

# A SYNOPSIS OF THE WOOD-BASED ENERGY AND HEATING INDUSTRIES IN THE NORTHEASTERN UNITED STATES WITH CONSIDERATION OF POTENTIAL IMPACTS ON FUTURE DEMAND FOR ROUNDWOOD

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**Abstract.**—The project team identified 323 facilities in the northeastern United States that input pulpwood or “energy wood.” Of these, 88 are located in Pennsylvania, Ohio, and West Virginia, part of the central hardwood forest region. In the 13-state northeastern region, 81 percent of the facilities that use pulp-type roundwood produce an energy-related product. For the three states that are part of the central hardwood forest, 75 percent of the facilities are in business to produce an energy product while the other 25 percent produce a more traditional product (e.g., pulp, oriented strand board). The 323 operations identified in the Northeast potentially consume 40.6 million tons (50-percent moisture content) of wood per year, of which 12.5 million tons is consumed in the three central hardwood states. Forest resource concentrations and levels of industrialization suggest that collection of data on future woody biomass demand be focused on five key states: Maine, New Hampshire, Vermont, New York, and Pennsylvania. Small-scale bioenergy projects pose no real threat of significantly reducing the general supply of woody biomass in the Northeast. The ongoing decline in pulp and paper production together with the apparent decline in other traditional woody biomass-using industries, will relieve the pressure on the woody biomass resource. Assuming a normal and expected evolution of events, woody biomass consumption in the region will increase by roughly 25 percent over the next decade. The variable that could most affect the woody biomass resource is the future direction of electricity production from wood and co-firing of wood in coal power plants, especially in Pennsylvania, West Virginia, and Ohio.

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## INTRODUCTION

The future energy landscape will be a product of current energy demographics within a given state and region, state and federal policies, renewable resource availability, and consumer demand. Our objective in this study was to estimate how wood-based energy might be a part of the future energy landscape in the northeastern United States. Knowledge of the current distribution of wood-based energy systems and regional trends in biomass energy adoption provide important background information and insight toward fulfilling this objective. This information can help us estimate possible shifts in biomass demand that will be of interest to resource managers, existing wood products industries, and prospective entrants into the region’s wood marketplace.

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Unfortunately, to accurately characterize the current status and trends for wood-based bioenergy is challenging and to project the future state of affairs is extremely difficult. The uncertainty involved in this undertaking is due to a myriad of factors, including: 1) the diversity of biomass-based energy technologies; 2) the incompatibility and incompleteness of state and regional forest products flow databases; 3) the wide array of regional and state policies toward energy production, emission controls, and forest management; and 4) the rate of change of policies and opinions.

Recognizing these challenges, we have included considerable discussion of the uncertainty factors that affect the following assessment of the current and future scenarios for wood use in bioenergy markets in the northeastern United States. The information in this report was obtained through extensive discussions and Web searches carried out over several months in 2008 and 2009.

## **RENEWABLE ENERGY GENERATION IN THE NORTHEAST**

Five energy-consuming sectors must be considered in discussing energy supply and demand. These sectors are: 1) commercial, 2) residential, 3) industrial, 4) transportation, and 5) electric power generation. These sectors are listed in reverse order in terms of their size. In 2008, these sectors consumed 4, 7, 21, 28, and 40 percent of the energy used in this country, respectively (Energy Information Administration [EIA] 2009a). As the most important sector, electricity generation is a key focus area for energy policy-makers.

It is important to recognize, however, that the other four energy-consuming sectors, as the end-consumers of the product produced by the electric power generation sector, can influence the production and distribution of electricity. This is less the case for the commercial and transportation sectors than it is for the residential and industrial sectors. Not only do these two sectors consume electricity at greater rates, but some of the generated electricity that is included in statistics is generated by the industrial sector for in-house use. In some cases, industrial generators produce excess electricity that enters the grid. Thus, if these sectors shift to alternate heating sources or if they lend strong support to policies that promote greater use of renewable resources as inputs by the electric power generation sector, they can have a substantial effect on electrical energy generation.

The overall average percentage of electric power generation that was derived from renewable sources in the United States in 2007 was 8.5 percent (EIA 2009b). In the northeastern United States, renewables produced a higher percentage of the electricity generated—9.2 percent (adapted from EIA 2009b; Fig. 1)—despite the fact that only 4 of the 13 northeastern states met or surpassed the national average for percentage of in-state electricity generation derived from renewable sources (EIA 2009b). Substantially higher levels of renewable use in the New England states is the reason the Northeast exceeds the national average. Maine leads the region in renewable energy generation and exceeds the national average by a very large margin. In fact, the proportion of Maine's energy that is non-hydroelectric renewable energy is the highest in the nation. Nationwide, hydro-electricity is the number one form of renewable electricity and wood is the second greatest contributor of renewable electricity (Fig. 1).

In 12 of the 13 northeastern states, hydro-electricity is either the most important or the second most important renewable energy source for the electric power industry. In eight of these states, landfill gas ranks as one of the top two renewable energy sources. Only in Maine, New Hampshire, Vermont, and Ohio is wood one of the two most important renewable sources of electricity. In 2007, wood constituted 23.9, 4.2, 7.8, and

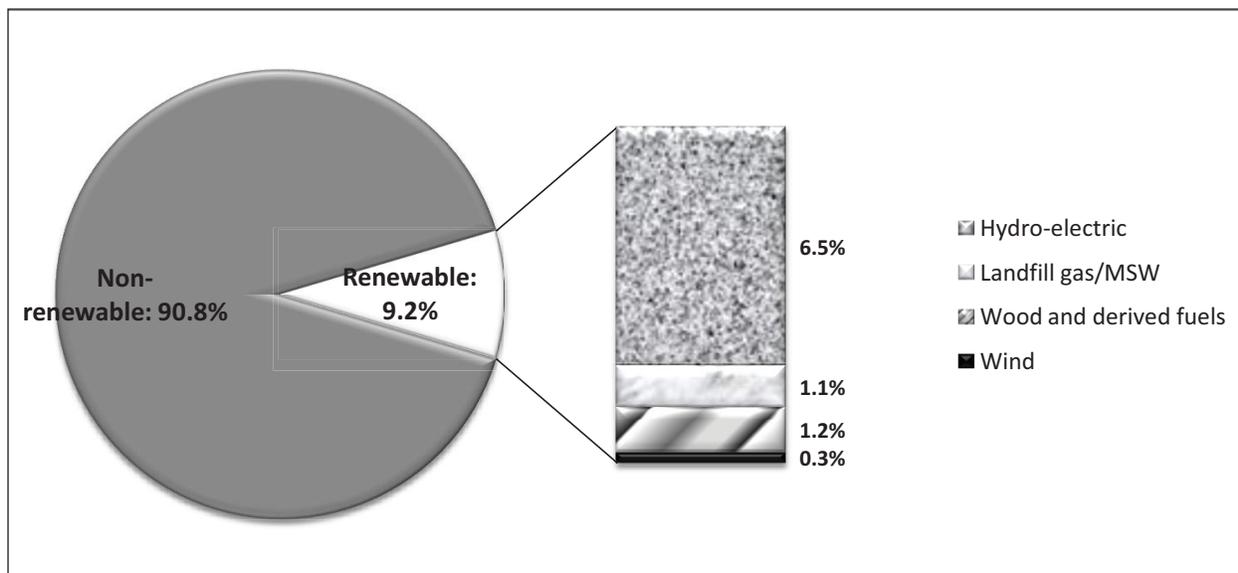


Figure 1.—Resources used to generate electricity in the 13 northeastern states in 2007 (EIA 2009b).

0.3 percent of total energy generation for Maine, New Hampshire, Vermont, and Ohio, respectively (EIA 2009b). Except for Ohio, the proportional use of wood rose significantly between 2003 and 2007 in these states.

## CONSUMPTION OF RENEWABLES

Total U.S. consumption of renewable energy rose 7 percent in 2008 at the same time total energy consumption declined by 2 percent (EIA 2009c). In 2008, energy sourced from renewable resources provided 7.3 percent of total U.S. energy consumption. Among the five market sectors for energy (electric power, transportation, industrial, residential, and commercial), the electric power and industrial sectors consume the largest proportion of renewable energy—51 and 28 percent, respectively (EIA 2009c). The transportation sector's share of renewable consumption (e.g., biodiesel and ethanol) rose significantly in 2008 and now stands at 11 percent. Residential markets consume 8 percent of U.S. renewable energy and the commercial sector consumes the remaining 2 percent (EIA 2009c).

The proportional breakdown of sources of energy consumed (in all sectors) in the Northeast is rather similar to the breakdown for the entire United States (EIA 2009a). The Northeast consumed a slightly lower proportion of energy derived from natural gas and a slightly higher proportion of energy derived from nuclear generation than the rest of the United States. However, when we look at a slightly broader landscape to include Virginia, Kentucky, and Tennessee, and reconfigure the groups being analyzed, important distinctions appear.

For the group of states in the area referred to as the “Central Appalachian Region” (Pennsylvania, West Virginia, Ohio, Virginia, Kentucky, and Tennessee), coal is the predominant source of total energy consumed (32 percent; Fig. 2) while the percentage derived from natural gas is lower than for the rest of the United States (EIA 2009a; Fig. 2). With the removal of Pennsylvania, West Virginia, and Ohio from the group of 13 northeastern states, the energy consumption profile for the remaining 10 states changes. Most notably, petroleum-based energy consumption levels are substantially higher than for the rest of the United States (Fig. 2) because a large proportion of households in the region use petroleum-based heat.

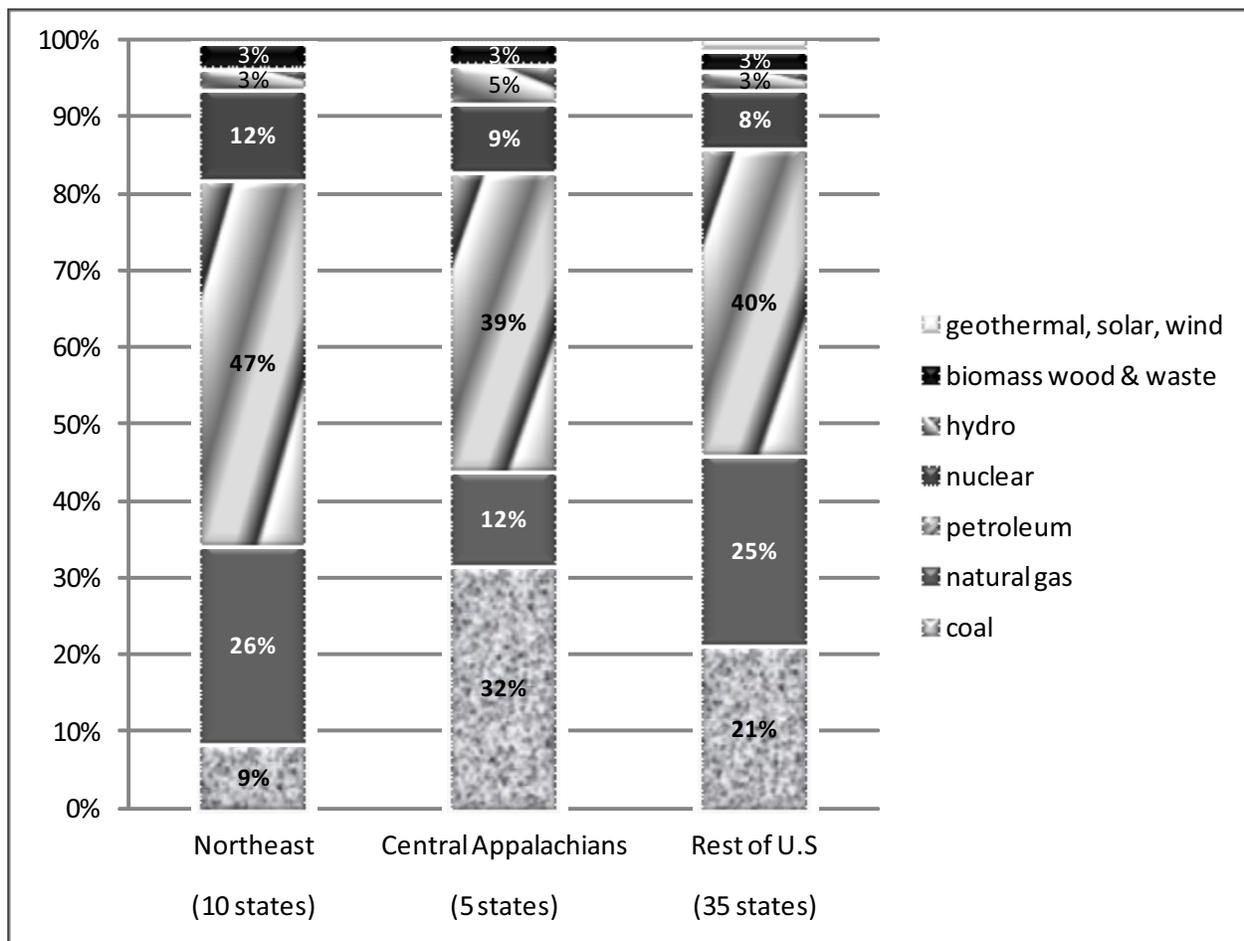


Figure 2.—Renewable energy consumption by all five sectors in the 10 northeastern states, 5 central Appalachian states, and the rest of the United States, 2007 (EIA 2009a).

## USES OF PULPWOOD AND ENERGY WOOD IN THE NORTHEAST

### CURRENT LANDSCAPE

To date, we have identified 347 current and planned woody biomass conversion facilities for the 13 northeastern states. Of these, 323 are currently in production and consume an estimated 40.6 million tons of wood per year (at 50-percent moisture content - wet basis), when operating at capacity. The total amount of wood consumption could rise to an estimated 53.6 million tons in 2015 as the 24 planned facilities that are not yet operating are brought on-line.

Figure 3 shows the distribution of production facilities in the northeastern United States that consume woody biomass of the sort that might be used to produce wood-based bioenergy. These biomass types include: pulpwood, logging residues, mill residues, whole-tree chips, limb wood, and urban forest residues. Some of the facilities shown on the map are producers of wood energy while others produce non-energy products (“traditional products”). Very generally, we can see that the New England States have been more inclined to utilize wood for electricity and pulp and paper production; ethanol and wood pellets projects have been more directed at the Pennsylvania and New York area; and wood combustion for heat is common throughout the entire northeastern region, although less so along the coastal plain.

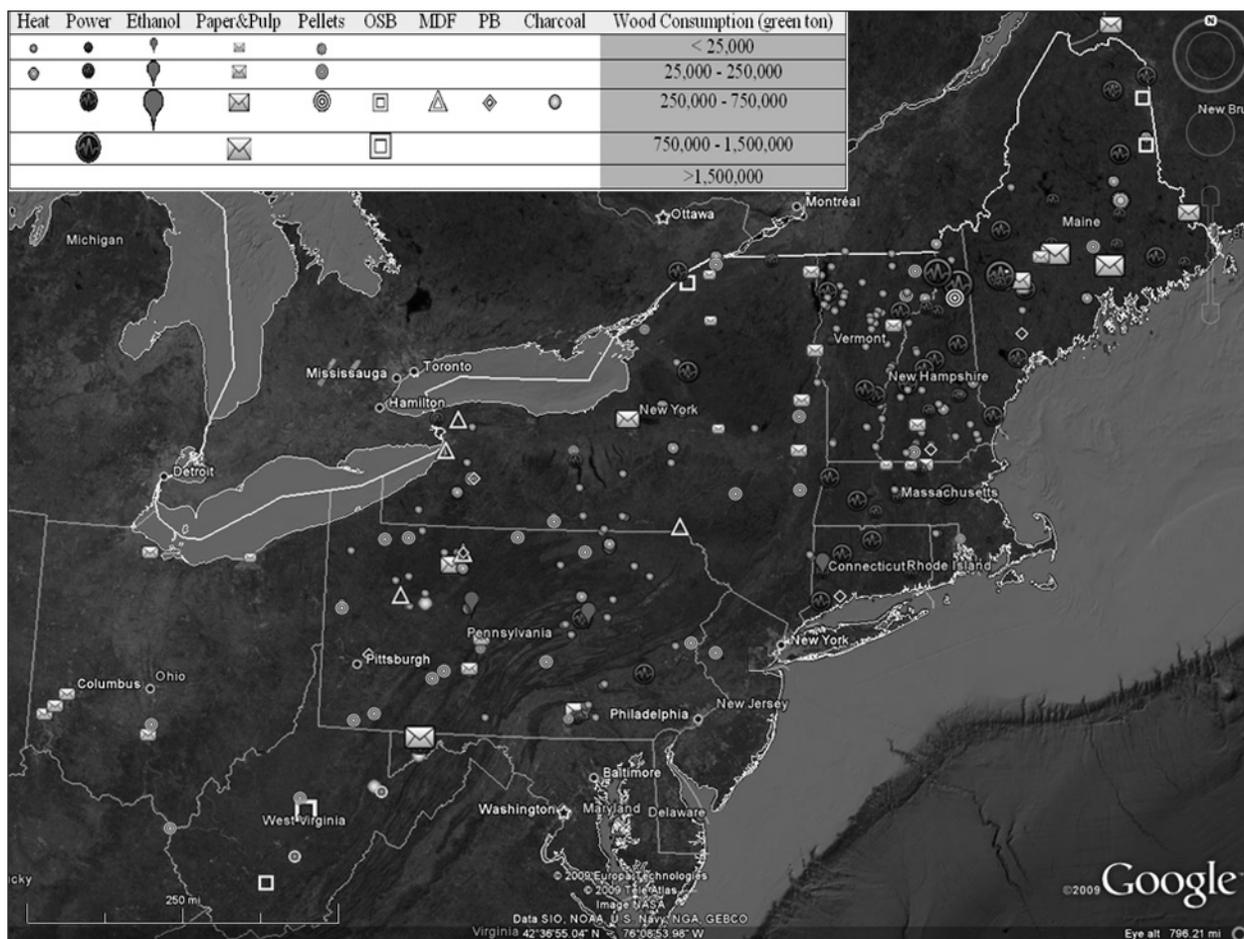


Figure 3.—Location, type, and size of woody-biomass consuming facilities, both existing and planned, in the northeastern United States. (OSB = oriented strand board; MDF = medium density fiberboard; PB = particle board.)

Focusing on the wood and energy industry demographics for the 4 states (Pennsylvania, Maryland, Ohio, and West Virginia) in this 13-state region that are part of the central hardwood forest landscape, 82 woody biomass-using facilities were identified. Of these, 89 percent are in business to produce an energy product while the other 11 percent produce a more traditional product (e.g., pulp, oriented strand board [OSB]) that might be competing for some of the same types of resource.

### Inventory of woody biomass-using facilities by product type

Figure 4 gives the percentage-based distribution of the number of facilities of different types converting woody biomass into wood or energy products in the northeastern United States in 2009. This figure also shows the relative wood consumption (based on green weight) for the different biomass conversion sectors considered in this analysis.

The concern is commonly expressed that new wood-based heating and pellet manufacturing enterprises are going to lead to over-utilization of the forest biomass resource in the northeastern United States. Wood-based heating systems now represent roughly half the total number of operations that utilize pulp and energy wood in the Northeast. Figure 4 shows that these 179 operations utilize only 9 percent of all the woody biomass consumed in the region. Extrapolating, it appears that even if the number of biomass heating facilities

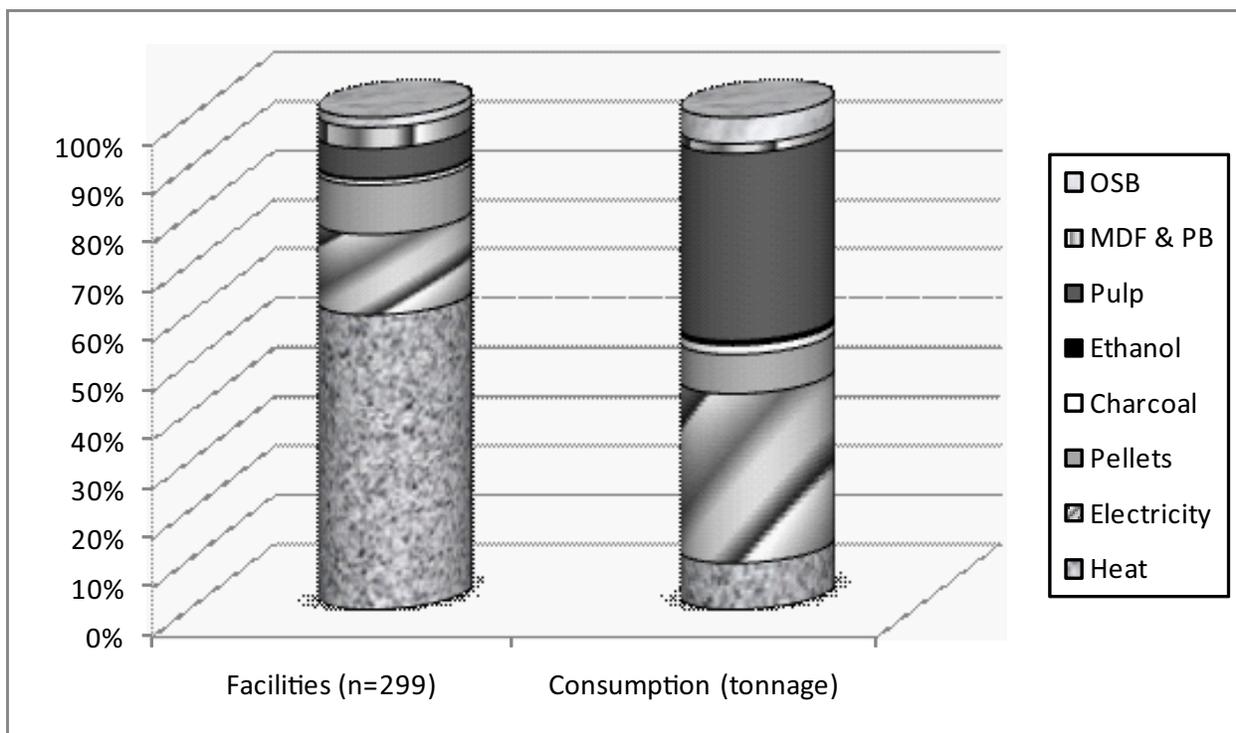


Figure 4.—Distribution of types of conversion operations utilizing pulp-type wood in the 13 northeastern states in 2009 in terms of numbers of facilities and wood tonnage requirements.

*quadruples* over the next decade, these district heating projects, schools and hospitals, and industrial wood boilers will still only consume roughly the equivalent of one-fourth of the tonnage of woody biomass currently demanded in the Northeast. Therefore, fears that expansion of current initiatives such as *Fuels for Schools* and community district heating projects will quickly impose hardship on the forest resource appear unfounded. Expansion of wood-based heating in the Northeast nonetheless may well have an impact on localized biomass roundwood and residue markets. However, significant shifts in energy policy could ratchet up demand for wood-based energy sources (such as pellets) such that large-scale wood-energy processing facilities could become a part of the region's wood utilization landscape.

Another important observation from Figure 4 is the much larger impact, per facility, that pulp mills and power plants have on the forest resource compared to other types of operations. Pulp mills constitute only 6 percent of the number of woody biomass utilizing operations, but they currently consume 38 percent of the total woody biomass (by weight). Power plants, in comparison, account for only 17 percent of the number of facilities, yet consume 34 percent of the woody biomass. The implication of these data is that each pulp mill and power plant has a significant impact on overall woody biomass availability.

Of the 40.6 million green tons of woody biomass currently consumed in the 13 northeastern states, 45 percent is consumed by traditional, non-energy industries. For the three central hardwood region states among this group of 13 northeastern states (West Virginia, Ohio, Pennsylvania), an estimated 11.1 million green tons of woody biomass were consumed in 2009. Traditional, non-energy industries consume 62 percent of the input volume in these states. Demand for pulpwood by large pulp and OSB operations and the current lack of wood-fired electricity plants explain the higher percentage of biomass going to traditional, non-energy industries in these three states compared to the rest of the northeastern region.

The siting of future woody biomass energy facilities in the vicinity of traditional wood products operations that have closed or curtailed production allows new ventures to capitalize on existing supply chain infrastructure, thereby minimizing costs associated with biomass acquisition. However, as new wood bioenergy facilities are built in coming years, to the degree that they increase demand for biomass faster than traditional wood consumption declines, there will be upward market pressure on wood prices. This price pressure will make it even more difficult for the traditional woody biomass-based facilities to remain competitive.

## **FUTURE LANDSCAPE**

A portion of our database contains information on announced but not yet permitted and/or built and operating, wood-based bioenergy installations. Based on data sources, future woody biomass demand (considering both the traditional and energy sectors) in the Northeast is projected to see a net increase of 32 percent by the year 2015. The increase in consumption is most dramatic over the next 2 years, after which the rate of growth slows. This growth curve is largely a function of the fact that the planning and start-up cycle for many wood bioenergy facilities is not much longer than 2 years—many facilities that may open in the more distant future have not yet been publicly announced and in some cases not yet conceived.

This projected 32-percent growth in woody biomass consumption for the region is based on four important assumptions: 1) all announced facilities will be built to their announced capacity; 2) no other unannounced facilities will start up during this time; 3) the consumption of woody biomass by all current operations stays the same; and 4) no new wood co-firing by existing power plants, aside from those that have already been announced, will occur. Of course, all of these assumptions are likely to be violated to a greater or lesser extent. Therefore, this portrayal of the future biomass utilization landscape informs our current understanding but is subject to annual revision.

### **Potential impact of electricity production from wood**

Use of wood for electricity generation is the major use of wood for bioenergy in the northeastern United States. Currently, wood-fired electricity capacity ranges from 0 megawatts (MW) in five states (Connecticut, Rhode Island, New Jersey, Ohio, and Delaware) to 600 MW in Maine. The increased demand in woody biomass required to meet the anticipated increase in electricity generation from wood will be significant, particularly in the New England states and Ohio. In terms of biomass consumption, the most significant projected increase is expected for power plants in Ohio (from 0 tons per year currently to 3.7 million tons/year), Massachusetts (from 0.3 million tons/year to around 2.25 million tons/year), New Hampshire (from 2 million tons/year to 4.5 million tons per year), and Connecticut (from 0.5 million tons/year to 1.3 million tons/year). Since Massachusetts' traditional wood products industry is relatively small, existing wood residues will not be sufficient to supply these new electricity-generating facilities. Feedstock requirements for the new facilities in New England are projected to result in a demand increase in the region of 3.5-4.0 million tons per year. This sharp increase in demand could cause considerable tightening of the local woody biomass market.

The Energy Information Administration (EIA 2009a) is projecting a large increase in biomass demand for energy production over the next decade and it projects this increase will come both from dedicated biomass facilities and from coal-fired production facilities beginning to co-fire with wood. To analyze the potential impact of this co-firing scenario, a sensitivity analysis was performed at varying levels of conversion to co-firing.

The sources for electricity production are unmistakably different across the Northeast. Wood-based electricity production is common in the New England states while coal-fired production dominates in the southern tier of the region (Fig. 5). Though nuclear, hydroelectric, and other forms of electrical capacity are important sources of power generation in the region, they have been omitted from Figure 5 so that wood and coal-based operations can be readily distinguished. This distinction is desired because, unlike nuclear and hydroelectric generation systems, coal-based systems can be partially or completely converted to wood-based systems.

What is not so apparent in looking at Figure 5 is the relative size and capacities of the wood-fired and coal-fired energy industries; this information is crucial for estimating the potential impact of future conversions to co-generation by the coal industry. In fact, the wood-fired electricity capacity of states such as Maine, New Hampshire, and Vermont is dwarfed by the total coal-fired power capacity in the other states of the Northeast. This comparison holds true even when the power plants that are planned and permitted but not yet on-line are included. It would be a mistake to focus solely on these new woody biomass energy projects because the potential impact of converting a coal-only plant to one that co-fires with wood and coal is probably the most important component of any discussion surrounding future forest sustainability in the Northeast.

Just a few years ago, the idea that coal-fired power plants would convert even a tiny percentage of their production to wood co-fired capacity seemed implausible. Today, state-mandated renewable portfolio

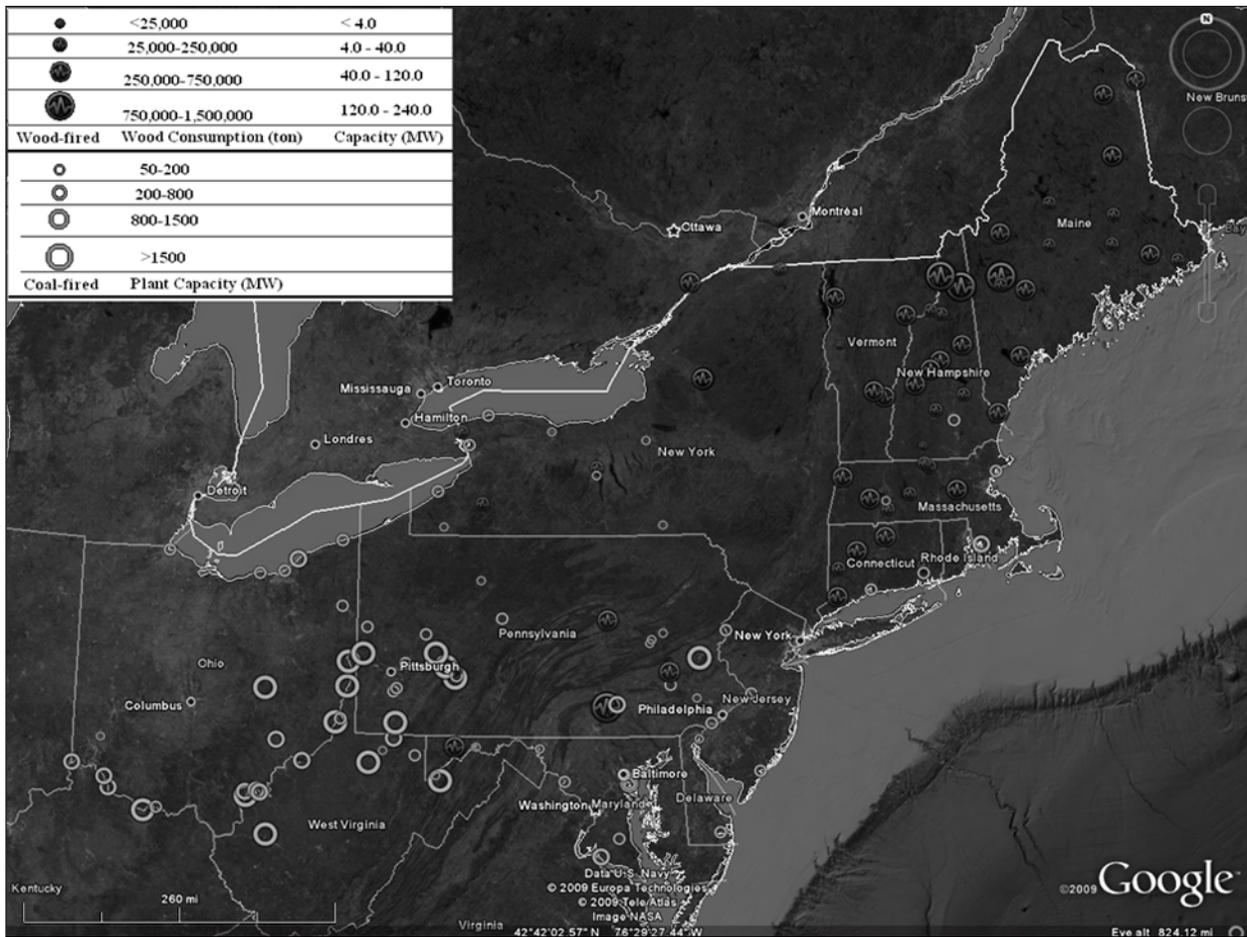


Figure 5.—Occurrence, size, and location of wood-fired and coal-fired electricity production in the northeastern United States – current and planned facilities.

standards and incentives for renewable energy (such as cap-and-trade or carbon tax schemes) are provoking many companies that own coal-based power plants to evaluate the costs and benefits of co-firing. Some of these evaluations have led to the decision to begin to do so.

### Co-firing scenario assessment

Recognizing that future co-firing of coal power plants with wood is likely the biggest determinant of future demand for woody biomass in the region, we had to estimate the degree of impact associated with different co-firing scenarios.

The assumptions used to develop the wood volume estimations in these scenarios were:

- Energy content of biomass – 8,600 Btu/lb (dry).
- Efficiency of power plant – 33 %.
- Hours of operation – 365 × 24 × 80% per year. 1 kwh = 3,412 Btu

Thus, to estimate the weight (bone-dry tons) of woody biomass required to produce X trillion Btu's:

$$\frac{X \times 10^{12} \text{ Btu}}{8,600 \text{ Btu/lb}} \times \frac{1 \text{ ton}}{2,000 \text{ lb}} \times \frac{1 \text{ million ton}}{10^6 \text{ ton}} = \frac{X}{17.2} \text{ million bone-dry tons}$$

Then, to estimate wood biomass requirements for a power plant with capacity of  $\alpha$  MW:

$$\text{Woody biomass demand} = \frac{\alpha \times 10^3 \times 7,008 \times 3,412}{0.33} \div (17.2 \times 10^6) \text{ bone-dry tons}$$

Using these calculations and the information in our database on existing coal-fired power plants, we estimated the potential impact of different levels of wood use in co-firing these plants.

If wood co-firing of existing power plants reaches only a 2-percent level across the industry, the impact is relatively minor—only Ohio, Pennsylvania, West Virginia, and Maryland would see a resource impact of more than 1 million green tons annually. Once wood co-firing reaches 3 percent, however, the impact on wood demand in Maryland (1.7 million green tons), Ohio (7.3 million green tons), Pennsylvania (6.4 million green tons), and West Virginia (4.6 million green tons) begins to reach a level where co-firing facilities will negatively impact the competing wood-using industries. Policies and incentives that promote large-scale wood-fired electricity co-generation (e.g.,  $\geq 5$  percent) could raise roundwood harvest in Maryland, Ohio, Pennsylvania, and West Virginia such that the growth-to-removals ratio approaches or dips below one. Currently, Maine is the only state in the region with a tenuous growth-to-removals ratio. While a growth-to-removals ratio of less than 1:1 may be justified on a short-term basis, it is unsustainable if continued for the longer term that would be necessary to support these larger wood co-firing projects.

Therefore, policy incentives that promote wood co-firing of existing power plants could have a negative impact if they result in co-firing these facilities at a rate in excess of 5 to 6 percent (BTU basis), on average. If utilities are able to pass on to consumers the fuel cost increases associated with higher demand for woody biomass, they may be in a position to out-compete other woody biomass users. The inefficiencies in the generation of electricity by co-firing with wood also need to be considered; power generation in power plants typically achieves less than 30 percent efficiency, which will be decreased with the introduction of wood into the feedstock. By contrast, combined heat and power plants typically can achieve efficiencies of 60 percent.

## Potential impact of ethanol production from woody biomass

Even under the most bullish of biomass-based energy projections of the Energy Information Administration, production of ethanol from woody biomass is projected to be only a small portion of the overall demand on biomass. Current technology limitations on the conversion of woody biomass to ethanol are clearly constraining industry development. Even assuming eventual technological breakthroughs that make cellulosic ethanol a sensible and profitable use of the resource, significant impact on the woody biomass resource from ethanol production appears to be at least a decade away.

Most current research is focused on cellulosic feed stocks such as corn stover, bagasse, and switchgrass, or single-species wood chips such as aspen, willow, or hybrid poplar. These fast-growing crop or plantation species have physical and chemical properties that make the chemical conversion from cellulose to sugars theoretically attainable in an efficient and cost-effective manner. However, *woody biomass from natural forests has more diverse and "contaminated" properties*; this woody biomass has yet to be proven in the laboratory, much less at the pilot scale, as economically feasible to process.

Currently, there are six ethanol operations in the database that have announced plans to use wood as a feedstock. These six facilities would consume 11 percent of the current woody biomass demand if they were to reach announced production levels. This scenario is highly doubtful, especially given the volatility (and decline in 2008) in oil and gasoline prices, and the de-emphasis during 2009 of policies to promote ethanol production.

## CONCLUSIONS

Pulp and paper operations, as well as OSB, medium density fiberboard, and particle board plants, currently account for roughly 50 percent of the woody biomass consumption in the northeastern United States. The ongoing decline in pulp and paper production in the Northeast, together with the apparent decline in other traditional woody biomass-using industries, will work to relieve the pressure on the region's woody biomass resource. It is possible that future consumption of woody biomass by bioenergy facilities can be supplied by biomass that will become available as a result of the declining consumption by traditional wood products manufacturers. Unfortunately, in some regions, it may be that upward price pressure on the woody biomass market owing to increases in the needs of the bioenergy industry could hasten the decline of the traditional wood industries.

Small-scale bioenergy projects pose no real threat of significantly reducing the general supply of woody biomass in the Northeast, but areas of heavily concentrated projects could experience local demand pressure.

The future direction of electricity production from wood and co-firing of wood in coal power plants is the variable with the highest potential impact on woody biomass consumption. Government policies and incentives that encourage use of woody biomass by large electricity producers, either through dedicated use of wood or through co-firing of coal power plants at a 5-percent or higher level of co-firing, can be expected to put pressure on raw material availability for other industry segments and, over time, wood resource sustainability in the affected regions.

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