Effects of Renewable Energy Mandates on the Sustainability of Forests in the Southeastern U.S.

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Summary. The potential for renewable energy production in the Southeastern United States rests heavily on its forest biomass. The Southeastern Forest represents 29% of the total forest acres in the U.S., and this complex biological system provides sustainable, cost competitive supply for 60% of our nation's traditional timber product output. Poorly crafted mandates or economic incentives for renewable energy can cause severe harm to this biological and economic system, creating conflict between the forest products industry and renewable energy producers that may endanger the long term sustainability of Southeastern forests. The existing federal Renewable Fuel Standard and proposed Renewable Portfolio Standard can drive demands for biomass to unsustainable levels, compromising biological processes and the values that society obtains from the Southeastern Forest. This paper shows that renewable energy mandates, if not materially offset by other, more weakly positioned renewable resources in the Southeast, could lead to a substantial increase in regional biomass demand. This increase could change the character of the forest, compromise forest values and reduce the quantity of fiber available for use in forest products.

Keywords. [Forthcoming]

Introduction

The U.S. Southeastern Forest, a thirteen state region[3] comprising 29% of our nation's forest (215 million acres), produces 60% of the nation's timber products. Private owners representing more than 4.9 million individual tracts of land provide a cost competitive sustainable wood supply for 97% of the South's timber products industry in addition to beneficial social and ecological values.

For over one hundred years, free market forces have balanced forest products demand with forest biomass supply in the Southeast. Recreational uses also are well established and in reasonable balance with commercial uses. Landowners have had adequate financial incentive to retain forests, increase growth, and regenerate following harvest, enabling the South's annual industrial wood production to increase from 6% to 16% of the world total over the last 50 years. Further expansion of the region's forest products industry is being restrained by rising costs and global competition. Mandates and incentives for renewable energy production have the potential to threaten forest sustainability and disrupt the free market drivers that enable forest industry competitiveness.

Due to the established supply chain, relative cost and supply of wood, and consistency of wood's material characteristics, it is reasonable to expect that renewable energy markets would select wood as a preferred biomass feedstock. Further, the financial incentives for renewable energy production, which currently exclude the renewable energy produced and consumed by the forest products industry, would create an uneven playing field in forest biomass markets. The escalating cost of forest biomass, caused by mandated renewable energy demand, will be

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absorbed by subsides and rate payers in the renewable energy markets, while increased fiber costs for paper and wood products will slow demand and weaken the health of the Southeastern forest products industry. The purpose of this paper is to explore the potential impact of mandates and incentives for renewable energy production on harvest levels and forest sustainability in the Southeastern U.S.

Methods

Demand Assessment

In recent years the Southeastern Forest has been at or near a sustainable condition in which forest growth equals forest removals plus mortality.[4] In this analysis, projected demand for biomass based on emerging government policies was compared with potential regional supply[5] to determine the potential impact on this balance.

Three new energy demands were assumed to occur within the Southern forest region: (1) Biomass Export, assumed to support renewable energy requirements of Kyoto Protocol member nations; (2) Biomass Electricity, assumed to meet a 15% renewable electricity portfolio standard; and (3) Cellulosic Ethanol, assumed to equal the Southeast's potential share of the national advanced biofuel goal.[6]

Biomass Export.—Three pellet plants have been announced in the Southeast (International Wood Fiber Report, 2008), two of which are operational, each with an expressed interest in exporting woody biomass to support foreign renewable energy requirements. The combined capacity of these plants is approximately 1.5 million dry tons of forest biomass per year. Due to the short history of this emerging business, this analysis will not attempt to project continued growth for this biomass energy category; however, the potential for higher demand certainly exists.[7]

Biomass Electricity.—The name plate capacity of electric power generators in the Southeast, excluding nuclear, wind, solar, hydro and non-utility generators, is approximately 223,500 MW (PennWell Corporation Utilities Database)[8]. A 15% renewable electricity standard would require that 33,525 MW be derived from renewables. Given the limited near-term expansion opportunities of non-biomass renewable energy sources in the Southeast, nearly all of this requirement is likely to be met with biomass. Since each MW would require at least 5,000 dry tons of biomass per year, the total incremental requirement would be 168 million dry tons annually.[9]

Advanced Biofuels.—The current Renewable Fuel Standard (RFS) requires 21 billion gallons of advanced biofuels be produced from cellulosic sources (Energy Independence and Security Act, 2007) At a conversion rate of 91 gallons per dry ton of wood,[10] this would result in additional demand equivalent to 230 million dry tons of wood nationwide. If this demand is allocated to

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[4] The 2007 RPA Resource Tables show that private forest inventory in the U.S. South grew at a compound annual growth rate of 0.6% between 2007 and 1987. http://fia.fs.fed.us/program-features/rpa/default.asp

[5] Consistent with volumes in DOE/USDA report, *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply*

[6] 21 billion gallons of Advanced Biofuel per the "Energy Independence and Security Act of 2007" times the fraction of the Southeastern forest's share of the total U.S. timber harvest.

[7] Forestry imports from aboard could exceed 20 million dry tons annually.

[8] This information is provided on a best effort basis and PennWell Corporation does not guarantee its accuracy nor warrant its fitness for any particular purpose.

[9] At a heat rate of 10.3 mmbtu/MWh and 8,000 btu/pound of biomass

[10] Ninety-one gallons per dry ton is the midpoint of the expected yields from the first six cellulosic ethanol plants selected to receive funding from the U.S. DOE.

regions in proportion to existing production levels, the Southeastern Forest might be called upon to furnish an additional 138 million dry tons annually.[11]

Supply Assessment

New biomass supplies available in the region were assumed to be consistent with the "moderate crop yield increase with land use change" scenario of the DOE/USDA report, *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply* (BTS). These supplies essentially fit into four resource groups: (1) forest residues, assumed to be excess standing timber, debris from harvesting operations, and excess mill residuals, (2) urban residues, assumed to be wood residuals available in municipal solid waste streams or from construction and demolition debris, (3) agricultural residues, assumed to be excess agricultural crop yields, the biomass residuals of crop management, and any secondary or tertiary residues, such as manure or food waste, and (4) energy crops, assumed to be purpose-grown crops in support of an energy production facility, *e.g.*, switchgrass, high-yield wood fiber plantations.

Forest Residues.—Data specific to the Southeastern Forest were obtained from DOE/USDA presentation materials entitled, "Forest Biomass Resources in the U.S. and the South." This work, a subset of the BTS, identified five sources of forest residues and the quantities deemed sustainably available in the Southeast. The sources totaled 42.3 million dry tons annually.[12]

Urban Residues.—Data specific to the quantity of residuals available from urban waste in the Southeast were also obtained from the BTS. This source includes the wood components of discarded furniture, pallets, and packing materials, as well as yard and tree trimmings, and construction or demolition debris. These sources totaled 12.8 million dry tons annually.

Agricultural Residues.—Data for agricultural residues specific to the Southeast were not readily available from the BTS. An apportioning method was necessary to maintain consistency with the national biomass availability values represented by the BTS. The National Renewable Energy Laboratory Technical Report, "A Geographic Perspective on the Current Biomass Resource Availability in the US," was used to identify the availability of resources in Southeast relative to national estimates. These values (agricultural residues 18%, manure 48%) were used to apportion the 113.2 million dry tons of agricultural residue and 65.9 million dry tons of secondary and tertiary residues identified as currently available in the U.S. (BTS Table B.2). In total, these sources amount to 53 million dry tons annually.

Additionally, the potential for greater quantities of agricultural residues was identified in BTS Table B.5. The same methods were applied to the difference between BTS Table B.5. and BTS Table B.2. and in this analysis this difference is referred to as Future Farm Residues. It is important to point out that these increases have not yet occurred and that these estimates carry a higher degree of uncertainty than estimates for other residues. In total, these future sources amount to 40.7 million dry tons annually.

Energy Crops.—As with agricultural residues above, the quantity of Energy Crops in the Southeast was not readily available in the BTS, though 155.7 million dry tons of annual energy crops were estimated to be potentially available nationwide. The method of apportioning Wood

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[11] The Southeastern Forest produces approximately 60% of the nation's wood products. Apportioning 60% of the biomass demand necessary to satisfy the RFS requirement to the Southeastern Forest results in 138 million dry tons of expected demand.

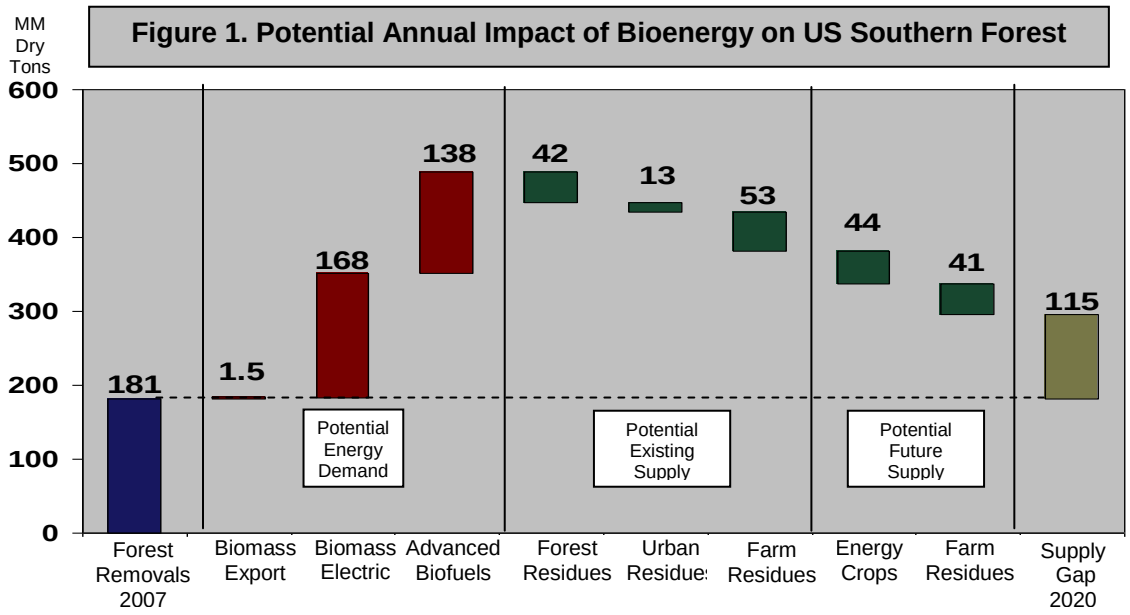
[12] Million dry tons of forest residue cited in the BTS by source: Logging Residue 14.3; Other Removal 7.7; Thin Timber 18.6; Thin Other 1.1; and Unused Mill 0.6.

Fiber and Perennials from BTS Table B.5. was to consider idle crop land as the opportunity to host these biomass sources. A USDA report, "Cropland Idled, by Region and States" showed that 28.2% of U.S. idle crop land is in the South. Assuming all of this land is converted to energy crop production, 43.9 million dry tons could be produced annually.

Results and Discussion

Supply versus Demand

The Renewable Fuels Standard (RFS) and the proposed 15% federal Renewable Portfolio Standard (RPS) would dramatically increase wood consumption in regions of the United States to unsustainable levels. In the Southeast, biomass export, biomass electricity, and advanced biofuels production total a projected 308 million dry tons per year of new demand (Fig.1). The potential new supplies in the Southeast, forest residues, urban residues, current farm residues, future energy crops, and future farm residues, totaled 193 million dry tons of potential supply. Biomass supply appears inadequate to satisfy the incremental demands of the renewable energy markets, with an annual gap in supply of 115 million dry tons. With no reductions in existing use, the demand nearly triples while the potential future supply doubles. Hence, the condition would not be sustainable. In fact, the future gap in supply versus demand exceeds the current demand for pulpwood (approximately 100 million dry tons) in the Southeast.



Cost of Supply

As shown if Figure 1, the supply of new biomass resources seems inadequate to satisfy renewable energy demand. Beyond the likely negative impacts this would have on the Southeastern Forest, this condition would lead to high market tension and rising feedstock costs. Understanding the relative costs of each biomass resource would help determine the order of usage and provide an indication of potential disruption to existing users of biomass supply.

This analysis assumes that all qualifying biomass resources would be available to potential renewable energy consumers and that future feedstock demand would progress from least-cost to

greatest-cost sources until demand is satisfied.[13] It is likely that variation in feedstock characteristics would affect facility costs (handling, storage, etc.) and that some of these costs would be separately incurred for each feedstock selected. These facility cost components were not considered in this approach. The cost of each biomass resource was compared on a delivered basis only.

The Energy Information Administration (EIA) report, *Biomass for Electricity Generation*, (Haq, 2008) contains supply curve data for biomass resources within each North American Electric Reliability Council (NERC) region. EIA data for the Southeastern Electric Reliability Council (SERC) region represents availability and cost of supplies for nearly the same geographic area as the Southeastern Forest. The report describes four different resource groups, largely similar to groups used in the current analysis: (1) Forest Residues–excess small pole trees, rough rotten salvageable dead wood and debris from harvesting operations, (2) Urban Residues–wood residuals from manufacturing, urban waste, construction waste and demolition debris, (3) Agricultural Residues–residues of wheat straw and corn stover, (4) Energy Crops–resources purposely grown for use in energy generation.

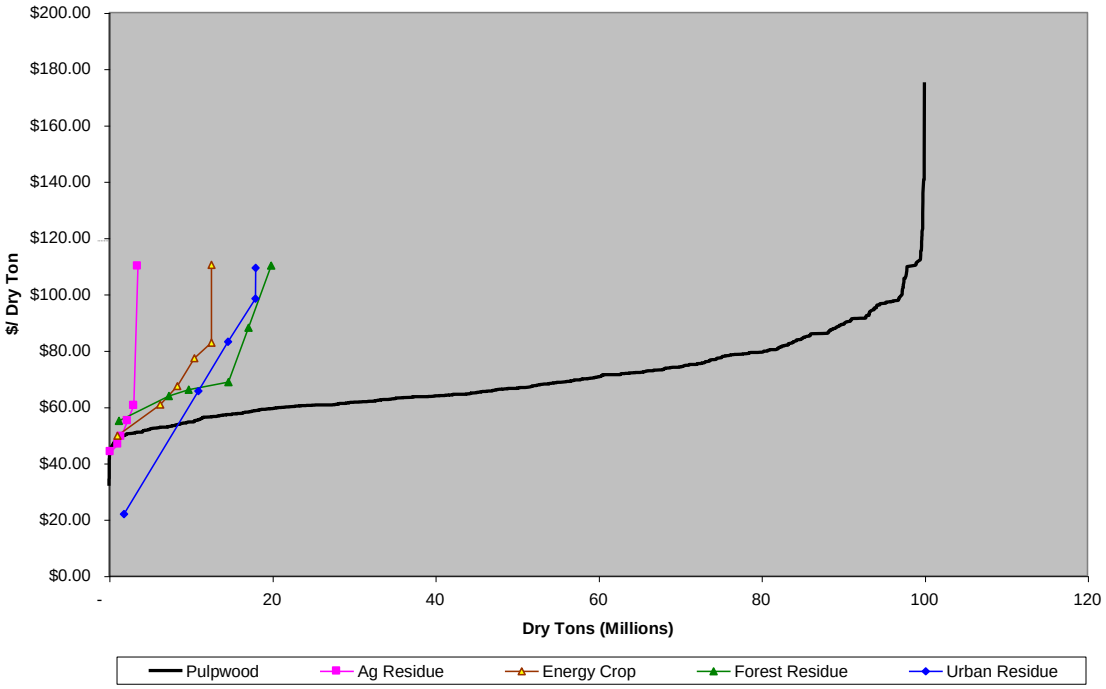
Figure 2 shows the availability and cost of each of EIA's biomass resources[14] and an estimated pulpwood supply curve for the Southeastern Forest. The U.S. Southeast, as represented by EIA's values for SERC, had potential biomass resources of approximately 54 million dry tons annually. This estimate was equal to one half of the baseline resources identified in the BTS.

In comparison, at an equivalent unit cost, the estimated Southeastern Forest pulpwood supply curve, with the associated forest residues, reflects a sustainable supply in excess of 120 million dry tons annually.

[13] A least-cost to greatest-cost approach is seen as a business imperative unless government intercedes through regulation.

[14] To facilitate the comparison, several adjustments were made to EIA's base data. National availability of each biomass resource was interpreted at various prices from EIA Figure 2. Quantity of biomass resource was allocated to the Southeast using the relative share of SERC as shown in EIA Table 2. Quantities were restated from Trillion Btu to Million Dry Tons per EIA Table 3. Prices were restated in 2007 dollars using PPI – Industrial Commodities. All results were displayed in dry tons.

Figure 2. **NEMS Southwide Biomass Supply Curve vs. Southwide Pulpwood Curve**
Dry Tons



From Figure 2 it is apparent that pulpwood supply is much more abundant at lower prices than any other source of biomass. At $100 per dry ton (roughly twice the current cost of pulpwood) 100 million dry tons of pulpwood are available versus a combined total of about 54 million tons from all other sources.

Given the established supply chain for forest products, the relative cost position and abundance of wood, and the consistency of wood's material characteristics, it is reasonable to anticipate that renewable energy markets in the Southeastern Forest would select wood as a preferred feedstock.

Production Tax Credit for Cellulosic Biofuels

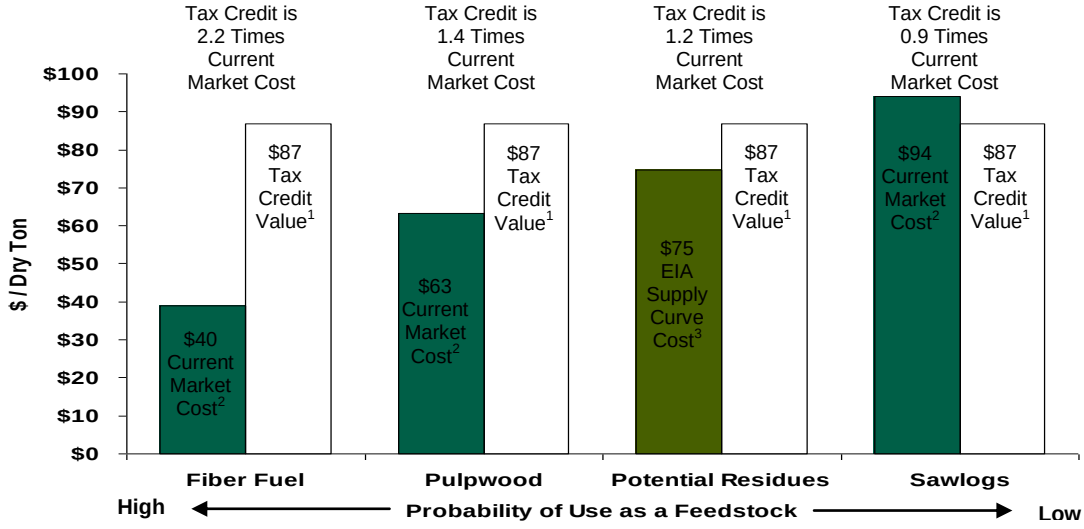
The gap between the estimated demand and the estimated supply of sustainable biomass residues and the characteristics of the pulpwood supply curve, imply that renewable energy producers need to access traditional forest product fiber supplies in order to satisfy renewable energy and biofuel mandates. Financial assistance offered to renewable energy producers can be restated in terms of dollars of assistance per unit of feedstock. Thus, the Production Tax Credit for Advanced Biofuels, of $1.01 per gallon, can be restated in dollars per dry ton of forest biomass. Technologies for converting forest biomass to advanced biofuels vary widely; however, an approximate yield can be used to demonstrate the potential value of the production tax credit on a feedstock equivalent basis. Assuming that 86 gallons of advanced biofuel can be achieved per dry ton of forest biomass and a production tax credit of $1.01 per gallon (Food, Conservation and Energy Act, 2008), the feedstock equivalent subsidy is $86.86 per dry ton of forest biomass. This subsidy exceeds the current price paid for most pulpwood consumed in the Southeast.

Forest biomass consumed by the forest products industry can be described in three broad product groups: (1) fiber fuel – logging and manufacturing residues currently used to generate renewable energy, (2) pulpwood – stem wood from trees, or sections of trees, not suitable for lumber, and (3) sawlogs – stem wood from trees of sufficient quality, length, and diameter to be suitable for

conversion into solid wood products. Each of these groups can be represented by an average delivered cost for the Southeastern Forest. The total delivered weighted average wood cost for the first six months of 2008 was obtained from Forest2Market [15]. To facilitate comparison with the biomass resources described in the section above, these delivered costs were assumed to be at 50% moisture content typical for forest supply. Therefore, the dry ton cost would be twice the reported delivered cost.

Figure 3 shows that the value of the production tax credit for advanced biofuels exceeds the current average market cost for fiber fuel and pulpwood. Recipients of the tax credit would receive a value of 1.4 to 2.2 times the current market cost for these products and have an effective cost for sawlogs of less than 10% the current market cost. The average cost of EIA's biomass resources was also shown to exceed the cost of the fiber fuel and pulpwood currently being used by the forest products industry.

Figure 3. Value of renewable energy tax credit vs. current market



[1] $1.01 per gallon x 86 gallons per dry ton of feedstock = $86.86 per dry ton
[2] Forest 2 Market – 1st Half 2008,
[3] Derived from EIA "Biomass for Electric Generation" escalated to 2008$ using PPI – Industrial Commodities

Already struggling financially, the forest products industry earned only a 4.5% rate of return on capital and 3.5% profit margin from 2000 to 2007 (American Forest and Paper Association); rising fiber costs and an uneven playing field with new biofuel and bioenergy competitors could cause significant market deterioration and have a serious negative impact on industry and jobs. The forest products industry has demonstrated that the conversion of trees into paper and wood products creates eight times the wealth, and thirteen times the employment, of converting trees into energy (Pöyry Forest Industry Consulting Oy and Foreco Oy for CEPI). Additionally, the pulp and paper industry derives 65% of its energy needs from forest biomass that are residues from the manufacturing process. At present, this percentage is not subsidized under the renewable portfolio standards as renewable energy. Clearly, the introduction of renewable energy mandates or financial support in the form of tax incentives or subsidies can have far ranging effects on the sustainability of the Southeastern Forest and the economic well-being of the Southeast.

[15] Forest2Market is the leading provider of market information for the forest products industry.

Conclusions

- In the Southeastern United States, biomass export, biomass electricity, and advanced biofuels production total a projected 308 million dry tons per year of new demand (Figure 1).

- The potential new supplies in the Southeast, forest residues, urban residues, current farm residues, future energy crops, and future farm residues, total a projected 193 million dry tons of potential supply.

- Biomass supply appears grossly inadequate to satisfy the incremental demands of the renewable energy markets, with an annual gap in supply of 115 million dry tons.

- With no reductions in existing forest use, the current sustainable demand nearly triples while the potential future supply doubles. In fact, the future gap in supply versus demand exceeds the current demand for pulpwood in the Southeast. The projected condition is expected to be unsustainable.

- Pulpwood supply in the Southeast is much more abundant at lower prices than any other source of biomass (Figure 2). At $100 per dry ton (roughly twice the current cost of pulpwood used to make pulp) about 100 million dry tons of pulpwood are available versus a combined total of about 54 million tons from all other sources. Due to the established supply chain, relative cost and supply of wood, and consistency of wood's material characteristics, it is expected that renewable energy markets would select wood as a preferred biomass feedstock.

- Government subsidies for biofuel (roughly $87 per dry ton of biomass) exceed typical, current fiber fuel and pulpwood raw material costs by roughly 40 to 100 percent and are roughly equal to saw-timber raw material costs (Figure 3) thereby providing a large advantage for new biofuel facilities in competing for fiber with existing users of the forest supply.

- Government mandates on utilities for renewable portfolios enable the pass through of fiber fuel costs to consumers, thereby creating a large competitive advantage over producers of international commodities vying for limited fiber supplies.

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