Advanced Biomass Conversions

Fueling America's Sustainable Future

Overview of Biomass Energy Technologies & Opportunities for Minnesota & Great Lakes Wood Products Companies

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Presentation Overview

- What's Changing for Wood Residue
- Biomass Information Summary
- Conversion Technologies Summary
- Current Options for Wood Processors
- Future Options for Wood Processors

What's Changing (1)

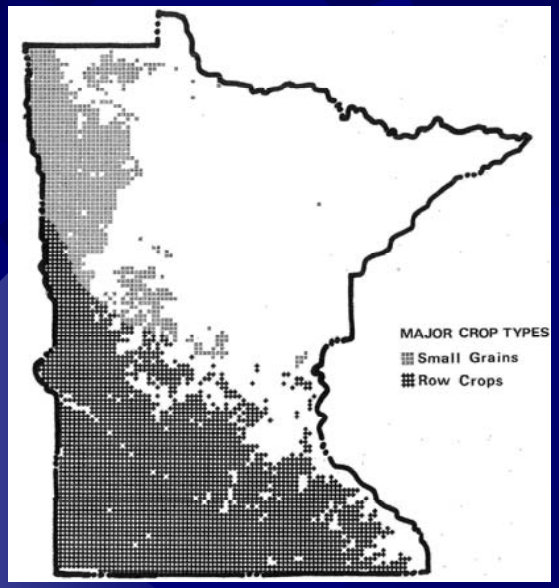
- In 1980 (Previous Energy Crisis)
  - Demand for Wood Products High – Lots of Wood Residue Available
  - Limited Management of Timber Constrained Available Supply
  - Waste Wood Use For Energy Economic for Large Companies
  - True Even After Energy Prices Fell in 1982
  - Small-Scale Use of Wood Waste for Energy Expensive
  - Short Crisis Span (1979-1981) Limited Technology Improvements
  - Wood Waste Disposal Costs Low
  - **Limited Economic Potential for Waste Wood Energy from Wood Processors**

What's Changing (2)

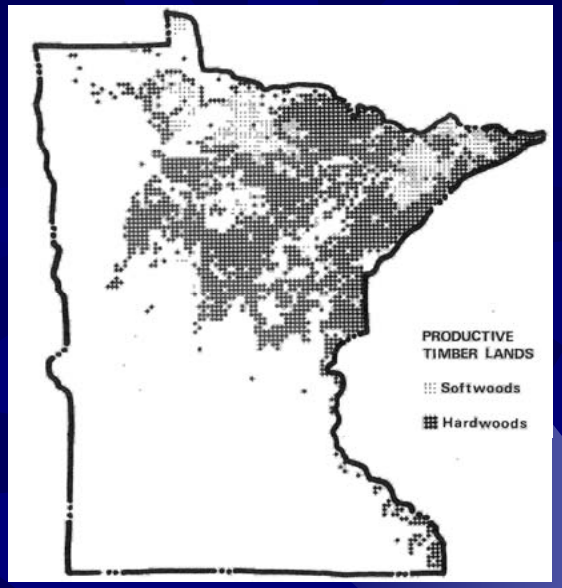
- In 2007 – Current Energy & Climate Crises
  - Demand for Wood Products Still High – Even More Wood Residue Available (Housing Market?)
  - New Potential to Increase Woody Biomass Growth Rates for Products and Energy Use
  - Waste Wood Use For Energy Potentially Economic for Smaller Companies (Higher Energy Price & More Options)
  - Climate Change Concerns Should Keep Energy Prices High and Favor Biomass Energy Demand
  - Small-Scale Use of Wood Waste for Energy Still Expensive, but Paybacks Have Improved
  - Energy/Climate Problems Will Persist – Stimulating New Technologies
  - Wood Waste Disposal Costs Higher?
  - **Increased Economic Potential for Waste Wood Energy from Wood Processors**

Minnesota Biomass Resources

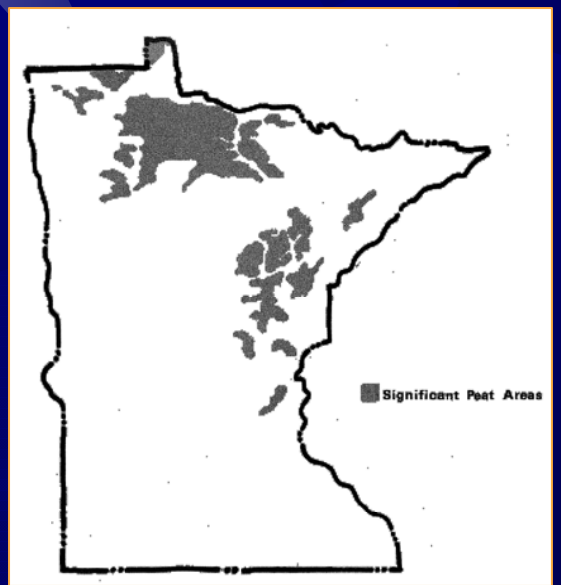
Agricultural Croplands



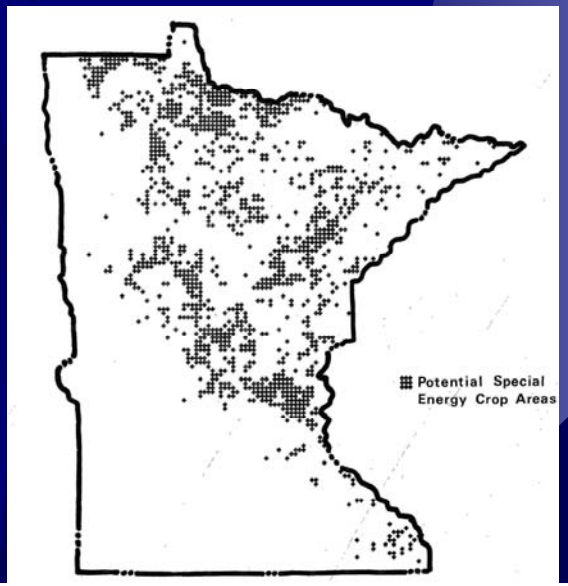
Productive Timberlands



Peat Lands



Available Areas for Energy Crops



Biomass Energy Types – *Minnesota/Upper Great Lakes Region*

- **"Biomass" Definition Includes: ALL Types of Biologically Derived Material Except Fossil Fuels**
  - Wood (Cellulose & Lignin): 7,600-9,600 Btu/lb (Dry)
  - Wood (Cellulose & Lignin): ~ 6,400 Btu/lb (Air Dry)
  - Corn Kernels (Starch): ~ 6,800 Btu/lb (Air Dry)
  - Crop Residues (Cellulose): 4,300-7,300 Btu/lb (Air Dry)
  - Switchgrass (Cellulose): 4,300-7,300 Btu/lb (Air Dry)
  - Municipal Waste (Food & Paper): 4,000-8,000 Btu/lb
  - Peat (Decomposition of Cellulose & Lignin): 8,500 Btu/lb
- **Wood Wastes (w/ Glues/Binders) of Most Interest Here**
  - Saw, Router and Drilling Dusts, Shavings & Fines
  - Unusable/Damaged Lumber, OSB & Particleboard
  - Essentially "Wood" Composed of Cellulose, Lignin but Often with Man-Made Organic Additions

Approximate Wood Energy Content

(Btu = “British thermal unit”: Amount of Energy Needed to Raise One Pound of Water, One Deg. F.)

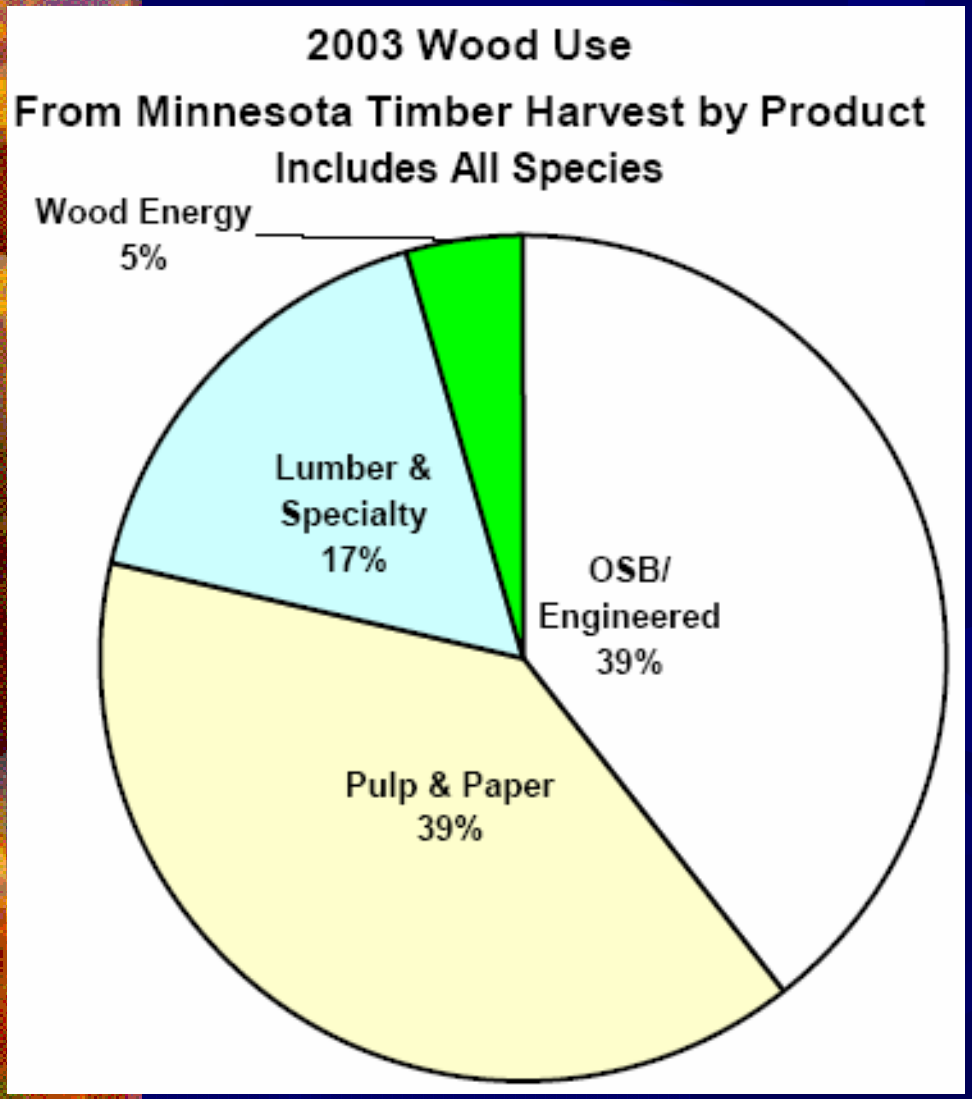
- 1 pound = 6,400 Btu (20% moisture)
- 1 board foot = 38,000 Btu
- 1 cubic foot = 240,000 Btu
- 1 U.S. ton = 13,000,000 Btu
- 1 cord = 19,000,000 Btu

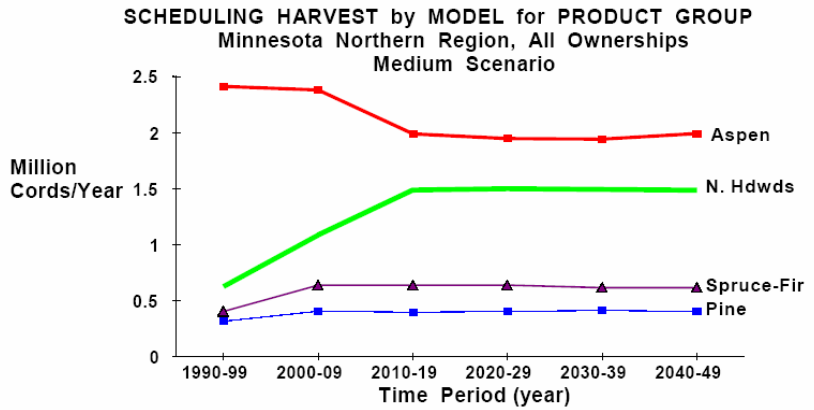
With Perfect Energy Conversion:

- 2.5 ounces of wood = 1 SCF Natural Gas
- 8.5 ounces of wood = 1 KWh Electricity
- 18 pounds of wood = 1 Gallon Gasoline

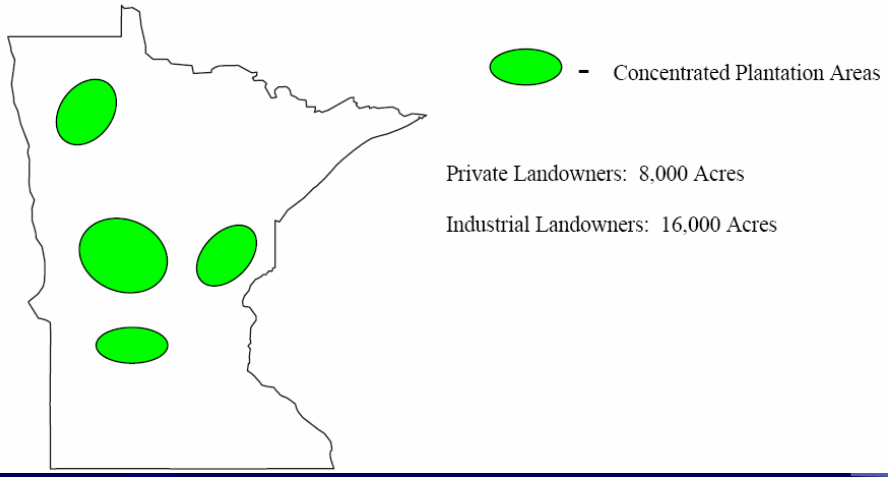
Wood Energy Use & Harvest in MN

(Source Minnesota DNR)





Source : GEIS table 6.8 medium scenario, 2nd run (p210 of M.P. & F. Reso. Base, 12/1992)
Assumptions used : Ownership constraints (riparian lands & old growth forests, etc.)



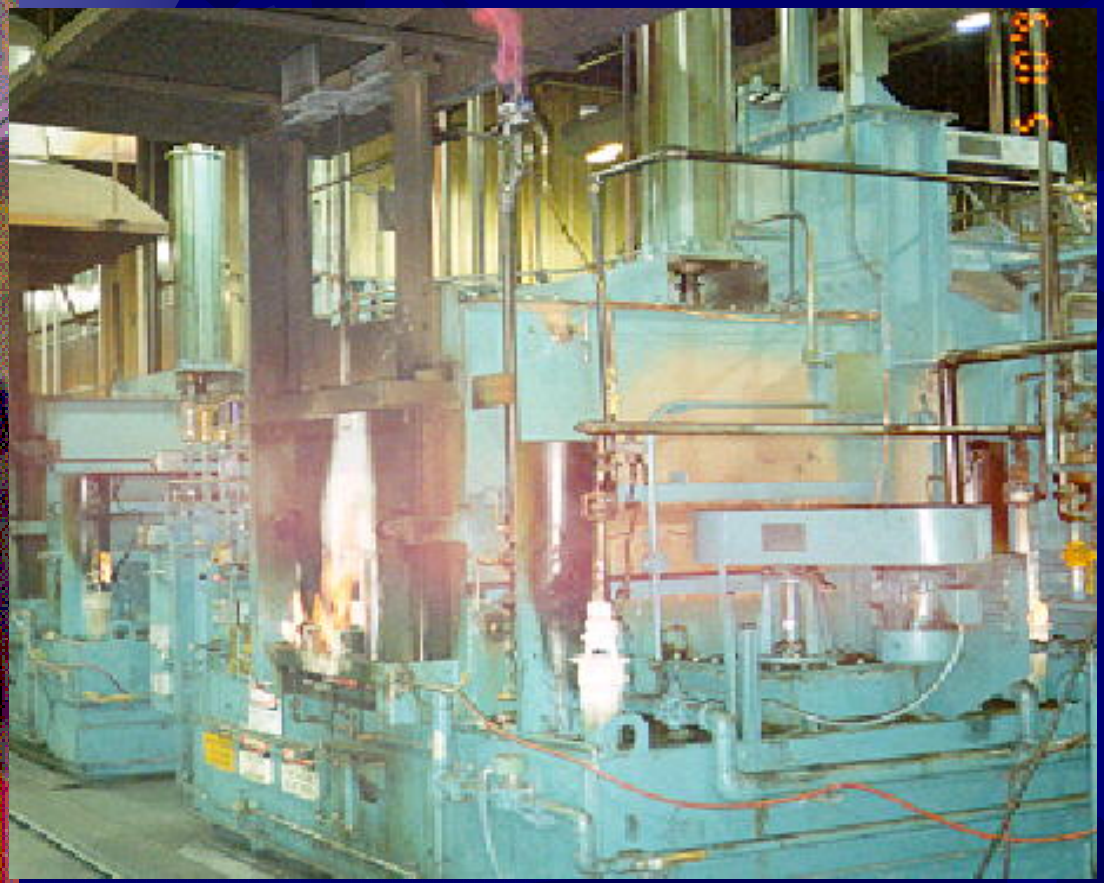
Secondary Wood Processors – *MN Annual Wood Waste Generated*

- "Small" Size – 13 tons/yr. = 170 MM Btu/yr.
  (1,500 Gallons of Gasoline)
- "Medium" Size – 100 tons/yr. = 1,300 MM Btu/yr.
  (12,000 Gallons of Gasoline)
- Largest 25 Firms – 4,000 tons/yr. = 50,000 MM Btu/yr.
  (480,000 Gallons of Gasoline)

Wood Energy Conversion – Some "Real World" Choices

- **Current Technology Conversion of One Pound of Wood**
  - Wood Combustion for Heat: 0-90+%
    - Result: 0 to 5,700 Btu of Heat
  - Wood to Charcoal (Pyrolysis): 15-30%
    - Result: 1.2 to 2.4 Ounces of Charcoal
  - Corn to Ethanol (Fermentation/Distillation): 20-40%
    - Result: About 1/40 Gallon of Ethanol
  - Wood to Ethanol (Biochemical): 25-30% Cellulose, 0% Lignin
    - Result: Less than 1/40 Gallon of Ethanol
  - Wood Gasification (Thermal/Chemical): 70-80%
    - Result: 4-8 SCF of Natural Gas Substitute
  - Wood to Methanol (Thermal/Chemical): 50-60%
    - Result: About 1/16 Gallon of Methanol

Unfortunately - Thermo-Chemical Gasification & Liquefaction Processes Need to be Large at Present



- Gasification
  - IGCC Coal (Mesaba Power)
  - Beulah Syngas (ND)
- Liquefaction
  - Petrochemical Reforming
  - Sasol Synthetic Fuel (SA)
  - Natural Gas Methanol Production

What's Really Practical Now (1)

- Small Processors - Transport to Offsite Conversation Facilities
  - Investigate Use for Wood Products First
  - Biomass-Fired or Cellulosic Fermentation Facilities
  - Larger Biomass-Fired Electric & Steam Plants
  - Regional Biomass Thermochemical Plants (Under Development)
  - Wood Processor Owned Facility Possible (Twin Cities Area)
- Individual Wood Processor Company Requirements
  - Cost-Effective Pre-Processing & Storage for Transport
  - Densification
    - Pelletizers or Briquettors
    - Owned, Rented or Through a Mobile Service
  - On-Site Dry Storage Location
- Costs and Benefits
  - Relatively Low Capital
  - Labor Costs per Ton May be High
  - Prices Should Increase with Time ($40/ton or More)

What's Really Practical Now (2)

- Medium and Large Processors - Direct Combustion for Heat Onsite
  - Investigate Use for Wood Products First
  - Boiler for Process Steam or Hot Water
  - Space Heating (Seasonal Use, Increased Storage Required)
- Individual Wood Processor Company Requirements
  - Cost-Effective Pre-Processing & Storage
  - Densification
    - Likely Needed
    - Densifier Depends on Equipment
    - Equipment Likely Owned
  - On-Site Dry Storage Location
  - Purchase and Installation of the Combustion System
- Costs and Benefits
  - High Initial Capital Cost
  - Labor Costs per Ton May be High
  - Reasonable Payback and Savings Should Increase with Time
  - Ability to Purchase Other Producer's Residue (Estimate at $40/ton)

In the Near Future (5-10 Years)

- Large Processors - Direct Conversion to Fuels or Power Onsite
  - Small Scale Wood Gasifier to Produce:
    - Natural Gas Substitute to Use with Existing Heating Systems
    - Alcohol or Hydrocarbon Fuels for Company Vehicles
    - Hydrogen for Fuel Cell Production of Electricity
  - New Technologies for Wood Residue Use in Products
- Individual Wood Processor Company Requirements
  - Same as Now
- Costs and Benefits
  - High Initial Capital Cost
  - Labor Costs Low
  - Payback and Savings Should Be Very Attractive
  - Significant Reduction in Purchased Energy

Thank You For Listening!