

# Wood-Based Biorefinery: Conversion of Cellulosic Biomass to Ethanol

and to Chemicals and Energy

--Syracuse, Smooth Rock Falls, Cazenovia--  
Stakeholders Presentation --

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## ESF Biorefinery Initiative

- In Paper and Bioprocess Engineering -
- Drs. Amidon, Liu, Ramarao, Francis, Lai, Scott, Biljanovic
- Other Departments - Drs. Volk, Stipanovic, White, Abrahamson, Winter, Nakas
- Many Others: from other faculties
- DOE, DOI, NSF, NASA, NYSERDA, NYS - Graduate and Undergraduate Students
- Empire State Paper Research Institute
- Biorefinery Research Institute

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# Outline

- Overview
- Hot-water Extraction
- Fractionation
- Ethanol
- Applications
- My Conclusions

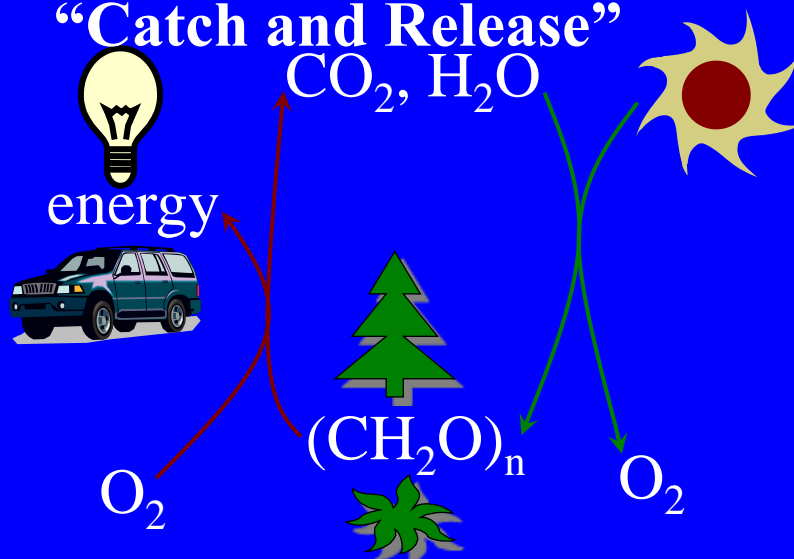
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## Overview: Renewable –

### “Catch and Release”

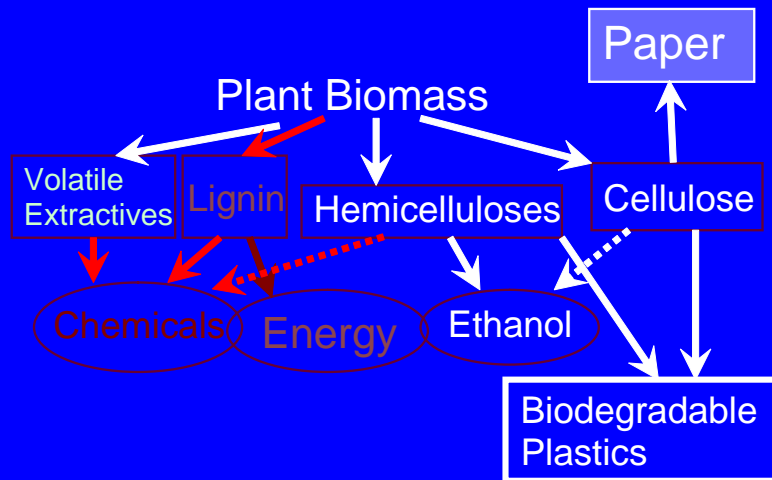


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## Overview



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## Biorefinery Overview

- Extraction (prior to Pulping or Burning)
- Fractionation of Wood Extracts
- Fermentation (for sugars and minor)
- Purification
- Pulping and Papermaking or Pellets, chipboard, flake/strandboard, fiberboard
- Burning/Gasification - CH&Power or FT

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## Hot-Water Extraction – Why?

- Abundant
- Safety, Environmental, Reuse
- Catalyst Use
- Product Value Preservation
- Product Separation Ease
- Membrane technology

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## Fractionation Products

- Acetic Acid
- Acetates
- Hexoses, Pentoses
- Oligomers
- Lignin fragments
- Furfurals
- Wood chips (Changed)

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# Ethanol Fermentation

- Micro-organism
  - Natural Strains: *Candida Shehatae*, *Yamadazyma Stipitis*, etc.
  - Recombinant Strains: *E-Coli*, *S. Cerevisiae*
- Anaerobic vs. Aerobic
  - Cell growth
  - By-products
- Other fuel chemicals
  - Hydrogen; Butanol; Propanol; ...

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# How

- Hardwoods are advantaged – Including Biomass Willow
- Use water as the solvent
- Use Membrane/Filtration Technology
- Commercialize pentose fermentations
- Use conventional wood chips and preserve structure in process
- Co-feed Biomass crops/Ag. Residuals

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## Future Industrial Applications

Paper Industry - Cellulose for Paper, Lignin for Energy with Hemicellulose for New Materials

- Wood burning industry - Lignin as Fuel and all other components for New Materials
- Wood Products industry - extracted wood for reconstituted wood products and composites?
- Purpose-built Biorefinery - All components available for New Materials
- Technology will differ for each industry
- Biomass Willow Growth and Gasification energy recovery - Has begun



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## MY Conclusions

- Biorefinery: a strategic direction to Energy and Chemicals
- ESF Biorefinery: water-based technology, Hwd applications are a near term advantage
- Essential components: Extraction; Fractionation; Fermentation; Pulping; Bleaching; Papermaking; Or Reconstituted Wood Products, Or Burn/Gasify, Pellets
- Some Investments ready now

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