Update and Context for U.S. Wood Bioenergy Markets

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Executive Summary

This paper quantifies the current baseline for forest industry wood consumption in the United States in order to provide context for wood bioenergy market developments and research. Specifically, we address the following questions:

- What is the current status of wood demand from bioenergy in the United States and how has it evolved since 2010?
- What is the current status of traditional wood demand from the forest products industry and forest supplies/growth in the U.S.?
- What are reasonable expectations for wood bioenergy growth in the U.S. relative to the forest products industry over the next ten years?

Establishing the current forest industry baseline and specifying what is "doable" and "operable" in regional U.S. bioenergy markets provides a factual basis for evaluating how wood bioenergy markets could affect forest supplies.

Key findings from this research include:

- Analysis and tracking of wood bioenergy projects by technology type and region affirm the slow, stuttered development of wood bioenergy markets in the United States. Two types of projects have led progress in wood bioenergy markets over the past three years. First, industrial combined-heat-and-power (CHP) plants and firms that build industrial CHP facilities and either use the electricity and heat/power produced for their own manufacturing plants or sell it to neighboring facilities. Second, pellet plants targeting both domestic and export markets have made progress.
- Since 2010, total potential wood use from announced and operating projects increased 3% while potential wood use from operationally "viable" projects increased approximately 10%. Based on Forisk analysis, 293 projects representing potential wood use of 75.4 million tons per year by 2023 pass basic viability screening. This estimate includes all woody feedstocks, including pulpwood, logging residues, and mill residuals.
- Consensus exists across public, private and international studies and data sources regarding the size and status of the U.S. forest products industry. Demand for "industrial" roundwood – the logs used at manufacturing facilities – is approximately 500 million tons per year during normal economic conditions.
- Wood bioenergy scenarios developed by the IPCC and applied to models of U.S. forests fail to account for the economic recession and the viable scale of actual and operable wood bioenergy projects.
- Viable wood bioenergy scenarios developed separately by U.S. Forest Service researchers and Forisk find the marginal increase in wood demand for pulpwood and logging residues from viable bioenergy projects compared to the overall forest industry in 2023 could be as much as 9% of the total wood use of the forestry sector or as little as 4%. The vast majority of wood use will still be from the traditional forest products sector. No viable scenario generates wood demand levels at the regional or national level that affect net forest growth or sustainability. While wood bioenergy projects could have no negative impact on forest supplies in the aggregate, local impacts will vary based on individual wood baskets and timber markets.

Acknowledgements: we wish to thank NCASI and researchers at the U.S. Forest Service for their willingness to share and discuss ideas and assumptions related to wood bioenergy markets and forest supply modeling associated with the RPA Assessments.

Introduction

Wood bioenergy markets in the United States continue to perplex interested parties. In particular, questions arise regarding how developing bioenergy markets will affect the use and demand for wood and, in turn, how this demand will affect wood supplies and economics in the overall forest products marketplace. Currently, private forest owners have long-established customers for the trees they grow on their lands: sawmills, pulp mills, OSB facilities and plywood plants. These customers expand and decrease their wood use over time depending on economic conditions and demand for their manufactured products.

Over the past few years, wood bioenergy projects garnered headlines, benefited from targeted legislation and financing programs, and produced dozens of failed and successful plants across the U.S. This provides data and information to evaluate the status of wood bioenergy demand relative to the established forest industry. It also frames the context for considering the implications from bioenergy projects related to wood raw material prices, forest management strategies and the long-term sustainability of U.S. forests.

This paper quantifies the current baseline for forest industry wood consumption in the U.S. in order to provide context for wood bioenergy market developments and research. When tracking wood demand and timber markets, we look not only to the past and to the future for guidance, but also to the side – peripherally – to gauge performance across wood-using markets and sectors. Specifically, we address the following questions:

- What is the current status of wood demand from bioenergy in the United States and how has it evolved over the past five years?
- What is the current status of traditional wood demand from the forest products industry and forest supplies/growth in the U.S.?
- What are reasonable expectations for wood bioenergy growth in the U.S. relative to the forest products industry over the next ten years?

Ultimately, establishing the current forest industry baseline and specifying what is “doable” and “operable” in regional U.S. bioenergy markets provides a factual basis for evaluating how wood bioenergy markets could affect forest supplies. This also allows us to evaluate recent research and scenarios applied to forward thinking analysis related to wood bioenergy markets.

Wood Bioenergy Market Development

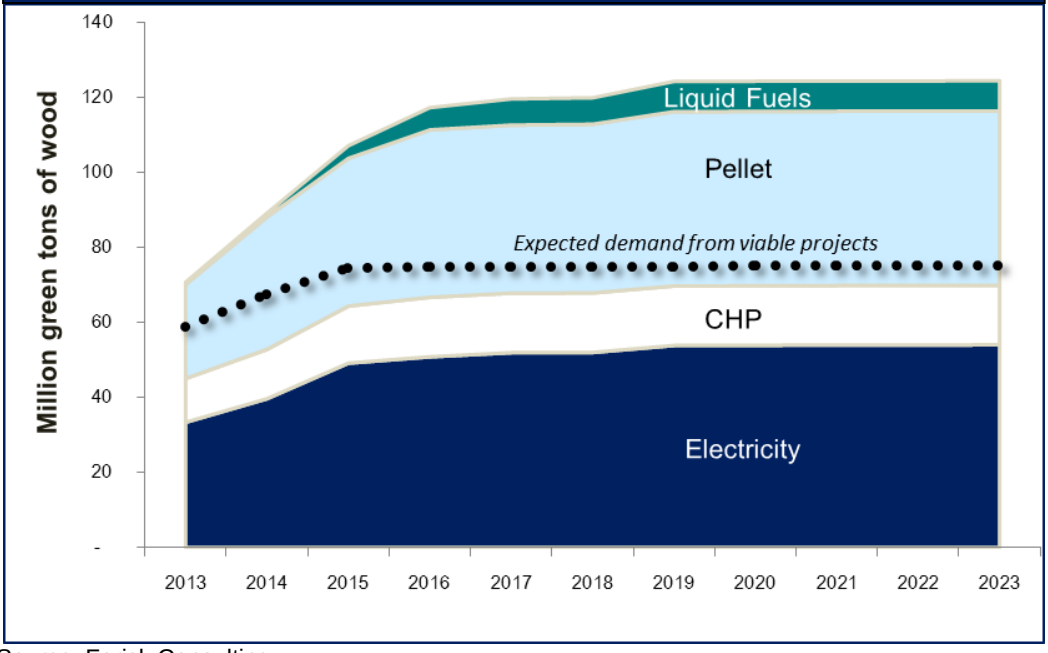
In 1972, the Club of Rome commissioned *The Limits to Growth*, a book which explored the interaction between exponential growth and limited resources. The book concluded that the world would reach its limit within 100 years of publication, resulting in a massive decline of population and industrial capability. While criticized at the time, key elements of the research – such as those associated with population growth and CO2 levels – held up, reinforcing historic relationships between resources and growing populations. However, the research understated the role played by prices and markets in allocating resources.

Lessons from this research apply when evaluating the development of wood bioenergy markets. While market forces and policy decisions struggle to coexist, the actual growth of bioenergy relative to available resources can be understood. Wood bioenergy projects must successfully navigate logistic challenges and access to wood raw materials within the context of existing forest industry markets. To a critical extent, assessing bioenergy markets is an exercise of measuring size and performance relative to the existing forest industry.

Analysis of projects "on the ground" frames our understanding of what is possible and viable for growing wood demand from bioenergy. Forisk uses a two-part screening methodology to estimate project viability by technology and by status. If the technology is viable today (such as wood pelletizing technology or wood to electricity) then the project passes the technology screen. For example, cellulosic ethanol technologies do not currently pass the technology screen. The status screen evaluates projects based on where they are in the development process. If a project has two or more necessary permits, contracts, or financing commitments, then it passes the status screen. "Likely" projects are those that pass both screens. (See Appendix A for additional details on the project screening methodology).

Since 2010, multiple wood bioenergy projects in the United States have opened, closed or advanced towards operational viability. However, the implications on potential wood use were modest. Total potential wood use from announced and operating projects increased 3% while potential wood use from operationally "viable" projects increased approximately 10%. As of April 2013, *Wood Bioenergy US* counts 456 announced and operating wood bioenergy projects in the U.S. with total, potential wood use of 125.0 million tons per year by 2023 from all feedstocks, including forest materials and mill residuals (Figure 1). Based on Forisk analysis, 293 projects representing potential wood use of 75.4 million tons per year pass basic viability screening.

Figure 1. Projected demand from wood bioenergy projects, 2013-2023



Source: Forisk Consulting
Note: largely excludes cogeneration projects at forest products facilities.

Analysis and tracking of wood bioenergy projects by technology type and region affirm the slow, stuttered development of wood bioenergy markets in the United States. These markets depend on legislative mandates or remain uncompetitive with traditional forest industry manufacturers or more economic energy sources such as natural gas. Two types of projects have led progress in wood bioenergy markets over the past three years. First, industrial combined-heat-and-power (CHP) plants and firms that build industrial CHP facilities and either use the electricity and heat/power produced for their own manufacturing plants or sell it to neighboring facilities. This

includes some government-sponsored completed CHP projects, such as Oak Ridge National Laboratory and the Savannah River Site. Second, pellet plants targeting both the smaller domestic and growing export markets have made progress. Export pellet plants are selling to European utilities to help them meet renewable energy requirements. In addition, there are select independent power producers who continue to build electricity plants.

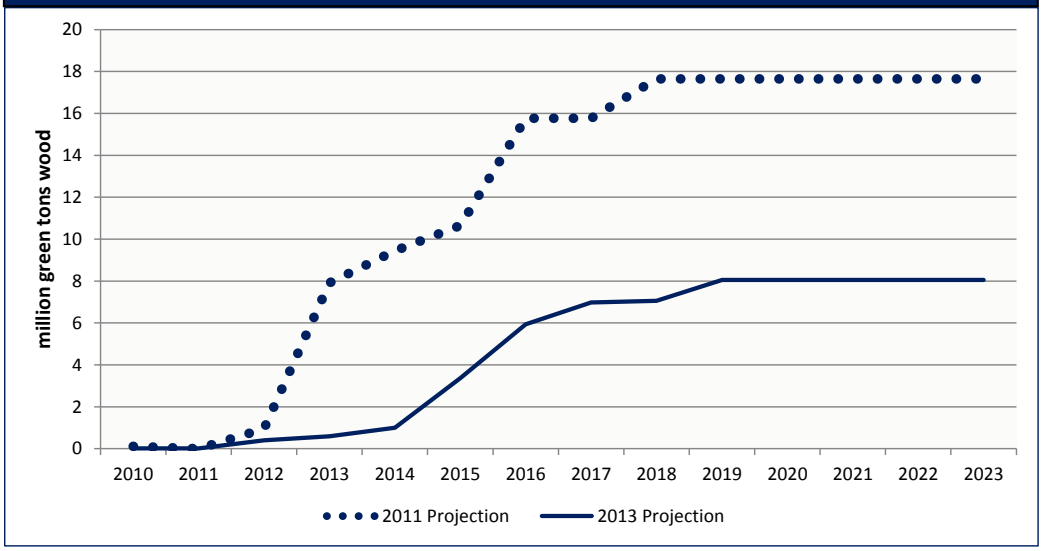
A review of the primary wood bioenergy technologies and project types reinforces these themes.

Wood-Based Liquid Fuels

Research by private and public organizations emphasizes the problematic development of the wood biofuels sector. In 2011, Forisk and the Schiamberg Group evaluated 36 publicly-known wood-using biofuels projects in the U.S. concluding that they would take eight to 11 years longer to develop than estimated by the projects themselves while singling out projects with drop-in fuels and specific technology types as having investment potential for investors. A review of the 36 projects from the 2011 study re-affirms that biofuels from wood is not a mainstream reality (Forisk 2012). As of April 2013, 13 of the original 36 projects have been cancelled and 12 remain in the planning or construction stages. Four have been shut down. In total, 27 of the 36 projects (75%) have been cancelled or have failed to advance. Unfavorable project economics and insufficient financing are the primary reasons for the cancellations and shut-downs.

Newly announced wood biofuel projects have become increasingly less ambitious and less relevant to forest industry firms and timberland investors. Analysis comparing projects in 2013 to those from 2011 find that current projects use less wood and scale at smaller production levels. Meanwhile, the traditional forest products industry is reopening closed plants and building new capacity in response to increasing housing demand. Analysis of potential wood use highlights the minimal relevance of the biofuels projects to timberland investors in the U.S. today and over the next ten years (Figure 2). Even the U.S. Forest Service set aside the wood biofuels sector in its December 2012 projections for the U.S. forest products industry (Ince and Nepal 2012). They note, “The scale of such technologies remains highly uncertain, so we do not include projected timber demands for such technologies.”

Figure 2. Comparison of wood demand projections from liquid fuel projects from 2011 study and 2013 study



Source: Forisk Consulting

Wood Pellets

The wood pellet sector highlights the localized and technology-dependent nature of wood bioenergy market growth and potential. Wood pellet project development in the South leads the U.S. across nine regional wood bioenergy subsectors: pellets, liquid fuels and electricity/CHP in the North, South and Pacific Northwest (Figure 3). Of current pellet project announcements, 89% of the total production by 2023 would be exported to European markets. However, the ability of U.S. firms and exporters to successfully produce wood pellets is limited by critical factors associated with port access and the economics of pulpwood markets. Location-based issues and raw material prices and availability drive due diligence efforts to a short list of logistically attractive wood basins that include varying levels of direct, unyielding competition for residual chips and pulpwood roundwood. These factors limit the potential growth of wood pellet producers within the United States.

Figure 3. Relative growth of wood bioenergy activity since 2010

Source: Forisk Consulting

Three factors help explain why pellet projects in the South lead the U.S. First, wood pellet plants rely on known, proven technologies. This facilitates the financing and development of new projects. Second, pellet projects require lower levels of capital investment relative to liquid fuel and large scale electricity projects. Pellet projects require $150 million or less while the others require hundreds of millions of dollars. Third, project developers and investors are responding to actual demand from actual customers (in Europe). For the pellet projects announced as of April 2013, 55% (32 of 58) focus on the export markets. For the South, export oriented projects account for 93% of the total.

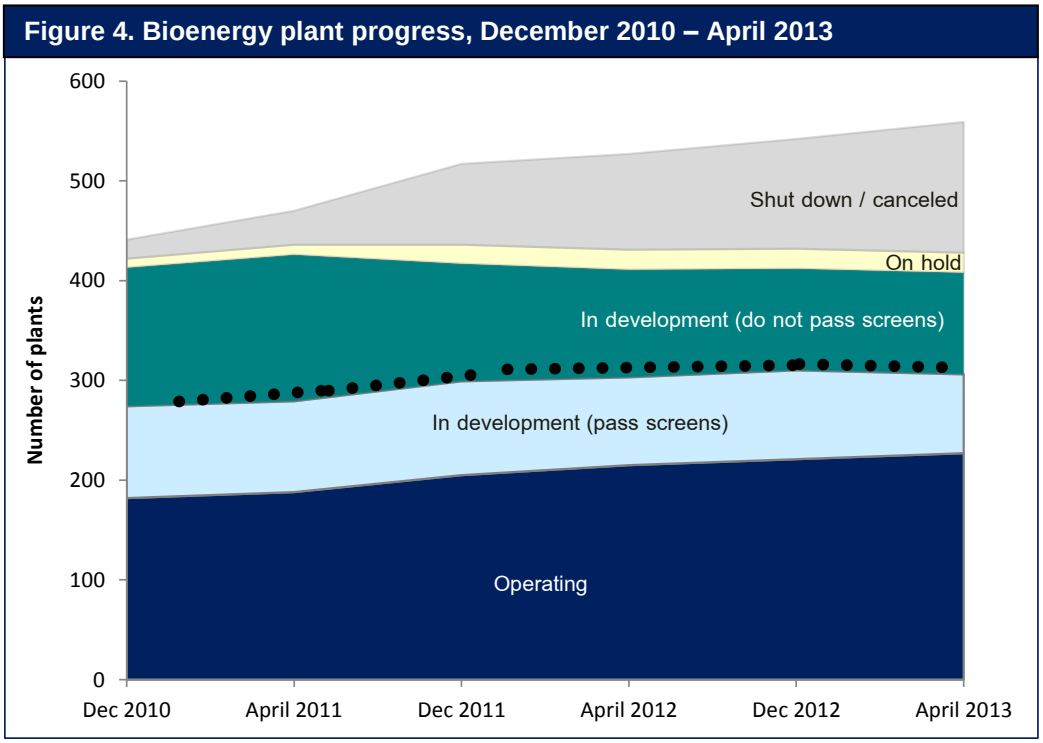
Wood Electricity

Large scale wood-to-electricity in the United States, shaped by monumental energy policies, began in the 1970s (Mendell and Lang 2012). However, as of May 2013, the United States does not have a federal mandate for renewable electricity, or renewable energy standard (RES). The lack of a federal RES slowed the development of stand-alone wood-bioelectricity plants.

While public policy appears critical in advancing wood bioenergy, market factors related to financing and project economics play instrumental roles in stalling wood electricity. Failure to secure off-take (PPA) agreements, the inability to obtain financing, and plentiful and cheap natural gas supplies have reduced expectations associated with wood-based biopower in the United States over the next ten years. Of the 151 projects on hold, shut down or canceled as of April 2013, 84 (56%) are wood-to-electricity or CHP projects.

Figure 4 summarizes the overall progress of wood bioenergy projects in the U.S. Projects have been put on hold, shut down, or canceled for a variety of reasons, including financing, the relatively high costs of woody feedstock compared with low natural gas prices, regulatory uncertainty, and difficulties obtaining economically sensible PPAs. In limited instances, local opposition to bioenergy projects has also slowed bioenergy market development.

Figure 4. Bioenergy plant progress, December 2010 – April 2013



Source: Forisk Consulting

Recent events related to the preference for natural gas support a story consistent with the historical evolution of U.S. energy markets. *Wood for Bioenergy* (Mendell and Lang 2012) details the central role of wood as an energy feedstock in the 1800s. However, markets shifted as cheap and plentiful coal replaced wood, establishing and repeating a trend of cheap energy quickly substituting for costly energy.

Looking Forward: Context for Potential Wood Bioenergy Market Growth

The economics of pulpwood markets are increasingly important for wood bioenergy projects. Current pulpwood users already buy nearly 140 million tons of pulpwood and in-woods chips in the South alone. Local wood supply and demand dynamics dictate market responses to new

entrants. Aggregate pulpwood and chip demand in the U.S. comes from three categories of end uses[1]:

1) **Paper and paperboard**, which includes all paper, containerboard and cardboard types produced in the U.S.
2) **Oriented strand board (OSB),** a type of engineered structural panel made from low-value wood raw material; strands, or long chips, of wood are glued together in a specific orientation to form panels. OSB is used in construction and directly competes with plywood.
3) **Wood use for bioenergy,** most woody biomass facilities intend to use the by-products of forestry operations for feedstock; however, some will require pulpwood-sized roundwood or clean pulp chips.

Multiple firms and government agencies develop projections of how wood demand from biomass firms will grow in the future. For example, the U.S. Forest Service released the 2010 RPA Assessment (USDA Forest Service 2012). The 1974 Forest and Rangeland Renewable Resources Planning Act required that the Forest Service prepare information for the American public regarding the future of America's forests and how they would meet resource demands. The RPA Assessment includes information on the current status and projected future state of forests in the U.S. on a 10-year cycle, as well as projections of wildlife and fish, water, outdoor recreation, and other natural resource issues.

As part of its projections for forests and forest products, the RPA Assessment tests multiple scenarios regarding wood bioenergy development. The scenarios, based on Intergovernmental Panel on Climate Change (IPCC) scenarios of global energy use, start in year 2020 and go through 2060. The use of IPCC scenarios provided a framework for working in parallel with other modeling efforts conducted in the scientific community at the time of the RPA research from 2005 through 2010. It also provided a broad range and breadth of possible outcomes without taking a position on likelihood. In addition to the IPCC scenarios, the RPA includes a historical fuelwood (HFW) scenario that is based on the relationship between fuelwood use and GDP in each country.

During and following research associated with the RPA, the U.S. economy declined as did wood use associated with forest products manufacturing. To address recent market events and other baseline assumptions in the RPA, U.S. Forest Service researchers Peter Ince and Prakash Nepal (2012) published research to address three issues with the 2010 RPA Assessment: 1) to account for the economic recession in the projections; 2) to account for changes in the bioenergy outlook and low natural gas prices; and 3) to consider currency exchange rates in their projections. Ince and Nepal follow the same methodology as the HFW scenario in the RPA assessment, with updated underlying assumptions, including housing starts.

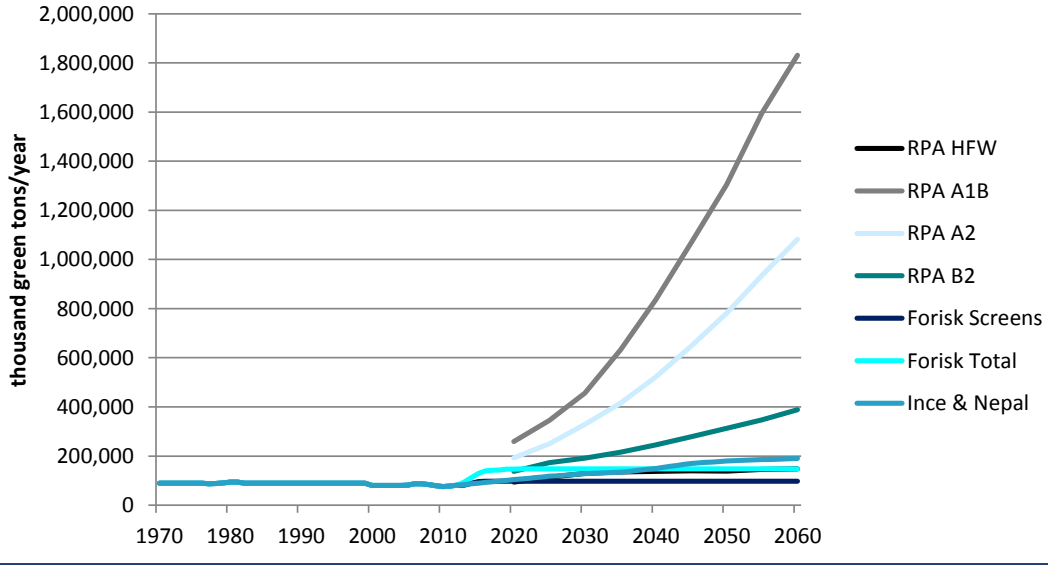
Forisk Consulting projects wood use from bioenergy projects using a bottom-up approach in its *Wood Bioenergy US* (WBUS) publication. WBUS tracks over 450 announced and operating wood-using bioenergy projects. Forisk projects the estimated wood use of each of these projects and sums the total wood use by each project until 2023. Forisk does not project bioenergy demand growth beyond the next 10 years.

Major differences exist in the assumed levels of wood demand for the IPCC scenarios and the work by Ince and Nepal and Forisk Consulting. As a result, the highest demand scenario from

[1] Another important forest industry sector that produces composite panels such as MDF is not included here because it relies primarily on manufacturing residuals for its raw material. This paper focuses on pulpwood and in-woods chips delivered directly from the forest.

the RPA projects significant growth of wood bioenergy in the U.S.; wood demand for bioenergy climbs to levels that are 5 times higher than all other wood uses by 2060. The Ince and Nepal projection and HFW scenario from the RPA fall closer in line to independently developed projections by Forisk in *Wood Bioenergy US* than the IPCC scenarios (Figure 5).

Figure 5. Comparison of wood bioenergy demand scenarios from RPA, Ince and Nepal, and Forisk Consulting



Sources: USDA Forest Service, 2012; Ince and Nepal, 2012; Forisk Consulting, 2013
Note: Forisk projections include operating cogeneration facilities at forest products plants. All projections exclude "fuelwood" estimates and include mill residues, pulpwood, and logging residues.

Analysis of the underlying assumptions highlights the disconnect between broad-based, demand-driven scenarios that assume aggressive growth in wood demand from bioenergy in the United States and assessments of what may be operable and "doable" on the ground. The IPCC-based scenarios in the RPA are not realistic in that they do not account for operational or market constraints. Notwithstanding assumed wood demand for bioenergy, the industry will likely not have the resources, technologies or competitive economics to deliver energy to the U.S. market at the assumed levels.

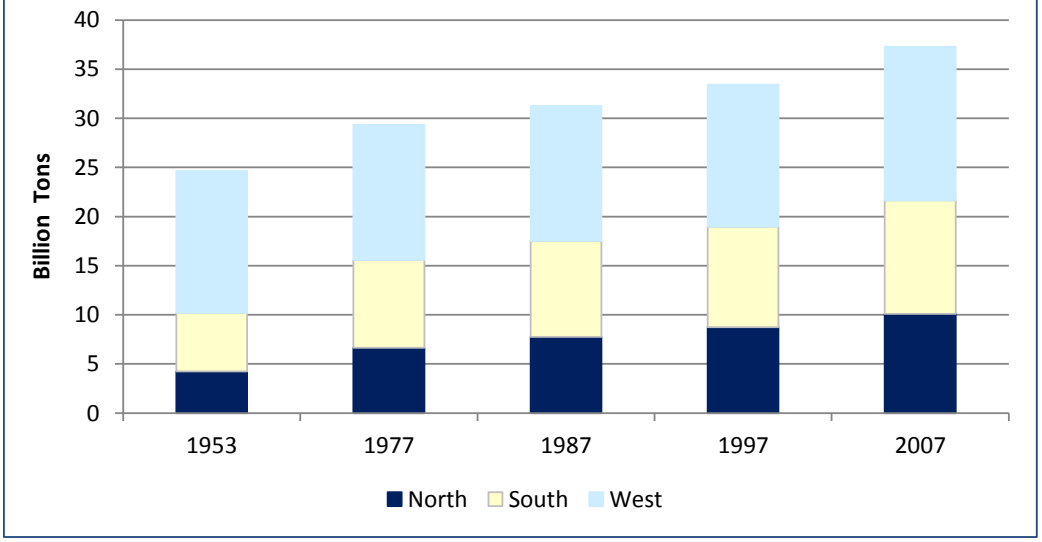
Bioenergy projections that account for historical relationships (HFW in the RPA and Ince and Nepal) more closely match the research by Forisk that relies on actual announcements by biomass firms. The reality of market-based scenarios further underscores the recent emergence of cheap and plentiful natural gas which has replaced planned wood bioenergy projects and capacity. In short, bioenergy projects participate in a competitive market for capital and wood raw materials, and the present outlook suggests that domestic growth in new sources of bioenergy from wood will be modest.

Forest Products Sector Demand

Analysis of forest inventories in the United States highlights how forest growth continues to outpace forest removals. Analysis of U.S. Forest Service inventory data by region confirms a continued accumulation of forest volume across public and private forest ownerships in all U.S. regions. While the specific supply and demand dynamics vary for specific local markets and

during specific local natural catastrophes, the aggregate assessment of forest volume trends remains unchallenged: forest inventories in the U.S. today exceed those of ten, twenty and fifty years ago (Figure 6).

Figure 6. Growing stock for US, all species, public and private ownership of timberlands



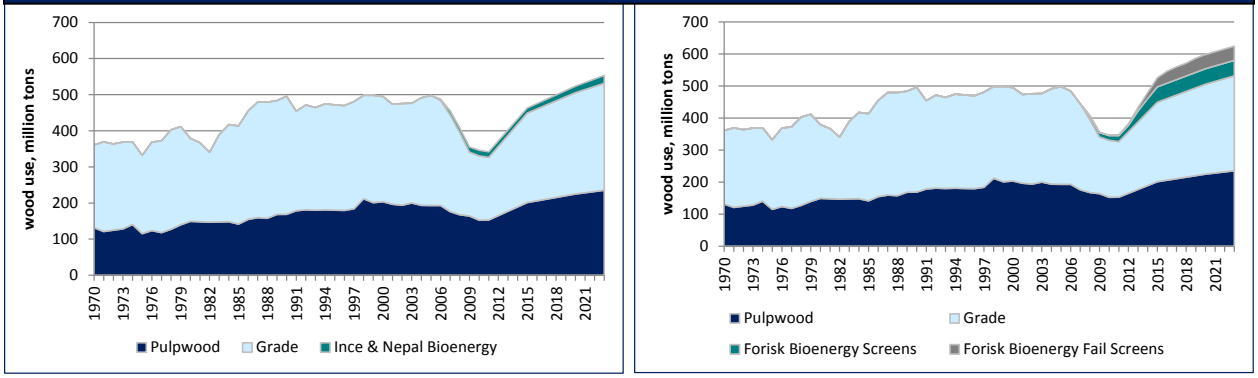
Source: US Forest Service (RPA Assessment) Smith et al. 2009

Total wood demand in the United States has declined in recent years. According to the United Nations, demand for "industrial" roundwood – the logs used at manufacturing facilities – declined 33% from 2005 to 2011, from 508 million tons to 341 million tons per year. According to the U.S. Forest Service, demand for roundwood – as measured by forest removals – declined 34% from 2005 to 2011, from 491 million tons to 326 million tons per year. And according to forest industry analysis and forecast work conducted by Forisk, demand for wood declined 31% from 2005 to 2012, from 500 million tons to 347 million tons per year.

Each of these sources indicates rising demand for wood over the past two years as markets continue to strengthen. As of year-end 2012, for example, U.S. Forest Service and Forisk analysis indicate forest industry demand for wood increased between 7 and 9% since 2011. Overall trends associated with (1) U.S. lumber consumption increasingly sourced by U.S. manufacturers at the expense of Canadian producers and (2) strong export markets for specialized pulp products and softwood lumber support projections of wood demand for the U.S. forest industry returning to 500 million tons per year by 2020. In addition, consensus exists across databases and studies from private researchers, the U.S. Forest Service, and public international databases that the supply of industrial roundwood in the United States exceeds this level of demand from manufacturing facilities and will likely continue to do so in the future.

The Ince and Nepal (2012) and Forisk scenarios show the marginal increase in wood demand for forest materials (i.e. pulpwood and logging residues) from bioenergy projects compared to the overall forest industry (Figure 7). In 2023 pulpwood and logging residue wood use from viable bioenergy applications could be as much as 9% of the total wood use of the forestry sector or as little as 4%. The vast majority of wood use will still be from the traditional forest products sector.

Figure 7. Projected wood demand by forest products and wood bioenergy sectors in U.S.

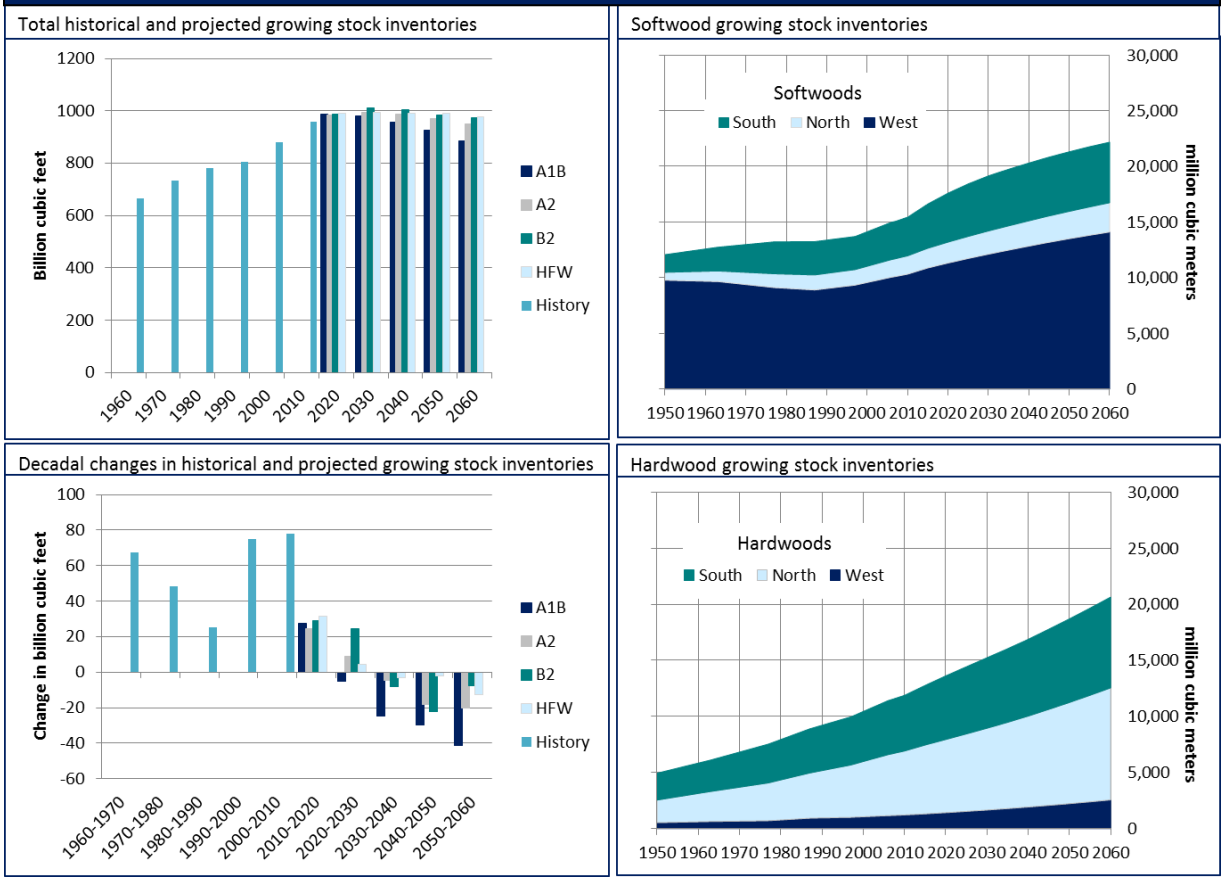


Source: Ince and Nepal, 2012; Forisk Consulting
Note: bioenergy projections include pulpwood and logging residues only; exclude mill residues and fuelwood.

Although wood demand from the forest products and bioenergy sectors is projected to increase, forest supplies are also projected to increase in aggregate (Figure 8). Future forest supplies from Ince and Nepal (2012) show increasing inventories; in contrast, the RPA assessment projects decreasing forest inventories. The baseline outlook for housing and demand for wood was lower in Ince and Nepal's model than in the RPA, and Ince and Nepal accounted for decreased demand for wood during the recession, while the RPA assessment did not. Also, Ince and Nepal projected much lower demand for wood for energy applications than most RPA scenarios (except HFW). Also, the two research assessments used different modeling approaches for forest supplies. The projections by Ince and Nepal account for recent events that affect wood use and include a more realistic wood bioenergy demand scenario than the RPA. Of the two supply projections, we view the Ince and Nepal projection as the most likely.

Forest supply projections by the U.S. Forest Service show that wood bioenergy projects pose no negative impact at a regional level. Bioenergy projects could have impacts at local levels depending on a variety of factors, including landowner dynamics, proximity to existing manufacturing facilities, prices, disturbance and other variables. Such variables are typically considered during project development and help determine the economic viability of a project.

Figure 8. Projected forest supplies from RPA Assessment (left) and Ince and Nepal 2012 (right).



Sources: USDA Forest Service, 2012; Ince and Nepal, 2012

Conclusions

This paper quantifies the current baseline for forest industry wood consumption in the U.S. to provide context for wood bioenergy market developments and research. Specifically, it addresses questions of wood demand from bioenergy, wood demand from the forest products industry, and reasonable expectations for wood bioenergy growth in the U.S. relative to the forest products industry over the next ten years. Establishing the current forest industry baseline and quantifying what is "doable" and "operable" in regional U.S. bioenergy markets provides a factual basis for evaluating how wood bioenergy markets could affect forest supplies.

Key findings from this research include:

- Analysis and tracking of wood bioenergy projects by technology type and region affirm the slow, stuttered development of wood bioenergy markets in the United States.
- Since 2010, total potential wood use from announced and operating projects increased 3% while potential wood use from operationally "viable" projects increased approximately 10%. Based on Forisk analysis, 293 projects representing potential wood use of 75.4 million tons per year by 2023 pass basic viability screening. This estimate includes all woody feedstocks, including pulpwood, logging residues, and mill residuals.

- Consensus exists across public, private and international studies and data sources regarding the size and status of the U.S. forest products industry. Demand for "industrial" roundwood – the logs used at manufacturing facilities – is approximately 500 million tons per year during normal economic conditions.
- Wood bioenergy scenarios developed by the IPCC and applied to models of U.S. forests have major flaws with respect to failures to account for the economic recession and the viable scale of actual and operable wood bioenergy projects in the United States.
- Viable wood bioenergy scenarios developed separately by U.S. Forest Service researchers and Forisk find the marginal increase in wood demand for pulpwood and logging residues from viable bioenergy projects compared to the overall forest industry in 2023 could be as much as 9% of the total wood use of the forestry sector or as little as 4%. The vast majority of wood use will still be from the traditional forest products sector.

Assumptions regarding market viability and what is operationally "doable" remain critically important when making projections of wood bioenergy impacts in the United States. This research reaffirms the importance of considering realistic scenarios that have basis in actual market transactional data and account for market responses. Wood bioenergy projects will likely have no negative impact on forest supplies in the aggregate, while more specific impacts will likely occur locally in individual wood baskets and timber markets.

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Appendix A. Screening Operating and Announced Wood Bioenergy Projects

This appendix summarizes the methodology detailed in a white paper commissioned by NAFO in 2010. The complete paper is available at: http://nafoalliance.org/wp-content/uploads/Forisk-A-Practical-Guide-for-Tracking-Wood-Using-Bioenergy.pdf

Forisk developed a wood bioenergy market screening methodology to assess project viability, and documented this method in a white paper published by the National Alliance of Forest Owners (Mendell and Lang 2010). The basic methodology for the screen relies on two criteria for wood-consuming projects:

- Technology: projects that employ currently viable technology pass the technology screen. These include pelletizing technology and wood-to-electricity projects.
- Status: projects that are operational, under construction, or received or secured two or more necessary elements for advancing towards operations pass the status screen.

The following checklist can be applied to replicate Forisk's project-by-project screening to assess if projects are likely to succeed:

Step 1: Technology Screen
Is the project a wood to electricity project, a pellet project, or a project that uses another technology that is commercially viable today?
If YES, then go to Step 2: Status Screen. If NO, stop – project fails the screen.

Step 2: Status Screen
Is the project operating*?*
If YES, then the project passes the screen. If NO, go to question 2a.

2a. Is the project under construction?
If YES, then the project passes the screen. If NO, go to question 2b.

2b. Does the project have two or more of the following?

- ☐ Secured site
- ☐ Financing
- ☐ Air permit
- ☐ Engineering Procurement and Construction (EPC) contract
- ☐ Power Purchase agreement or off-take agreement
- ☐ Public Service Commission approval
- ☐ Interconnection agreement
- ☐ Wood supply agreement

If YES, the project passes the screen and demonstrates momentum towards initiating construction. If NO, then the project fails the screen and is not considered likely to succeed at this time given publicly-available information.