

The Lake States Outlook for Sustainable Forest Bioenergy and Biofuels Production

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Summary. The Lake States region of Minnesota, Wisconsin and Michigan offers significant potential for forest bioenergy and biofuels production. Nearly seven million dry tons of additional biomass from public and private lands could be utilized beyond what is currently used for pulp and paper production, engineered wood products, and various bioenergy applications. This paper examines the sustainability of regional biomass use in the context of an existing forest products industry, projected resource needs over the next decade, and impacts on price and feasibility. The region is distinct for its renewable energy and biofuels standards, use of biomass harvest guidelines, and the magnitude of third-party forest certification. The cumulative effect of these initiatives on resource competition and active forest management are discussed in the context of an emerging Lake States bioeconomy.

Keywords. *Bioenergy, Regional Outlook, Minnesota, Wisconsin, Michigan*

Introduction

The Lake States region offers significant potential for forest bioenergy and biofuels production. Combined, there are more than 52 million acres of public and private forestland in Minnesota, Wisconsin and Michigan (Butler 2008). While much of the available volume of woody biomass is utilized for pulp and paper production and various other durable goods, nearly seven million dry tons of additional biomass have been identified that could be utilized for energy or biofuels processing in region (Skog 2008).

There also exist abundant agriculture feedstocks in the region, with more than 21 million dry tons of agriculture residues annually available (Oak Ridge National Laboratory 1999). When combined with forest residues from timber harvesting activities, agriculture and forest feedstocks have the potential to significantly lessen dependency on imported fossil fuels. Agriculture feedstocks are an important source for the manufacturing of biobased products but they are insufficient at meeting growing demand. Woody biomass production can diversify feedstock procurement to increase overall supply, stabilize volatile markets and supply disruptions, and provide a potential carbon neutral source.

In this section, we characterize the volume of woody biomass available in the Lake States and implications for sustainability as the bioeconomy grows. Competition for woody biomass and unique regional distinctions are highlighted that may provide opportunities but also illustrate particular constraints for market and industry development. Prospects for thermal heating, bioenergy and biofuel production are provided for each state in the region.

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Regional Distinctions

The primary forest products industry of the Lake States is comprised of three main sectors: pulp and paper, engineered wood products, and lumber. Combined, about 4,100 wood-using companies produce some \$40 billion of forest product shipments each year, and as of 2005 total direct employment exceeded 200,000 jobs. In Wisconsin, approximately 96,000 individuals are employed in primary forest manufacturing making it the largest component of Wisconsin's manufacturing workforce. An additional 150,000 indirect jobs are created by Wisconsin's forest products industry (Mace et al 2004). In Michigan, the industry is the fourth largest sector employing nearly 69,000 individuals with an annual payroll of \$2.9 billion (Berghorn 2005). An additional 150,000 jobs are created from indirect and induced impacts (USDA Forest Service 2008). And in Minnesota, the forest products industry employs some 40,000 individuals, about 14,000 in primary manufacturing and logging and 26,000 in secondary manufacturing having a total annual payroll of \$1.92 billion (Minnesota DNR 2007).

The forest products industry has declined in the Lake States in recent years because of global economic factors contributing to fewer housing starts and from increased operations costs. Job losses have been significant in some areas as facilities close and companies move operations to other states or countries. Mill slowdowns and curtailments have also had a significant impact on timber markets resulting in declining harvest levels across the region. As recently as 2005, the average stumpage price paid for aspen pulpwood in Minnesota was \$59.70/cord on public land timber auctions (Governor's Task Force 2006) compared to \$28 in 2008 (Minnesota DNR 2008). Just when companies were entering into higher-priced contracts the demand and value for forest products declined threatening the solvency of many long standing companies.

Investments and expansion of the Lake State's bioeconomy could be a boost to the industry and for communities in which wood manufacturing facilities are located. But there must also be safeguards for sustainable forest management. The boom-and-bust cycle familiar to the industry not only hurts rural communities but in the case of energy and fuel production could also destabilize the broader economy at the expense of forest sustainability. It is within this context that specific efforts are underway in the Lake States that distinguish the region from other parts of the country. These efforts may serve as a model and to illustrate the complex linkages and considerations for forest sustainability while seeking to increase woody biomass production.

Renewable Energy Standards

The increased demand for woody biomass is in part a result of Renewable Portfolio Standards (RPS) requiring utility companies to obtain various percentages of renewable feedstocks to generate electricity. Almost one third of states across the country have adopted some form of mandatory RPS with each of the three Lake States specifying woody biomass as an eligible feedstock. Michigan is the most recent state to enact an RPS in which 10% of energy production must originate from renewable sources by the year 2015 (Dsire 2008c). Wisconsin has a similar RPS of 10% by 2015, though a non-binding goal of 25% by 2025 was announced in 2008 (Dsire 2008b). Minnesota updated their RPS in 2007 expanding renewable energy production by a mandatory 25% by the year 2025 (30% by 2030 for Xcel Energy) (Dsire 2008a).

Regional Fuels Standards

State incentives that encourage the development of first stage biofuels, like corn ethanol, generally also apply to advanced biofuels like cellulosic ethanol. Each state in the region has policies promoting biofuels development and is a signatory to the regional Midwest Energy Security and Climate Stewardship Platform Plan (AFDC 2008). The Plan includes commitments to establish cellulosic ethanol manufacturing in the region by 2012.

Minnesota currently mandates that all gasoline in the state contain a minimum of 10% ethanol blend and rises to 20% by 2013 (AFDC 2008). Also by 2015, all gasoline sold in Minnesota must include a 5% blend of cellulosic ethanol. Wisconsin has a non-binding goal of 25% renewable transportation fuels by 2025 (AFDC 2008; Sustainable Business.com 2008b). Currently, all gas stations in Minnesota sell E10 gasoline (10% blend of ethanol), and about 75% of Wisconsin stations provide the same (Wisconsin Office of Energy Independence 2008). In addition, Wisconsin is pursuing plans to encourage the availability of E85 along major highway corridors throughout the state. Finally, each state actively provides grants to support biofuels research and infrastructure development.

Biomass Harvest Guidelines

Expansion of a forest-based bioeconomy could potentially benefit the economy of the Lake States by expanding markets for wood products, creating jobs and reducing reliance on fossil fuels. However, concerns have been raised about the sustainability and environmental impacts of increased biomass removal. Understanding these impacts and assuring that the harvest of woody biomass is done within the framework of sustainable forest management is a priority in the region particularly among groups such as the Wisconsin Council on Forestry, Minnesota Forest Resource Council, and the Great Lakes Forest Alliance.

The *Woody Biomass Harvest Guidelines* published in January 2008 by the Minnesota Forest Resources Council were the first such guidelines in the United States to address sustainable removal of woody biomass for energy production (MFRC 2008). Working in consultation with an interdisciplinary group of industry, agency, university, tribal and environmental experts, the Minnesota guidelines include provisions for the retention of snags, down woody debris, and remnant live trees to sustain wildlife diversity. Also included is consideration for forest management practices in riparian areas, maintenance of soil productivity, and leaching of nutrients on sensitive soils.

A handful of states have followed suite. Wisconsin is in the process of finalizing their guidelines that includes consideration for biodiversity, water course management, and soil productivity. A diverse group of stakeholders and experts will inform an advisory committee, which will report to the Wisconsin Council on Forestry for final approval and inclusion in the Wisconsin's Forest Management Guidelines.

Third-Party Forest Certification

In recent years, forest certification systems, such as the Sustainable Forestry Initiative (SFI) and Forest Stewardship Council (FSC) have become popular and effective tools to verify sustainable forest management practices. Third-party oversight under both programs assures that forest managers consider multiple use values of forestland, encourage harvesting techniques that minimizes the disturbance to the environment, and requires monitoring and management for regeneration after harvest operations.

Nearly all of the public forestlands in the Lake States have been certified by either the FSC, SFI or both. A combined 15.9 million acres of forestland had been certified by one or both programs, representing some 29% of all certified forests in the United States in 2008. Minnesota leads with 4.8 million acres of state land dual FSC-SFI certified and an additional 2.7 million acres of county and private forestland certified under one or both programs. A total of 5.0 million acres of Michigan forestlands are dual certified, and 3.4 million acres of Wisconsin forestland. An additional 2.2 million acres of non-industrial private forestlands are also under review in Wisconsin, which are already certified by the American Tree Farm System (Fernholz 2008). The predominance of certified lands poses a potential competitive advantage for the region in terms of providing certified sustainable woody biomass for bioenergy and biofuels production.

Competition for Biomass

According to USDA Forest Service, Forest Inventory and Analysis (FIA) figures, annual net growth outpaces harvest levels in the region with growing stock on timberland of approximately 22.4 million cords. The volume harvested and utilized by the more than 4,100 primary wood products companies was approximately 12.3 million cords in 2005. Michigan leads in growing stock with about 9.1 million cords annually compared to 4.2 million in removals (USDA Forest Service 2008). Wisconsin follows with 7.1 million cords of annual growth and approximately 4.4 million in removals (USDA Forest Service 2007), and Minnesota harvested approximately 3.7 million cords in 2005 on 6.2 million cords of growth (Minnesota DNR 2007).

While the volume of biomass appears significant when measured in terms of net annual growth, available biomass is somewhat less. This is because estimates of resource availability emphasize total *physical* biomass without taking into account the range of constraints imposed by economic and environmental realities tied to harvest costs, transportation distances, environmental laws, or site access and suitability. Unrealistic supply estimates threaten the viability of new businesses by disrupting supplies, forcing companies to buy biomass at higher prices, or to travel greater distances for procurement. Failure to adequately estimate supplies may also result in the over-building of processing facilities, which threatens the sustainability of the resource base, not to mention the viability of existing forest products industries.

Residues are highly price-sensitive, meaning that the higher the price the more residues are feasible to be removed. Generally, only the lowest-value material is used to produce heat, bioenergy and biofuels because of the need to remain competitive with fuel sources like natural gas or coal. The value of residual biomass is also determined by the proximity to processing facilities and the number of competing uses in the area. The increased demand for biomass created by incentives for renewable energy generation could create increased competition for feedstock. The pulp and paper industry, in particular, is at risk of increased competition at a time when it is facing increasing global competition from China and parts of Europe. Industry experts have also expressed concern for increased competition for roundwood. As the availability of forest residues declines, demand could increase for higher-value roundwood, resulting in upward pressure on delivered log prices and the prices of traditional forest products (CITE).

Expanding interest in the use of woody biomass is coming from many directions. Proposed new pellet, energy, and biofuels plants in Wisconsin alone could increase annual demand within five years by upwards of one-million cords. Even if half of the projected facilities were to be built, the increased demand could significantly affect current market prices for pulpwood and perhaps sawlogs. The prospects for thermal heating, bioenergy, and biofuels production are presented here to illustrate potential demands on the forest resources in the region.

Prospects for Thermal Heating

In conversations about the growth of the bioeconomy, thermal heating is considered a minor player. In reality, thermal heating using densified wood pellets represents a significant portion of renewable energy generation and on a Btu-basis is economically competitive with many popular alternatives, including heating oil, electricity, natural gas and propane (Pellet Fuels Institute 2008). Densification of woody biomass can also make transportation over longer distances affordable due to the higher energy content of smaller volumes, and from ease of handling.

Driven primarily by European demand for district heating and combine-power-heat facilities, North American production is expected to reach 4 million tons in 2008 split evenly between Canada and the United States. Global capacity during this same period will reach approximately 10.6 million tons (Swaan 2008). Current production in the Lake States is estimated at XX tons of pellets produced annually, and is expected to increase.

There is currently 282,000 tons of anticipated wood pellet capacity slated to come on line in Wisconsin in the next few years. The newest plant is scheduled to start production in Hayward, WI using about 80,000 cords of forest residues annually. Superior Wood Products anticipates receiving permits within the year to build a plant in Bayfield County, WI having a production capacity of about 100,000 tons of pellets annually and generate up to 4,775 kilowatt hours (kWh). Total demand from pellets in Wisconsin could reach 519,000 cords, with about half of this demand met by using forest residues and the remaining from mill wastes.

In Minnesota, approximately 100,000 tons of pellets are produced annually with another 230,000 tons of additional capacity projected to come on line within the next few years. Of that Ireland-based Kedco Group of Cork has proposed construction of a pellet facility in Duluth, MN that would utilize upwards of 1.1 million dry tons of forest residues intended for shipment to power plants in Europe (Way 2007). There is approximately another 150,000 tons of pellet production in Michigan spread out over six processing plants, each with plans to significantly expand production in the near term either through double-shifts or new presses. More than half of their required feedstock comes from mill residues but declining timber markets and subsequent supplies of sawdust are forcing producers to procure a greater percentage from forest residues.

Prospects for Bioenergy

Extensive bioenergy capacity exists in region with combined woody biomass electricity generation of 3,137 megawatt hours (EIA 2008). That is enough energy to power some 2.4 million homes assuming one megawatt hour of base load energy powers 750 homes. Michigan generates more than half this amount with 1,713 megawatt hours produced annually, followed by Wisconsin with 838 megawatt hours and Minnesota with 586 megawatt hours. Capacity for electricity generation from woody biomass is expected to grow in the coming decade, in part as a result of the new renewable energy mandates previously discussed.

In Wisconsin, woodlands provide the largest share of the state's renewable energy resources. Prospects for bioenergy development include the purchase of the E.J. Stoneman plant in Cassville, WI by DTE Energy Services. The company plans to convert the coal-fired power plant to a 40-megawatt biomass facility capable of powering upwards of 40,000 homes. DTE Energy Services has signed a power-purchase agreement with Dairyland Power Cooperative and is expected to begin operations summer 2010 (The Business Journal of Milwaukee 2008). Also involving conversion of a coal-fired plant, Alliant Energy has proposed an expansion to their Nelson Dewey plant in Cassville, WI. The new 300-megawatt plant would co-fire coal with 20 percent other bio-fuels such as switch grass, corn stalks, and woody biomass. If approved, the new plant could begin operations by 2013 (Alliant Energy 2008).

Also in Wisconsin, Xcel Energy has submitted to the Wisconsin Public Service Commission a plan to convert their Bay Front co-fired power plant in Ashland, WI to a biomass gasification facility. Construction on the \$55-\$70 million plant is scheduled to begin in 2010 and come on line in 2012 using more than double its current use of woody biomass, from 200,000 tons annually to as much as 450,000 tons. Forest residues would comprise some of the new source, but the company is also pursuing alternative sources like railroad ties and short-rotation woody crops (Excel Energy 2008).

The prospects for bioenergy in Minnesota are equally high, particularly since passage of the Next Generation Energy Act of 2007 with requirements for 25 percent of energy coming from renewable energy sources by the year 2025 (Dsire 2008a). Several facilities are in the planning stages and many are conducting feasibility studies for combined agriculture and forest feedstocks. The largest expected plant is the Rock-Tenn industrial combined-heat-and-power facility in St Paul, MN. Rock-Tenn is the largest paper recycling plant in the Upper Midwest, recycling 1,000 tons of paper per day. It is also the largest user of electricity in the area and until recently received most of its energy from waste steam generated from a nearby coal-fired plant. The proposed conversion to biomass would require about 125,000 dry tons of feedstock sourced from urban wood wastes, agriculture and harvest residues. A recent assessment identified about 6 million dry tons of available feedstock in proximity to the plant with about 103,000 dry tons from forest residues within 100 miles (Nelson 2007).

Minnesota Power set out in 2007 to construct a 50-megawatt biomass energy facility using harvest residues from roundwood harvests in surrounding forests in northern Minnesota. The biomass facility would be part of the company's compliance with a requirement for 25% energy production from renewable energy sources by the year 2025 as stipulated in The Next Generation Energy Act of 2007. A biomass feasibility assessment was conducted after announcement of the plant, in which it was determined that although adequate feedstock existed procuring a consistent volume at a price-competitive level would be difficult. Rather than competing with traditional pulp and paper mills and other forest products industries in the area, many of which purchase electricity from Minnesota Power, the company opted to decrease the size of the facility to 24-megawatts. Not only would it be easier to procure a sustainable source of feedstock, but it would allow the company to consider biomass expansions at existing company-owned and co-location with customer-owned facilities.

AbitibiBowater is adding a biomass boiler to their Fort Frances, Ontario pulp and paper mill just across the boarder from International Falls, MN. The construction of the new high pressure steam boiler is an attempt to reduce electricity costs to the mill at a time when Abitibi has closed mills in other parts of the world. The boiler will be fired on mill wood residues plus biomass from external sawmills and harvesting, and will generate approximately 4.5-megawatts of power. The revamped plant is on schedule to begin operations in early 2009 with financial assistance from the Ontario government (Abitibi-Consolidated 2007; John Harrison, pers. comm., AbitibiBowater, Nov. 30, 2008).

Minnesota Power is studying the feasibility of developing a bioenergy facility with maximum power generation capacity of 24-megawatts at the Laskin Energy Center in Hoyt Lakes, MN in the northeastern portion of the state. The plant would be co-located with an existing coal-fired power plant and fired using harvest residues from state and county forest lands and private industrial forests. Development of the new commercial-scale generation facility will help Minnesota Power meet its commitment to the state's recently enacted RPS (TSS Consultants 2008).

Prospects for bioenergy in Michigan are generally located in the Upper Peninsula of the state. The largest project is the proposed construction of a Renewafuel woody biomass facility in Marquette, MI. At full production, the plant will produce 150,000 tons of fuel cubes for steam generation for the local utility company and two nearby iron ore mines (Cleveland-Cliffs 2008). Northern Michigan University in Escanaba, MI is also seeking air permits from the Michigan Department of Environmental Quality to build a biomass boiler fired with forest and mill residues (Anthony Weatherspoon, pers. comm., Michigan Department of Natural Resources, Nov. 12, 2008).

Prospects for Biofuels

Due to the existence of significant field crop agriculture, such as corn and soybeans, the Lake States produce significant amounts of biodiesel (mostly from soybean oil) and grain (corn) ethanol. In terms of biodiesel, the Lake States has about 133 million gallons per year (mgy capacity from 10 plants).

Minnesota has the greatest capacity with 63 mgy and Michigan and Wisconsin each have about 35 mgy (National Biodiesel Board 2008) with production capacity expected to grow in the coming years.

Extensive capacity for corn ethanol also exists, and in particular in Minnesota. There are a total 35 plants across the three states having a combined production capacity of about 1.6 billion gallons per year (State of Nebraska 2008). Michigan contributes about 264 mgy, Wisconsin about 500 mgy, and Minnesota 827 mgy. Like the prospects for biodiesel, production capacity for corn ethanol is growing but is expected to grow at a slower rate than in recent years due to increased emphasis on second-generated advanced biofuels like cellulosic ethanol and increased competition for corn.

On the horizon, but not yet realized is the prospect of cellulosic ethanol using woody biomass. Currently, the state of the art of cellulosic ethanol manufacturing makes it difficult to use woody and agricultural feedstocks together, but this is likely to change with near-term advances in processing technology. It is also unlikely that the volume and timing of feedstock would be sufficient that only one type of feedstock could be used. Therefore, as plants are built, the handling and processing technology will need to be flexible in order to utilize the mix of agriculture and tree species prevalent in the region.

In each of the three states there is at least one serious proposal for constructing a cellulosic ethanol plant. All would use woody biomass as the primary feedstock. The first plant expected to come online is the northern Wisconsin Flambeau River Biorefinery in Park Falls, WI. Flambeau River Biofuels obtained more than \$30 million in grants from the U.S. Department of Energy and USDA Forest Service toward the engineering and construction of the plant, which is expected to come on line in 2010 and convert 1,900 tons of forest residues into 40 mgy of fuel and 2 trillion Btu of heat and power. Spent pulping liquor from the co-located Flambeau Rivers Paper would also be used in the plant (Paper Age 2007).

NewPage Corporation in Wisconsin Rapids, WI was the first in the country to receive DOE funding for construction of an integrated biorefinery for production of renewable biofuels at an existing pulp and paper mill (\$30 million). The 5.5 mgy biorefinery will produce synthesis gas that would replace natural gas, while producing steam and Fischer-Tropsch liquid transportation fuels. Approximately 500 dry tons per day of woody biomass will be utilized when the plant begins operations in 2012. NewPage has also received \$4 million in additional Department of Energy grants for research to overcome the recalcitrance of biomass by the Value-Prior-to-Pulping (VPP) process (DOE 2008).

The objective of VPP is to remove the ethanol and acetic acid from wood chips prior to the pulping process. Pulp and paper plants could then significantly leverage their revenue stream by incorporating VPP with other biorefinery technologies, which could significantly reduce the cost of the pulping process (Closset 2004). The key to success will be improving the yield of sugars extracted from the hemicellulose, developing effective enzymes that are reasonably priced, and documenting that the process will not negatively affect paper quality. There are 10 Kraft mills in the three states, and X mechanical/semi-mechanical, groundwood mills that are suitable for VPP as presently defined.

The Mascoma cellulosic ethanol plant in Sault Ste Marie in the eastern Upper Peninsula of Michigan is expected to come on line by 2012. Wood chips from forest residues will be the primary feedstock and the plant will have a projected capacity of between 38 and 76 mgy (Sustainable Business.com 2008a). And in Little Falls, MN SunOpta, Inc. plans to bring on line a plant in 2012 that would initially be designed to produce 10 mgy from forest residues with modular scale-up plans to expand to 38-50 mgy. The residual lignin would be used as fuel stock for a gasification and co-generation system providing enough power for their operations.

Recent research establishes that there is support for the development of cellulosic ethanol within the region (Solomon and Johnson 2008). This is important because biofuels will continue to require state and

federal support and financing during the initial development period to remain competitive with gasoline and corn-based ethanol. The benefits however are substantial. A recent regional economic assessment found that one 20-mgy cellulosic ethanol plant could gross \$45 million per year (REMI 2006). The pulp and paper industry in Wisconsin processes over 3 million dry tons of wood chips per year and directly or indirectly supports about 36,000 jobs. Combined with pulp and paper processing in Michigan and Minnesota, the Lake States are uniquely positioned to be a significant producer of biofuels and biochemical manufacturing.

However, bio-refining and cellulosic ethanol production could significantly alter demand for woody biomass. Assuming a 90 gal/cord production rate (Aden et al. 2002; Lynd et al. 2007), each proposed plant in Wisconsin and Minnesota would require an additional 450,000 cords of wood and the Mascoma plant in Michigan could require as much as 850,000 cords of new wood. Assuming a conservative average of 5-10 cords of biomass equivalent removed per acre of productive forestland across the Lake States (approximately 20% of standing volume in slash) (Sorensen 2006), a minimum of 44,000 acres would be required for every 40 mgy of cellulosic ethanol production. As the yield per acre of biomass decreases, as much as 89,000 acres in annual harvest could be necessary.

Biomass Resources and Availability

Harvest residues, or the tops and branches of trees and trees too small for other markets, are the largest potential source of biomass for energy and fuel production. They are also the least expensive when integrated with commercial timber harvesting operations in which the sawlogs are removed for other markets. As such, the prospects for a forest-based bioeconomy hinges on the ability to economically remove and transport harvest residues to processing facilities. Also important are the waste materials from primary and secondary wood-processing facilities. These mill wastes are cleaner and of higher quality, but are mostly already utilized in existing energy facilities or for industrial heating applications. Dedicated energy crops also hold significant potential, though none currently exist in the region. Idle crop land and favorable agriculture conditions make the Lake States an appealing location for various types of energy crops including poplar plantations and switch grass. Plantations do not approach the biodiversity present in well-established forests, but when compared to row crops, they offer considerable environmental benefits including improved soil conservation and species diversity (Public Service Commission of Wisconsin 2006).

Several other feedstocks also offer potential but the economics of harvesting and transport are limiting factors. In particular, brush from brushlands and precommercial thinning of industrial forestlands offer significant sources of woody biomass that are currently underutilized. Significant sources of agriculture residues and from switch grass also have potential to be incorporated into a biomass procurement system, but the technology and transportation distances will need to be flexible and financially feasible. Other sources like urban wood wastes and land clearings are largely already used for mulch markets in the major metropolitan areas.

Economics of Availability

Setting aside the cost of extraction and transportation, the physical potential for additional woody biomass production in the Lake States has been estimated as high as an additional 37 million dry tons per year (Halvorsen et al. 2008; Solomon et al. 2007). While significant, the volume of available at a price-competitive rate and within regional environmental guidelines is much less. In order to more accurately estimate woody biomass availability, supply estimates have been made for each county in Minnesota, Wisconsin and Michigan for different levels of roadside or mill gate costs. Supply estimates focus on the largest and least expensive source of biomass—integrated harvesting operations where a majority of the material removed is utilized in traditional timber and pulpwood markets. The roadside cost includes estimated harvest and chipping costs and projected stumpage price. It also assumes that only a fraction of

the available logging residue and thinned material (55% on public land, 60% on private land) would be recovered from each site, which factors in unrecoverable amounts and the volume required to meet retention standards per the Minnesota biomass harvest guidelines.

Amounts from integrated harvesting operations were estimated by simulating uneven-aged thinnings on USDA Forest Service FIA plots that have a stand density index greater than 30% of the maximum of the plot's forest type. Harvest costs were estimated using the FRCS model (Fight et al. 2006). The stumpage price paid on public land is assumed to be \$4 per dry ton while the price on private land begins at that level and increases as integrated harvesting operations expands in use until sawlog and pulpwood harvest also provides feedstock for biomass markets. At the point where all operations are integrated, biomass stumpage price reaches 90% of pulpwood stumpage price.

Although the Department of Energy's Billion Ton report (Perlack et al 2005) identifies potential supply from conventional sources (e.g., pulpwood), when roadside prices reach about \$40 per dry ton estimates are not available at the county level. Estimated supply therefore focuses on the amounts from integrated harvesting, but could be higher if mill residue is drawn away from conventional pulpwood markets as the demand and price biomass increases. Estimates include amounts from both private and public forests (Skog 2008).

Assuming environmental safeguards and \$100 per dry ton at roadside, the annual supply of biomass from integrated harvesting operations is estimated to be 7 million dry tons. Minnesota would contribute 3.2 million dry tons, followed by Michigan with 2.6 million dry tons, and 1.2 million dry tons in Wisconsin (Fig 1). Much of that amount would also be available at reduced prices. For instance, if companies could pay \$40 per dry ton for wood chips, the available supply would be 2.9 million, 2.4 million and 1.2 million dry tons, respectively. Current markets range anywhere from \$30 per dry ton for delivered chips for ethanol production to \$36-\$50 for energy (Terry Mace, pers. comm., Wisconsin Department of Natural Resources, Oct. 20, 2008).

Assuming a 35-mile one-way transport distance, the current cost to remove residual biomass is \$28 per dry ton when integrated with a traditional timber sale having a viable sawlog and pulpwood market. This includes the additional cost of chipping and biomass stumpage. At that same distance, dedicated whole-tree chipping on a low-value aspen site currently averages about \$42 per dry ton. The challenge is that many sites are further than 35-miles from the processing facility and are cost-prohibitive to transport (Peterson 2005).

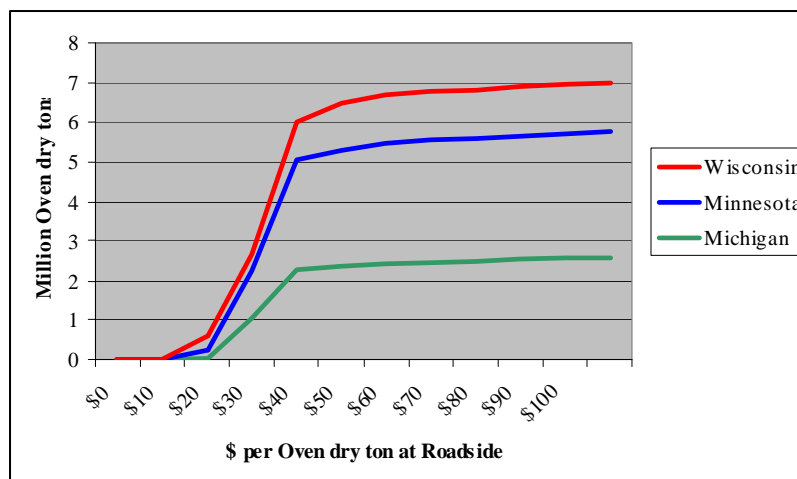


Figure 1. Estimated biomass supply from integrated forest harvesting and unused primary mill residues (\$ per oven-dry ton at roadside), 2008.

Diversity of Land Ownership

Individual, private owners own the majority of productive forests in the Lake States, more than 30.3 million acres (58%) (Figure 2). State lands are the next largest land holding with about 9.6 million acres (18%), followed by 7.3 million acres of federal land, which are primarily USDA Forest Service lands and some tribal. County and local government lands are an additional 5 million acres (10%) (Butler 2007). The availability of woody biomass from these land owners is distributed broadly across Wisconsin with supplies somewhat more focused on certain counties in Michigan and Minnesota (Figure 3).

Although the acreage of forested land and the amount of growing stock in the region are increasing, woody biomass availability is constrained by uncertainties about the willingness of private landowners to sell timber or thin forests. The abundance of residues is largely unrealized because most are never harvested. In addition, private forests are being divided into ever-smaller parcels and increasingly, these new owners are absentee, wealthier, and less engaged in forest management, which further reduces harvest levels and limits site access. Between 1984 and 1997, the number of non-industrial private owners increased 20 percent in Wisconsin, and each year an additional 3,500 new parcels were created (Finan 2000). A similar trend exists in Minnesota where ownership size is decreasing and development is increasing. Minnesota data indicate that the average track size of forestland sold decreased from 72 to 59 acres (18%) from 1989 to 2003 and even more so since 1991 (30%) (Mundell et al 2007). This phenomenon of “parcelization” threatens the availability of biomass, not to mention concerns about biodiversity and other environmental considerations.

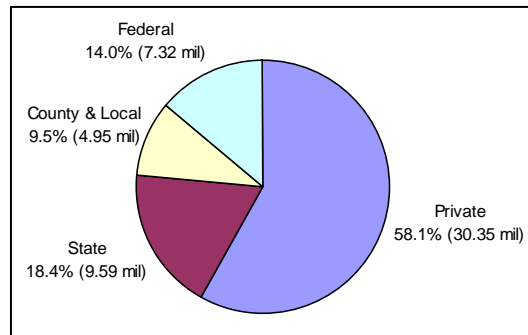


Figure 2. Combined land ownership patterns in Minnesota, Wisconsin and Michigan, 2007 (Butler 2007).

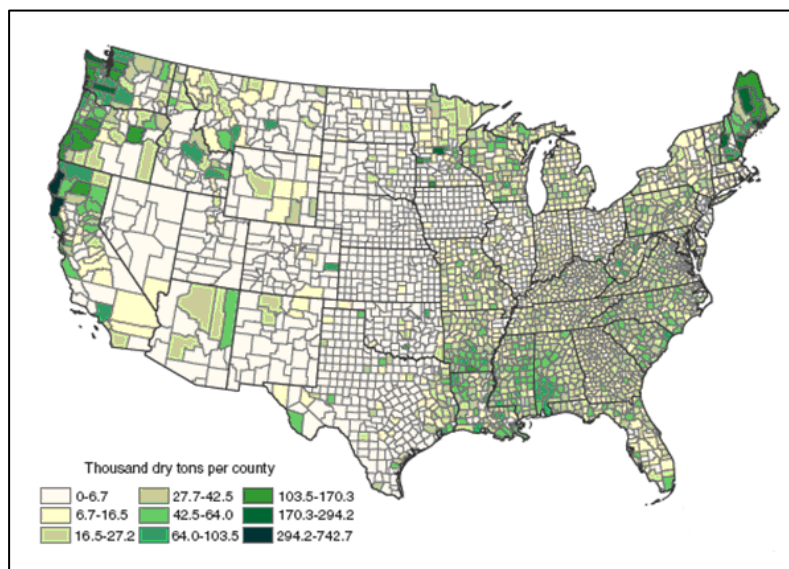


Figure 3. Estimated annual woody biomass supply by county (thousand dry tons), 2005 (Perlack 2005).

Implications for Lakes States Bioeconomy

There are high expectations for the Lake States bioeconomy. Prospects exist for increased employment and economic benefits in rural areas. There is potential for enhanced forest productivity through precommercial thinning and timber stand improvement activities. And renewable sources of electricity and fuels offer opportunities for reduced dependence on fossil fuels. The fundamental question is whether or not a forest-based bioeconomy is sustainable.

Significant volumes of biomass exist within the region and while much of it is used in the manufacturing of conventional products and materials, an abundant volume is underutilized and potentially available. Assuming environmental safeguards and an average cost of woody biomass at roadside of \$40 per dry ton, annual availability is estimated at 6.5 million dry tons (Skog 2008). Actual availability will depend on the proximity of processing facilities to harvest sites, competition for biomass, and the type and quality of biomass available.

Several efforts are underway to increase biomass production and assess the feasibility of different feedstocks. At the legislative level, state renewable energy and biofuel policies are providing incentives for businesses to invest in electricity and biofuel production. And partnerships among industry, government and community stakeholders are helping to build the technical and financial capacity necessary to implement projects. As a result, the demand for woody biomass will likely continue to increase.

Also increasing is an awareness of the unintended consequences of biomass utilization and impacts on forest sustainability. There exists concern that companies will compete for a finite amount of biomass within an economically-defined distance from their facilities. Depending on the mix of available feedstock and site conditions related to soil sensitivity and biodiversity, there is the potential to over-harvest. This is particularly a concern for areas where supply estimates are incomplete or inaccurate. The Minnesota biomass harvest guidelines and soon to be released Wisconsin guidelines provide a voluntary, though critical safeguard for sustainable forest management. Third-party forest certification is another key feature in the Lake States. Nearly all state and county forestlands have been certified and the USDA Forest Service is exploring the possibility of certifying National Forest lands, which are not eligible. If trends continue, those that pay for the energy and fuels or for the wood pellets may demand or give a competitive advantage to suppliers in the region that are certified.

From the perspective of existing forest products industries, increased demand for pulpwood could have a deleterious affect on markets and business retention. Failure of the existing industry would have a ripple effect in terms of jobs lost in primary manufacturing and it would also result in fewer trees harvested from which forest residues and mill wastes are derived—the largest sources of woody biomass for energy and biofuels production. Dedicated whole-tree harvesting for just biomass extraction is economically viable only if producers are able to pass on the added costs to consumers without putting themselves at a disadvantage to traditional fossil fuels markets.

From a public policy perspective, a key issue is determining the highest and best value for woody biomass. Using wood for energy helps states meet their renewable energy standards, thereby reducing carbon emissions and creating jobs locally. The trade-off is that to the extent that using wood for energy displaces use for conventional forest products, there is a significant drop-off in economic value. For example, it is estimated that an energy plant using 400,000 dry tons of biomass employs about 30 people (100 indirect jobs) and \$20 million in economic value. That same 400,000 dry tons of wood used in one existing pulp and paper mill employs about 500 people (2,200 indirect jobs) and \$328 million in direct product value (Terry Mace, pers. comm., October 20, 2008). A recent regional economic modeling effort found that one 20-mgy cellulosic ethanol plant would contribute \$45 million a year using 250,000 dry

tons (REMI 2006). Optimizing the end use that maximizes economic benefit is just one consideration. Other values related to environmental protection, recreation, wildlife habitat, and carbon sequestration, including the emergence of carbon credits, must be considered when determining the highest and best value from woody biomass. Informed public policy must in turn consider the impacts of financial and non-financial assistance on emerging and existing forest products industries.

Conclusion

The outlook for thermal heating, bioenergy, and biofuels production in the Lake States holds great promise, but questions remain. When looking to the future with a focus on sustainability, the most significant need is accurate assessments of biomass availability. Woody biomass has the benefit of being available year round, but gaining access to the resource can be a challenge especially in regards to economic efficiency. The physical presence of biomass is just one part of the equation. Realized volume is also affected by the economics of harvesting, transportation costs to different processing facilities, the value of different feedstocks, and the social acceptability and availability on private and public lands. The increasing number of private landowners, decreasing sizes of ownership, and shifting interests in managing forestland will create challenges to providing sustainable supplies unique to the Lake States. But as the bioeconomy grows, efforts to ensure the sustainable use of woody biomass will also become more sophisticated with enhanced monitoring and implementation of biomass harvest guidelines, procurement from certified landowners, and the creation of policies that encourage the highest and best use of the available forest resource.

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