A Primer on Woody Biomass Energy for the Forest Community

Introduction

Wood-based energy is an appealing and growing opportunity for the forestry community in the northeastern United States. Demand for wood energy is increasing as society seeks more renewable sources of energy. Using woody biomass as an energy source is both a tremendous opportunity and challenge. The opportunity is for economic growth that works hand in hand with improved forest management and ecosystem enhancement. The challenge is that, if poorly carried out, forests can be damaged and livelihoods endangered. Therefore, the development of wood energy requires careful consideration and good information for decision makers to analyze options. This fact sheet discusses some of these issues with respect to those in the forestry business such as timber harvesters and forest managers.

Woody Biomass

Woody biomass comes from a number of sources, including logging residues, small-diameter or low-value trees, mill residues, and other forms of wood waste. Logging residues are the most prevalent form of woody biomass and are defined as slash, tops, limbs, and other woody materials left after conventional forest products are harvested. The amount of logging residue available is large, often constituting 25–45 percent of the harvested timber in a logging operation in northeastern forests. Therefore, biomass production from logging residue is feasible if the market exists.

Another potential source of woody biomass is short-rotation woody crops (SWRC) that are usually grown using agronomic techniques in open fields. Willow and poplar are the two most common species used for SRWC in the Northeast, although other species may be good candidates as well.

Woody biomass removals can assist with other management goals such as timber stand improvement, reduction of insect, disease, or fire risk, and reduced use of herbicides to control competition and improve aesthetics and wildlife habitat. Since much of the harvesting that occurs in the Northeast, especially "high grades," leaves large amounts of logging residues, these degraded, low-value forests could be used for bioenergy as part of the stand-improvement process.

Woody biomass markets are either for heat, electricity, or for "biomass to liquid fuel" plants (such as for cellulosic ethanol production). In most cases, they will purchase the wood as chips. "Dirty" chips (with bark included) or "hogged" fuels (pulverized wood with variable composition and size) are the lowest value material from a harvest because they have leaves and bark included or are not of uniform in size, which is a real problem for some handling systems. Clean chips are manufactured from debarked wood, resulting in a higher value chip that can leave more nutrients in the forest (most tree minerals are in the leaves, twigs, and bark).

Feedstock Availability

The total availability of forest biomass is promising: total growth of wood in the Northeast exceeds removals and has done so for decades now. The actual practical supply of forest biomass for bioenergy is not as simple as that, though, because it will be affected by an array of factors, including economic, environmental, and social considerations. In most cases, the forester or logger will be responsible for procuring feedstock for a bioenergy energy system. Assessments of existing woody biomass feedstock volumes that could be available are necessary for planning the development of individual biomass projects or for developing a regional bioenergy industry. Regional assessments are needed to determine the best areas to target for development of this industry. More localized assessments are needed to determine the economic viability of a planned facility at a specific location. Many states use the U.S. Forest Service Forest Inventory and Analysis (FIA) to develop biomass assessments.

Production Costs

Technologies for forest management, biomass harvesting and transportation, and energy conversion will dictate the production costs of forest biomass and bioenergy. To maximize efficiency, loggers should be thinking about full utilization of biomass processing equipment. Customers need to match production to equipment capacity. For example, if you expect to harvest 50,000 tons of wood chips per year, you should buy equipment that is sized to harvest that amount only—don't waste money on oversized equipment.

Handling logging residue presents a challenge for forest operations since existing logging equipment is largely designed to handle roundwood. Logging residue has a low bulk density, is dispersed across the site, and is therefore costly to collect. The proportion of solids in logging residue and chips can be less than 20 percent. To make it profitable, many argue that "in the woods" chipping is the most effective option.

Specialized equipment has been designed to facilitate woody biomass processing and is commercially available, but these machines represent significant capital investment and additional cost. Capital costs to purchase chipper/grinder and chip

vans range from $100,000 to $600,000 (forwarder not included). Debarking and chipping equipment significantly increases the operation costs. As clean chip biomass facilities develop, higher demand (and price to some extent) for small-diameter material will justify adding the extra equipment. There is also research underway looking for more profitable methods of harvesting, processing, and loading wood residues.

Where whole-tree harvesting and skidding are used, the majority of logging residue is concentrated at log landings, but some residue inevitably remains near where each tree was felled and along skid trails. Because of these factors, as well as environmental concerns (discussed below), not all logging residue is or would be available for use as a woody biomass feedstock. The industry's need for new equipment like chippers and chip vans could be difficult to meet given aging demographics of loggers and lingering skepticism from the collapse of the biomass industry in the 1980s.

Biomass Market Development

Currently, the market for forest biomass is limited. To encourage the forest community to produce biomass for energy, local markets must have buyers of forest biomass. Under current market conditions, cost remains a major barrier to market penetration of forest bioenergy. The cost of utilization equipment (combustion systems, chip systems, biorefineries) is a key factor for the market. Technological advances, as well as social, political, economic, and environmental factors, will affect the cost competitiveness of this renewable energy source.

Competing uses of forest resources for pulpwood, timber, and ecological services will affect the supply of forest biomass for energy. Some existing wood processors are unlikely to welcome increased competition for wood supplies, especially those competing for the same product such as pulpmills. The degree to which feedstock needs overlap between new bioproducts industries and the traditional forest products industry will in large part determine the level of competition for raw materials. This crossover between possible end uses of logging residues and roundwood means that an increasing demand for forest-biomass-derived bioenergy may affect the price or availability of wood resources for traditional wood products such as pulp, paper, and oriented strand board. Clean chips are usually required from certain liquid energy plants and pellet mills. Clean chips are the ones that directly compete with pulp markets.

Some argue that an existing and viable forest products industry is needed for the development of biomass markets. This is currently true in the Northeast where the harvest of saw logs and other high-value products is the economic driver that enables biomass harvesting. Many companies harvesting biomass need the high-value products to be financially viable. In addition, some biomass facilities, especially pellet manufacturers, prefer sawmill wastes generated from primary wood products manufacturing. As sawmill residue becomes more scarce, more focus will be on harvesting logging residues.

Not all forest biomass is created equal. The emerging bioproducts technologies and products will demand specific quality of raw material defined by species, bark content, size distribution, or contaminant limits. This will provide market niches for specific types of biomass. The opportunity that this creates for forest operations in the bioproducts industry is one of service. Forest operations can increase value to the supply chain as new technologies are required for certain bioproducts. Although these will increase costs associated with harvest and processing, pricing will also need to reflect the realities of added processing costs.

Energy Prices Versus Production Costs

The prices of other types of energy, such as fossil fuels, will have an influence on the demand and supply of forest biomass. Increases in the prices of oil, natural gas, or coal will favor bioenergy. Forest bioenergy will also face competition from other renewable energy sources, such as agricultural crops and crop residues, solar, wind, and hydroenergy, among others.

The conventional wisdom has been that woody biomass is a low-value material and the cost of removal generally exceeds market prices. For many timber stand improvements, the biomass itself usually does not have economic value to a landowner and in some cases there may be a landowner fee to remove the biomass from the site (e.g., landowner pays to have slash removed). This scenario is likely to change as the biomass industry grows and demand for feedstock increases.

Conversion of forest biomass into a usable form has distinct phases: harvesting, accumulation, processing, and transport. In the first phase, the cost of a dedicated biomass harvest (removing biomass only for energy) often exceeds the value of that material. That is why biomass harvests generally need to be combined with a harvest of high-value material to make it profitable. Until delivered prices increase or harvesting technologies improve, there will be few cases of dedicated biomass-only harvesting. In the second and third phases, the most cost-effective system for accumulating and processing forest residue for biomass is in-woods chipping as part of a conventional logging or thinning operation. However, some researchers are investigating the potential of "bundling," or pressing branches into a tight bundle of regular size, as a possible cost-effective alternative. The fourth phase, transportation, is a key cost factor in biomass use. Financial viability thresholds exist where transport distances are too long or when site access is too remote or difficult. Bulk vans, due to their relatively light weight and large capacity, are generally considered to be the most cost-efficient mode of transporting preprocessed woody biomass, provided the access roads are suitable for these over-the-highway carriers. The tractor-trailer/bulk van combination is generally considered the most cost-efficient mode of transporting woody biomass.

Economic Budgets

A biomass harvester's profit is equal to the difference between what is paid at the mill or plant (delivered price) minus the costs paid to the landowner for the trees (stumpage cost), harvesting, and transportation costs:

profit = delivered price – stumpage cost – harvest cost – transportation cost

Consider the following scenario to chip a one-truck payload of 25 green tons (20 minutes at $125/hour) and deliver its biomass to a facility 50 miles away ($4.00/mile). The facility pays a delivered price of $18.00 per green ton.

	Per load	*Per green ton*
Delivered price	$500.00	$18.00
Transportation costs	$200.00	$8.00
Harvesting costs	$42.00	$1.68

profit plus stumpage (per ton) = $18.00

This leaves $8.32/ton for stumpage and profit—not much. Therefore, current markets do not allow logger to pay much (if anything) for biomass. Improvements in feedstock productivity and biomass harvesting and transportation systems could improve this scenario of the delivered feedstock.

Harvesting costs will vary depending on silvicultural treatment. If the treatment is part of an integrated harvest system that allows for cost sharing between timber harvest and residue procurement, costs are usually lower than for a dedicated biomass harvest or the biomass produced from short-rotation crop energy plantations.

Environmental Considerations

Forest biomass/bioenergy production could have both positive and negative impacts on the environment, which in turn will influence forest biomass supply. On one hand, forest bioenergy can displace carbon emissions from burning fossil fuels, and thinning unhealthy or damaged stands can enhance the health and productivity of the forest ecosystems. On the other hand, if harvesting operations are poorly managed, water quality concerns, soil compaction, nutrient depletion, and wildlife habitat degradation could occur.

Intensive harvesting operations for bioenergy can increase the risks of damaging impacts on the soil, water, and biodiversity of forested landscapes. The key to decreasing these risks and maintaining environmentally sustainable biomass production operations is designing and carrying out low-impact operations. Professional foresters are ideally situated to be able to guide forest management plans and harvest operations in ways that are sustainable. There is a need for forest management plans that incorporate biomass energy harvests, as well as harvesting schemes and equipment that integrate wood biomass harvest with timber harvest. In addition, a need for assistance exists in identifying and developing markets for woody biomass.

Downed woody debris or a standing dead tree can become habitat for wildlife or be used to reduce soil compaction and erosion. Therefore, a certain amount of logging residue should be left scattered throughout a site to decompose, used in trails, or processed as biomass. These decisions need to be made in the context of economic benefits of removing the biomass as well as the alternatives, which may have important environmental benefits. Because these decisions require tradeoffs, it is important for proper guidelines and policies to be in place to help landowners, contractors, and foresters make informed decisions. In some cases, harvesting requirements are set by third-party environmental certification standards like those found under the Forest Stewardship Council or Sustainable Forestry Initiative. These standards may preclude some biomass removals.

Many states have developed best management practices (BMPs) for biomass harvesting. Common topics discussed in most of these guidelines include deadwood, wildlife and biodiversity, water quality and riparian areas, soil productivity, and silviculture. For example, many guidelines have recommendations for retaining forest floor, stumps and snags, a certain percentage of slash (e.g., 30 percent), avoiding reentry after harvest, and avoiding sensitive areas like wetlands, bogs, and so forth. Biomass harvest can be a detriment to wildlife, especially if the local fauna depends on large amounts of downed woody debris. However, other species may benefit from the active management that biomass harvest allows. Finally, larger openings that occur when all vegetation is removed might make introduction of invasive species more likely. BMP information is available through Cooperative Extension and state forestry programs for each state.

Policies

Policies pertaining to energy, forest management and utilization, environmental protection, and land use, as well as assistance and incentive programs to forest landowners and bioenergy producers and consumers, will affect the forest biomass industry. The emerging renewable energy market has already led to public policy decisions that influence biomass energy development. As the market grows and technology develops to process woody biomass more efficiently, one can expect more policies and incentives that can significantly affect both emerging and established sectors of the forest industry. Many national, state, and local policies and incentives encourage woody biomass production and utilization. Becoming familiar with these policies and incentives can help you better assist and advise your clients with bioenergy and bioproducts information and advice. Since legislation is constantly evolving, be sure to review specific details that you share with your target audience to make sure they are current.

At the federal level, several laws, such as the Energy Policy Act of 2005, the Healthy Forests Restoration Act of 2003, and the Farm Security and Reinvestment Act of 2002, address the provision of such incentives. Tax savings are often used to pro-

mote economic development in the United States. A case in point is the Energy Tax Incentives Act of 2005. This law provides major tax cuts to producers to boost renewable bioenergy production and conservation.

While federal programs are the most visible, many states also have incentives for businesses interested in developing renewable energy sources. Many of these incentives are in the form of tax credits. Some states also have a renewable portfolio standard (RPS) that requires energy suppliers to include a specified amount of renewable energy as a part of its portfolio of fuels. Policy makers use resource tiers and credit multipliers to encourage diverse renewable technologies.

Developing a forest bioenergy industry can have a number of positive effects on rural economies. Woody biomass harvesting, transporting, and processing are labor intensive. Some estimates suggest that for every job created at a biomass energy facility an additional ten jobs are created in the forestry, equipment, and related support businesses.

In addition, high transport costs limit the economical transportation distance for woody biomass feedstocks, keeping jobs in the local area. This is important for areas looking to replace forestry jobs lost due to mill closures and industry restructuring. Performing a project-specific assessment is imperative to understand the actual impact of a given bioenergy project or industry.

Summary

This table summarizes some the advantages and disadvantages of harvesting woody biomass.

Advantages	*Disadvantages*
Can provide new jobs and cost savings for carrying out silvicultural activities	High capital costs of harvesting systems require higher volume and large tracts to remain profitable
Can provide environmental benefits, especially restoring degraded forests	Can hinder long-term site productivity and lead to negative impacts on wildlife and biodiversity if poorly maintained
Can generate additional income from a landowner's property	Higher harvesting and transportation costs mean stumpage (payment to landowner) is generally low

There is no doubt that the opportunity for woody biomass harvesting will increase. However, in many ways there is more skepticism than optimism about emerging woody biomass markets, partly because the woody biomass market has boomed and collapsed in the past. It is not a get-rich-quick proposition and it will take time for more the forestry community to embrace it. At present the production of woody biomass for energy still needs to be combined with conventional logging to be economical. Biomass prices are still generally lower than prices of other forest products. In addition to the prices paid for biomass, there could be cost savings for landowners through stand improvement, increased forest health, and greater productivity. Biomass markets can make good forest management practices affordable as long as long-term environmental impacts are addressed. When carried out correctly, biomass energy represents a significant opportunity for members of the forest products community to improve their business opportunity while simultaneously improving the health of the forest. Time will tell whether it remains a niche market or becomes a major component of the forest industry in the Northeast.

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