TIMBERLAND INVESTMENT RESOURCES LLC

growing value for our clients every day

TIR

THE EMERGIN BIOENERGY SECTOR AND ITS EVOLVING IMPACT ON TIMBERLAND INVESTMENT MARKETS

Chung-Hong Fu, Ph.D., *Managing Director*

Economic Research and Analysis

February 2013

Executive Summary

As global interest in renewable energy grows, a string of new investments have been made in recent years in power and biofuel plants and wood pellet mills that require large quantities of wood fiber. For timberland investors, this emerging market for woody fuel stocks holds the potential to increase the income-generating potential of their timberland.

A versatile feature of wood is that energy can be extracted from its fiber in a variety of ways. In fact, there are four wood bioenergy technologies in active development and evolution today: electricity production through direct firing or co-firing of wood with coal; direct firing of wood in boilers for combined heating and power (CHP); production of wood fuel pellets to be burned for heating, electricity production and CHP; and, production of liquid biofuels, like cellulosic ethanol, biodiesel and biosynthetic crude oil, for use in transportation applications.

In the U.S., the push for expanded wood-based bioenergy has come from the states, which are implementing Renewable Portfolio Standards (RPS) to promote the development and use of wind, solar, geothermal, agricultural and wood-based generating technologies. Beyond the United States, many other countries also have adopted renewable energy policies that emphasize wood bioenergy. The European Union (EU), for instance, is at the forefront of this movement. Its 27 countries have collectively adopted a goal of generating 20 percent of their energy production from renewable sources by 2020.

The growth of the North American wood bioenergy sector has been dramatic over the past few years. In fact, associated demand for wood grew by about 20 million green tons during the previous half decade (for purposes of context, pulpwood use by the entire U.S. pulp and paper industry totaled nearly 200 million tons during this same period). Much of this bioenergy-related growth in wood demand was attributable to the appetites of the EU countries' for wood pellets.

In the United States, the South is attracting most of the bioenergy-related investment capital that is currently being deployed. This is because the region has substantial timber resources; highly competitive wood costs relative to other markets; abundant timber processing resources; and a high quality transportation infrastructure.

Looking ahead, TIR expects a continued expansion of the wood bioenergy sector, with most of this growth in coming years being driven by increased demand for wood pellets and wood-based electricity generation. In fact, Forisk Consulting estimates that the new generating capacity that is expected to come on-line in the U.S. over the next several years will require more than 33 million tons of wood fiber. In the U.S. South, which is home to the world's largest pulpwood market, bioenergy investments over the next five years could elevate total pulpwood demand by as much as 10 percent from 2012 levels. The increase in aggregate U.S. pulpwood demand could be as high as 11 percent.

For timberland investors, increasing timber prices will be the greatest relevant impact of the growth of the wood bioenergy sector. Over the next 10 years, pulpwood prices are expected to increase an average of 5 to 6 percent per year in the South. They also are expected to increase by 2 percent in the Lake States and 1 percent in the Northeast. The expanding bioenergy sector will be a factor in these increases and this is likely to cause investors to consider the impact bioenergy-driven demand for wood will have on local market dynamics when analyzing specific investment opportunities.

Introduction

In recent years, a new wood-using sector has rapidly emerged to respond to the growing domestic and global appetite for renewable energy. The wood-based bioenergy market is beginning to re-shape timber market dynamics and nowhere is this more true than in the United States, where a string of new investments have been made in power plants, biofuel facilities and wood-pellet mills that require large quantities of wood fiber. For timberland investors, this emerging market could become an increasingly prominent source of income generation from their forest assets in the years to come.

The purpose of this paper is to provide a succinct and realistic assessment of the wood bioenergy sector and its prospective influence on timberland asset class dynamics. The paper begins by defining wood bioenergy as a sector and by assessing its prospects for growth. It continues with a forecast of how this growth will impact timberland markets. Finally, the paper concludes by providing insight and guidance on how investors can take advantage of emerging bioenergy markets to improve the performance of their timberland portfolios.

What is Wood Bioenergy and Why does it Matter?

The term woody biomass energy – or simply wood bioenergy – commonly refers to the commercial or industrial conversion of wood into heat, electricity or transportation fuel. Despite the recent attention it has been receiving, wood-based bioenergy has had a long and established history of commercial use. For decades, pulp mills and sawmills have burned their own wood residuals in boilers to generate steam and power, which has been used to support their manufacturing processes.

Types of Wood Bioenergy

Despite this long history, during the past decade there has been growing public awareness of the need to reduce carbon emissions from power generation to address the risks of global climate change. In addition, rising prices have created a pressing need, especially among Western industrialized nations, to reduce their dependence on imported fossil fuels by increasing their reliance on renewable fuel sources. Consequently, many regard energy drawn from forests, a major renewable resource, as a potential solution to both

problems – one that can complement other "green" energy technologies like solar, wind, geothermal and hydroelectric.

A versatile feature of wood is that energy can be extracted from its fiber in a variety of ways. In fact, there are four wood bioenergy technologies in active development and evolution today: (1) electricity production through direct firing or co-firing of wood with coal; (2) direct firing of wood in a boiler for combined heating and power (CHP); (3) production of wood fuel pellets to be burned for heating, electricity production and CHP; and (4) production of liquid biofuels, like cellulosic ethanol, biodiesel and biosynthetic crude oil, for use in transportation applications.

Diversity of Feedstocks

Just as there is a wide range of end-uses for woody biofuels, different types of wood are suitable for certain types of energy applications. Most woody bioenergy feedstocks come from five main sources:

1. *Harvesting and Logging Residuals:* These are the unmerchantable tree tops, limbs, branches and stumps that remain after a timber harvest. In certain regions, especially the West Coast, this type of wood fiber is frequently referred to as "hog fuel."

2. *Mill Residuals:* This is the sawdust, shavings and wood chips that are produced when a sawmill or panel mill converts raw timber into finished products like lumber or plywood.

3. *Clean Wood Chips:* These are wood chips produced from whole logs that have been de-limbed and de-barked specifically for the purpose of producing chips. Clean wood chips are most frequently employed with bioenergy conversion technologies, such as wood pellet manufacturing, that require consistent, high quality wood fiber. In the United States, the types of logs that are commonly converted to produce clean chips are 8 inches (20cm) in diameter, or smaller – a log grade commonly referred to as pulpwood. In addition to bioenergy applications, pulpwood is commonly used to manufacture various types of pulp as well as composite wood panels, including oriented strand board (OSB), particleboard and medium density fiberboard (MDF).

4. *Whole Tree Chipping:* This process entails cutting and chipping small, whole trees at harvesting sites and making use of their branches, bark and limbs as well as their heartwood logs.

5. *Urban Waste and Land Clearing Materials:* This refers to wood collected in urban or suburban areas – often from residential landscaping activities like the pruning or removal of trees and the clearing of forests and individual trees for construction projects and utility infrastructure maintenance. Contrary to prevailing assumptions, old lumber from demolished or remodeled buildings is not utilized in wood bioenergy applications.

For the most part, wood-pellet mills have the highest quality standards for their feedstocks. They typically require clean wood chips or clean mill residuals. For this reason, they compete directly against traditional pulp and paper mills and oriented strand board (OSB) mills for access to pulpwood. Some wood biofuel production applications also require clean feedstocks, but others, such as direct-fired electricity production facilities, are very flexible and can make use of almost any type of wood-based feedstock.

These different requirements are important to remember when analyzing the impact bioenergy can have on a particular wood market.

Wood Bioenergy's Importance to Timberland Investors

The rapid growth of wood bioenergy is of value to timberland investors, first and foremost, because of its ability to boost demand and competition within wood markets. New demand for bioenergy also can create markets for harvesting residuals and for fiber produced from whole tree chipping operations – thus producing additional sources of revenue for timberland owners. In some cases, forest owners also can benefit from coordinating and cooperating with bioenergy companies by initiating long-term fiber supply agreements (also known as forward contracts).

Although national wood markets are affected, the full impact of bioenergy is mainly realized at local and regional levels. This is because wood is a low-value, bulky material. As a result, transportation costs can be a significant factor in a bioenergy producer's ability to

control its input costs and to operate profitably. In many cases, wood-based bioenergy facilities are focused on procuring their feedstocks from sources located within 75 to 100 miles (120 to 160 kilometers) of their operations. For this reason, timberland investors need to have an informed perspective on the characteristics of local and regional wood markets when they are evaluating specific timberland investment opportunities and the associated cash flow and total return assumptions that are being employed for acquisition modeling purposes.

Sources of Wood Bioenergy Investment and Demand

U.S. Federal Policy Initiatives

U.S. Federal public policy support for the wood bioenergy sector exists in the form of a national subsidy for stand-alone biomass electricity called the Production Tax Credit (PTC). It offers up to a 2.2¢ per kilowatt hour (kWh) credit to renewable energy producers. There also are federal targets for biofuel consumption, including cellulosic ethanol, which can be made from wood. The 2007 Energy Independence and Security Act (EISA) set national targets for renewable fuel usage in gasoline called Renewable Fuel Standards 2 (RFS2). These targets, however, lack teeth, as the U.S. Environmental Protection Agency (EPA) can revise them based on prevailing or anticipated market conditions. For instance, in 2012, the RFS2 target level was 500 million gallons of cellulosic ethanol, but the EPA scaled this back – revising the target to 8.65 million gallons because of the lack of commercial-scale cellulosic ethanol plants in the U.S. that have advanced beyond the pilot and experimental stages of operation. The United States has neither federal mandates for reducing carbon emissions nor renewable electricity production targets.

State-Level Push of U.S. Domestic Bioenergy

Compared to the federal government, U.S. state governments have provided more support and incentives for the wood bioenergy sector. The principal policy tool states employ are Renewable Portfolio Standards (RPS). Also referred to as Renewable Energy Standards (RES) or Alternative Energy Portfolio Standards (AEPS), RPS targets establish state-level mandates for utilities – outlining how much of the electricity they generate for consumers should be produced from renewable fuels or alternative energy

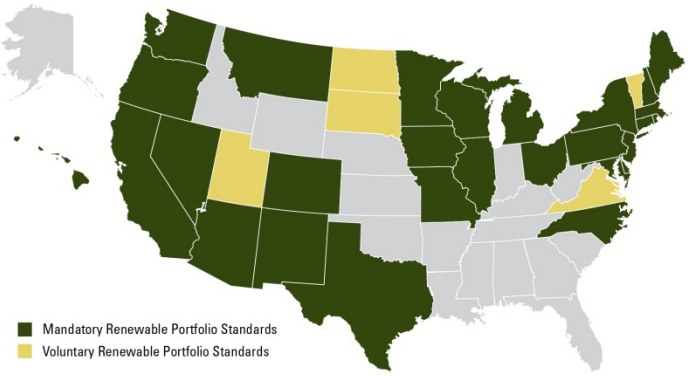

Figure 1. States that have adopted mandatory renewable portfolio standards (RPS) are shown in blue. States with voluntary RPSs are shown in yellow. *Source: Dale Green*

technologies. Each state's RPS targets are different, but most qualify wood bioenergy as a renewable or alternative energy source along with wind and solar. According to the U.S. Energy Information Administration, 30 states and the District of Columbia had enforceable RPSs as of 2012. An additional 7 states have voluntary renewable energy goals. The State of California, for instance, has endorsed an RPS target of having 25 percent of its electricity produced from renewable fuels or alternative energy sources by 2016 – and 33 percent produced by such fuels and technologies by 2020. Since there are limitations on how much solar and wind power can realistically contribute to the achievement of these targets, wood bioenergy is positioned to play a significant role in the electricity generation equation for California and many other states in the future.

International Policy Drivers of Wood Bioenergy

Unlike the United States, many other countries have adopted renewable national energy policies that include and promote wood bioenergy. The European Union (EU) countries are at the forefront of this movement. The 27 countries that comprise the EU have collectively adopted a goal of sourcing 20 percent of their energy from renewable sources by 2020. These countries also have agreed to reduce their output of greenhouse gases by 20 percent below 1990-levels by that date. Individual EU countries may adopt even more aggressive targets for themselves. For instance, the government of the United Kingdom has determined that one-quarter of its 20 percent renewable energy target should come from the use of woody biomass by 2020.[1] Germany has set a renewable energy generation target of 35 percent by 2020 and 80 percent by 2050. Beyond their longstanding efforts to deploy wind and solar technologies, many European utilities are making sizable investments in wood bioenergy power production, with a particular emphasis on the use of wood fuel pellets.

The actions of the EU countries are significant for the U.S. timber market because they cannot reach their

[1] Jeff Wright of ArborGen. "Developing dedicated forest bio-energy plantations." Who Will Own the Forest? Conference, Portland, Oregon. 20 September 2012.

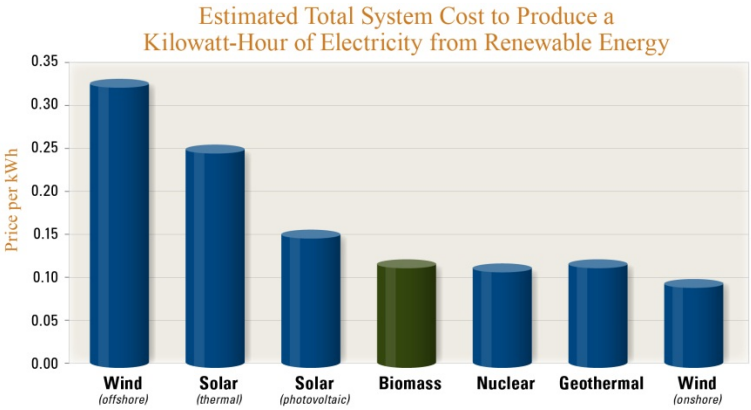

Figure 2. The projected rate in cents per kilowatt-hour that must be charged to cover the cost of a renewable energy power plant built and operated in 2017. Prices are in 2010 dollars.

Source: U.S. Department of Energy, "Levelized Cost of New Generation Resources in the Annual Energy Outlook 2012,"

aggressive renewable energy targets by relying solely on their own forest resources. Consequently, the importation of woody biomass fuels is a major priority for Europe, and North America's forests are a logical and accessible resource base for meeting this demand. Among the European nations currently sourcing wood pellets from North America, the UK, Belgium, Germany and the Netherlands have been among the most aggressive importers.

Beyond Europe, several East Asian and Latin American countries also have set renewable energy targets that include the use of wood bioenergy. South Korea, for example, hopes to raise the share of its electricity generated by renewables from less than 4 percent in 2011 to more than 11.5 percent by 2030. The South Korean government believes it will need 5 million tons of wood pellets by 2020[2] to accomplish this goal. Following the Fukushima nuclear power plant disaster in 2011, Japan also is planning to increase its reliance on renewables and has included wood bioenergy in its plans for diversifying its generating capacity. In Latin America, Brazil's 10-year plan focuses on tripling the nation's use of renewable energy by 2020. While Brazil enjoys wood self-sufficiency because of its abundant forest resources, many Asian countries, including South Korea and Japan, do not – and they are expected to follow Europe's lead by focusing on the importation of large quantities of woody biomass from North America.

Economic Drivers of Bioenergy

While growth in the bioenergy sector largely has been influenced by government policies and subsidies, it is not immune to economic and market forces. The tightening of credit markets and the decline in natural gas prices somewhat dampened the level of investment being made in bioenergy in the U.S. in 2011 and 2012.

On a more positive note, high oil prices have helped support bioenergy development by emphasizing the need for cost effective, non-fossil fuel alternatives. In addition, wood biomass power generation is competitive from a cost standpoint when compared with many other renewable energy sources (see Figure 2).

[2] Wood Resources International. "South Korea and Japan will become large importers of pellets and energy chips in coming decade." 25 September 2012.

Development of Wood Bioenergy in the United States

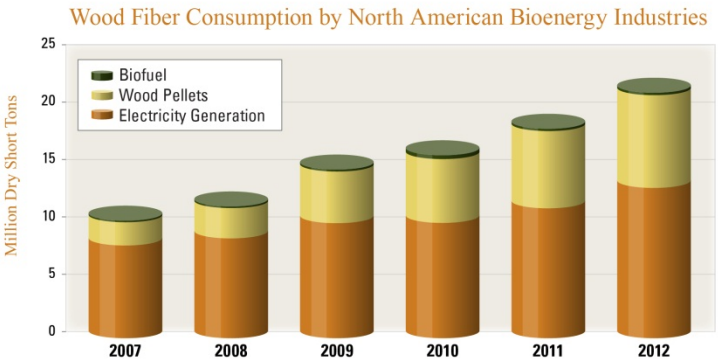

Figure 3. Estimated wood consumption in dry weight by North American bioenergy industries from 2007 to 2012. To convert dry weight to "green" weight (i.e., weight at harvest) simply double the values. *Source: RISI*

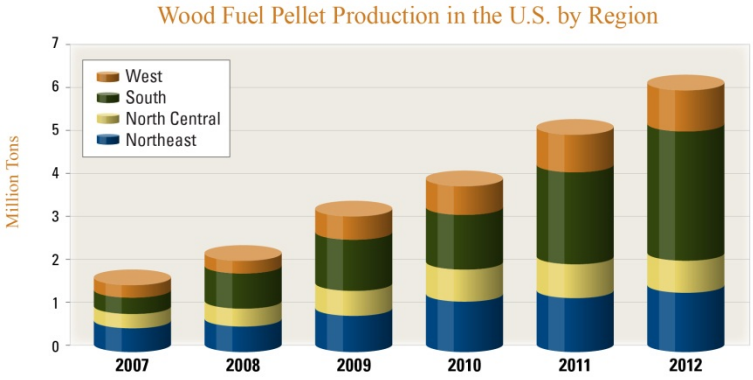

Figure 4. Production of wood fuel pellets in the United States by region from 2007 to 2012. *Source: RISI*

The growth of the wood bioenergy sector in North America has been dramatic in recent years. Total wood consumption by the sector doubled from about 10 million to more than 20 million dry tons between 2007 and 2012 (Figure 3). Because wood has a 50-percent moisture content at harvest, that amount is doubled to determine total timber demand. On this basis, North American bioenergy investments saw timber consumption rise by about 20 million green tons in half a decade. To put that expansion into context, pulpwood use by the entire U.S. pulp and paper sector totaled close to 200 million tons in 2012. In other words, during the last five years, wood bioenergy investments increased wood demand at a rate that was equivalent to one-tenth of the U.S. pulp and paper industry's use of pulpwood.

Much of this growth in wood bioenergy is being driven by demand for wood pellets – primarily for export to EU markets (Figure 4). Total pellet production has more than tripled since 2007 from 1.7 million tons to an estimated 6.1 million tons in 2012. Much of this export-driven production has occurred in the U.S. South – and the region also is seeing significant domestic increases in wood biomass demand as utilities and private operators are increasingly developing significant wood-to-electricity generation facilities from Virginia to Texas (Figure 5).

In contrast to pellet and bio-power investments, wood-based biofuels have made little progress. As we referenced earlier, several demonstration and pilot plants have been built, but the first commercial-scale wood-based biofuel plant in Soperton, Georgia, which was developed by Range Fuels, failed and was shuttered in January 2011. More recently, a new commercial-scale, wood-based biofuel production facility was launched by KiOR in Columbus, Mississippi. The new plant was scheduled to begin production during the fourth quarter of 2012. It is slated to make cellulosic bio-crude as a feedstock for refining gasoline and diesel fuel. If proven commercially viable, it may mark a turning point for cellulosic biofuel investment and expansion. Failure of the KiOR plant, however, could result in the continued marginalization of the transportation fuel segment of the wood bioenergy sector.

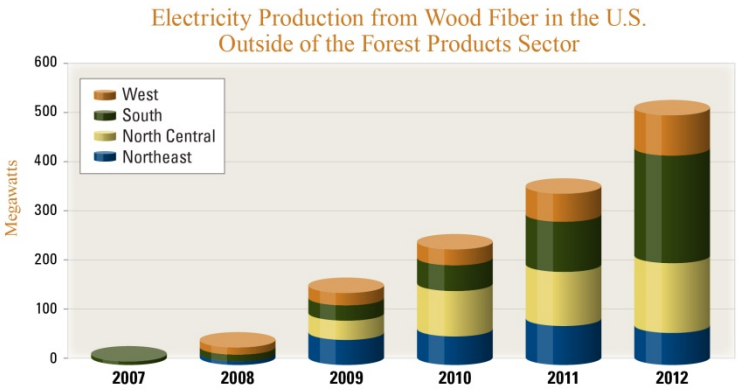

Figure 5. Production of electricity from wood by utilities in the United States. This excludes the use of wood residuals by the paper and wood-products industries for internal energy use. *Source: RISI*

Figure 6. Average delivered F.O.B. prices in U.S. dollars per oven-dried metric ton across select major timber markets in the third quarter of 2012. *Source: Wood Resource Quarterly, 2012 Q3.*

Bioenergy Development Focused on U.S. South

As is evidenced by the charts displayed in Figures 4 and 5, much of the new wood bioenergy capacity that is being developed in the United States is being placed in the U.S. South. Half of the nation's wood-pellet production and 42 percent of its wood-based electricity production in 2012 was sighted in the region. There are three reasons the South is attracting most of the bioenergy investment capital being deployed in the U.S. The region has substantial timber resources, offers competitive cost advantages and has high quality infrastructure and transportation resources.

In terms of resource availability, the U.S. South has the largest private, commercial forest resource base in the world. Although Russia and Canada have larger forested landscapes, their forests are predominantly publicly owned and much of each country's forestland is encumbered by long-term timber-cutting agreements with private industry. Competitive wood-fiber pricing is the second advantage the U.S. South offers. The cost of sourcing wood fiber from the region is relatively low when compared to other global markets (Figure 6). The third and final reason the U.S. South is attractive for the wood bioenergy sector is that the region has considerable logistical and transportation infrastructure advantages. For example, the cost of shipping wood pellets to the EU is about US$36 per ton from the U.S. South as compared to US$44 per ton from Brazil and US$67 per ton from British Columbia, Canada.[3]

Future Outlook

Looking ahead, TIR expects continued expansion of the wood bioenergy sector over the next several years, with much of this growth being driven by demand for wood pellets that will be used for electricity generation. Wood fuel pellet production, which, as was explained earlier, is driven primarily by demand from sizable export markets, is expected to reach an annual rate of 10 million tons by 2017 – an increase of 64 percent from 2012 levels (Table 1). Woody biomass electricity generation is projected to more than double over that same five-year period to more than one thousand megawatts (MW) per year. Between the three regions in the United States

[3] Jeff Wright, "Developing Dedicated Forest Bio-Energy Plantations". Who Will Own the Forest? Conference, Portland, Oregon, USA, 20 September 2012.

(South, North and West), wood-to-electricity investments are well distributed, but the U.S. South still holds the leading share at 38 percent. In the case of wood pellets, the South is the source of most new production capacity and the region's market share is projected to rise to about 60 percent.

Table 1. Production of wood fuel pellets in the United States for 2012 and forecasted for 2017. *Sources: Forest Economic Advisors & RISI*

Wood Pellet Production

United States Region	2012 Production *(million tons)*	2017 Forecast *(million tons)*	5-Year Increase	2017 Regional Share
North	2.14	2.48	16%	25%
South	3.01	6.07	102%	60%
West	0.97	1.49	53%	15%
Total	**6.12**	**10.04**	**64%**	

Table 2. Production of wood-based electricity among utilities in the United States for 2012 and forecasted for 2017. Excludes production by mills for on-site energy use. *Sources: Forest Economic Advisors & RISI*

Electricity Production from Woody Biomass

United States Region	2012 Production *(megawatts)*	2017 Forecast *(megawatts)*	5-Year Increase	2017 Regional Share
North	210	386	84%	35%
South	217	418	93%	38%
West	94	309	229%	28%
Total	**521**	**1,113**	**114%**	

These investments in wood pellets and biomass electricity production will result in increasing demand for wood biomass of all types. Forisk Consulting estimates that the new generating capacity that is expected to come on-line over the next several years will likely require more than 33 million tons of wood fiber (Table 3).

Although some of these emerging woody biomass requirements can be met by logging residuals that are of marginal value to forest owners, most of this demand will be met by the production, harvesting and processing of pulpwood. There are two reasons for this. First, a large percentage of the new investments being made in the bioenergy sector are in pellet mills, which have strict wood-quality specifications (They typically require the use of clean logs or mill residuals). Harvest residuals, trees that have undergone whole chipping, and urban/suburban waste are unacceptable feedstocks for pellet production. Second, the availability of clean forest or harvest residuals is relatively limited. Dale Green, a forestry researcher at the University of Georgia, has performed studies that show that only one ton of usable biomass residuals are produced from every 6 to 15 tons of harvested pulpwood logs.[4]

Table 3. Projected additional demand for pulpwood within the next five years based on new bioenergy projects considered viable by Forisk Consulting. *Sources: Forisk Consulting and RISI*

Electricity Production from Woody Biomass

U.S. Region	New Bioenergy Demand *(million tons)*		Portion Requiring Pulpwood or Clean Chips		Additional Demand for Pulpwood *(million tons)*	2012 Total Pulpwood Demand *(million tons)*	Increase in Demand Above 2012 Levels
North	9.6	X	77%	=	7.4	49.2	15%
South	19.7	X	91%	=	17.9	185.8	10%
West	4.3	X	61%	=	2.6	10.7	25%
Total	**33.6**	X	**83%**	=	**27.9**	**245.7**	**11%**

As is shown in the table above, 83 percent of the 33.6 million tons of wood biomass required for bioenergy production will be derived from pulpwood or clean chips. However, all of the wood chips and residuals produced as byproducts of sawmills and plywood mills already have existing economic uses. Any additional purchases of wood chips by new bioenergy plants will therefore displace current users of the product. Consequently, non-bioenergy chip users will be forced to meet their

[4] Dale Green. "Wood bioenergy & timberland investing." NCREIF Timberland Committee, Orlando, Florida. 8 November 2012

fiber needs by purchasing pulpwood on the open market. The net effect will be a one-to-one demand displacement of chips for pulpwood. In the U.S. South, which is home to the nation's leading pulpwood market, bioenergy investments over the next five years could increase total pulpwood demand by as much as 10 percent as compared to 2012 levels (Table 3). Across all U.S. pulpwood markets, the aggregate increase could be as much as 11 percent.

Impact of Wood Bioenergy on U.S. Timber Markets

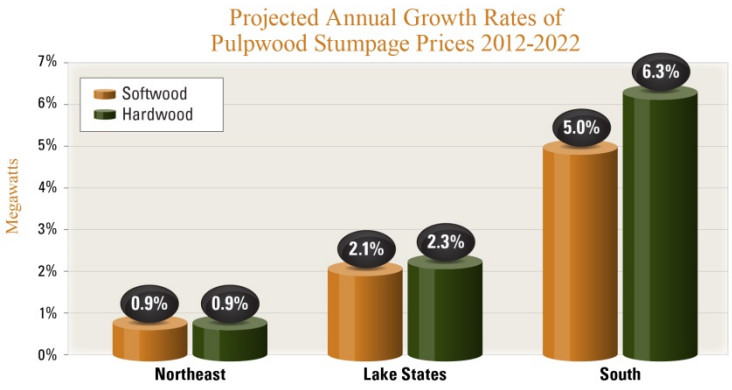

Figure 7. Compound annual growth rate of standing pulpwood prices between 2012 and 2022 as forecasted by RISI. Note: The Pacific Northwest is absent because it is predominately a sawtimber market and lacks a meaningful pulpwood market. *Sources: RISI North American Timber Forecast, Nov. 2012.*

The rising need for wood fiber for bioenergy applications can benefit forest owners in a variety of ways. In some cases, bioenergy plants can create local markets for logging residuals where none previously existed. Unfortunately for forestland owners, the values generated by the sale of such residuals are relatively slight and inconsequential – normally well below $5 per ton. On a positive note, however, local bioenergy facilities may indirectly help drive up sawlog prices because of the increased demand they produce for sawmill residuals. The greatest impact bioenergy markets will have on timberland owners, however, will be in the manner in which they influence pulpwood prices.

From this perspective, timberland investors with holdings in the U.S. South are expected to derive the greatest benefits from bioenergy-driven wood demand. The timber research service, RISI, forecasts average annual price increases of 5.0 percent and 6.3 percent for softwood and hardwood pulpwood respectively in the U.S. South in the coming decade (Figure 7). Other pulpwood-producing regions, specifically the Lake States and the Northeast, also are expected to experience more limited gains of 1 and 2 percent respectively.

There are many factors are at play with regard to these projected pulpwood price increases, but it is reasonable to assume that wood bioenergy will play a significant role. The pulp and paper industry is the leading consumer of pulpwood in the United States, but the sector is expected to gradually lose capacity over the coming decade due to the substitution of electronic media for printing and writing papers. Increased competition from Asian and Latin American producers also is expected to be a factor. According to a recent analysis by Forest Economic Advisors, pulpwood usage by the U.S. pulp and paper industry is expected to fall at an average annual rate of around 1.5 percent per year

for the next decade. New investments in bioenergy plants could help counter these losses and, in several cases, push total demand higher.

The South shows a larger increase in price appreciation than other regions because its internal market for pulpwood is considerably more competitive. Outside of paper, the South has a large base of sizable packaging, containerboard and oriented strand board (OSB) mills. Packaging and containerboard demand is expected to hold steady because there are few substitutes for the products and limited competition from imports. In addition, a wave of new OSB mills is expected to come on-line in the region within the next few years. This will help boost OSB production in the South as the U.S. housing market recovers. Tightening supply will be another factor that helps push regional pulpwood prices higher. It will be caused by the relatively low rates of planting that have occurred in much of the South since the 1990s. Under such conditions, the 10 percent increase in incremental demand (see Table 3) from newly fired wood bioenergy facilities could have an outsized impact on prices.

Unlocking Bioenergy Opportunities for the Timberland Investor

There are two levels at which a timberland investor can take advantage of the emerging wood bioenergy sector. One is at the property level, where bioenergy opportunities can influence how an investor acquires and manages a property. On a more strategic level, however, investors also should be analyzing the influence the sector is likely to have on investment performance from an over-arching portfolio standpoint.

Incorporating Wood Bioenergy Considerations into Property-Level Investment Decisions

When building out a portfolio of timberland investments, the investment performance of each individual timberland holding is strongly affected by its surrounding wood market, which is commonly defined as the base of mills and conversion facilities within a 75-to-100-mile radius. With this in mind, it is helpful to consider the following:

- **Favor Markets with Positive Wood Drain to Growth Ratios:** There is a strong correlation between supply and demand ratios and timber prices. This means it is important to compare the wood consumption needs of the surrounding mills

(including the bioenergy plants that exist or are planned) with the region's capacity to sustainably produce wood. If the wood drain to wood growth ratio is expected to increase above equilibrium (i.e., ratio above 1.0) the region's forest inventory will likely decline and this will help support timber prices. If the local mill capacity is below the timber productivity of the area (i.e., ratio below 1.0), then the regional wood inventory is likely to rise and prices could come under long-term pressure. In short, when analyzing the market dynamics of a given timberland investment opportunity, it is important to be cautious about making acquisitions in oversupplied markets.

- **Understand the Complementary or Competitive Nature of Wood Bioenergy Facilities**: The manner and degree to which timber prices shift is often influenced by the type of bioenergy projects that are being built in an area. Some bioenergy plants directly compete with neighboring mills for the same wood fiber resource, while others are more complementary. For example, wood-pellet plants directly compete with pulp mills and panel mills for sawmill residuals and pulpwood logs. In contrast, a wood-burning power plant may focus on using low-value harvest residuals and urban/suburban waste – wood usage that will complement rather than increase competition within that log or wood market. Moreover, a biomass power plant's net impact on an area's pulpwood prices may be modest compared to the influence a pellet mill would have in the same region. This means timberland investors should take these differences into consideration when modeling anticipated income flows from a prospective forest acquisition.

- **Adjust Discount Rates for Risks of New and Proposed Bioenergy Developments:** When evaluating a potential investment, it is wise to apply an appropriate risk premium to the discount rate when modeling the impact future bioenergy demand is expected to have on regional fiber demand and pricing. This is especially important when evaluating the impact of new bioenergy capacity that is planned but not yet operational. Some bioenergy projects, such as those involving the production of biofuels, may be unproven commercially. Other bioenergy projects may be

highly dependent upon government subsidies or regulatory support. Still others may be highly sensitive to energy price and fiber-cost fluctuations.

- **Adjust Forest Management Strategies to Better Suit Local Wood Market Needs:** If a timberland holding is located near significant wood bioenergy facilities, there can be benefits to shifting one's forest-management strategies to better fit the fiber needs of that market. This could mean growing more pulpwood and less sawtimber than originally anticipated. One also may choose to re-think what tree species to plant, what genetic tree variants to employ and when to harvest. In some cases, this planning may cause an investor and its forest investment manager to employ new harvesting and processing techniques, like whole-tree chipping or the active recovery of logging residuals.

Incorporating Wood Bioenergy Considerations into a Timberland Portfolio Strategy

Strategically, there are some other portfolio-level considerations a timberland investor may want to weigh when evaluating the impact of wood bioenergy demand on investment performance.

- **Employing Long-Term Wood-Supply Contracts Might Lower Portfolio Volatility:** Many utilities with bioenergy mandates seek stability with regard to their capacity to access renewable fuel sources and therefore some choose to offer pricing premiums to landowners to ensure the predictability of their fuel supplies. From an investor's standpoint, such arrangements can be beneficial by locking in guaranteed demand for one's wood. Consequently, establishing a cooperative joint venture or a long-term wood supply contract with one or more bioenergy producers may help reduce the volatility of one's portfolio. The caveat is that bioenergy producers typically prefer to negotiate supply contracts with timberland owners that have land bases of sufficient scale to substantially meet their operational needs. Another consideration is that fiber-supply contracts restrict a forest owner's flexibility to take advantage of positive swings in a wood market's demand and pricing dynamics. This can cap a timberland property's income-generating potential in a competitive timber market.

- **Diversifying the Portfolio to Balance Exposure to Bioenergy Demand:** Because it is still an emerging industry, the wood bioenergy sector is very fluid from a supply and demand standpoint. As a result, it is wise for timberland investors to avoid having too much exposure within a single wood market. This is true regardless of whether that market is dominated by demand for paper, packaging, lumber, panels or wood bioenergy. It is always advisable to maintain an appropriate risk and return balance by diversifying one's portfolio by geographic location, tree species, timber age class and end-use product markets.