

# The Biorefinery in New York: Woody Biomass Into Commercial Ethanol

*Implementation Will Come Through  
Multi-Institution Collaboration*

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# Outline:

## 6 Ws

*What, Where, When, Why, Who, How*

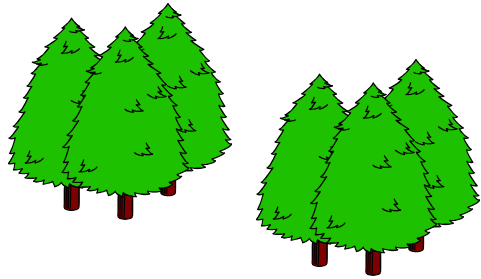


# What:

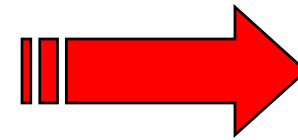
*Biorefinery in New York - Enhancing the speed to application of a new technology by erecting a virtual enterprise from multiple companies with much to gain in their core businesses from the parts of the novel technology that look easy to them.*



# What - The Wood-Based Biorefinery



Biomass  
Feedstock



Renewable,  
Sustainable  
Bioproducts:  
*Fuels, Chemicals,  
Materials*

*Renewable Resources to "Green" Bio-Products*

# What:

*Wood Growing, Procurement, Chipping,  
Chemical Processing - Pulp and Paper  
Willow Biomass Growing, harvesting,  
Burning - Farmers/Wood Fuel Industry  
Fermentation of sugars to products and  
marketing - Ethanol Industry*



# Where:

*Conventional Wood Processing for Pulp in  
Ticonderoga NY*

*Biomass Willow - New York Field Trials in  
Tully NY and Lyon Falls NY*

*Fermentation of Sugars in Fulton NY*



# When:

*In the next year*

- Extraction of wood sugars at ESF Pilot*
- Burning of Extracted Wood at Lyonsdale*
- Ethanol from Wood Sugars at ESF Pilot*
- Northeast Biofuels reconfiguration*



# When:

*Over the next two years*

- Extraction of wood sugars at Ticonderoga*
- Burning of Extracted Wood at Lyonsdale*
- Ethanol from Wood Sugars at NEB, Fulton*



# When:

*Over the next three years*

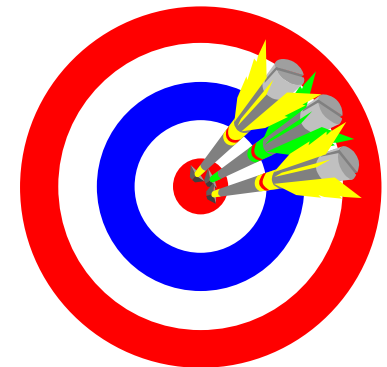
- Commercial Scale Extraction of wood sugars at Ticonderoga and shipping*
- Extraction and Burning at Lyonsdale*
  - Ethanol from Ticonderoga and Lyonsdale*
- Wood Sugars produced at Northeast Biofuels*



# Why - Targets for a National Biobased Industry

Bio-Product	Current	2020	2090
Liquid Fuels	1-2%	10%	50%
Chemicals	10%	25%	>90%
Materials	90 %	95%	99%

NRC Report - 2000



# Why - Paper Industry

- Paper Industry - Cellulose for Paper and Lignin for Energy yields low profitability
- Insert a new process in front of the digester to extract hemicellulose and convert to ethanol, PHA's etc. recover acetic acid and enhance energy efficiency
- Estimated Profit increase for complete Paper Industry application is \$3.3 Billion per year (Thorp - PIMA '04 Presentation)
- Total estimated at 1.9 Billion gallons ethanol and 600 Million gallons acetic acid for industry wide application



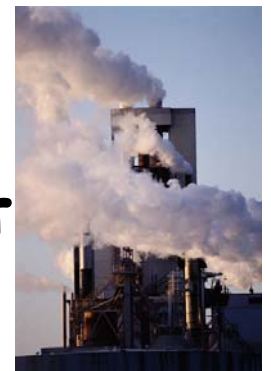
# Why - Wood Burning Industry

- Wood burning industry - Marginal Economics and only lowest quality wood economic
- Evolutionary Change - Wood cost at \$40-80 per dry ton (\$0.02-0.04/dry pound) and extraction at 15% of mass with 2/3 as sugars and 1/3 as acetic acid/extractives
- Sugars at \$0.07/pound and acetic acid/extractives at \$0.30/pound -  $.046 + .10 = \$0.146/\text{lb}$ . produces value for the 300 pounds extracted from  $\frac{1}{2}$  to all of the wood cost
- Residue burned with cost reduction greater than the 15% of mass lost
- Biomass Willow an economic fuel crop



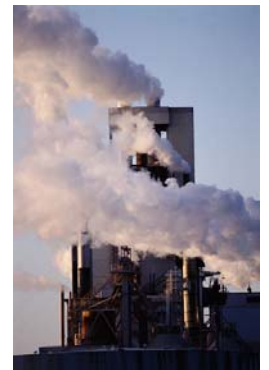
# Why-Wood Sugar Ethanol Production in Fulton New York

- New York Corn for Dairy Use - Most commodity corn shipped from Mid-West.
- Corn Market Price fluctuation are a serious business risk
- Sugar source diversification has beneficial short term and long term impact on business model
- Wood sugars locally grown and lower in cost
- Adjacent to Tug Hill Plateau with abundant low cost hardwood forests and Ontario Lake Plain with excellent Biomass Willow growing potential



# Who

- International Paper Ticonderoga NY
- Lyonsdale Biomass in Lyons Falls NY
- Northeast Biofuels in Fulton NY
- The Glue to get them to stick:  
SUNY College of Environmental Science and Forestry, SUNY Center for Sustainable and Renewable Energy, Syracuse Center of Excellence in Environmental and Energy Systems.
- Case-New Holland USA- a critical industrial partner in Biomass Willow harvesting equipment development.





## How

- Fractionate Woody Biomass with a low cost and environmentally preferable system that preserves current uses
- Obtain a low cost easy to clean up sugar stream
- Process advantageous for Hardwoods
- Easy separation of valuable co-products



# How

- Use water as the solvent
- Use Membrane Technology
- Commercialize pentose fermentations
- Use conventional wood chips and preserve structure in process
- Use membrane and filtration technology

# Biorefinery Core Competencies

- Feedstock Selection (Fast Growing and, perhaps Low or High Lignin/hemicellulose)
- Biodelignification (fungi, enzymes)
- Cellulose, hemicellulose, and lignin separation yielding “usable” fractions (ESF Process)
- Cellulose, hemicellulose and lignin applications
- Waste and energy recovery
  - Gasification *for new products*



# Conclusions

- 🚀 Wood holds great promise as the "*Biorefinery*" feedstock of choice.
- 🚀 Cellulose, Hemicellulose, and Lignin will all enjoy broad utilization.
- 🚀 Advances in separations systems, biotechnology, biomass gasification, silviculture, and agro-forestry will establish the 21<sup>st</sup> century and beyond as the "Age of Wood".
- 🚀 We need to start with the low hanging fruit.



# The Coming Age of Wood

*Egon Glesinger, 1949*

.... forests can be made to produce fifty times their present volume of end products and still remain a permanently self-renewing source for raw materials.....

Only forests - no other raw material resource - can yield such returns. The forest can, and so must, end the chronic scarcities of material goods that have harassed man's experience since the beginning of history.





# The Biorefinery in New York: Woody Biomass to Ethanol

Thank You

# Future Industrial Connections

- Paper Industry - Cellulose for Paper and Lignin for Energy with Hemicellulose and extractable such as acetic acid, turpentine, fatty acids etc. for New Materials
- Wood burning industry - Lignin as Fuel and all other components for New Materials
- Purpose-built Biorefinery - All components available for New Materials
- Technology appropriate may well differ depending on the industry
- Waste and energy recovery
  - Gasification evolution has begun

