Advancing the Forest Biorefinery

Forest Products

Techno-Business Forum

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The Forest Biorefinery
Today’s Industry Situation

- U.S. forest products industry is an important and vital segment of the nation’s economy
  - Is the world’s largest manufacturer of forest products
  - Directly employs over 1.3 million people
  - Ranks among the top ten manufacturing employers in 42 states
  - Estimated payroll of $50 billion.
  - Sales top $230 billion annually in the U.S. and export markets.

- BUT...
  - Industry has not earned its cost of capital in a decade
  - Mergers and Acquisitions
    - Necessary for survival
    - Won’t solve major problem
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Today’s Industry Situation

- The world has changed
  - Tropical pulp mills have advantage in the HW market
  - China is filling their needs with modern, high-technology, low-cost mills
  - Competition from foreign-made products in the U.S. market is growing

- Two choices
  - Allow production (and supply chains) to migrate offshore
  - Introduce new line of products to provide significant growth
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Goal

- **Goal** is to evolve existing pulp mills into forest biorefineries that
  - Produce fuels, chemicals, and power streams
  - Continue to meet growing demands for traditional pulp and paper products
  - Increase revenue while protecting core business

- Excellent alignment with the mandates of government agencies striving to improve the nations’ energy self-sufficiency
- Valued by society and the marketplace because they help preserve infrastructure, jobs, supply chains & permits
The Big Change: The Forest Biorefinery

- The Chemical Pulp Mill has
  - Existing infrastructure to procure, receive, store, and handle harvested wood
  - Skilled labor force
  - The permits needed to operate

- Program consists of three parts:
  1. Sustainable Forest Productivity
  2. Extracting Value Prior to Pulping
  3. New Value Streams from Residuals and Spent Pulping Liquors
Value Prior to Pulping

- Uses hot water extraction vessels (low pressure digesters) to extract hemicelluloses

- Acetic acid separated, and sugars fermented to fuel grade ethanol with known processes

- Removing the “sugars” improves throughput potential of existing operations

- Ethanol is at the low end of potential products

- Development of further value includes a
New Value from Spent Liquors

- Add a gasifier and convert spent pulping liquors into syngas
- There are two choices for processing of syngas
  - Power, or
  - Fuel/chemicals
- Both require syngas conditioning
- Convert to polysulfide pulping
New Value from Spent Pulping Liquors—Power

- Add a turbine power island
- Utilize “syngas” to power the mill; sell excess electricity to grid
- Reference mill increases biomass consumption by ~50%
- Better economics possible with acquisition of additional biomass
- Profit potential limited by historically slow moving wholesale electrical prices IN AREAS WHERE COAL DOMINATES, e.g., the Southeastern U.S.
New Value from Spent Pulping Liquors—Fuel

- Add Fischer-Tropsch unit; convert BLG syngas to Renewable Fischer-Tropsch Fuel (RFTF) for sales to the petrochemical industry
- Convert chemical recovery unit to a biomass boiler
- Procure additional biomass to run the mill; install condensing turbine to convert excess steam into power
Current Mill – Industry wide production levels

- O₂
- CO₂
- Purchased Power – 6 GW
  - $2.0 billion
- Black Liquor & Residuals
- Pulp
- 55 million tons

BL Recovery Boiler, Power Boiler

Steam, Power & Chemicals
The Forest Biorefinery – Production

- Extract Hemicelluloses
- New products: fuels, chemicals & polymers
  - 1.9 billion gallons Ethanol
  - 600 million gallons Acetic Acid

- Power
  - 116 million BOE
- Or
- Liquid Fuels/Chemicals
  - 109 million barrels

- Syngas
- Black Liquor & Residuals
- Steam, Power & Chemicals
- BL Gasifier
- Wood Residual Gasifier
- Combined Cycle System
- Process to manufacture Liquid Fuels and Chemicals
- Pulp
  - 55 million tons
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Research Needs

- Develop technology to effectively
  - Extract hemicelluloses from wood chips
  - Economically convert extracted hemicelluloses into fuels and chemicals
  - Remove remaining barriers to gasification of spent pulping liquors
  - Economically convert syngas into fuels and chemicals
  - Effectively integrate the new processes into existing mill infrastructure

- Develop sound economic studies
- Partner with government agencies whose mandates are aligned with our goal
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Conclusions

- The forest products industry has a unique opportunity to
  - Tap the enormous potential of managed forests to produce liquid fuels, electricity and new biomaterials without increasing greenhouse gas emissions
  - Manufacture these sustainable products and energy opportunities for its own benefit, the Nation and Society
  - Leverage its resources to develop and deploy the needed technology

- The forest products industry has a unique opportunity to reinvent itself