Advancing the Forest Biorefinery

Forest Products Techno-Business Forum

Gerard Closset

October 27, 2004

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

The Forest Biorefinery
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

The Forest Biorefinery 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

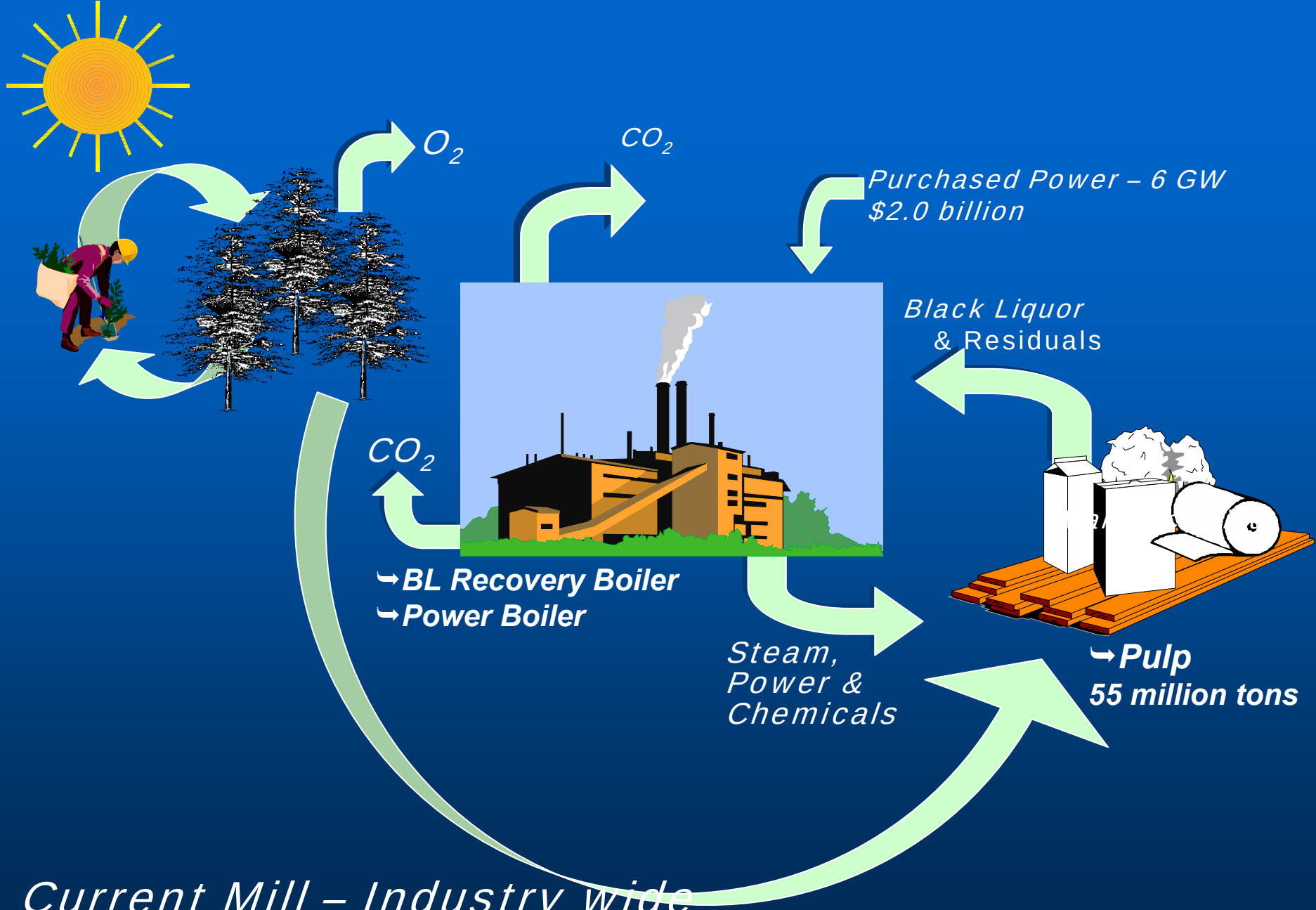
- Add a gasifier and convert spent pulping liquors into syngas
- There are two choices for processing of syngas
  - Power, or
  - Fuel/chemicals
- Both require syngas conditioning
- Convert to polysulfide pulping

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

CO_2

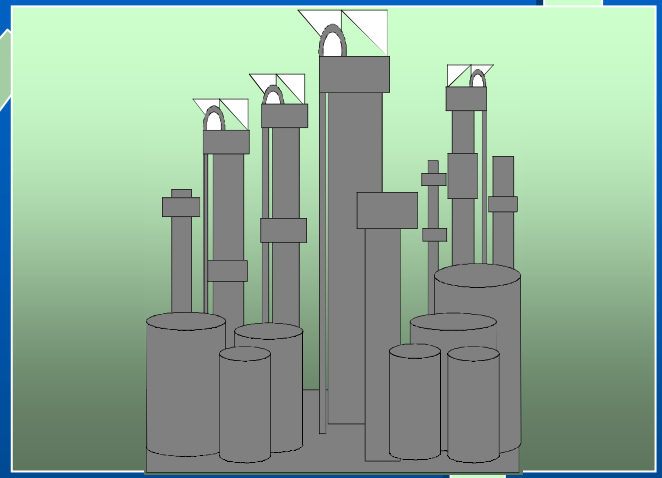
O_2

Power
116 million BOE

Or

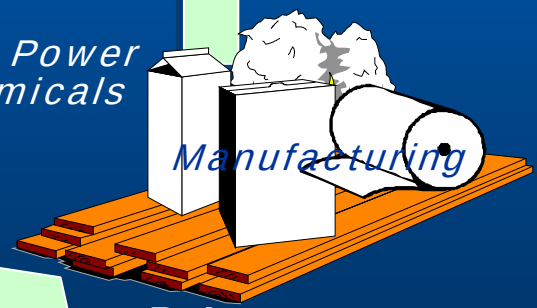
Syngas

Liquid Fuels/Chemicals
109 million barrels



Black Liquor
& Residuals

Steam, Power
& Chemicals



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

➥ BL Gasifier
➥ Wood Residual Gasifier
➥ Combined Cycle System
➥ Process to manufacture Liquid Fuels and Chemicals

➥ Pulp
55 million tons

The Forest Biorefinery – Production

The Forest Biorefinery 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

The Forest Biorefinery 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 green house 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