Climate Change and New Hampshire's Forest Industry:

A Discussion of Potential Changes



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CLEAN AIR COOL PLANET

SOCIETY FOR THE PROTECTION OF NEW HAMPSHIRE FORESTS
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Introduction

Climate change is anticipated to have a significant impact on many aspects of forestry and the forest products industry. This white paper examines some of the potential impacts from climate change to New Hampshire's forest industry.

The purpose of this paper is to illustrate a few discrete ways in which climate change may impact the forest industry of New Hampshire. This analysis is intended to provide a point of reference for discussion about ways that New Hampshire's forest industry may be impacted – both positively and negatively – as a result of climate change. This should not be considered a comprehensive analysis of the multiple and potentially significant impacts climate change may have on New Hampshire forests or forest industry.

This white paper examines scenarios developed in a way that might be characterized as "optimistic" – it assumes that change is gradual and orderly. In fact, climate change could bring about changes to the forests and forest industry that are dramatic and unpredictable, and has the potential to be chaotic for the state's forest industry and forest economy.

Executive Summary

Climate change is expected to have a significant impact on the forests and forest industry of New Hampshire. Over the coming years and decades, changes in the state's climate are expected to move portions of the forest that are "maple-beech-birch" or "northern hardwood" forest to an "oak-hickory" forest. In addition to changes in forest type, New Hampshire can expect a number of other changes to its forest and forest products industry. While the impacts and timing of climate change on New Hampshire are impossible to predict, it is likely that impacts include:

- Longer mud seasons, limiting times that loggers are able to operate in the woods and thus limiting the volume of wood harvested annually;
- Shorter winters, a time when timber harvesting is generally favorable, with loggers able to operate on a wide variety of forest and soil types without negatively impacting the forest floor;
- Increased frequency of severe weather events, such as the Ice Storm of 1998. This is important because large rain events can cause ground conditions where loggers are unable to operate, and events such as an ice storm can cause significant damage to standing timber.

Today, New Hampshire is the second most forested state in the nation. Due to the state's relatively high percentage of forestland that is in private ownership, any changes to the forests and forest industry will have a pronounced private sector impact.

New Hampshire forest industries directly employ over 8,000 individuals, with an annual payroll of nearly $325 million. These production and manufacturing jobs, usually located in rural communities, pay wages above the New Hampshire average.

Climate change is anticipated to have a significant impact on many aspects of forestry and the forest products industry. This analysis is intended provide a point of reference for discussion about ways that New Hampshire's forest industry may be impacted – both positively and negatively – as a result of climate change. This should not be considered a comprehensive analysis of the multiple and potentially significant impacts climate change may have on New Hampshire.

Three discrete scenarios are evaluated where climate change is expected have a negative impact on New Hampshire forest industry.

- Changes in forest type could result in direct economic loss to New Hampshire forest industry of $3.3 billion over the next century, and total economic loss to New Hampshire (direct and indirect) of $13 billion;
- An slow increase in the length of mud season by ten days over the next century could result in direct economic loss to New Hampshire forest industry of $1.9 billion over the next century, and total economic loss to New Hampshire (direct and indirect) of $5.6 billion;

  - An more dramatic increase in the length of mud season by sixty days over the next century – a loss of roughly 20 percent of the current logging season -- could result in direct economic loss to New Hampshire forest industry of $11.5 billion over the next century, and total economic loss to New Hampshire (direct and indirect) of $33.9 billion;
- The decline in maple could entirely eliminate the state's maple industry within the next half century, and cause direct economic loss to New Hampshire of $1.8 billion over the next century.

This analysis examines scenarios in a way that might be characterized as "optimistic" – it is likely that impacts to New Hampshire's forest industry and forest economy will be felt in a number of ways not considered in this paper, and that some changes will be dramatic and unanticipated.

Impacts of Climate Change to New Hampshire Forests

Climate change is expected to have a significant impact on the forests and forest industry of New Hampshire. Over the coming years and decades, changes in the state's climate are expected to move portions of the forest that are "maple-beech-birch" or "northern hardwood" forest to an "oak-hickory" forest. Of course, this does not mean that every parcel will change at once, and forest types will likely transition over time as a result of harvests, forest type, forest management techniques, climate and other factors.

Legitimate scientific disagreements exist as to how and in what manner climate change will impact forests and forest types. This is because the forest is a complex ecosystem, with some species highly sensitive to changes in temperature, precipitation and growing season, while other species are less sensitive. It is not the place or purpose of this paper to examine or evaluate the disagreements that exist; the fact is that all five major climate change models evaluated by the USDA Forest Service[i] all show significant and dramatic changes to regional forests as a result of increases in atmospheric CO_2 and climate change.

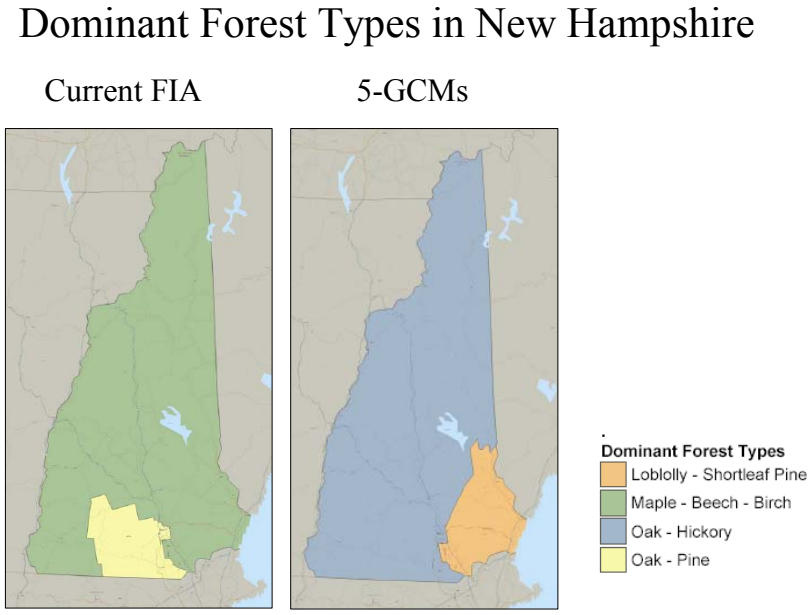
The USDA Forest Service, Northeastern Research Station has prepared maps showing the anticipated impacts of climate change on the forest types of the region. This information, used to produce the maps shown below, contains the following cautionary note:

> "The predicted changes in distribution as a result of climate change presented here are not highly reliable due to uncertainties and underlying assumptions. They do, however, provide a picture of the sensitivity of species to climate change, the environmental variables that drive the current distribution, and the kind of distributional changes that could happen under a warmed climate. Some of the changes could be truly dramatic."[ii]

This map below (5-GCMs) shows how some forest modelers see the region's forest when the equilibrium level of CO_2 in the atmosphere has doubled.[iii] Researchers and policy makers disagree on when this doubling of CO_2 will occur, with many anticipating within a century or sooner.

It is critical to note that global circulation models do not track forests and forest types on small scales, in this case by county. This information, developed from maps of the USDA Forest Service, is presented solely to illustrate the potential change to New Hampshire's forests.

Current and Future (5 Global Circulation Models) Forest Types[iv]



In addition to changes in forest type, New Hampshire can expect a number of other changes to its forest and forest products industry. While the impacts and timing of climate change on New Hampshire are impossible to predict, it is likely that impacts will include:

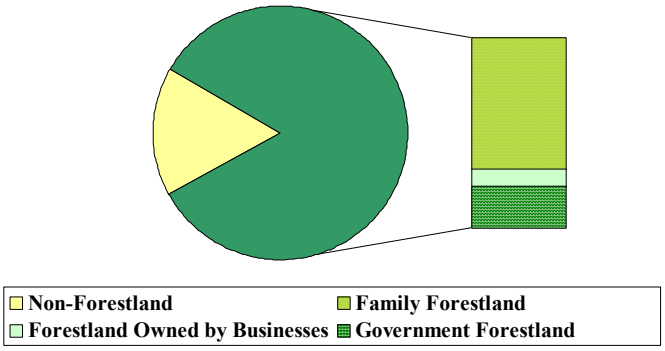
- Longer mud seasons in both the spring and fall, limiting times that loggers are able to operate in the woods and thus limiting the volume of wood harvested annually;
- Shorter winters, a time when timber harvesting is generally favorable, with loggers able to operate on a wide variety of forest and soil types without negatively impacting the forest floor. For example, ice coverage on Lake Winnipesauke has decreased by an average of 14 days when comparing the late 19th century and the late 20th century.[v] While lake ice is not the same as frozen ground condition, it is logical that they are highly correlated.
- Increased frequency of severe weather events, such as the Ice Storm of 1998. Weather data for New England shows a trend toward an increasing number of precipitation events with 2 or more inches of rain (or snow equivalent) over the past century.[vi] This is important because large rain events can cause ground conditions where loggers are unable to operate, and events such as an ice storm can cause significant damage to standing timber.

Overview of New Hampshire Forests and Forest Industry

Since colonial times, the forests of New Hampshire have been an important part of the state's economy. The state has a long history of logging, forest management, lumber production and paper mills – contributing significantly to the economy since before the state's inception.

Today, New Hampshire is the second most forested state in the nation. This state is 85 percent forested, with 4.8 million acres of forestland out of a total of 5.7 million total acres of land. Three quarters of the state's forestland is in private ownership, with 3.2 million acres in the hands of individual or family ownerships, and another 0.4 million acres owned by businesses. Due to the relatively high percentage of forestland that is in private ownership, any changes to the forests and forest industry will have a pronounced private sector impact.

Distribution of Forestland in
New Hampshire by Ownership Type



New Hampshire's forest industry is a critical part of the state's economy, and provides the economic base for many rural communities. Despite the loss of the state's two pulp mills in 2006, the industry remains a significant employer, and an anchor of the state's rural economy.

According to 2005 data from the U.S. Department of Commerce, Bureau of Economic Analysis, the forest product sector directly employs over 8,000 – roughly ten percent of the state's manufacturing industry. Employment is in four core sectors:

- Forestry & logging 1,719 employees
- Agricultural and forestry support services 1,290 employees
- Wood product manufacturing 3,624 employees
- Furniture manufacturing 1,520 employees[vii]

The 2005 data also listed 2,715 individuals employed in pulp in paper manufacturing in some form. Several paper mills continue to operate in New Hampshire, including facilities in Berlin, Groveton and Bennington. However, each of these mills uses pulp imported from mills outside of the state, so the jobs associated with paper production in the state can no longer be attributed to in-state forestry activities. The pulp and paper industry remains an important market for New Hampshire landowners, who continue to supply pulpwood to mills in Maine, New York and Canada; the pulp mill manufacturing jobs associated with these facilities are not located in New Hampshire.

The forest products industry provides jobs and benefits to workers throughout New Hampshire, and often provides jobs in rural areas that are well paying. The industry provided nearly $325 million in payroll to New Hampshire workers in 2005.[viii] Payroll figures for 2005, by sector, are:

- Forestry & logging $78,062,000
- Agricultural and forestry support services $27,535,000
- Wood product manufacturing $148,909,000
- Furniture manufacturing $68,753,000

These figures, when used together, show that New Hampshire forest industry has over 8,000 employees with an annual payroll of nearly $325 million. This computes to an average (mean) wage package[ix] of $39,650 per forest industry employee in 2005; above the New Hampshire "all occupations" mean wage of $37,990 for May 2005.[x]

The value added by manufacturers and the value of shipments are key indicators of how industries contribute to a local economy. In New Hampshire, the wood products industry adds $292 million of value to products annually, and has shipments valued at over $575 million.[xi] This means that the value of product roughly doubles from when it enters the manufacturing process (e.g., arrives at a sawmill) until when it leaves (e.g., as boards) – money that stays in the New Hampshire economy. The furniture industry has $92 million in shipments valued at $152 million, with roughly 60% of value created through the manufacturing process and circulating in the New Hampshire economy.

Economic Impacts of Climate Change to New Hampshire Forest Industry

Given the uncertainty regarding changes in the forests of New Hampshire due to climate change, it is difficult to precisely evaluate the economic impact of the possible changes. Further, climate change is one of many factors that will impact the forest products industry in New Hampshire. Other factors that will influence the forests or forest economy include:

- Land use changes (including loss of timberland to development and regulatory limitations);
- Changes in regional, national and international demand for forest products;
- Investment in forest products manufacturing within and outside of New Hampshire;
- International exchange rates;
- Development of new technologies, products and manufacturing systems;
- Impacts of unknown regulations; and
- A number of other factors.

For sake of simplicity in this analysis, the rest of the factors impacting forests and the forest industry are largely assumed to be static, unless otherwise noted. Obviously, this will not be the case. The forest products industry is dynamic and subject to influence by an enormous number of factors. For purposes of this analysis only the potential impacts of climate change are evaluated.

Further, it is important to note that this analysis looks only at specific and discrete potential changes to the state's forest industry due to climate change. As such, it is likely to significantly underestimate the entire economic impact of climate change to the forest products sector.

Change in Species

The change in species from the current mix of hardwoods to an oak-hickory mix will have significant impacts on New Hampshire's forest industry. As the forest changes slowly, over the course of a century, New Hampshire sawmills are expected to transition to this new species mix, as well as other species found in the oak-hickory mix. However the value of all species is not the same. For example, sugar (hard) maple sawlogs in New Hampshire ranged in value from $525 to $750 per thousand board feet in the latter half of 2006, with an average (mill delivered) price of $641 per thousand board feet.[xii] During this same time period, hickory sawlogs in Tennessee[xiii] were valued at between $170 and $325 per thousand board feet, with an average (delivered) price of $274 per thousand board feet[xiv].

In order to understand the economic impact of such a shift, INRS assumed that *all* sugar maple transitioned to hickory over a 100 year time period, with 1% of maple lumber processing disappearing annually, being replaced by hickory, so that after a century hickory processing has completely replaced sugar maple processing in New Hampshire sawmills.

Other assumptions included in this analysis include:

- An annual rate of inflation of 3%;
- Growth in value of both maple and hickory sawlogs (mill delivered price) at 1.5% above inflation;
- Assumes that the combined sugar maple + hickory rate of lumber production remains at the 2004 sugar maple level of 6,274 MBF.[xv]

Using these assumptions, the value of sawlogs delivered to New Hampshire sawmills for processing drops by $300,000 annually in ten years, $1,000,000 annually in twenty years, and nearly $10 million annually in 50 years. After a century, the total cumulative direct economic loss to New Hampshire's landowners, loggers and foresters from a species shift of sugar maple to hickory would be $3.34 billion. Given that research shows each dollar of sawmill activity has a "multiplier effect" of 3.83[xvi] (that is, it circulates in the local economy 3.83 times), this represents nearly $13 billion lost to New Hampshire's economy.

Assuming that sawlog stumpage prices (the value paid to a landowner) are roughly half of the mill delivered price, this represents a loss of timber yield tax to New Hampshire communities of over $150 million.

This species change is one of many that may occur in New Hampshire forests, and is but a small portion of the economic loss New Hampshire forest industry – landowners, loggers, foresters, mill and others – could suffer due to changes induced by climate change. It is also possible that during the decline of some commercially important species, such as sugar maple, the volume *and* grade will decline, causing some additional economic loss to the state's forest industry.

Increases in the length and severity of mud season

One of the anticipated changes from climate change is an increase in the length of "mud season(s)", periods in the spring and fall when saturated soil makes logging on many sites ecologically destructive. New Hampshire, as most states, has "Best Management Practices" that help loggers decide how to minimize soil damage from logging, but there is a period of time each year when saturated ground makes logging on many sites impossible, idling people and machinery.

The length of the mud seasons varies considerably from year to year, from logger to logger, and depending upon the type of ground being operated. Loggers currently report being "shut out" of jobs from two to eight weeks per year, with four weeks (20 work days) being the consensus "average" downtime. Anecdotally, loggers indicate that the length and duration of mud season is increasing, both because of weather related phenomenon and because of heightened sensitivity to environmental issues.

- *Modest Increase*

Assuming that climate change increases the length of mud season by one day per decade, a number many loggers and procurement foresters found anecdotally conservative given recent trends, loggers will see twenty-five days of lost production in fifty years, and 30 days of lost production in a century. For purposes of this analysis, it is assumed that these production days lost to mud season are not made up by an increase in productivity during other times of the year.

In 2004, New Hampshire landowners received roughly $35.4 million for stumpage sold.[xvii] This represents *daily* stumpage payments to New Hampshire landowners of $116,000, assuming a 6-day workweek. As in the above analysis of change in species type, it is assumed that inflation is 3% annually, and that forest products increase in value at a rate of 1.5% above inflation. Given this, each day lost to mud season represents $200,000 in lost stumpage after ten years, $300,000 in 20 years, and $1.2 million in 50 years.

The total cumulative loss of stumpage payments to New Hampshire landowners due to a ten day increase in mud season over the next century is estimated at $1.9 billion. Given that research shows each dollar of timber harvesting activity has a "multiplier effect" of 2.95[xviii] (that is, it circulates in the local economy 2.95 times), this represents over $5.6 billion lost to New Hampshire's economy. This also represents a loss of timber yield tax to New Hampshire communities of over $190 million.

- *Dramatic Increase*

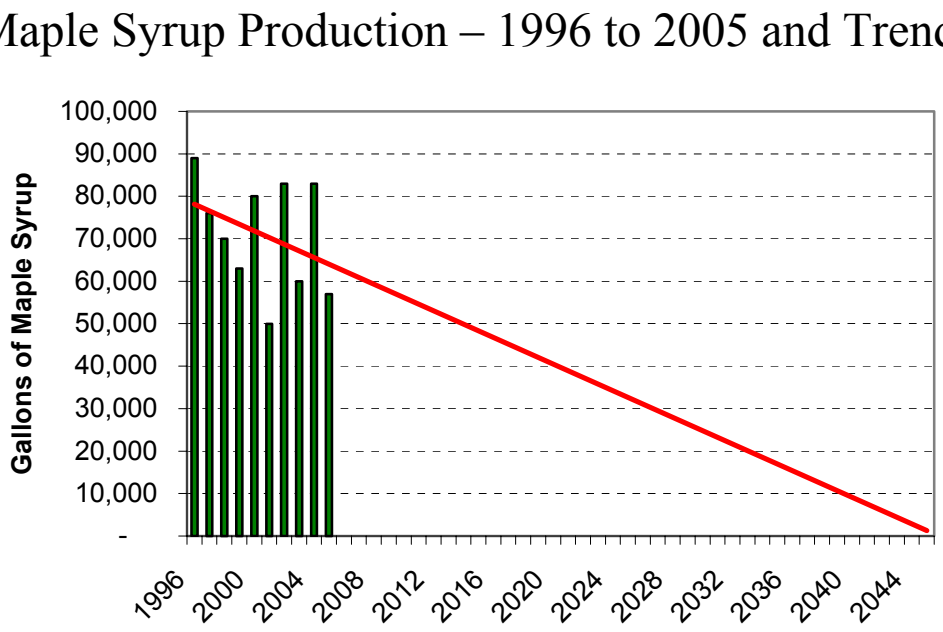
How future mud seasons will occur is, of course, unknown. The case above shows the impacts of a mud season that increases by 50% in a century. Given climate trends and the situation loggers faced in 2006 and 2007, many regard this as an optimistic view. In order to understand the impacts of a more dramatic loss of logging due to extended mud seasons, a reduction of 20% of current annual logging days over the next century was analyzed. This results in 35 total days of lost logging in 25 years, 50 days in 50 years, and 80 days in a century. Again, it is assumed that these production days lost to mud season are not made up by an increase in productivity during other times of the year.

Given this scenario and the assumptions used above, the annual loss to New Hampshire's forest economy would be $1.2 million in ten years, $3.9 million in twenty years and $36.6 million in 50 years. The total cumulative loss of stumpage payments to New Hampshire landowners due to a 60-day increase in mud season over the next century is estimated at $11.5 billion. Given that research shows each dollar of timber harvesting activity has a "multiplier effect of 2.95[xix] (that is, it circulates in the local economy 2.95 times), this represents over $33.9 billion lost to New Hampshire's economy. This also represents a loss of timber yield tax to New Hampshire communities of over $1.1 billion.

Decline and loss of the maple syrup industry

While certainly not a core part of New Hampshire's forest industry, maple syrup production is an important niche market, and a critical part of the state's identity. Visits to maple sugaring operations, ranging from small backyard operations to mid-sized commercial facilities, are a "rite of spring" in New Hampshire, and provide economic benefit to landowners and support the cultural fabric of the state.

Over the past decade (from 1996 to 2005), maple syrup production has been on a downward trend in New Hampshire. Assuming that the current trend is related to changes in the climate, and that this trend continues as it has over the past decade, maple syrup production in New Hampshire will cease around 2046.



Assuming that maple syrup declines according to the trend established over the past decade, New Hampshire will slowly lose its maple industry, and the economic benefits that go with it. The average sale price for a gallon of maple syrup in New Hampshire from 1996 – 2005 was $39.03. Assuming that this price increases at the rate of inflation (assumed to be 3%), New Hampshire will lose $1.4 million in annual syrup sales in ten years, $3.1 million in annual sales in twenty years, and $12.9 million in annual sales in fifty years (when compared to current maple syrup production levels). The cumulative impact to New Hampshire's economy from lost maple syrup sales over the next century is estimated to be $1.8 billion.

Combined Impacts of Climate Change on New Hampshire Forest Industry

The three scenarios discussed above—a change from maple to hickory, an increase in the length of mud seasons, and a loss of the maple syrup industry – are only a few of the impacts that New Hampshire forests and forest industry may experience as a result of climate change. Further, as discussed above, the changes evaluated above may be considered optimistic, because change is assumed to be gradual and predictable. It is highly possible that transition will be marked by swings in weather patters and climate conditions, punctuated by dramatic events such as ice storms.

Given these cautions, the figures presented should be viewed as only a portion of the potential impact that New Hampshire forests and forest industry will experience as a result of climate change.

Annual Direct Loss to New Hampshire Forest Industry

	10 years	20 years	50 years	100 years
Species Change	$ 309,159	$ 1,017,950	$ 9,960,170	$ 185,724,502
Mud Season (10 days)	$ 177,362	$ 583,987	$ 5,714,047	$ 106,548,237
Maple Syrup	$ 1,441,274	$ 3,110,846	$ 12,906,208	$ 56,579,604
Total	$ 1,927,795	$ 4,712,783	$ 28,580,425	$ 348,852,343

Cumulative Direct Loss to New Hampshire Forest Industry

	10 years	20 years	50 years	100 years
Species Change	$ 1,379,539	$ 7,953,394	$ 137,884,918	$ 3,334,281,080
Mud Season (10 days)	$ 791,427	$ 4,562,780	$ 79,103,160	$ 1,912,842,780
Maple Syrup	$ 8,377,729	$ 27,091,063	$ 244,155,034	$ 1,769,044,810
Total	$ 10,548,696	$ 39,607,238	$ 461,143,111	$ 7,016,168,670

Opportunities for New Hampshire Forest Industry to Mitigate Climate Change

In addition to the significant negative impacts to New Hampshire's forest economy, a sample of which are evaluated above, New Hampshire forests and forest industry could play a role in reducing CO_2 emissions that contribute to climate change. Biomass energy is the most obvious way that may be positive for both forest industry and forest landowners, and a way that New Hampshire is already participating in emissions mitigation.

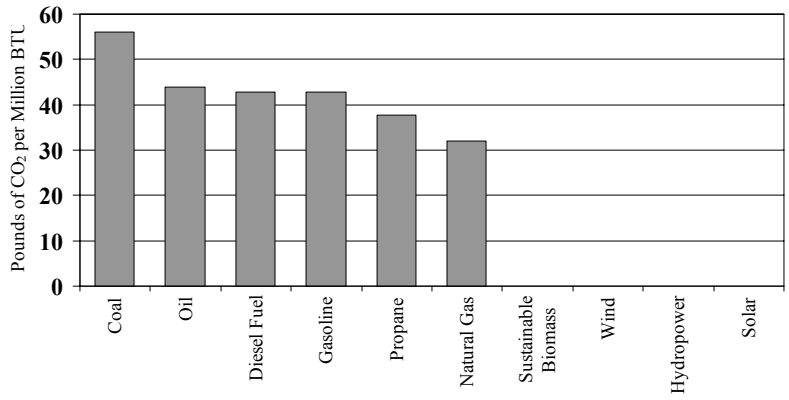
Biomass Energy

New Hampshire has five wood-fired power plants, with roughly 78 MW of net generation, that have been operating for almost twenty years, as well as a new 50 MW power plant located in Portsmouth, NH. Combined, these six facilities produce roughly 1 million MW hours of electricity, or 4.25% of the state's 2005 electricity generation level.[xx, xxi]

Biomass electricity facilities rely upon a carbon source, wood, that is already part of the above-ground carbon cycle. While CO_2 is emitted from wood-fired electricity generation, it does not introduce new carbon to the planet's above-ground carbon reserves, as do combustion of fossil fuels such as coal and petroleum products.

When biomass is removed from a forest as part of a sustainable timber harvesting operation, and a growing forest remains, that biomass is generally considered "carbon neutral". That is because, over time, the growing forest captures and stores (sequesters) carbon to replace carbon that has been removed and released through burning. As shown in the chart below, when biomass is sustainably harvested, it has a "net zero emission" profile for CO_2, comparable with other renewable generation sources[xxii] and far superior to fossil fuels.

Carbon Dioxide Emissions by Energy Source



A recent analysis of the economic impact of biomass power in New Hampshire shows over $1 million in economic impact (direct and indirect) for each megawatt of operating biomass generation capacity.[xxiii] Assuming that this economic impact increases at the rate of inflation (assumed to be 3%), the economic benefit to New Hampshire and its forest economy, the *annual* economic benefit to New Hampshire's economy of having 118 MW of operating wood-fired generation is expected to be $207 million in ten years, $278 million in twenty years, and $675 million in fifty years. The cumulative economic benefit to New Hampshire of 188 MW of wood-fired electricity over the next century is estimated at $93 billion.

Wood-fired generation faces serious economic challenges, and is by no means assured into the future. New Hampshire's older wood-fired facilities have long operated under rate-orders (similar to contracts) that guaranteed above-market prices for electricity. These are expiring, and the continued operation of existing facilities is unknown at this time. New facilities (i.e., PSNH's Northern Wood Power Station) rely upon renewable energy mandates in other New England states to support operations. At least in the near term, it is likely that some level of public policy support is necessary to support wood-fired electricity generation at current levels. If total biomass generation (either from existing or new facilities) were to drop below 118 MW, economic benefits would drop as well. Similarly, biomass generation above 118 MW would increase the economic benefits to the forest industry and the state.

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Endnotes

[i] These global circulation models are from the: 1. Goddard Institute of Space Studies (NASA); 2. Geophysical Fluid Dynamics Laboratory; 3. Hadley Center for Climate Prediction and Research (UK); 4. United Kingdom Meteorological Office; and 5. Canadian Climate Center.
[ii] USDA Forest Service – Climate change Tree Atlas of the Eastern USA. http://www.fs.fed.us/ne/delaware/atlas/index.html
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[iv] Maps produced by Innovative Natural Resource Solutions LLC based upon: Prasad, A. M. and L. R. Iverson. 1999-ongoing. A Climate Change Atlas for 80 Forest Tree Species of the Eastern United States [database]. http://www.fs.fed.us/ne/delaware/atlas/index.html, Northeastern Research Station, USDA Forest Service, Delaware, Ohio.
[v] Clean Air Cool Planet and The Climate Change Research Center, University of New Hampshire. *Indicators of Climate Change in the Northeast.* 2005.
[vi] Ibid.
[vii] Bea.gov/bea/regional/spi/action.cfm
[viii] US Department of Commerce. *Annual Survey of Manufactures*, November 2006
[ix] Payroll includes both wage and compensated – sick and vacation time; it does not include benefits such as health care insurance
[x] U.S. Bureau of Labor Statistics
[xi] US Department of Commerce. *Annual Survey of Manufactures,* November 2006
[xii] New Hampshire Timberland Owners Association. *Timber Crier – Market Pulse.* Fall 2006 Newsletter. Mill delivered price.
[xiii] The nearest forest products market report found that listed hickory as a commercially important species was in Tennessee.
[xiv] Tennessee Department of Agriculture – Division of Forestry. *Tennessee Forest Products Bulletin.* Volume 30, No. 4. October 2006.
[xv] Personal communication, Sarah Smith – UNH Cooperative Extension. January 4, 2007.
[xvi] University of Maryland, Department of Natural Resources. "Economic Impact of Forestry and Wood Products Industry in Maryland". 1999.
[xvii] Based upon 2004 timber yield tax of $3,537,523. Personal communication with Roger Ferland, NH Department of Revenue Administration, January 4, 2007.
[xviii] University of Maryland, Department of Natural Resources. "Economic Impact of Forestry and Wood Products Industry in Maryland". 1999.
[xix] University of Maryland, Department of Natural Resources. "Economic Impact of Forestry and Wood Products Industry in Maryland". 1999.
[xx] US Department of Energy, Energy Information Agency. *U.S. Electric Power Industry Net Generation by State.* 2005.
[xxi] New Hampshire is a net exporter of electricity, so this represents a percentage of the state's electricity use.
[xxii] Maine State Planning Office and University of Maine. *State of Maine Climate Action Plan.* 2000.
[xxiii] Innovative Natural Resource Solutions and Draper Lennon, Inc. *Identifying and Implementing Alternatives to Sustain the Wood-Fired Electricity Generating Industry in New Hampshire.* Developed for the NH Department of Resources & Economic Development. January 2002.