Presentation 2.10: Economic and environmental implications of woodfuel production and competition of woodfuel production and other uses

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Abstract
The forest products industry has a unique opportunity to increase its revenue and its contribution to a sustainable environment by evolving its mills into operations that manufacture a new stream of high-value (and "green") chemicals, fuels and/or electric power while continuing to produce its traditional line of wood, pulp and paper products. This opportunity is very real because the industry controls all of the raw material necessary to develop this new line of products and the technologies required for implementation are either commercially available or under development.

This opportunity is called the "Integrated Forest Products Biorefinery" (IFPB). While the sole products of existing pulp and paper manufacturing facilities today are pulp and paper, their infrastructure is geared to collect and process biomass. These mills provide an existing foundation to develop the IFPB. In an attempt to best develop and implement the necessary and diverse technologies, Agenda 2020 has focused its IFPB strategy on three main components: 1) "Extracting Value Prior to Pulping" addresses opportunities from the time the wood is chipped at the mill but before it is pulped in the digester.

A key focus will be hemicellulose extraction from wood chips prior to pulping followed by their utilization as biomaterial feedstock; 2) "New Value Streams from Residuals and Spent Pulping Liquors" addresses the opportunities to manufacture bio-products after the pulp digester. A key focus will be on conversion of biomass, including forest residues and spent pulping liquor (black liquor), into syngas through gasification technologies; and then on the conversion of the syngas into liquid fuels, power, chemicals and other high-value materials. The IFPB will maximize utilization of energy streams and minimize waste; and 3) "Sustainable Forest Productivity" involves the application of biotechnology to sustainable forestry that will allow the management of forest land at a high intensity on fewer acres.

The current supply potential for the IFPB is discussed and shown to be significantly greater than current industry usage and that substantial opportunity exists to harvest previously unavailable wood on federal lands at high risk of fire. The supply issues and economics of a first–of-a-kind commercial scale forest biorefinery in the U.S. are discussed. Preliminary estimates, when extrapolated at the national level show promising biofuels production levels and advantageous environmental implications. The results of an independent BLGCC study support these estimates. The advantages of the IFPB are summarized in concluding slides.

Economic and Environmental Implications of Woodfuel Production and Competition with Other Uses

Presentation to the
International Seminar on Energy and the Forest Products Industry
Rome, 30-31 October 2006

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Today's Presentation

- Agenda 2020 Context
- Integrated Forest Products Biorefinery (IFPB)
  - Concept
  - IFPB Components
  - Biomass Potential
  - Example: Biorefinery Demonstration
- IFPB Impact Studies
  - Economic Implications
  - Environmental Implications
- IFPB Advantages & Benefits

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Agenda 2020: Technology Alliance of the Forest Products Industry

- Special Project of the American Forest & Paper Association
- Industry-led partnership with government and academia for collaborative, pre-competitive research, development and deployment
- Advance breakthrough technologies that hold the promise of reinventing America's forest products industry
- Intersection of improved financial performance with addressing shared industry and national goals
  - Provide the research foundation for new technology-driven business models that will enable the forest products industry to meet competitive challenges
  - Contribute solutions to strategic national needs associated with energy efficiency, energy security, diversified energy supply, and environmental performance
- Creating and capturing value through innovation in processes, materials, *and markets*

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Agenda 2020 Focus for the Future

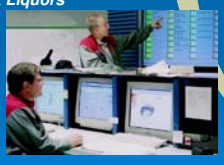
The Seven Technology Platforms – Crafted for High Value/Low Risk with a Proven Portfolio Tool

Nanotechnology
➥ *Biomaterials manipulation and manufacturing at atomic level*

Positively Impacting the Environment
➥ *Expand the Carbon Cycle Benefits*
➥ *Enhanced Site, Activity and Product Environmental Footprint*

Next Generation Fiber Recovery and Utilization
➥ *Recycled Fiber Indistinguishable from Virgin Fiber*

Advancing the Forest "Biorefinery"
➥ *Sustainable Forest Productivity*
➥ *Extracting Value Prior to Pulping*
➥ *New Value from Residuals and Spent Liquors*

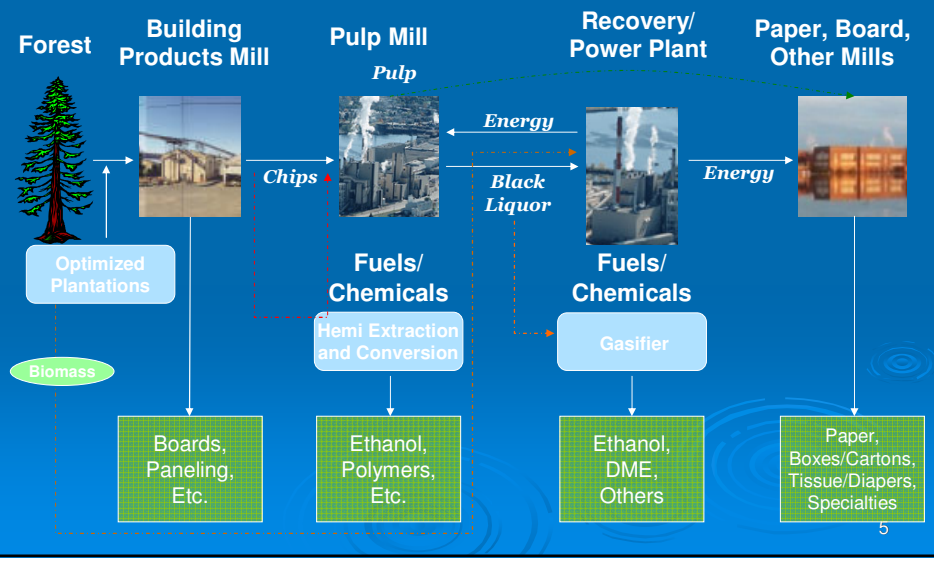


Breakthrough Mfg. Technologies
➥ *Major Manufacturing Cost/Capital Reduction*
➥ *Significant Enhancement in Product Properties with Existing Assets*
➥ *Substantial Improvement in Energy Efficiency for Existing Processes*

Technologically Advanced Workforce
➥ *From Workforce to Knowledge Workers in 7 years*

Advancing the Wood Products Revolution
➥ *Improved Building Systems*
➥ *Reduced System Costs*

Agenda 2020: Integrated Forest Products Biorefinery (IFBP) Concept



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Components of the Agenda 2020 IFPB Technology Strategy

Value Prior to Pulping –

Fermentation/Biochemical Pathway

- Separate and extract selected components of wood prior to pulping, and process these streams to produce commercially attractive chemical and liquid fuel products

New Value Streams from residuals and spent pulping liquors –

Thermochemical Pathway

- Convert forest and agricultural residues and spent pulping liquors into liquid fuels, power, and chemicals

Sustainable Forest Productivity

Feedstock Pathway

- Apply biotechnology and nanotechnology breakthroughs to sustainable forestry to manage U.S. forest land at a high intensity

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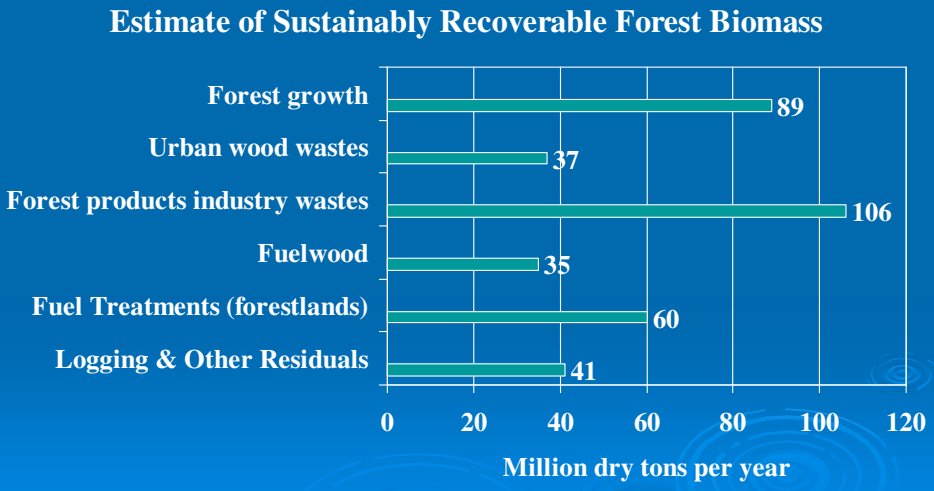
Current Supply Potential for IFPB is Three Times Current Industry Usage



Source: USDA/DOE Biomass as Feedstock for a Bioenergy and Bioproducts Industry, 2005.

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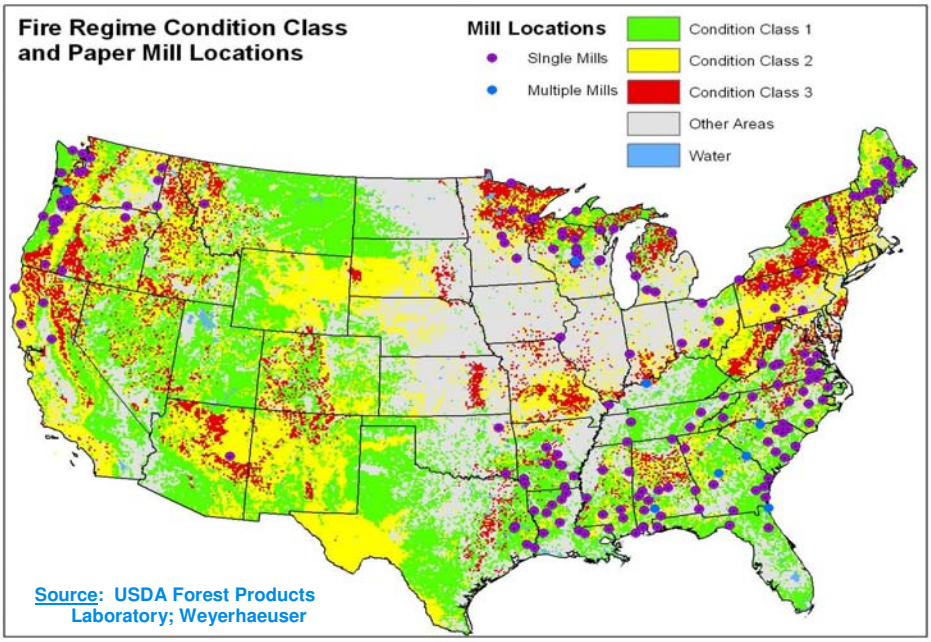

Source: USDA Forest Products Laboratory; Weyerhaeuser

Agenda 2020 Example: Southeast Arkansas Biorefinery Demonstration at Cypress Bend Mill

- Leadership: Potlatch Corporation
- Location: Bleached Kraft board mill in McGehee, Arkansas
- Driver: Potentially to reduce natural gas usage by 1,600,000 MMBTU per year and purchased electricity by up to 80,000 MWH
- First-of-a-kind Commercial Scale Biorefinery
- Interface with forest products industry through Agenda 2020 to help advance deployment of biorefinery technologies

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Objective: Implement a Fully Integrated Agricultural & Forest Products Bio-refinery to:

- Use untapped waste products from farming and the forest to produce bio-fuels and other chemicals
- Use the waste heat from the biorefinery to meet the energy needs of existing manufacturing operations
- Include both the Thermochemical (gasification) and Bioconversion (fermentation) Pathways to maximize conversion of the untapped waste streams
- Combine both biorefinery production with “industrial gasification”, e.g. displacing natural gas consumption & fossil fuel consumption in industrial use

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Cypress Bend as a Demonstration Site

- Cypress Bend is on the Mississippi River in SE Arkansas, making fuel shipment and feedstock deliveries by barge possible
- Single line Pulp & Paper Mill producing 300,000 TPY of bleached Coated Food Board
- Consumes 1,100,000 TPY of wood Chip
- Adequate biomass available within 100 miles
- Mill could utilize the waste heat from the biorefinery
- Mill is also located in a sparsely populated, economically depressed, rural area where local and state governments are eager for industrial development
- Cost models suggest ROI would be acceptable

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Cypress Bend Integrated Ag & Forest Biorefinery: Estimated Availability of Biomass

Source	Recoverable Residues	Production Residues	Total
In Forest :			
Residues	6,000,000		6,000,000
Thinnings / Excess Growth	1,200,000		1,200,000
Agricultural:			-
Rice	1,803,000	898,000	2,701,000
Cotton	18,000	89,000	107,000
Corn	248,000	-	248,000
Soy Beans	-	-	-
Sorghum	-	-	-
Wheat	600,000	-	600,000
MSW			-
Waste Paper	-	894,000	894,000
Woody Debris	-	9,800,000	9,800,000
Misc.	-	149,000	149,000
Total Available	9,869,000	11,830,000	21,699,000
Energy Crops	-	12,500,000	12,500,000
Black Liquor		4,919,000	4,919,000
Net Biomass (Dry TPY)	9,869,000	29,249,000	39,118,000
Percent Economically Recoverable			50%
Total Available Biomass Dry TPY			19,560,000
Gallons of Bio-fuels/Ton			50.00
Total Potential Bio-fuels (Gallons Per Year)			978,000,000

IFPB Studies
US National Potential of SE Arkansas IFPB Model

- Biofuels from production from syngas to liquids technologies could exceed 175 MM barrels per year (5.5 billion gallons).
- Ethanol production from hemicellulose extraction might exceed 45 MM barrels per year (1.4 billion gallons).
- Natural gas consumed in lime kilns would be reduced by about 90,000,000 MCF per year (14% of Forest Products industry usage).
- The technology can be implemented at any manufacturing site that has access to bio-mass and a use for the waste heat.
- Market for bio-fuels and chemicals are far greater than potential production (room for many players).
- Key considerations:
  - Availability of untapped biomass
  - Transportation of biomass
  - Size of heat sink in industrial facility

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IFPB Studies
Results of Study of Independent BLGCC, 2005

Improved energy efficiency with increased power output

- Over 116 million BOE of electricity per year potential with broad application in US industry, equivalent to 2.8% of all U.S. petroleum imports
- Over 109 BOE in liquid fuel or chemicals (including hydrogen) per year potential with broad application in US industry

Improved Emissions Profile

- 80%-90% reduction of NOx and SO_2 emissions
- 80%-90% reduction VOCs and particulate matter
- Reduction of over 20 million tons carbon emissions
- Carbon-neutral in relation to greenhouse gas emissions when combusted

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IFPB Studies
Analysis of Energy Benefits and Environmental Performance

- Cost/benefit study underway by Princeton University and Navigant Consulting, Inc.
  - Work Performed for the U.S. DOE Under Cooperative Agreement Number DE-FC26-04NT42260
  - Final report expected by November 30, 2006
- Focus on the thermochemical pathway, with various production scenarios for biofuels, biochemicals and/or electric power
- A "well-to-wheels" approach used to quantify emissions and energy benefits
- Sensitivity analyses conducted to address uncertainty in the data around several key variables
  - Capital costs
  - Retail energy prices and commodity (product) sales prices
  - Wholesale electricity prices (changes in natural gas captured here)
  - Level of renewable energy incentives

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National Impacts Analysis » Summary

Biorefineries offer the potential for significant national energy and emissions benefits.

- Under the configurations analyzed, the P&P industry has the scale to produce (by 2034):
  - In excess of 10 billion gallons per year of biofuels, or
  - As much as 20,000 MW of biomass power.
- The rate of market penetration has a major impact on the extent of the benefits
  - ~3x difference in cumulative impacts (2010-2034)
  - ~1.7x difference in annual impacts in 2034
- Under the *Aggressive* market penetration scenario:
  - Cumulative net fossil energy savings could be as high as 16 Quads.
  - Cumulative net petroleum displacement could be as high as 13 Quads (~2.2 billion barrels of oil)
  - Annual net CO_2 emissions reductions could exceed 100 million tons
  - The cumulative monetary value of CO_2, SO_2 and NOx emissions reductions could range from $6-40 billion.

PRELIMINARY RESULTS

NAVIGANT CONSULTING

Only Some Factors Addressed by Cost/Benefit Model

Public Sector Benefits	**Reduced emissions** **Reduced fossil fuel use** Improved energy security & diversity Displace high-priced and volatile fossil fuels The value of technology leadership
Pulp & Paper Industry Benefits	**Replace Tomlinson boilers with BLG to improve competitiveness – higher energy efficiency, reduced emissions, modified pulping strategies, improved safety.** **Opportunity for new revenue streams from sale of biofuels and bio-based chemicals.** Utilization of woody biomass (beyond existing residues) for added revenue.
Energy Industry Benefits	**Increasing need for clean fuels to meet fuel formulation requirements and new Federal Renewable Fuel Standard[1]** **Helps meet rising demand for renewable energy, e.g., Federal Renewable Fuel standard, state renewable portfolio standards, and state renewable fuels mandates[1]** Helps pulp and paper producers maintain competitiveness in global markets - can help retain jobs and contributions of this industry to the U.S. economy.

1. Value is expressed by way of incentives and "green" premiums.

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IFPB: Forest Products Industry Advantages

- Forest-based materials as feedstock
  - Forest-based materials represent 30% of resources needed to support emerging bio-industries.
  - Ethanol production from wood-based hemicellulose uses significantly less fossil fuel when integrated with existing manufacturing.
  - Managed forests have positive ecological impacts that are not mirrored in other renewable feedstocks.
- Industry has infrastructure and expertise
  - Industry owns and manages operations for feedstock harvesting, transportation and storage, manufacturing and conversion, and waste handling and recovery.
  - Raw material already is being supplied to mills.
  - Industry has experience in chemical processing and handling in compliance with related standards and regulations.
  - Location of facilities in rural areas can realize important synergies between agricultural and forest-based feedstocks.

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IFPB: Forest Products Industry Advantages (cont)

- If fully developed and commercialized, IFPB technologies have potential for significant national benefits:
  - Diversified, more secure national energy supply
  - Geographically distributed supply source
  - Reduced environmental impacts
  - Improved energy efficiencies
- Carbon benefits include:
  - Displace use of natural gas and fossil fuel use in industrial applications (including power generated using fossil fuels)
  - "Green" liquid transportation fuels produced as co-product, displacing use of petroleum fuels
  - Use of energy crops can lead to changes in land management, increasing the net average carbon stored per acre

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Questions?

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Energy Use in Key Industrial Sectors

(All Figures in Trillion BTUs)

Sector	Natural Gas	Residual Fuels	Distillate Fuels	LPG/ NGL	Coal and Coke	Derived Net Electricity	Other	Total Use, Net
Chemicals	1984	50	9	51	284	602	749	3729
Mining	1268	5	262	0	77	355	631	2598
Pet Ref	948	70	4	33	0	123	2300	3478
Forest Products	659	152	21	9	279	327	1825	3272
Steel	456	29	5	0	48	163	971	1672
Glass	194	3	0	1	0	54	2	254
Aluminum	189	0	1	1	1	246	3	441
Metalcasting	136	0	1	2	0	63	31	233
Agriculture	77	0	339	221	0	221	14	1072
TOTALS	5911	309	642	318	689	2154	6526	16749

Taken from "Profile of Total Energy Use for US Industry", Energetics, Inc. for the US DOE, 12 / 04.
LPG / NGL = Liquefied Petroleum Gas / Natural Gas Liquids
Table does not include energy sources used as raw materials.

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Southeast Arkansas Biorefinery Status: Partners and Support

- Key Collaborators/Endorsers
  - Agenda 2020 (tech advisory group)
  - Winrock International
  - Arkansas Governor's Office
  - Arkansas Senators & Congressional Delegation
  - Arkansas Department of Agriculture
  - Arkansas Farm Bureau and other local agricultural organizations
  - Oak Ridge National Laboratory
  - National Renewable Energy Laboratory
  - Pacific Northwest National Laboratory
- Other Regional Partnership Potential
  - Mississippi Biomass Initiative
  - Nature Conservancy
  - Delta Authority
  - Southern Innovation Initiative
- Federal Briefings
  - DOE
  - DOD
  - Forest Service
  - USDA
  - EPA
  - Commerce
  - Senators & Representatives
- Discussions Underway with
  - Petrochemical Companies
  - Technology Vendors
  - Researchers

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