Considerations for a Sustainability Wood Biomass Industry

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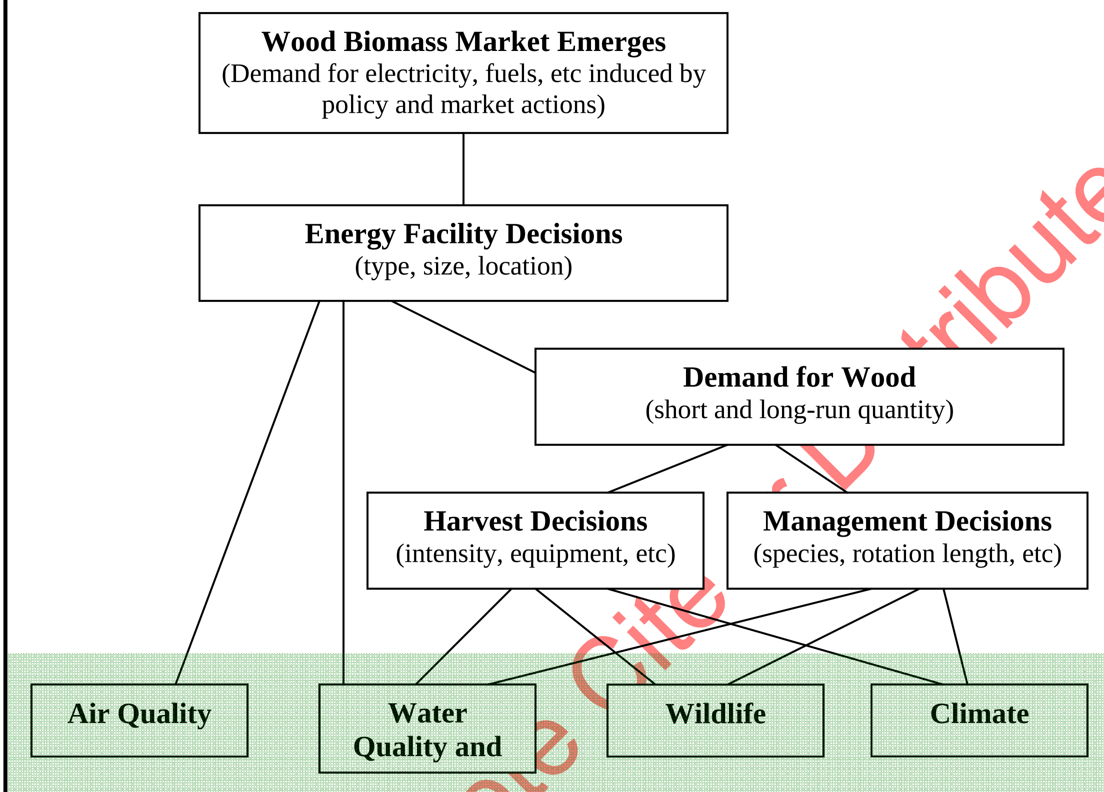
Introduction

Growing climate concerns and energy demands have prompted a new round of public and private investment in forest-based bio-energy production. Renewable energy opportunities are oft cited as the vanguard of a green economy offering new, living wage green jobs. In many regions of the country, especially the Southeastern United States, biomass resources are cheap, plentiful and increasingly sought for energy generation. Developing a sustainable wood biomass resource offers the potential of a carbon neutral, renewable fuel that could enhance economic returns for private landowners, improve forest management and wildlife habitat, reduce atmospheric greenhouse gases and revive rural economies. That's a lot to hope for from one fuel source.

The emergence of a new biomass market will create cascading decisions by facility managers, forestry professionals and landowners that affect forest resources. Figure 1 offers a schematic outline of the linkages and decision points that influence environmental sustainability of wood biomass markets. Not all impacts will be negative. Some market-induced actions will improve environmental resources while others may undermine sustainability efforts. Building a greener future with energy from forests likely will require new policies and new technologies to ensure wood bio-energy production improves wildlife, water, climate and air resources while maintaining healthy diverse forests.

[1] Environmental Defense Fund

Figure 1. From biomass market to environmental resources, a cascade of decisions affecting forest and environmental sustainability.



This paper explores the linkages and decision points outlined in figure 1 (above). The lines connecting boxes do not have arrows – the decisions made in the forest flow "down" to the resources but also "up" to influence future decisions about energy facilities. The paper addresses wood biomass sustainability in three sections: 1) overarching sustainability concerns regarding wood biomass production; 2) consideration of the effect on specific environmental resources (wildlife, water, air and climate); and 3) broad policy options for a wood biomass energy market.

Sustaining a New Energy Source: Overarching Considerations for a Wood Biomass Industry

Sustaining long-term wood biomass production requires consideration of resource supply, landowner and logger economics and ecological principles. Most biomass sustainability studies have focused on resource supply: will forests provide enough wood to sustain an industry? How much wood is needed for a 100MW facility? When considering the sustainability of biomass, a broader set of questions need to be addressed.

As the wood biomass market matures, facilities will be built to maximize economies of scale. Biomass technologies (i.e. gasification, incineration, enzymatic processes) have associated production levels that maximize economic returns. Building a facility too small or too large will

create an unsustainable economic model. Will the economies of scale that develop overlap with the natural ecology of scale that exists among the various forest types, soil conditions and biological diversity in a given geography. In the past, when the economic scale outpaced the ecological scale, forest management intensified, rotations shortened and the most productive species proliferated. Can wood biomass economies of scale be designed to overlap with natural ecologies of scale? Or will forest management practices be altered in a way that undermines the sustainability of other forest resources? These are the questions and issues raised in this section.

Biomass facility type, size and location determine landscape-scale impacts on forest resources.
Wood is bulky, heavy and expensive to move around. Most wood biomass will be harvested within 30 to 50 miles of the energy facility where it is consumed, regardless of plant size or type. Regional demand for wood biomass will be driven by the size of energy generation facilities (i.e. how much wood it uses) and proximity to other wood using facilities. In turn, the demand for biomass will drive the price of biomass. These price signals will influence harvest intensity, replanting rates, species composition, rotation length and a host of other management decisions that will affect not just individual tracts, but collectively the landscape. Larger plants will require more wood from the same sourcing area, shifting demand and prices, potentially creating local hotspots and cumulative impacts on the forests. The impacts will be more dramatic if multiple plants are located close to each other.

Large, centrally located wood biomass facilities have increased potential to drain forest resources, intensify management and potentially degrade other environmental resources (water, wildlife, air, etc). Will economic signals be sufficient to ensure mills are located in a manner that avoids landscape scale issues? Will biomass markets expand options for forest management or drive shorter rotation, monoculture energy crops? Policies should be crafted to reward smaller facilities (i.e. those that utilize less wood) and appropriately spaced facilities. For example, a biomass utilization board could be created to review applications and approve facility locations to ensure sustainable forest resources for the life of the facility, given other expected uses of forests in the region These policy questions will not only affect the biomass market but also the future of our forested landscape.

Increasing competition for wood biomass resources will likely affect forest sustainability and existing industries.
Bio-energy is just the latest forest industry to utilize small-diameter wood resources. The pulp and paper industry in the United States has been using wood biomass for over 100 years. More recently new wood processing facilities (i.e. chip mills, oriented strand board mills, etc) have created new demand sources for biomass resources. These existing industries have helped create transportation networks, logging infrastructure, trained workers, public policies, and forestry-dependent communities across the country. Today, many of these systems and communities are stressed by global competition, resource concerns and new land uses (i.e. development).

Emerging wood biomass markets face different economic realities (i.e. ability to pass on costs to utility customers, policy-induced demand). Will biomass facilities locate where wood is plentiful and competition is low? Or where logging infrastructure is abundant but resource competition is high? Over time, biomass markets will stabilize as winners and losers are determined. But the

struggle for market dominance can be messy for workers, communities and the environment. New policies likely will be required to minimize expected disturbances during the transition to a new energy economy.

Private landowner may respond to higher price for biomass by intensifying management practices.

The nation's forests are owned by over ten million landowners, all making individual decisions that affect not just their forests, but their neighbor's forests and the surrounding landscape (Butler, 2008). As a wood energy market emerges, these landowners will be rewarded with increased prices for wood biomass; as prices increase, more and more landowners will likely shift their management practices to produce more wood biomass for these new markets. Each landowner will respond to market signals differently. Additional research is needed to determine likely price points where forest management could intensify with negative ecological consequences.

Careful consideration of biomass economics and landowner actions now will reduce potential future community and ecological conflicts. In many areas of the country, especially the Eastern U.S., private landowners will be expected to produce the vast majority of wood biomass. In these same areas, few rules or regulations govern private forest management and economic price signals become a dominate driver of landowner actions. Ideally the price of wood biomass will be sufficient to reward sustainable forest management but not so high as to drive more intensive practices that undermine the sustainability of wildlife, water and climate. The history of forests over the last two centuries has been one of booms and busts (from over-harvests to no management), raising concerns that the emerging biomass market could create similar cycles.

Public policies and discussions require ecologically grounded definitions of wood biomass.

In recent state[2] and federal[3] legislation and policy discussions[4], the term "wood waste" has been overused and misused. Unlike other biomass sources (i.e. hog waste or poultry litter), wood is not a waste product; nor is it unlimited like solar or wind resources. Wood is not wasted in a forest system. From an economic perspective, the landowner may miss the income associated with wood left on the forest floor. But ecologically, as trees fall to the forest floor, they provide years of wildlife habitat, they slow surface flow, reducing erosion potential, and over the years, those trees decompose, returning nutrients to the soil and forming new organic layers. How much wood is needed to adequately perform these functions? Scientists agree that forests don't function properly without coarse woody debris left on site. “The consensus among experts is that the absence of downed woody debris would be detrimental to biodiversity and ecological processes.” (Hess, 2000)

The term "wood waste" connotes an expectation that forest residues or logging slash would be the primary driver in an early wood biomass market. This seems an increasingly unrealistic expectation. Anecdotal evidence suggests biomass users will enter the roundwood market (i.e. buying pulpwood size trees) even in areas where harvest residues may be prevalent (Waller, 2008). Policy discussions, statutory definitions and rulemaking processes need to recognize the

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[2] See legislation from Texas and North Carolina
[3] House Bill 5236
[4] For example see: http://www1.eere.energy.gov/femp/pdfs/bamf_woodwaste.pdf

expected sources of wood biomass and contain adequate safeguards to ensure the sustainable use of forests and forest resources.

Ensuring sustainability requires monitoring and measuring activities at multiple scales, with focus on local, landscape scale.

Sustainable biomass management will require new measurement and monitoring technologies to collect data at local and landscape scales. Most existing biomass-availability studies have analyzed wood biomass sustainability at state or multi-state regions. These coarse studies are useful for regional perspectives. But biomass facilities will be built in local communities, utilizing forest resources from a few counties in a state. Existing public data and analytical tools are not prepared to address questions of sustainability at this level nor are existing public policies demanding the monitoring and measuring required to address the shortcomings.

Sustaining Environmental Resources: Consideration of more than just the trees

Ensuring forest sustainability requires a broad consideration of environmental resources including wildlife, water, soils, air and climate. These environmental resources are affected across the landscape by the collective site-level decisions of countless land managers. The effect of forest management on some resources is generally well understood (i.e. water) while others require more research for understanding potential biomass impacts (i.e. soil nutrients). Federal, state and local policies have intended (and unintended) consequences on these resources. Global and regional economic drivers influence the relative abundance of resources, many of which have little or no assigned economic value. This section raises broad concerns and policy questions associated with several broad forest-related resources (wildlife, water, climate and air). Other papers are being developed to explore each in more detail www.Pinchot.org/bioenergy_paper.

Biomass harvest technology and intensity will affect wildlife populations.

Impacts on wildlife populations from biomass removal vary by species of interest and forest management decisions. While recognizing that some species will benefit from increased biomass harvest regimes, the removal of coarse woody debris has the greatest potential negative consequences for wildlife species. The removal of coarse woody debris from harvest sites has been found to negatively impact breeding bird abundance, diversity and richness. A recent study documented "neo-tropical migrants had fewer breeding territories on plots where downed coarse woody debris was removed."(Lohr et. al. 2002) Similarly, removal of coarse woody debris from harvest sites has been documented to impact the reproduction and population levels for small mammals, including mice (Loeb 2003) and shrews (McCay et. al. 2004). Other studies have shown reduced or no impacts from removal of coarse woody debris (Moseley et. al. 2008).

Considerations for critical wildlife populations at the tract and landscape scale should be part of any harvest plans and biomass policies. Similarly, new methodologies are needed to measure the impacts (positive and/ or negative) of biomass harvesting on critical species and wildlife guilds. Identification of best harvesting practices for forest and wildlife goals will be critical to sustain ecological resources during biomass harvests.

Potential water quality concerns from biomass harvests suggest need for new or improved Best Management Practices (BMPs).

Wood biomass creates fewer impacts to water resources than annual row crops for energy production (National Research Council of the National Academies, 2008). Yet, increased reliance on wood biomass for energy production could increase water quality concerns compared to less intensive forest management. Of concern is the potential for more intensive harvests on marginal sites and the loss of coarse woody debris from harvest sites. Coarse woody debris promotes soil and slope stability, decreasing the potential for erosion. Downed wood serves as a natural obstacle that captures, retains and stores eroding sediment (Fuhrman, 2004). As discussed above, biomass markets could create economic incentives to remove coarse woody debris from harvest sites, potentially increasing water quality concerns across the state.

Implementing forestry Best Management Practices (BMPs) have been shown to effectively protect water quality during forestry operations. In North Carolina, implementation of BMPs occurs on about 82% of harvest sites, but implementation is voluntary. When BMPs were not implemented, 42% of harvest sites were found to be a threat to water quality (NC Division of Forest Resources 2005). As additional coarse woody debris or "wood waste" is removed from sites for wood energy production, the threats to water quality will increase.

Figure 2: North Carolina Best Management Practices (BMP) field manual. Top photo indicates proper BMP for skid trail maintenance. Loss of biomass from site may result in bottom picture.

Many of the state's voluntary Best Management Practices are designed to use wood biomass (the limbs and tops) to reduce soil compaction, to slow overland flow, and to maintain water quality. For example, the NC Best Management Practices (BMP) field manual indicates residual biomass should be spread across skid trails to reduce erosion and compaction. As this material gains economic value, will this BMP be implemented? BMP implementation will likely suffer as biomass materials gain economic value – in fact, they may disappear from the site altogether.

Minnesota has developed Best Management Practices (BMPs) for wood biomass harvests (Minnesota Forest Resources Council 2007). Several other Midwestern and Northeastern states are in the process of developing or have recently completed

standards for wood biomass. See [Reference Alexander Evans article] for more discussion of state efforts. There's good reason for additional states to follow this example. Developing wood biomass harvest BMPs that address water quality, wildlife habitat, critical natural communities and soil quality could go a long way to addressing tract level sustainability.

Wildlife BMPs for biomass harvests should be developed that ensures 1) sufficient coarse woody debris is retained on site; 2) snags and vertical structure is retained in clearcuts; 3) rare and declining forest types are not converted or negatively impacted; and 4) wood biomass operations restore and improve wildlife habitat.

Biomass facilities could impact environmental resources including air and water quality.
Most environmental concerns regarding wood biomass utilization stem from potential impacts of forest management on wildlife and water quality. Yet, environmental considerations of wood biomass utilization should not stop when the log trucks or wood chips cross the mill gate. The combustion, gasification or conversion of wood to energy has potential environmental consequences. What control technologies (or standards) are needed to ensure emissions don't degrade local and community air quality? Do wood biomass facilities or mills pose a threat to water quality? What permits should be required? What research or monitoring is needed to ensure facilities maintain environmental quality? These are critical, unanswered questions to be addressed by policy makers and the forestry community as wood biomass markets develop.

Water supply considerations critical for biomass utilization facilities.
Existing electricity generating facilities and fuel refineries consume large amounts of water. A 250 megawatt coal fired power plant uses 3.4 million gallons of water daily (Aden 2008). Current corn ethanol technologies consume 6 gallons of water for every one gallon of ethanol produced (Ibid). Cellulosic biorefineries are estimated to use even more water, 9.5 gallons of water per gallon of ethanol (National Research Council 2007). Assuming an increased prevalence of future droughts, water supply constraints should be considered in the siting and permitting of future biomass energy facilities (especially future ethanol plants[5]). These are issues that deserve additional research and careful consideration.

Maintaining carbon neutrality of wood biomass will be critical.
New sources of renewable energy, including wood biomass, are being promoted in large part to reduce greenhouse gas emissions. Yet, several recent articles have raised real questions about the actual "carbon footprint" of renewable energy sources, most notably corn ethanol and switchgrass (Searchinger et al 2008). Earlier studies of corn ethanol failed to take into account the carbon emissions from land use shifts when corn was diverted from food systems to energy production. As forest biomass markets emerge, the carbon footprint should be monitored not just for the wood chips but also for changes in land use, forest structure and transportation infrastructure.

The best way to drive additional biomass investments into the woods is to get the carbon accounting standards right. If all fuels had to meet a low carbon fuel standard, wood based

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[5] See for example, article from Tampa Bay, Florida with water demands from new ethanol plant: http://www.economist.com/world/na/displaystory.cfm?story_id=10766882

cellulosic ethanol would likely experience increased demand relative to other fuel sources. If low carbon sources were required for electricity, wood based electricity generation would likely increase significantly.

Policy Considerations for Sustainable Wood Biomass

The emergence of wood biomass markets will be driven largely by policy mechanisms to address climate and energy demands. Without these policy drivers, significant demand for wood biomass utilization may not materialize. Three broad options exist for policy related to wood biomass. On one end of the spectrum, policies could allow the development of a wood biomass market with no further considerations or safeguards. This is the "build it and hope" approach; hope that the market equilibrium maintains ecologically sustainable forestry practices. On the other end of the spectrum is the "do-nothing" approach. This approach was taken in North Carolina when the utility commission approved a voluntary green energy program. That program, NC GreenPower, choose to largely prohibit wood from forest harvests in their renewable energy products instead of grapple the complex sustainability issues. Similarly, the federal Renewable Fuels Standard took this approach with federal lands.

The third way and perhaps the most productive is finding a balance that allows the removal of harvest residues and forest thinnings with assurances that sufficient woody debris remains on site for wildlife, water quality and soil stability. In fact, it is likely this is the only approach that will gain the necessary political support to move wood biomass from a niche market to mainstream energy source. The elements of a sustainable wood biomass policy should include the following environmental safeguards:

A) ***Protect water quality during harvests, regeneration and utilization:*** In a wood biomass harvest, where most of the slash and debris is removed for energy production, the opportunity for water quality degradation increases, especially on steeper slopes and more erosive soils. Similarly, during utilization, wood energy facilities should be designed and permitted in a manner that protects water quality.

B) ***Ensure sufficient safeguards for wildlife and biodiversity:*** Wildlife BMPs for biomass harvests should be developed that ensures 1) sufficient coarse woody debris is retained on site; 2) snags and vertical structure is retained in final harvests; 3) rare and declining forest types are not converted or negatively impacted; and 4) wood biomass operations restore and improve wildlife habitat.

C) ***Minimize landscape scale impacts on forest resources:*** The emerging wood biomass market has the potential to shift forest types, age classes and management intensity across the landscape. As biomass prices increase, more and more landowners likely will respond by selling younger trees, shifting management intensity and converting forest types. Policies should ensure that new wood biomass facilities have sufficient resources available over the life of the plant and will not create unsustainable harvest patterns across the landscape.

D) ***Consider water supply constraints and demands:*** New sources of energy production, whether a new coal plant, wood based electricity or ethanol production will require new

sources of water. Water supply is expected to be increasingly constrained. The water demand can vary significantly by technology emphasized for energy production. Additional research and consideration is needed as policies are developed.

E) ***Protect air quality:*** While using wood biomass for energy generation generally produces less air pollution than fossil fuels, it is not a pollution-free energy option. Appropriate controls must be used to ensure that harmful particulates, metals and other pollutants are minimized. Just as size and location of wood biomass energy facilities will determine the pressure on the forest resource, they will also determine the extent to which cumulative emissions must be managed.

F) ***Maintain carbon neutrality:*** Wood biomass will loose favor and likely public incentives if markets drive utilization that is not clearly carbon neutral (or negative). Measuring and monitoring the carbon footprint of wood biomass markets will require new tools and techniques.

G) ***Provide a well funded research agenda:*** in the midst of a biomass boom. Policies will be developed over the coming months and years without full information. With a lack of research, policy makers should proceed with caution. They should support and engage broad range of academic, business and NGO professionals in a comprehensive research agenda. Questions to answer include:

   i. What land use changes are expected with a shift to wood-based electricity and fuel production?
   ii. How will an increasing price for wood biomass shift landowner management decisions?
   iii. How much wood is available for the many economic demands placed on the region's forests, including pulp, OSB, wood-based electricity, cellulosic ethanol, carbon sequestration?
   iv. What role do existing or potential incentives have on wood biomass production? How much will they drive biomass production?
   v. How will wildlife species respond to varying intensity of coarse woody debris removal?
   vi. How will soil nutrient cycling and organic soil production respond to varying intensity of coarse woody debris removal?
   vii. What new policy and economic mechanisms are required to enhance rural communities with wood biomass markets?

Conclusion

The decision is ours: what future will we choose for our forests and for our ever-growing energy needs? Too often critical decisions have been made in isolation, by different agencies and through industry-specific policies. Today's challenges demand a coordinated policy crafted to expand new markets, protect existing industries, reward private landowners and maintain diverse, healthy forest systems.

These varied goals can be met; and must be met, if we are to achieve our forest conservation and renewable energy goals. Decisions made today will determine whether existing and new markets for forest resources will be well balanced with ecological objectives for protection of wildlife habitat, soil health, and air and water quality. And these decisions will have local, national and global consequences. This paper provides a framework for thinking about the emerging wood biomass market; it doesn't provide the answers or even all the questions. Those hopefully will be asked and answered soon. And the answers will determine for decades the future of our forests and our environment.

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