



Biorefinery R&D Needs in the 2009 Forest Products Industry Technology Roadmap

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Agenda 2020 Technology Alliance

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What is Agenda 2020?

The Agenda 2020 Technology Alliance

- is a *member-supported* organization
- promotes the advancement of *breakthrough technologies* that have the *potential to transform* the industry's products and processes

We pursue this goal by:

- Identifying the *priority technology needs* of the forest products industry
- Facilitating *collaborative, pre-competitive* R&D programs supported by *government funding* that involve multiple companies and research institutions
- Exploring emerging technologies

The Potential of Breakthrough Technologies – Large Benefits to the Industry

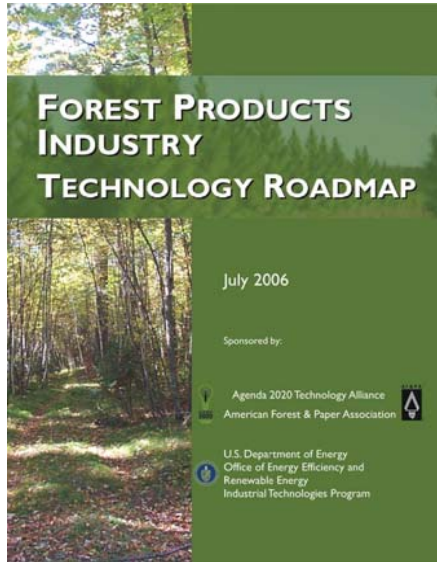
- New breakthrough technologies can
 - Reduce energy consumption, greenhouse gas emissions, water consumption, fiber demand, and input costs
 - Improve sustainability and public image of forest-based sector
 - Provide more economic value from wood and products

- Example:

20% reduction in energy globally = US\$9 billion a year

- Based on US EIA data for 2005 global forest products energy consumption
- Assumes 50% of reduction in coal, 25% in oil, and 25% in natural gas at US 2007 average costs

The Industry's R&D Needs – 2006 Technology Roadmap

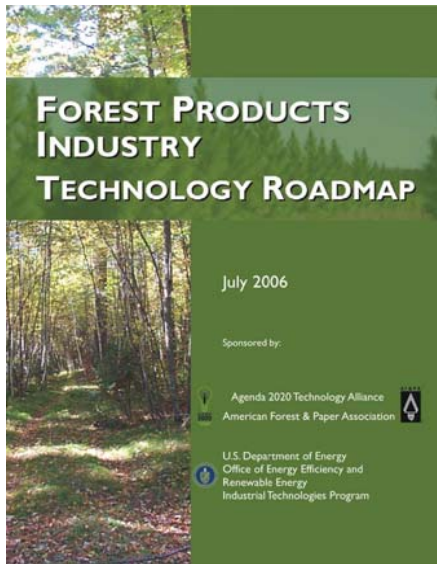


- R&D needs in six focus areas
 - Forest productivity
 - Forest biorefinery
 - Breakthrough manufacturing
 - Wood products
 - Environmental
 - Fiber recovery
- Broad recognition in federal agencies, academics, and international communities
- Many successful outcomes
 - Value Prior to Pulping consortium
 - Pine Genome Initiative
 - DOE-funded projects in conversion of biomass and pulp and paper energy reduction
 - International conferences on forest products nanotechnology
 - Recognition of forest products in National Nanotechnology Initiative
 - NPT2 college training programs

The Industry's R&D Needs – 2006 Technology Roadmap Needs Updating

- Much has changed since 2006
 - Climate change, GHG emissions
 - Emphasis on sustainability
 - Concerns about wood supply
 - Uncertainties of energy and water availability
 - Rising input costs

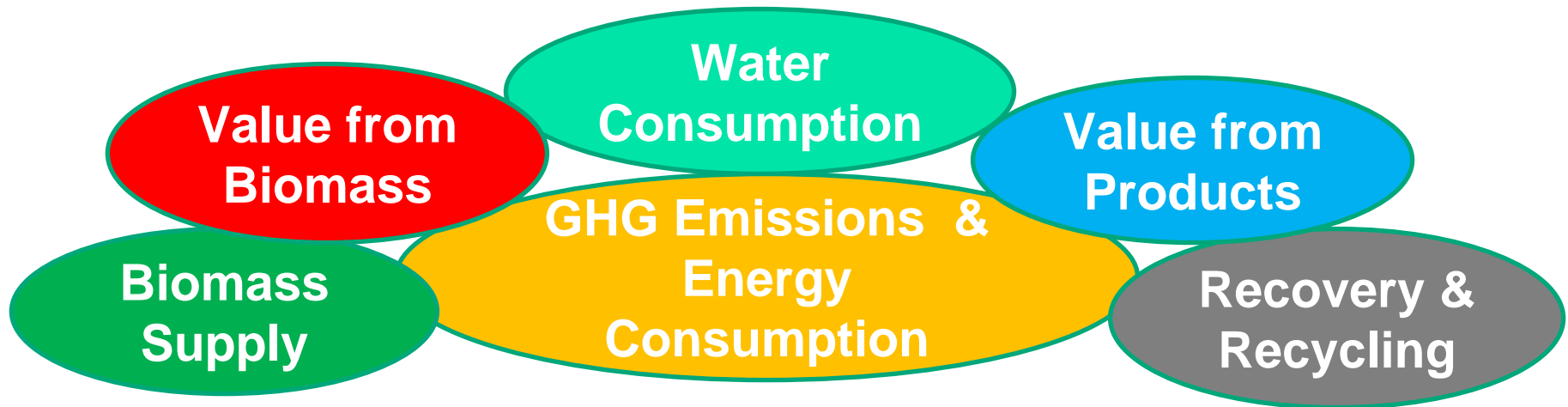
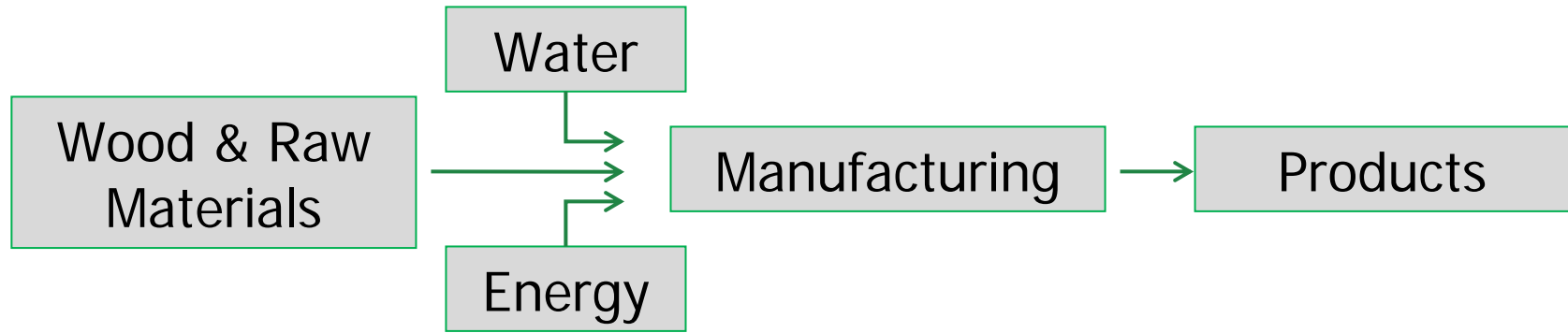
- Launched new roadmap process in 2008



The Process – 2009 Technology Roadmap

- Open process
- Partnership between Agenda 2020 and IPST at Georgia Tech
- Strategic Issues Workshop – December 2008
 - Business-focused, 45 participants
 - Defined priority issues facing the industry
- Technology Roadmap Workshop – April 2009
 - Technology-focused, 90 participants
 - Targeted the priority issues
 - Roadmap report to be issued soon

Forest Products Technology Agenda – Six Strategic Focus Areas in 2009 Roadmap



Reduce carbon emissions and energy consumption at mills and plants substantially

- Eliminate CO₂ emissions from fossil fuels (BIOREFINERY)
 - Use renewable sources for non-steam thermal demand – biomass-derived fuels to replace fossil energy
- Reduce energy demand in manufacturing
 - Deliver a drier sheet to dryer section
 - Reduce energy required to wash pulp and prepare black liquor for burning by 50%

An excellent way to reduce carbon emissions is to use more energy derived from renewable biomass.

64% of all energy in the paper industry is biomass-derived.

Reduce fresh water intake in manufacturing at least 50%

- Drastically reduce the amount of fresh water used in pulping and papermaking
 - Remove non-process elements (NPE) from chips prior to pulping (BIOREFINERY)
 - Reduce fresh water used in pulp washing
- Develop technologies for reuse of effluent in plants after treatment
 - Separate dilute contaminants (both inorganic and organic) from reusable water

Little work in water reduction is related to biorefinery.

Biorefinery integrated with pulp mill systems can reduce water consumption of separate non-integrated plants.

Increase value of products by developing new features

- Achieve 20-50% improvement in performance/weight ratio of paper and packaging without compromise in performance criteria
- Develop new bio-based composites and nanomaterials
 - Functional interfaces between inorganics and wood-based materials
 - Value-driven applications of wood-based nanomaterials
- Develop new types of biomass-based packaging
 - Bio-based coatings and fiber treatments that permit displacing non-renewable polymers in packaging (BIOREFINERY)

Small link with biorefinery technologies.

Improve recovery and recycling of waste wood and fiber products

- Enable recycled fibers to have runnability equivalent to virgin fibers
 - Machine design, water systems, fiber modification, nanotechnology
- Improve sorting of recovered wood and fiber
 - Document destruction processes that maintain fiber integrity
- Recover urban waste wood for energy (BIOREFINERY)
- Use non-fiber components more efficiently
 - Separate filler from recycling wastes and reuse recovered filler

Small overlap with biorefinery.

Increase the supply of high-quality fiber and low-cost biomass

High impact on biorefinery opportunities!

- Improve tree properties (BIOREFINERY)
 - Genomics of major species
 - Improved methods to multiply high value trees (conifers)
- Produce more wood (BIOREFINERY)
 - Increase production of usable woody biomass
 - Purpose-grown trees
- Develop efficient harvest supply chain (BIOREFINERY)
 - Systems for efficient harvest, processing & delivery of quality feedstocks for various conversion processes
 - Systems for growing and harvesting small-diameter, short-rotation woody crops

Get value from woody biomass in new ways

Direct alignment with biorefinery technologies!

- Develop thermochemical conversion processes that scale to feedstock availability (BIOREFINERY)
- Redesign pulp mills into flexible biorefineries and use purpose-grown crops (BIOREFINERY)
- Make products with higher value than current mix (BIOREFINERY)
- Improve separation of woody biomass into usable components (BIOREFINERY)

Develop thermochemical conversion processes that scale to feedstock availability

- Develop a scaled-down Fischer-Tropsch process
- Identify and reduce required syngas conditioning and cleaning
- Develop catalysts for product flexibility and scalability
- Develop less capital-intensive technologies
- Develop cost-effective processes to concentrate dilute solutions of ethanol, butanol, etc.
- Increase flexibility in material handling and processing in pulp mill systems

Redesign pulp mills into flexible biorefineries and use purpose-grown crops

- Transform pulp mills into flexible biorefineries by employing low-lignin feedstock and simplifying pulping, bleaching, and recovery, and using advanced fractionation and energy management
- Develop flexible biomass fractionation technologies
- Maximize carbon in biomass for biorefinery purposes
- Use genetic engineering to design plants with low recalcitrance to make them easier to process

Make products with higher value than current mix

- Chemicals, advanced fuels, and polymers from sugars and lignin
- Processes to produce lignin-based materials with higher value than fuel value
- Make products from viable black liquor gasification process
- Develop new uses and markets for carbon fibers, nanocellulose-based materials, and other products derived from wood components

Improve separation of woody biomass into usable components

- Develop methods to achieve solvent and/or enzymatic deconstruction
- Investigate depolymerization by supercritical water
- Develop new pulping or other processes that allow the separation of lignin in high-value forms
- Develop custom microbes for specific fermentation processes
- Develop affordable size reduction techniques

Completing the 2009 Technology Roadmap

- For final report, add to technology needs from workshop
 - Wood products R&D needs
 - International roadmaps and programs
- Issue final report before end of 2009 and distribute broadly
- Communicate roadmap priorities to industry, federal agencies, and research institutions
- Convene session in about a year to review progress and status

EU FTP Strategic Research Agenda Aligns Well with the New US Roadmap

FTP Strategic Research Agenda	US 2009 Roadmap
<p>Innovative products</p> <ul style="list-style-type: none"> Paper and packaging Building products Next generation of composites Biofuels Pulp, energy & chemicals from wood 	<ul style="list-style-type: none"> Increasing value from products Getting value from biomass
<p>Intelligent and efficient mfg processes</p> <ul style="list-style-type: none"> Reduced energy consumption Fewer inputs, more performance New technologies 	<ul style="list-style-type: none"> Reducing carbon emissions & energy Reducing fresh water consumption Increasing value from products
<p>Availability and use of forest biomass</p> <ul style="list-style-type: none"> “Tailor-made” wood supply Recycling 	<ul style="list-style-type: none"> Supply of woody biomass Getting value from biomass Recovery and recycling
<p>Multifunctional demands on forests</p>	<ul style="list-style-type: none"> Supply of woody biomass

Where Do We Go Next?

- Build industry consensus for highest priorities and most urgent R&D needs
- Form collaborations to pursue top R&D priorities
 - Universities, research institutions, and national labs
 - Alliances with chemical industry and other energy-intensive industries
 - Links beyond the traditional forest products industry R&D community
 - International interactions
- Seek support and funding from government agencies and industry (producers and suppliers)

Challenges for New Technologies

- Demonstrate economic advantages relative to incumbent technologies
 - Example: Ethanol from hemicellulose extraction versus value as fuel in black liquor
- Move quickly from development/demonstration into commercial use
 - How to fund first-of-a-kind new technologies
 - Involvement of suppliers
 - Intellectual property rights
- Improve overall sustainability profile and avoid negative environmental impacts
 - Life cycle analysis metrics
 - Benefit from integrating with other processes

In Conclusion

- New technology roadmap highlights current industry priorities and R&D needs in strategic focus areas
- Current climate promises increased US government support for industrial technology development priorities
- Good opportunity to benefit from technology breakthroughs in coming years

QUESTION: What important R&D needs were missed?

For More Information



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