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A TIMBERLAND INVESTOR'S PRIMER TO BIOENERGY OPPORTUNITIES

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Introduction

When we think of commercial timberland, the first image that comes to mind are thousands and thousands of acres of forests being grown and harvested to produce wood products like paper, cardboard boxes, building materials and furniture. Normally, we do not think of timberland as an energy source to light our homes, power our factories, or fuel our cars. Yet, forests are gradually assuming this new and emerging role – a role that, in some respects, is not much different than a coal mine or an oil well: *forests are an economic asset for generating energy products.*

For the last few years, there has been significant growth in markets for wood-based bioenergy. With new markets come new opportunities for the timberland investor. This paper will serve as a guide and introduction to bioenergy as it relates to timberland investments. We begin by describing the role timber can play in alternative energy markets. That will be followed by an explanation of how an investor can leverage these newly emerging bioenergy markets into improved investment returns. The focus of the paper will be the United States, but much of what is discussed has general applicability to timberland investments worldwide. The closer a nation's energy policy and energy infrastructure conforms to that of the United States, the more relevant the paper will be to timberland investments in that region as well.

First, we should define what is meant by bioenergy.

> **Bioenergy** is a concatenation of the full name, *biomass energy*. At its most fundamental level, bioenergy is the utilization of renewable organic material to generate energy for human use. The defining attribute of bioenergy is its renewable nature. Fossil fuels such as coal, crude oil and natural gas are organic, but they are not renewable. Renewable, organic energy sources include not only trees, but agricultural crops, agricultural residues, processed animal fat and livestock manure.

The Role of Timberland in the Emerging Market for Bioenergy

A harvesting operation for small diameter pine timber (also known as pulpwood) in the U.S. South. This type of timber can serve as a key source for wood bioenergy.

Biomass energy is expected to play a growing role in meeting the world's energy needs. The United Nations Food and Agriculture Organization (FAO) projects that annual demand for bioenergy will rise 40 percent globally by 2020 from the base year of 2005.[1] There are two key reasons for this projected growth. First, bioenergy is largely carbon neutral. All of the carbon contained in a biomass energy product – be it plant or animal matter – was originally drawn from the atmosphere. This means the amount of carbon dioxide (CO_2) greenhouse gas released by generating or converting biomass energy to produce energy is roughly equal to the CO_2 that was captured in its creation. Consequently, any social or governmental mandate to reduce society's carbon footprint will naturally favor the use of biomass feedstocks as an energy source.

A second key attraction of bioenergy is its versatility as an energy source. Once collected, biomass can be used for heating homes and offices, it can be converted into electricity for the power grid, or it can be made into liquid fuel for transportation.

Turning Trees into Biomass for Energy

Biomass from standing trees comes from four different sources. If the tree is a commercial species, it can be harvested for its logs when it meets a certain minimum size. Everything else is considered *logging residuals* or *logging waste.* However, these "waste" products are often an excellent source of biomass energy.

Of course the logs themselves can be used for energy production, but bioenergy producers must compete on price for such high quality wood against paper and building products manufacturers. A third source is trees that are too small, diseased or too malformed to be used in paper or lumber production. The fourth and final source is residuals from wood product mills. This typically includes bark, chips, sawdust and shavings. Table 1 below summarizes the different parts of a harvested tree that can be used for bioenergy production.

In short, demand for wood-based biomass energy is creating new markets for tree products, like logging waste. The bioenegy industry also can support markets for traditional log products by (a) competing directly with paper and panel mills for pulpwood logs, and (b) by

buying sawdust and shavings from sawlogs processed at sawmills.

Table 1. Product categories of timber and their applicability to serve as biomass energy.

Common Industry Label	Tree Size/Source	Product from Tree	Economically Viable as Biomass Energy	Competing Industrial Product
"Pre-merchantable" Timber	< 6 Inches in Diameter	Whole Tree	Yes	None
Pulpwood/Pulplog	6 to 8 Inches in Diameter	Logging Residuals (tops and branches)	Yes	None
		Log	Yes	Pulp (for Paper); Panels; Boards
Sawlog/Sawtimber	Greater than 8 Inches in Diameter	Logging Residuals	Yes	None
		Smaller, Secondary Log	Yes	Pulp (for Paper); Panels; Boards
		Primary Log	No	Lumber; Plywood; Poles
Mill Residuals	Leftover Material After Logs are Processed into Product in a Mill	Sawdust, Shavings, Bark	Yes	Mill Boiler, Pulp (for Paper); Panels; Boards

Shavings and sawdust from sawmill operations can serve as excellent source of biomass energy.

Using trees for bioenergy is not without complications. Not all forest biomass is created equal. There are a variety of bioenergy technologies in use and each has different requirements for the quality and type of raw material it can employ. Some tree species are preferable to others. Wood fuel pellet manufacturers, for example, favor pine species. There also are standards for moisture content, energy density, bark content, size and contaminant ratios.

Bioenergy Uses of Wood

Biomass from trees can be used effectively in four different types of bioenergy applications. In order of market share and importance, these are: (1) direct combustion; (2) wood fuel pellets; (3) wood-based biofuels; and (4) gasification and pyrolysis.

Direct Combustion

Most power plants that take woody biomass use direct-fired systems. They burn wood to produce steam, which

drives a turbine to generate electricity. In some cases, the spent steam from the power plant is then used in industrial processes or to heat buildings.

Wood fuel pellets

Direct-fired bioenergy plants either can rely solely on wood or be co-fired with a fossil fuel, usually coal. Aside from reducing a power plant's carbon footprint, a key advantage of co-firing wood with coal is that it significantly reduces sulfur dioxide emissions. From an economic standpoint, the minimum threshold for dedicated biomass electric generation facilities is 10 megawatts (MW).

Wood Fuel Pellets

Wood pellets are another established renewable energy product produced from trees. They are formed from powdered wood that is compacted into small pencil-thick cylinders. Wood pellets are made from sawdust, which is a byproduct of lumber production. Clean chips made from the logs of softwood trees, such as pine, also can be used to produce them. Wood pellet manufacturers, however, do not use logging residues because bark and contaminants create undesirable smoke and ash when the pellets are burned.

Wood pellets are used primarily to heat homes and buildings. An estimated 800,000 homes in the U.S. use wood pellets for heat. Most of this usage occurs in the Northeast where cold weather conditions make pellets a popular and relatively inexpensive fuel source. Wood pellets also may be co-fired for electricity generation in modern pulverized coal power plants. Europe is the primary driver of this market. Today, more than 80 pellet mills are operational in North America. Together, they produce more than 1.1 million tons of wood pellet fuel per year, much of which is exported to European utilities, which are focused on meeting aggressive renewable energy targets.

Wood Based Biofuels

Wood pellets and direct-fired electricity are well established and economically viable sources of energy. Refined woody biofuels, like ethanol and biodiesel, on the other hand are still striving to achieve commercial viability. While the technology to convert trees into ethanol and biodiesel exists, the processes required to mass produce such fuels on a cost effective basis are still being perfected. However, higher oil prices and ongoing advancements in biorefinery technologies are

likely to provide the nascent industry with much needed momentum

Looking ahead, the outlook for wood-based biofuels is favorable because agricultural crop-based ethanol production alone cannot meet the future expected demand in the U.S. for renewable fuels. A study by Hill et al. in 2006 calculated that even if the U.S. used all of its corn and soybean cropland for the production of ethanol, it only would meet 12 percent of U.S. gasoline consumption and just six percent of its diesel consumption.[4] If the U.S. wishes to significantly raise the amount of transportation fuel derived from renewable sources, it must seek alternatives to crop-based fuels, and wood-based cellulosic ethanol is the primary option available.

New research may lower future costs, but given the current technology, it is estimated that wood-based cellulosic biofuels become cost competitive with crude oil at about $90 per barrel, and possibly as low as $70 per barrel.[5] With respect to gasoline, wood-based ethanol becomes economical to produce when gasoline prices rise above $2.25 per gallon (before taxes) or approximately $2.65 per gallon at the pump with taxes.[6] This is before any government subsidies or credits are taken into account.

Sidebar 1

Rules of Thumb for Wood to Energy Conversion

Ever wondered how much wood is needed to create a measure of energy? Here are some simple rules for back-of-the-envelope conversions:

- One dry ton of forest residue can produce around 80 gallons of cellulosic ethanol.[2]
- It takes roughly 10,000 green tons or more wood per year to generate one megawatt (MW) at a biomass power plant.[3] (Note: one megawatt can supply electricity to about 240 to 300 households for one year.)
- One ton of forest residue has about 9.25 million British thermal units (BTUs) of energy.[2]
- Four cubic meters of wood is equivalent in energy to 1 metric ton of oil (or 7.2 barrels). (Note: 1 barrel of oil can make 19.5 gallons of gasoline.)

Gasification and Pyrolysis

Heating wood under high temperatures in a low oxygen environment prevents combustion. Under such conditions, biomass converts to a gaseous blend of hydrogen (H_2) and carbon monoxide (CO) known as *synthesis gas* (or *syngas*). Syngas then can be burned in a conventional boiler to generate steam, which, in turn, can be used to heat buildings or to produce electricity. Alternatively, syngas can be burned like natural gas in a turbine to directly generate electricity. Pryolysis is very similar to gasification. When wood is heated at a high temperature and all oxygen is completely removed a thermo-chemical process creates

a liquid rather than a gas. Pyrolysis oil, like syngas, can be burned to generate electricity, or be used as feedstock to make industrial chemicals that then can be used to manufacture plastics and adhesives.

At this point, investments in gasification and pyrolysis markets have lagged behind the more popular wood bioenergy alternatives of direct combustion, wood fuel pellets and cellulosic ethanol. Although large-scale commercial production of energy and chemicals from gasification and pyrolysis has not yet been achieved, experts believe the technologies hold significant potential.

Public policy has been the leading driver of renewable energy demand.

Policy Drivers for Using Wood for Energy

All four major types of wood bioenergy: direct combustion, wood pellets, biofuel, and syngas/pyrolosysis – have been aided to some extent by the recent increases in fossil fuel prices. Nonetheless, public policy has been the leading driver of renewable energy demand. Governments have been promoting bioenergy markets in the United States in four primary ways: (1) by establishing Renewable Portfolio Standards (RPS) at the state level; (2) by creating federal incentives and tax credits; (3) by establishing a national Renewable Fuels Standard (RFS); and, (4) by setting renewable energy targets, as the European Union has done.

Renewable Portfolio Standard

At present, 29 states have adopted a *Renewable Portfolio Standard* (RPS) and an additional five states have RPS goals.[7] A Renewable Portfolio Standard requires electricity sellers to obtain a certain amount of electricity from renewable sources. As would be expected, each state has different targets for renewable energy and different definitions for what qualifies as "renewable" energy. Some states' targets are quite aggressive. California, for instance, aims to obtain 33 percent of its electricity production from renewable sources by 2020. Despite the variations of RPS standards, virtually every state qualifies biomass as a renewable energy source. In fact, some states, particularly those with limited capacities to produce electricity from solar, hydro and wind generating technologies, are placing their primary emphasis on biomass as a source of renewable energy.

Logging residues such as branches and stumps historically had little economic value but are increasingly serving as feedstock for bioenergy production.

To help promote the private sector development of renewable energy projects, a number of states employ Renewable Energy Certificate (REC) programs in conjunction with their Renewable Portfolio Standards. A REC represents one megawatt hour (MWh) of electricity produced from a renewable source. Renewable energy producers can earn RECs by making electricity from wood or some other renewable resource. RECs can be sold to utility companies so they can meet their RPS requirements. Wood bioenergy projects that otherwise could not compete with coal or natural gas can be made profitable if sales of RECs are included.

Federal Incentives and Credits

At the time of this writing, there is no U.S. federal equivalent of the states' Renewable Portfolio Standard. This may change as new energy legislation winds through Congress (see Sidebar 2). Until (and if) that happens, the main federal policy instrument that is available for promoting renewable energy production is tax credits and incentives.[8] See the appendix for a list of existing federal incentives for alternative energy sources. Among other things, they include a cellulosic biofuel credit of $1.01/gal and a combined heat and power (CHP) credit of 10 percent on the first 15 megawatts. Unfortunately, the fluidity of U.S. environmental and energy policy, and the limited lifespan of these various incentives and tax credits create uncertainty for biomass energy producers.

Federal Renewable Fuels Standard

The United States has adopted a national Renewable Fuels Standard through the Energy Independence and Security Act of 2007. The federal mandate seeks to quadruple the production of ethanol and other transportation fuels from present levels to 36 billion gallons per year by 2022. Of this amount, 16 billion gallons are to be produced from cellulosic biofuels. Unfortunately, the definition of timberland qualifying as "renewable biomass" for the RFS excludes all but eight percent of private forestland.[9] There is an effort underway in Congress to craft new energy legislation that will employ a broader and less restrictive definition of renewable biomass for the RFS and under that standard most private timberland would qualify.

European Union Renewable Energy Mandates

As was previously referenced, the European Union has adopted rules requiring its member countries to generate

20 percent of their electricity from renewable sources by 2020. This mandate has produced a surge in wood fuel pellet exports from North America, Australia and Brazil as European utilities ramp up to meet their renewable energy targets. In the first half of 2009, North American shipments of wood pellets to Europe doubled over the first half of 2008 to 680,000 tons.[10] According to RISI, Canadian shipments rose 22 percent, but U.S. exports increased ten-fold. Total shipments for the whole of 2009 are forecasted to reach 1.5 million tons.

It is not just wood pellet markets that benefit from Europe's increasing focus on renewable energy. All types of wood biomass from North America are impacted. A case in point is the 19 new biomass energy projects slated for development over the next five years across the United Kingdom.[11] These projects are expected to require 30 million tons of wood fuel a year. However, the UK's domestic harvest only reaches 10 million tons annually. Experts believe much of the wood deficit for the UK's new bioenergy plants must be met with woody biomass shipments from the U.S. South. Sourcing biomass from South America is a less viable option for these facilities because most of the plantation wood grown on the continent is already dedicated to domestic Latin American wood product companies. Furthermore, with the exception of Brazil, most South American nations lack the infrastructure, specifically adequate deep sea ports, to transport large amounts of wood to Europe or elsewhere.

Electric utilities in the Southeast and the Midwest already have begun to build or reconfigure power plants to use biomass based on the expectation that the government will impose renewable energy generation targets.

Outlook for Public Policy to Drive Growth in Bioenergy

It is difficult to predict how new laws and regulations will affect the biomass energy market. Yet, the general trend is clear: the momentum in public policy is to increase renewable energy use over fossil fuels. Many expect to see a national renewable energy standard for the U.S. in the not too distant future. If a federal renewable energy policy framework is adopted, the use of wood-based energy sources could dramatically increase. In fact, electric utilities in the Southeast and the Midwest already have begun to build or reconfigure power plants to use biomass based on the expectation that the government will impose renewable energy generation targets.

Sidebar 2

Bioenergy Regarding Current Legislation in Congress

At the time this report was written, a bill that set targets for U.S. renewable energy use already had been approved by the U.S. House of Representatives. That bill passed on June 26, 2009 and is now being considered by the U.S. Senate. The American Clean Energy and Security Act (now designated as HR 2998) also is known as the Waxman-Markey climate bill. It would mandate that 15 percent of the electricity generated in the United States must come from renewable sources by the year 2020.

From the standpoint of forestland owners, one of the more notable aspects of the Waxman-Markey bill is that the legislation adopts the broader 2008 Farm Bill definition of "renewable biomass" rather than the more restrictive definition found in the 2007 Energy Independence and Security Act. This means that if the bill passes in the U.S. Senate, timber from most privately-owned forestland would qualify as a renewable energy source under federal Renewable Electricity Standards (RES), Renewable Fuels Standard (RFS). In addition, the legislation is likely to make it easier for landowners to sell carbon offset credits from their sustainably-managed forests.

Monetizing the Bioenergy Opportunity for Timberland

For timberland investors, the growth of bioenergy markets will be increasingly relevant for two reasons:

1. **Increased prices for existing commercial log products.** Markets for small diameter pulpwood logs will be supported as pulp, paper and panel mills compete with bioenergy facilities for the same wood resource. In addition, markets for large diameter sawtimber logs will be supported because sawmills will have more opportunities to increase income by selling wood residuals (sawdust, bark and chips) to bioenergy facilities.
2. **Emerging markets for previously unmerchantable wood products.** Logging residuals and small trees that are too small to be accepted by wood products mills will be increasingly in demand by bioenergy facilities.

Capturing the benefits of this dual market will require that timberland investors employ both a portfolio-level and property-level strategy.

Portfolio Timberland Strategies to Bioenergy

When acquiring timberland within an investment portfolio, it is important to recognize that future demand

Wood chips can be burned directly for heating and electricity, converted into biofuel, or pulverized into powder to make wood fuel pellets.

dynamics across regional timber markets are not the same. Investors should seek opportunities in areas where strong investments have been made in wood product mills and wood bioenergy facilities. Another important consideration is market infrastructure. Biomass, particularly forest residuals, has a low value to mass ratio. Transportation and processing costs therefore are often the deciding factors when it comes to determining the economic viability of biomass derived from a timberland investment. Proximity to the bioenergy facility, the accessibility of roads and transportation networks, and the capacity of local logging crews to effectively process and handle woody biomass are important considerations that must be analyzed before one invests in a region with the objective of capitalizing on emerging bioenergy markets.

It certain cases, it may be advantageous to consider long-term fiber supply agreements with bioenergy operators (sometimes known as *forward contracts*). Major biomass energy facilities require a great deal of wood fiber – with some consuming as much wood as a large scale sawmill or paper mill. Consequently, a bioenergy facility may be willing to consider a contractual agreement with a major neighboring timberland owner to purchase a minimum amount of wood per year. The timberland investor benefits from the establishment of a guaranteed market for its wood, which lowers market exposure and risk and allows for better planning.

Property Level Timberland Strategies to Bioenergy

Once a timberland investment has been made, capitalizing on opportunities in the bioenergy sector depends on an investor's ability to develop and execute a property-level strategy. Timberland properties should be managed to produce timber products that best match the needs of regional wood buyers – whether they are pulp, paper, or panel mills or bioenergy facilities.

As was mentioned previously, bioenergy facilities often have specific requirements with regard to the types of fuels they will accept. Pellet plants, for example, prefer softwood pulpwood logs. As a result, investors wishing to service a local pellet market may emphasize producing southern yellow pine products on short rotations of 16 years. In contrast, a co-generation power plant that burns wood with coal is likely to view pulpwood that sells for $8 a ton as too expensive a fuel source, preferring instead to purchase logging residuals at a price of $3 ton. An investor wishing to sell wood

products to that cogeneration facility may employ a different forest management regime – choosing to focus on the cultivation of large-diameter sawtimber rather than pulpwood. A sawtimber rotation tends to be considerably longer (22 to 27 years) than a pulpwood rotation. However, stands that are being grown for sawtimber undergo periodic thinnings to reduce competition and to promote more robust growth among the strongest and healthiest trees. These low quality thinnings and the substantial volumes of logging debris that are generated by the final harvest of a sawtimber stand can serve as ideal and competitively-priced sources of fuel for cogeneration facilities.

Touching on International Opportunities

The markets for bioenergy vary from one country to another, but taken on a global scale, they are growing. (See Figure 1 for growing global demand for bioenergy.) Wood biomass energy markets are global as wood chips, wood pellets and biofuels are effectively shipped by sea and rail. The most common trade pattern is for timber-rich regions supplying the biomass fuels to industrialized nations that are under mandates to increase their renewable energy use. A case in point is the imports of wood fuel pellets and wood chips from Australia, Canada, the United States, and Brazil for electricity generation in the European Union. Outside the U.S., some countries do offer domestic wood bioenergy markets. Steel companies in Brazil, for instance, often rely on eucalyptus plantations to provide charcoal, which is used as fuel to make pig iron and steel.

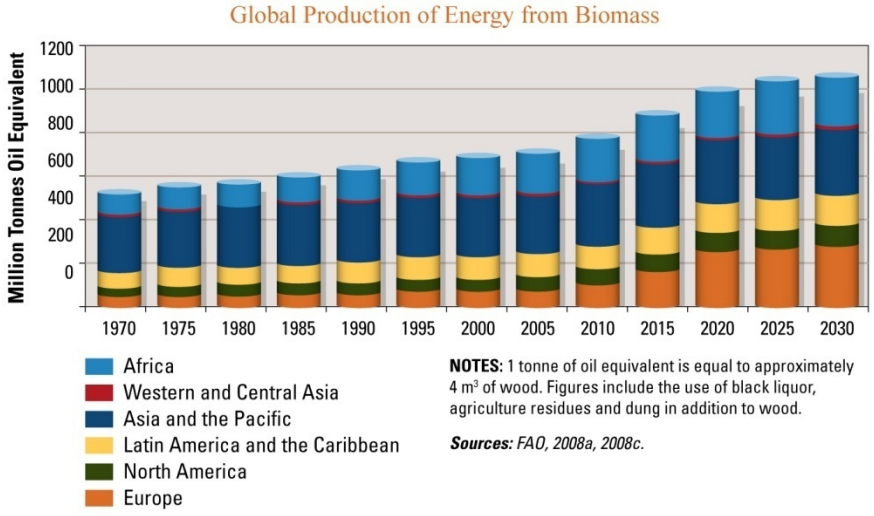

Figure 1. Historic and projected global production of energy from biomass by the United Nations Food & Agriculture Organization.

Relevance of Wood Bioenergy in a Timberland Portfolio

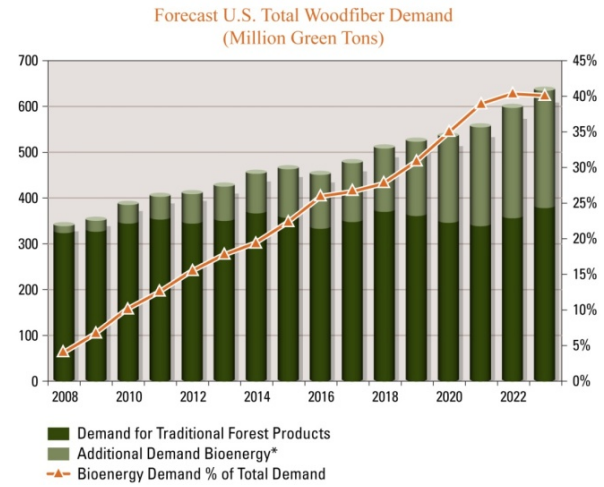

Figure 2. Forecast of total U.S. wood fiber demand from bioenergy and traditional forest products

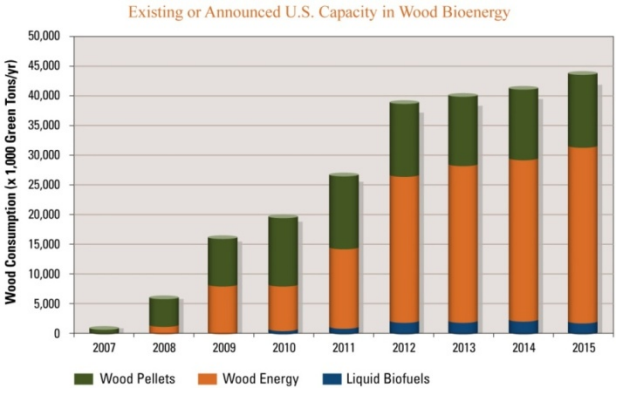

Figure 3. Existing or Announced U.S. Capacity of Wood Bioenergy by Energy Product

Of all the environmental markets that have emerged during the last few years, the wood bioenergy market is the most defined and offers the greatest value generation potential for timberland investors. The arguments are convincing: (1) much of the technology is already established and proven; (2) capital investment in wood based bioenergy facilities continues to be strong both in the United States and around the world; and (3) public policy at home and abroad continues to favor greater use of alternative energies.

By one estimate, biomass is expected to contribute 4.5 percent of all electricity used in the U.S. by 2030.[12] In turn, much of the growth in demand for wood will come from bioenergy, not from traditional forest products markets like lumber and paper. By 2023, RISI estimates that total wood demand will nearly double from its 2009 level and up to 40 percent of this increase will be attributable to wood used in the bioenergy sector (see Figure 2).

Based on the number of existing bioenergy facilities in the U.S., as well as those that have been announced or are under construction, wood pellets are the leading source of bioenergy consumption in the United States. However, wood energy (i.e., electricity generation) is expected to surpass the wood pellet sector in the coming years (see Figure 3).

Given the increasingly prominent role bioenergy is playing in timber markets, it is important for timberland investors to build portfolios with knowledge of where bioenergy facilities are operational and where and when they are being built. This knowledge can lead to improved returns by enabling investors to participate in markets where the bioenergy industry can support timber demand and pricing. It also can help investors design and adapt their forest management regimes to conform to the needs of nearby bioenergy facilities. Looking ahead, these considerations are sure to play an increasingly important role in acquisition due diligence and the development of forest management plans for specific investments.

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