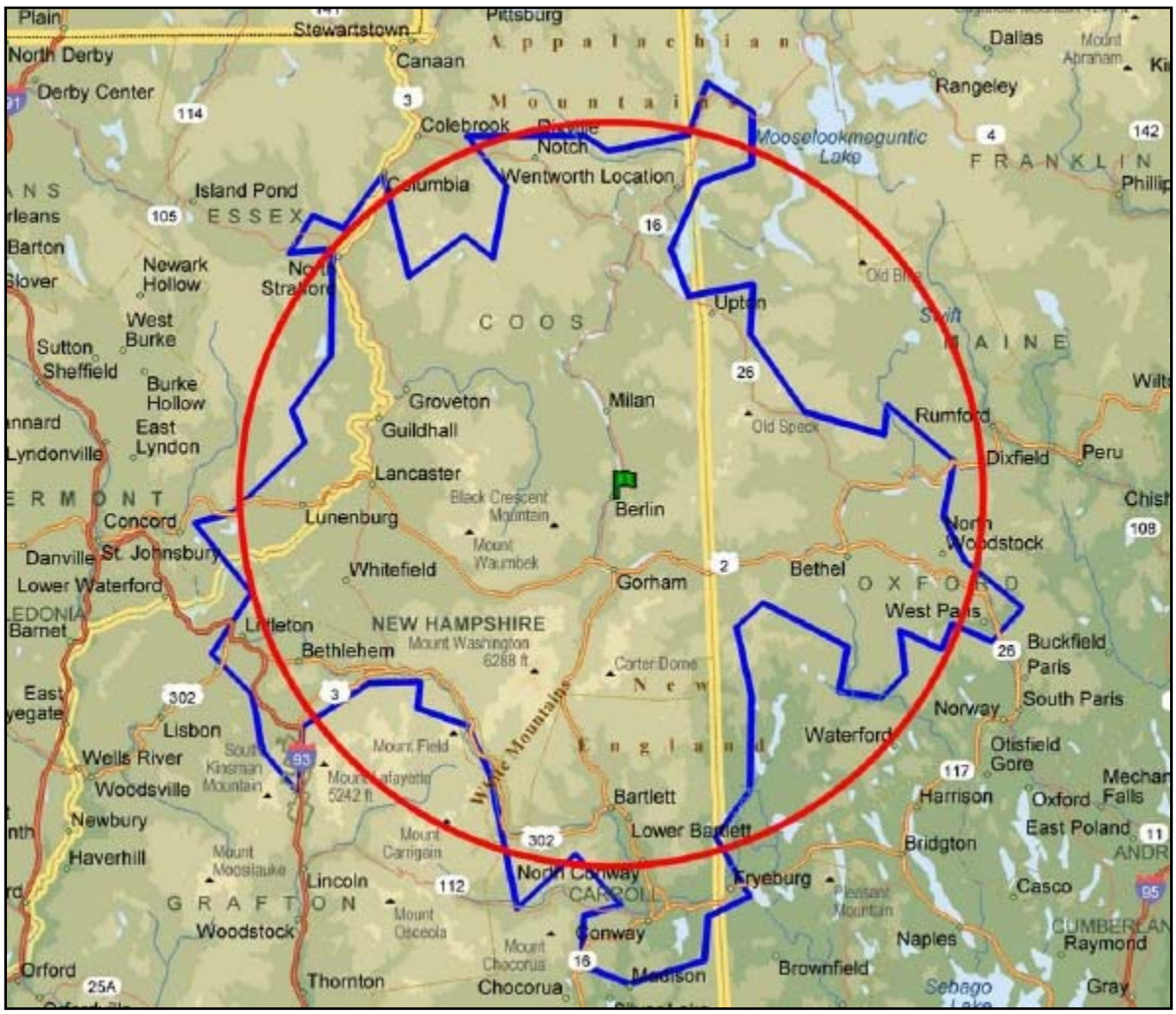
Facility	Current	Potential	Assumed	Total
	Annual Wood Use (Green Tons)			
30 Minute Drive Time				
Laidlaw - EcoPower	0	750,000	-	750,000
Greenova Pellets	0	400,000	400,000	400,000
Running Total	0	1,150,000	400,000	1,150,000
60 Minute Drive Time				
North Country Renewable Energy	0	1,200,000	-	1,200,000
Whitefield Power & Light	180,000	0	180,000	180,000
Pinetree - Bethlehem	230,000	0	230,000	230,000
Running Total	410,000	2,350,000	810,000	2,760,000
90 Minute Drive Time				
New Page	1,300,000	0	1,300,000	1,300,000
Pinetree - Tamworth	300,000	0	300,000	300,000
Running Total	2,010,000	2,350,000	2,410,000	4,360,000
Other Proximate Facilities				
Androscoggin Mill	1,645,000	0	1,645,000	1,645,000
Boralex - Livermore Falls	350,000	0	350,000	350,000
Pinetree - Ryegate	260,000	0	260,000	260,000
Bridgewater Power & Light	225,000	0	225,000	225,000
Alexandria Power	0	200,000	200,000	200,000
Total	4,490,000	2,550,000	5,090,000	7,040,000

Forest Growth and Removals

Using the USDA Forest Inventory & Analysis database, INRS determined the growth and loss (harvest and mortality) for a region within a 30-mile radius (roughly a 60 minute drive time) of Berlin, NH. INRS used the most complete FIA information, which is 2005 for Maine and New Hampshire.

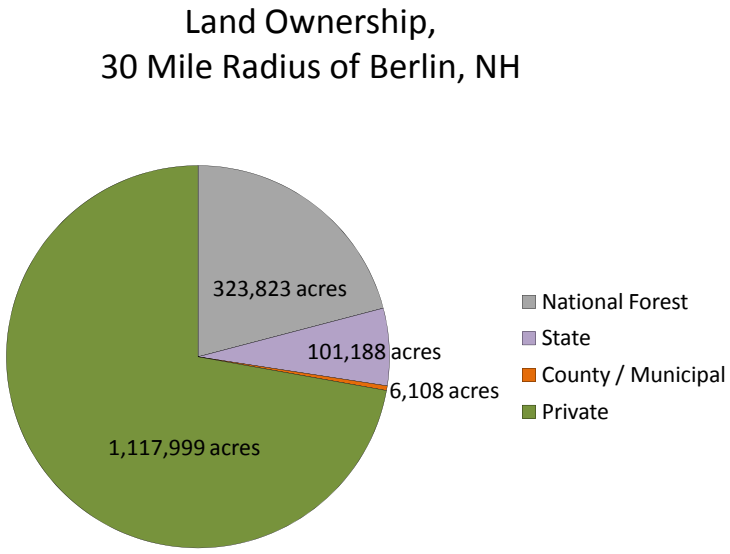
Figure 7 shows a 60 minute drive time from Berlin, as well as the 30-mile radius that was used for this analysis.

Figure 7. 30 Mile Radius and 60 Minute Drive Time, Berlin, NH



In the 30 miles surrounding Berlin, NH, roughly 36 percent of the timberland[5] is publicly owned, including 28 percent that is part of the White Mountain National Forest. For purposes of this analysis, INRS has assumed that no volume of biomass fuel will come from public lands. This is conservative, and it is possible that a biomass plant in Berlin, NH would receive fuel from proximate public land. However, public lands – particularly the National Forest System – have proven to be unreliable sources of wood, and as such are not used in the growth / removal analysis conducted below.

Figure 8. Timberland Ownership Types within 30 miles of Berlin, NH



[5] "Timberland" refers to land that is biologically and legally capable of growing commercial forest products.

In a 30 mile radius surrounding Berlin, NH, net growth slightly exceeds annual removals on private timberland. Using historic data, from a period when two pulp mills were active in the region, total net biomass growth from private timberland in this region is estimated at 132,000 green tons annually.

Figure 9. Annual Forest Net Growth and Removals, Private Timberland within a 30 Mile Radius of Berlin, NH

	Stem Only	Tops / Branches[6] green tons[7]	Total
Net Growth	1,035,619	300,329	1,335,948
Removals	933,308	270,659	1,203,967
Growth less Removals	102,311	29,670	131,981

[6] Assumes 0.29 green tons of tops and branches available for each ton of roundwood growing.

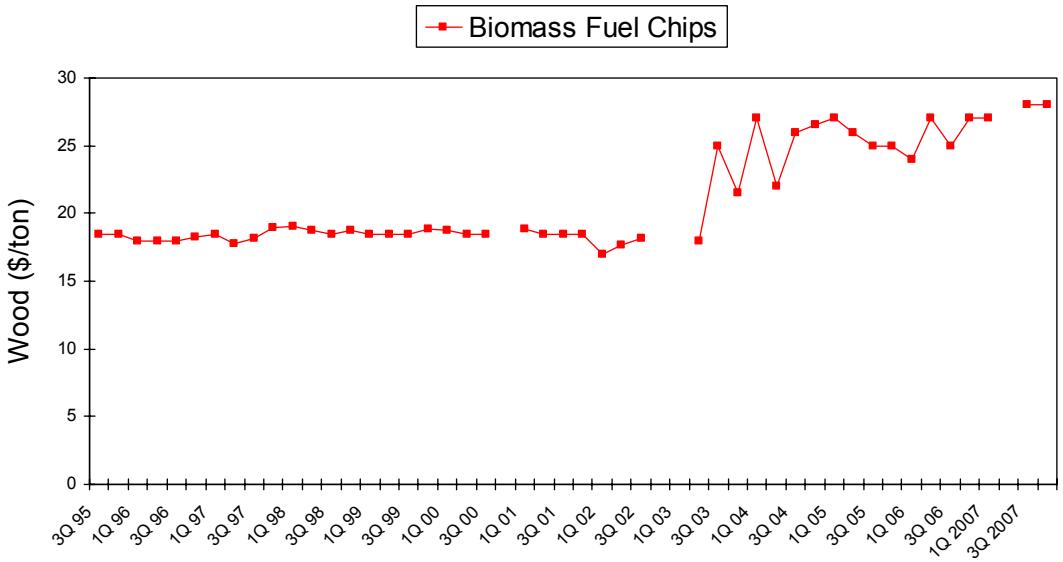
[7] USDA Forest Inventory & Analysis data presented is in cubic feet. INRS converted this to green tons assuming 85 cubic feet of solid wood per cord, and that a cord of green wood weighs 2.5 tons.

Historic Wood Pricing in Northern NH

Northern New Hampshire has long had markets for biomass fuel, most notable Whitefield Power and Light and Pinetree – Bethlehem. These facilities, as well as nearby facilities in Vermont and Maine have long purchased biomass chips from local landowners and loggers.

The New Hampshire Timberland Owners Association[8], the state's forest industry trade association, publishes market prices for wood, by region, on a quarterly basis. Using these publicly reported figures, biomass chips in Northern NH were price stable at roughly $18 per green ton through 2002. At that point, prices began to rise, and the most recently reported pricing (4th Quarter 2007) is $28 per green ton, delivered. Figure 10 shows the reported pricing from 1995 through 2007.

Figure 10. Historic Wood Pricing in Northern NH, 1995 - 2007



Data Sources: *NHTOA Timber Crier*

[8] Eric Kingsley of Innovative Natural Resource Solutions LLC was Executive Director of the NHTOA from 1995 – 2000, a period when some of this data was collected.

Direct Conversations with Potential Suppliers

A survey of existing and potential wood fuel producers for the proposed Clean Power Development project in Berlin, NH was completed by North Country Procurement, Inc. (NCP) of Rumney, NH. The survey included direct interviews with contractors, phone interviews, and discussion with two major land holding companies in New Hampshire and Maine. The purpose of the survey was to determine wood fuel availability at certain defined prices delivered to the proposed facility. Fifteen logging contractors (the largest and most active contractors in the region, all firms that currently supply existing biomass or pulpwood markets) were interviewed for the study, not including the aforementioned landowners.[9]

During the interview process, different delivered price scenarios were provided to the contractors to determine level of interest and potential volumes each would be willing to produce fuel for. The ranges in prices were:

- $28 per green ton (delivered),
- $30 per green ton (delivered), and
- $32 per green ton (delivered).

There was minimal interest indicated by contractors at the $28 / ton level (roughly equivalent to current pricing), but producers did seem to agree that a $30 / ton price given current market conditions and operating costs was a minimum bench mark price for new biomass capacity in this region. The contractors interviewed indicated that 78 loads per week, or roughly an additional 120,000 green tons annually would be available at this price.

At the $32 / ton price there was considerable interest. Based on the limited number of contractors NCP contacted, 235 loads or 350,000 tons annually (based on an average load of 30 tons) would be available from these surveyed contractors. These contractors should not in any way be considered the only volume of wood fuel available to a project in Berlin. NCP has been responsible for the start up procurement of four existing wood fired power plants. NCP's experience has found that once a facility has broken ground, additional interest is generated by either logging contractors or individuals with prior harvesting experience.

Based on the interviews conducted by NCP staff, we have concluded that a delivered price of $32/ton would be sufficient to provide the proposed plant with the required wood fuel. This price is based on current harvesting costs and market conditions.

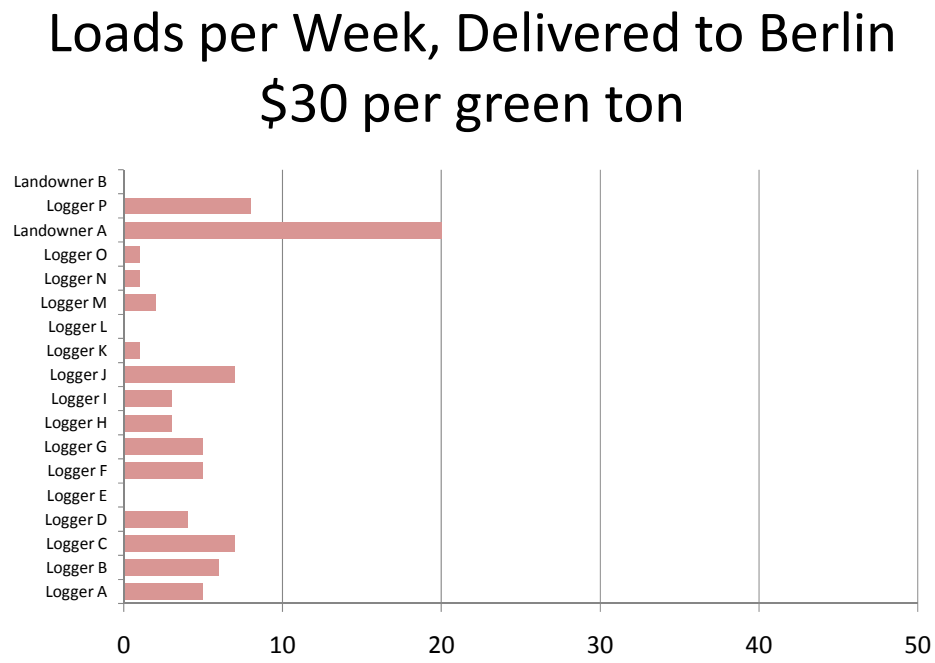
Diesel fuel price fluctuations have a considerable influence on market price for wood fuel. All other market influences being stable, the price of wood fuel generally changes by $1.00/ton for every 50 cent/gallon change in diesel fuel. The $32/ton estimate for wood fuel equates to a diesel fuel price of $3.50/gallon (the price of diesel at the time this work was conducted[10]).

[9] These interviews were conducted over a three week period in January and February 2008, and NCP believes that more time would have identified additional supply capacity.

[10] The New England benchmark price for diesel on May 19, 2008 is $4.61, equating to biomass prices at roughly $34.25 per green ton, delivered.

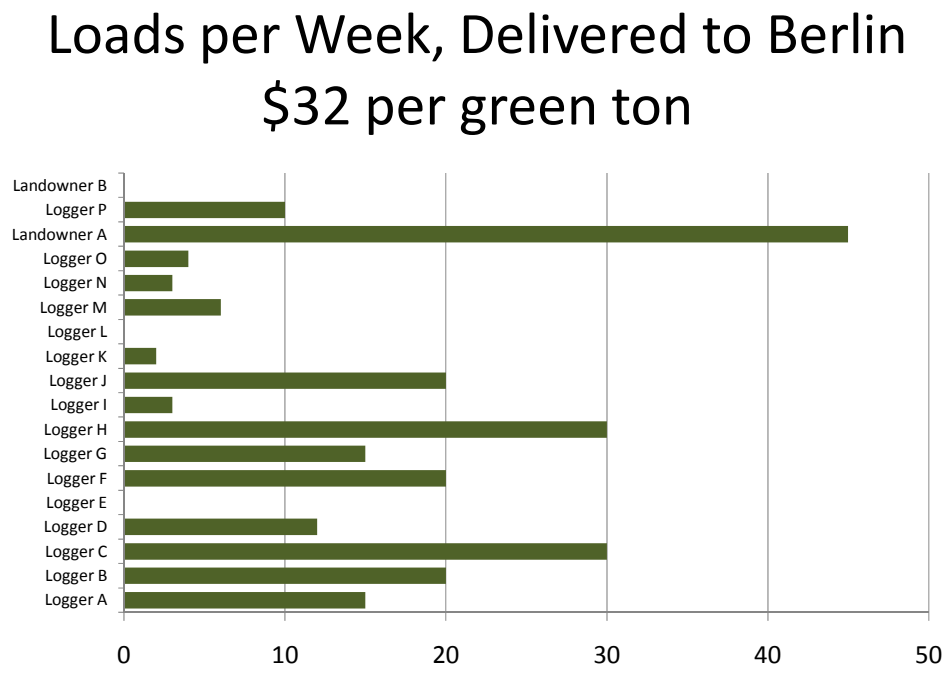
NCP spoke with existing loggers and two major landowners about their ability to add capacity or production to existing timber harvesting operations in order to generate biomass fuel to supply the facility. At a price of $30 per green ton, the largest suppliers in the region indicated that an additional 78 loads per week would be available; roughly 120,000 green tons annually.

Figure 11. Wood Availability at $30 per Green Ton, Delivered



At $32 per green ton (delivered), these same suppliers indicate a willingness to make almost three times the volume available, indicating that this is likely a market price threshold in the Berlin region. These potential suppliers are able to provide 235 loads per week, or roughly 350,000 green tons annually at this higher price.

Figure 12. Wood Availability at $32 per Green Ton, Delivered



Historic Timber Harvest Volumes and Projected Biomass Fuel Availability

As part of the enforcement of the Timber Tax (RSA 79), New Hampshire collects volume, species and product information from every commercial timber harvest in New Hampshire. Following completion of a timber harvest, landowners are required to file a "Report of Cut", which provides a detailed accounting of the forest products removed during harvest[11].

The New Hampshire Division of Forests & Lands has compiled this information for tax year 1998 through 2005, and provided this information for Coos County to Innovative Natural Resource Solutions LLC. The volumes and species of wood harvested during this time period are detailed in Table 6, below.

INRS recognizes that the likely procurement radius for a biomass plant in Coos County, NH likely includes parts of Maine, and likely excludes parts of Coos County. However, the land ownership patterns, forest types and other factors are such that Coos County data can and does serve as a reasonable proxy for the procurement radius expected for a biomass plant located in Berlin.

For purposes of this report, INRS assumed that wood delivered to Clean Power Development's Berlin, NH biomass facility comes from land proximate to the facility (roughly one hour drive time). At this time, a number of biomass plants get wood from further away than this. However, with a number of new biomass facilities under development, it is highly probably that biomass will become a more localized fuel source, and as such we have assumed that fuel is procured exclusively from local sources. This is a conservative assumption.

[11] This data does include information from timber harvests conducted on public lands (e.g., the White Mountain National Forest or Nash Stream State Forest) in Coos county.

Table 6. Annual Timber Harvest Volumes by Product, Coos County, 1998 - 2005[12]

	1998	1999	2000	2001	2002	2003	2004	2005
Sawlogs								
White Pine (mbf)	2,451.3	3,405.5	2,323.4	2,807.1	1,773.7	3,789.0	5,555.4	3,743.0
Hemlock (mbf)	534.7	172.7	235.2	112.2	102.5	275.3	534.4	220.0
Red Pine (mbf)	624.8	112.1	59.8	24.1	39.1	16.4	116.2	188.7
Spruce & Fir (mbf)	24,413.2	25,896.7	26,520.3	24,297.3	21,268.1	20,454.7	31,902.7	23,149.4
Hard Maple (mbf)	7,703.1	7,762.9	8,493.6	5,150.6	5,588.2	7,327.0	9,940.2	6,672.5
White Birch (mbf)	1,168.7	1,485.4	2,091.7	1,014.5	1,227.3	1,329.4	1,705.7	1,338.3
Yellow Birch (mbf)	3,234.3	2,912.3	3,143.7	2,719.9	3,434.3	3,811.4	3,793.2	3,432.0
Oak (mbf)	134.5	113.2	139.9	26.1	68.4	235.6	550.5	163.2
Ash (mbf)	600.8	666.5	776.6	375.9	196.6	814.3	635.9	445.5
Beech & Soft Maple (mbf)	1,295.3	1,092.6	1,229.9	1,057.7	1,095.0	1,296.1	1,927.6	1,424.1
Pallet & Tie Logs (mbf)	5,640.1	4,769.9	5,105.2	3,807.5	3,864.3	5,128.5	7,598.6	6,456.4
Other (mbf)	809.8	300.6	1,366.2	1,106.6	302.2	377.6	816.2	177.4
Exempt (mbf)	67.8	95.0	40.9	106.0	87.2	39.5	88.2	130.5
Pulpwood / Low Grade								
Spruce & Fir Tons	38,150.2	26,869.5	28,863.4	35,923.9	26,047.5	35,245.0	124,357.4	29,685.4
Hardwood & Aspen Tons	294,248.0	182,625.8	238,041.8	192,669.9	229,055.0	277,019.2	429,778.3	249,773.5
Pine Tons	1,465.8	2,185.5	605.1	1,159.8	933.1	4,543.5	6,543.5	4,626.7
Hemlock Tons	866.8	343.9	812.4	188.3	127.1	2,993.9	13,808.7	5,065.9
Whole Tree Chips Tons	70,941.4	66,446.0	63,173.4	35,592.5	78,497.9	63,133.1	87,987.9	89,627.4
Spruce & Fir Cords	18,711.7	23,729.9	23,715.3	16,979.2	13,453.4	14,248.2	9,181.0	12,917.4
Hardwood & Aspen Cords	28,888.4	78,701.7	78,386.3	57,018.7	45,440.0	43,685.0	32,293.5	75,175.6
Pine Cords	1,654.1	2,572.8	1,761.1	1,366.5	1,810.9	806.7	377.4	553.7
Hemlock Cords	615.1	1,025.1	1,587.9	1,025.4	681.2	677.0	1,629.7	1,109.8
Whole Tree Chips Cords	7,113.8	8,630.0	10,791.9	3,859.7	1,557.4	6,584.4	7,902.1	14,452.6
Birch Bolts Cords	2,417.4	1,496.4	1,181.3	2,069.7	638.9	574.3	535.4	113.6
Cordwood & Fuelwood Cords	1,273.0	1,782.2	2,335.6	2,030.9	2,536.4	3,458.4	2,036.8	4,646.0
Exempt Cords	402.8	501.0	540.5	419.0	452.0	520.5	514.0	334.0

[12] Information from NH Report of Cut Forms, provided by NH Division of Forests & Lands (Matt Tansey, personal communication, February 2008)

Table 7 shows the green tons per thousand board feet of timber (mbf). These factors were used to convert the information in Table 6 into green tons, a common unit that allows comparison across the products. The conversions for sawtimber are contained in Table 8, the conversions for low-grade products are in Table 9.

Table 7. Green Tons per Thousand Board Feet of Sawtimber, by Species[13]

Species / Product	Green Tons / MBF
White Pine	3.2
Hemlock	4.5
Red Pine	3.8
Spruce & Fir	3.5
Hard Maple	5.3
White Birch	4.5
Yellow Birch	5.1
Oak	5.6
Ash	4.3
Beech & Soft Maple	4.3
Pallet & Tie Logs	4.5
Other	4.5
Exempt MBF	4.5

[13] www.woodlist.com

Table 8. Annual Sawlog Harvest Volumes by Species in Tons, Coos County, 1998 - 2005

	Green Tons							
Sawlog Species	1998	1999	2000	2001	2002	2003	2004	2005
White Pine	7,844	10,898	7,435	8,983	5,676	12,125	17,777	11,977
Hemlock	2,406	777	1,058	505	461	1,239	2,405	990
Red Pine	2,374	426	227	92	149	62	442	717
Spruce & Fir	85,446	90,638	92,821	85,041	74,438	71,592	111,660	81,023
Hard Maple	40,826	41,143	45,016	27,298	29,617	38,833	52,683	35,364
White Birch	5,259	6,684	9,412	4,565	5,523	5,983	7,676	6,022
Yellow Birch	16,495	14,853	16,033	13,871	17,515	19,438	19,346	17,503
Oak	753	634	784	146	383	1,319	3,083	914
Ash	2,583	2,866	3,339	1,616	845	3,501	2,735	1,916
Beech & Soft Maple	5,570	4,698	5,289	4,548	4,709	5,573	8,289	6,124
Pallet & Tie Logs	25,380	21,464	22,973	17,134	17,390	23,078	34,194	29,054
Other	3,644	1,353	6,148	4,980	1,360	1,699	3,673	798
Exempt MBF	305	427	184	477	393	178	397	587

Table 9. Annual Low-Grade Harvest Volumes by Species in Tons, Coos County, 1998 - 2005

Product / Unit Reporting	Green Tons							
	1998	1999	2000	2001	2002	2003	2004	2005
Spruce & Fir Tons	38,150	26,869	28,863	35,924	26,047	35,245	124,357	29,685
Hardwood & Aspen Tons	294,248	182,626	238,042	192,670	229,055	277,019	429,778	249,773
Pine Tons	1,466	2,186	605	1,160	933	4,544	6,543	4,627
Hemlock Tons	867	344	812	188	127	2,994	13,809	5,066
Whole Tree Chips Tons	70,941	66,446	63,173	35,592	78,498	63,133	87,988	89,627
Spruce & Fir Cords	43,037	54,579	54,545	39,052	30,943	32,771	21,116	29,710
Hardwood & Aspen Cords	75,110	204,624	203,804	148,249	118,144	113,581	83,963	195,457
Pine Cords	3,804	5,917	4,050	3,143	4,165	1,855	868	1,274
Hemlock Cords	1,415	2,358	3,652	2,358	1,567	1,557	3,748	2,553
Whole Tree Chips Cords	17,785	21,575	26,980	9,649	3,893	16,461	19,755	36,132
Birch Bolts Cords	6,285	3,891	3,071	5,381	1,661	1,493	1,392	295
Cordwood & Fuelwood Cords	3,310	4,634	6,072	5,280	6,595	8,992	5,296	12,079
Exempt Cords	1,007	1,253	1,351	1,048	1,130	1,301	1,285	835

Figures 13 through 23 walk through an analysis of potentially available biomass fuel for a facility in Berlin, NH, based upon historic harvesting practices. The base data used for this analysis is the New Hampshire Report of Cut (RSA 79) for Coos County, 1998 – 2005, contained in Figure 6. For 2006 and 2007, tax years for which no data is yet available, INRS assumed an average (mean) of the previous eight years.

Figure 13 shows timber harvest volumes in Coos County by product type, with pulpwood being the dominant product, by weight. As this chart shows, removals of low-grade products (pulpwood and biomass chips) are roughly three times the volume of sawlog removals.

Figure 13. Timber Harvest in Coos County by Product Type, 1998 - 2005

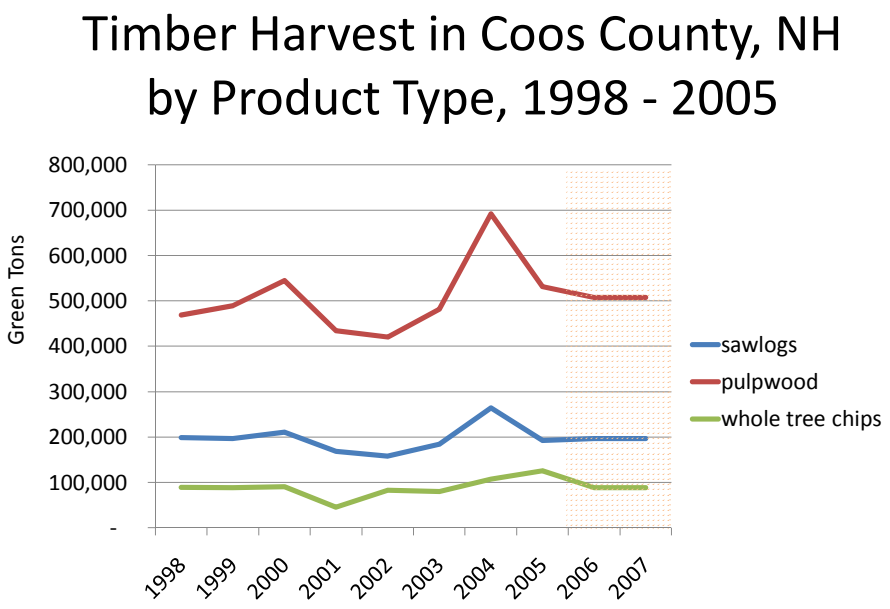
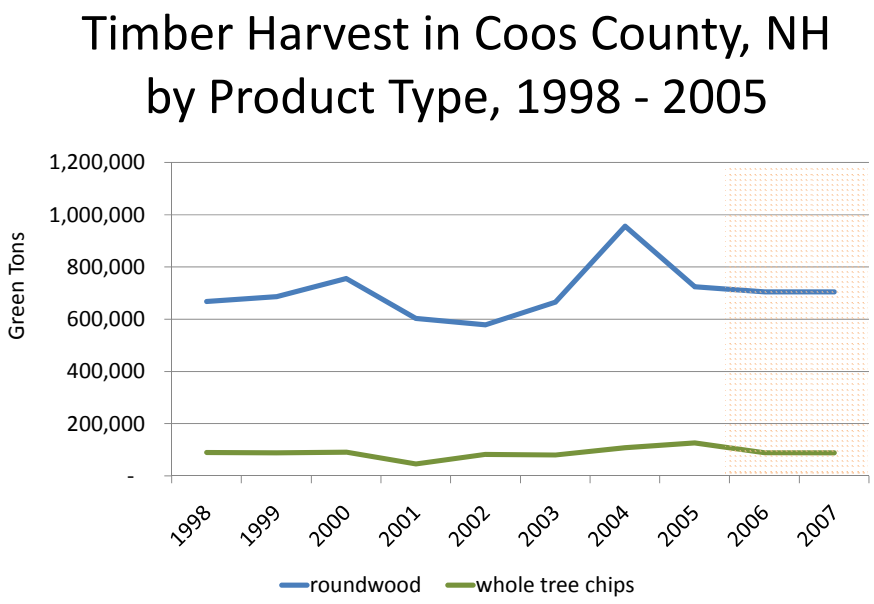


Figure 14 shows the total volume of roundwood (sawlogs and pulpwood) and biomass chips removed from Coos County harvests.

Figure 14. Timber Harvest in Coos County (Roundwood / Whole Tree Chips), 1998 - 2005



Assuming that 0.29 tons of biomass is potentially available for each ton of roundwood harvested, and that roughly 15 percent of the roundwood harvested is off-spec or off-species and cannot be used for higher value products, INRS modeled potential biomass chip availability (red dashed line). The potential volume of chips available is well in excess of current harvest levels, as shown in Figures 15 and 16.

Figure 15. Modeled Biomass Chip Availability, Coos County, 1998 – 2005

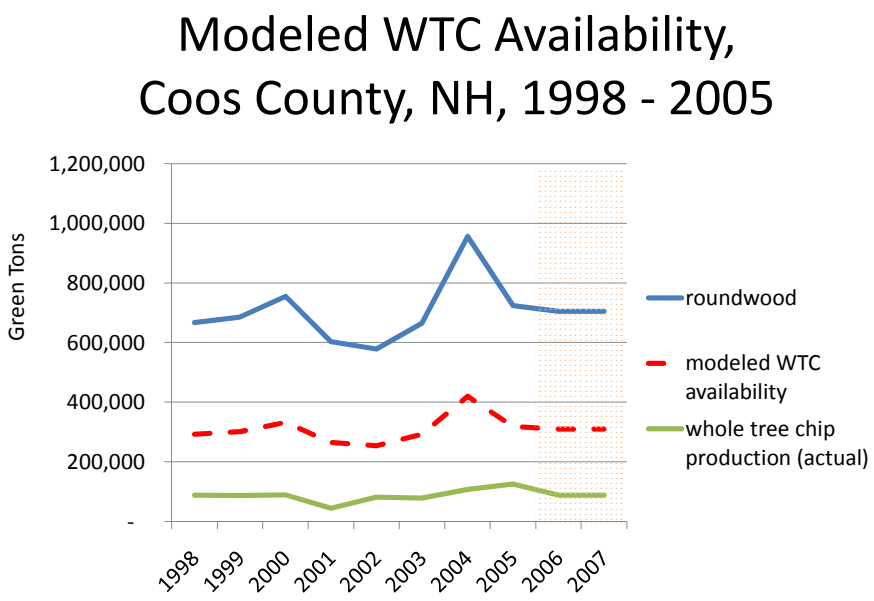


Figure 16. Modeled Biomass Chip Availability and Actual Biomass Fuel Harvest, Coos County, 1998 – 2005

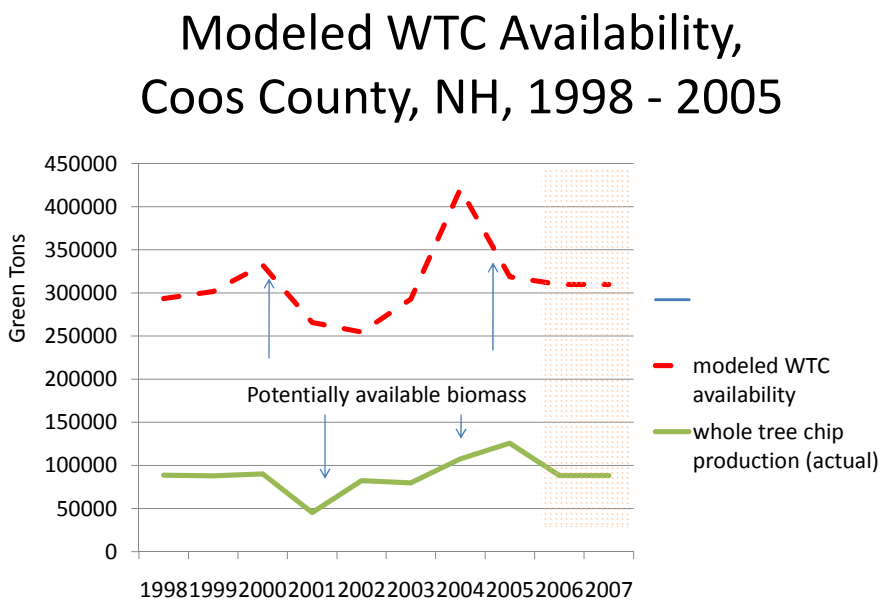
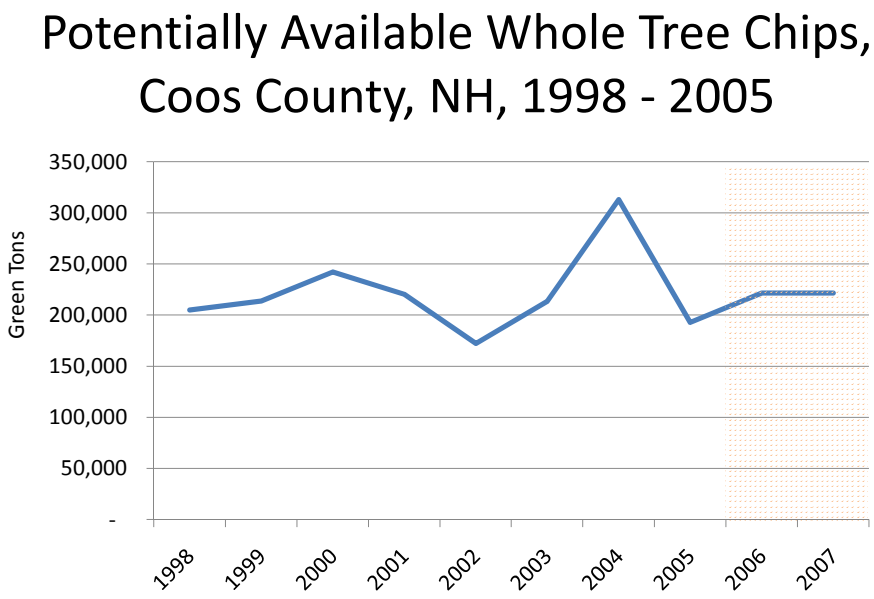


Figure 17 shows the net potential biomass fuel available from harvests in Coos County. Based upon past harvest patterns, between 200,000 and 300,000 green tons of biomass could be available from existing timber harvests in Coos County.

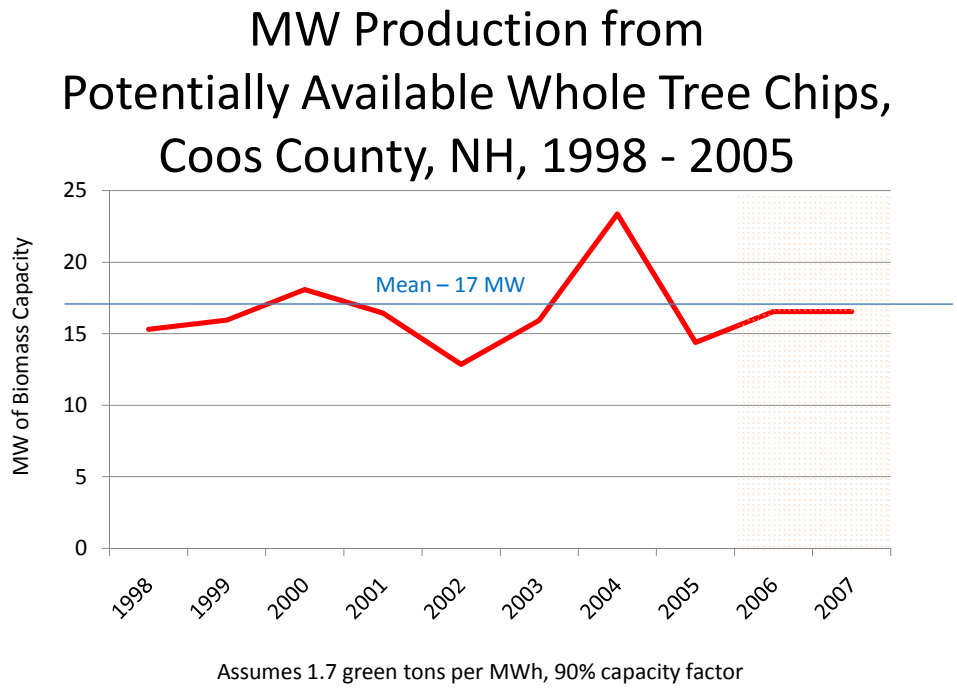
Figure 17. Potentially Available Biomass Fuel Chips, Coos County, 1998 - 2005



For traditional stoker grate or fluidized bed biomass boilers, INRS assumes that 1.7 green tons of wood fuel are necessary to produce 1 megawatt hour (MWH) of electricity. Operating at a 90% capacity factor, this means that each megawatt (MW) of electric generation will consume roughly 13,400 green tons of biomass.

Figure 18 uses these assumptions to show the size biomass facility that can be supported from the net available biomass in Coos County.

Figure 18. MW Production from Potentially Available Biomass, Coos County, 1998 - 2005



Given the change in markets for low-grade wood, particularly the loss of the pulp mills in Berlin and Groveton, NH, it is reasonable to assume that some of the pulpwood harvested would be available for biomass production if the pulpwood markets did not exist. Noting that pulp mills remain active in nearby Maine and Canada, and continue to purchase significant volumes of pulpwood from harvests in Northern New Hampshire, INRS assumed that one third of the pulpwood harvest could potentially be used as biomass fuel, with the remainder going to pulpwood markets outside of New Hampshire.

Figure 19 shows the annual pulpwood harvest volumes in Coos County, NH. Figure 20 shows one third of this volume.

Figure 19. Annual Pulpwood Harvest, Coos County, 1998 - 2005

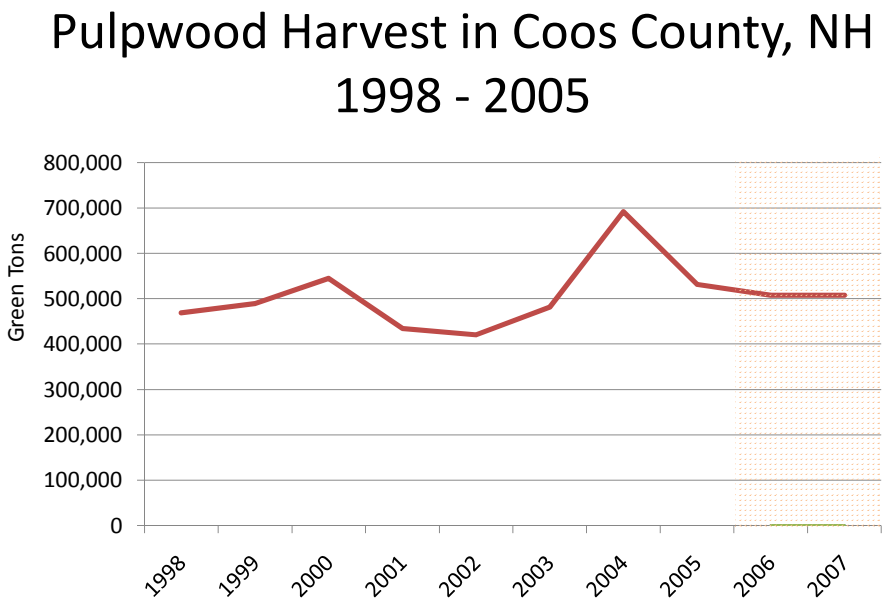
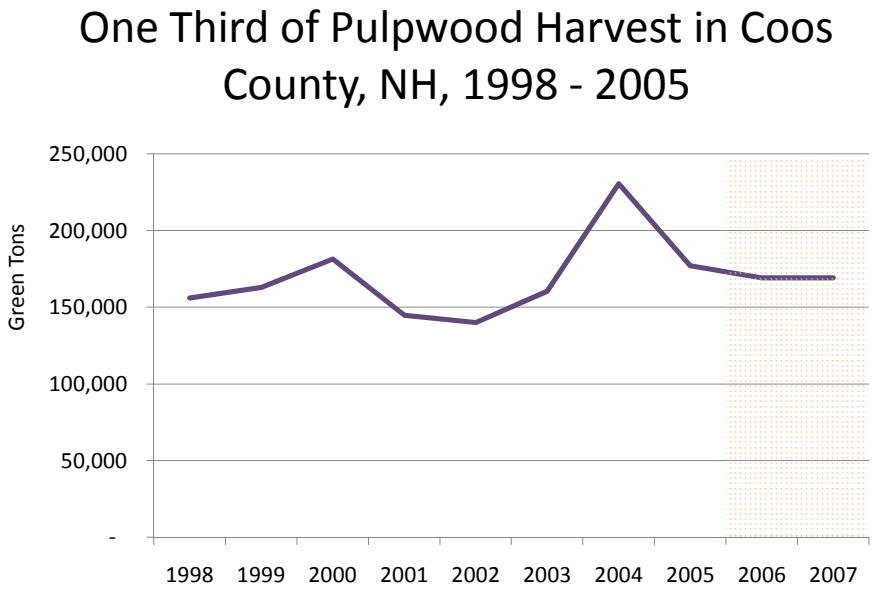


Figure 20. One Third of Biomass Harvest, Coos County



Making the same assumptions used for figure 18, INRS estimated the size of the electric facility that can be supported from this volume of pulpwood.

Figure 21. MW Potential from 1/3 of Pulpwood Harvest, Coos County

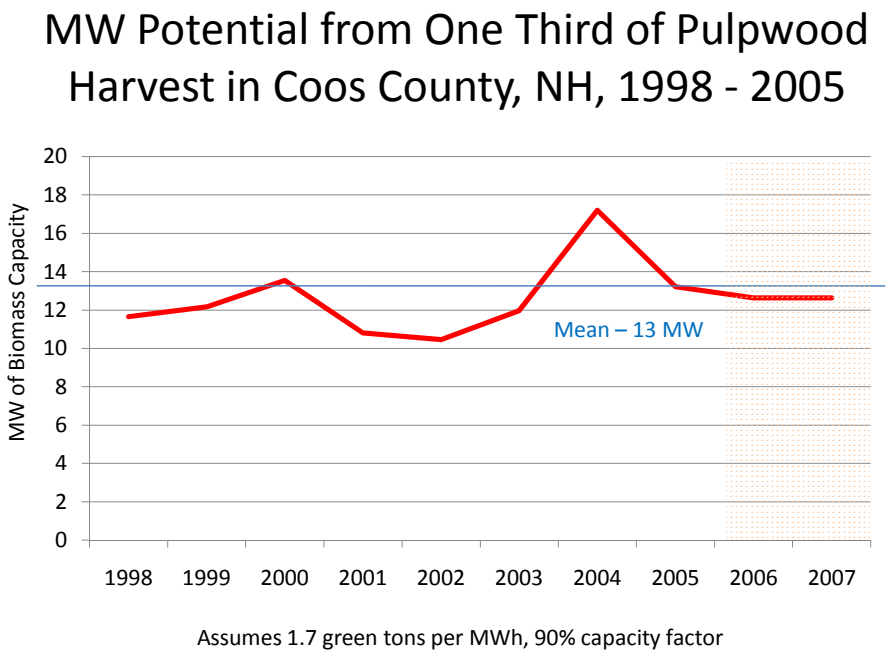
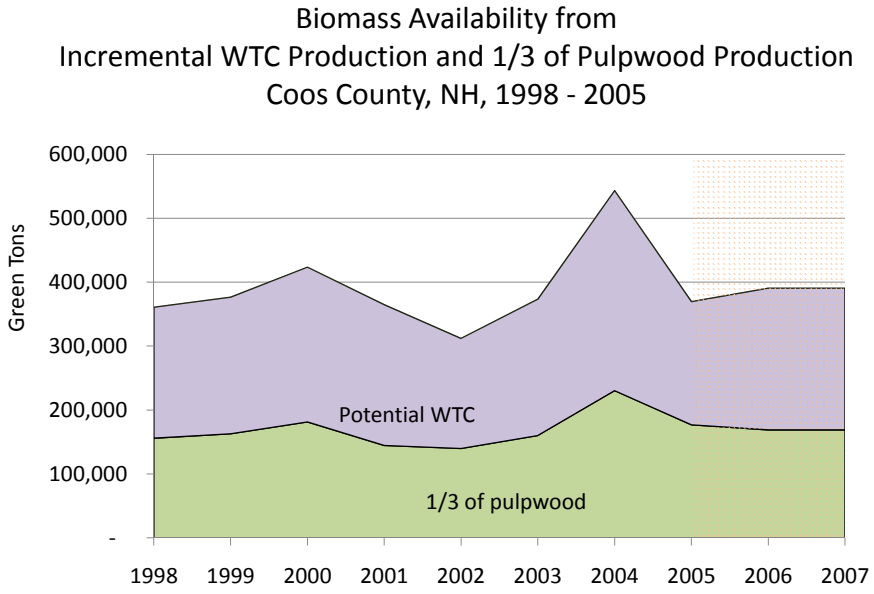


Figure 22 shows the biomass fuel potentially available from a combination of a re-direction of pulpwood (Figure 20) and potentially available tops, branches, and off-spec wood (Figure 17).

Figure 22. Potentially Available Biomass, Coos County, 1998 - 2005



Based upon historic timber harvest figures for Coos County, the net available biomass fuel, combined with a third of traditional pulpwood harvest, can support nearly 30 MW of new biomass generation.

Efforts to construct facilities in excess of this size would require biomass fuel prices that INRS views as economically unsustainable, imports of wood fuel from outside of the immediate region (which would add to transportation costs, potentially making the fuel uneconomic), improvements in efficiency of biomass conversion, or changes in harvesting patterns.

Figure 23. MW Production from Potentially Available Biomass, Coos County, 1998 - 2005