

# Ongoing Small Diameter Utilization Research Projects

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# FPL Organization

- **7 Research units, 2 pioneering scientists**
- **Economics & Statistics (Skog & Evans)**
- **Engineered Properties & Structures (Green & Ross)**
- **Composites Sciences (Winandy)**
- **Institute for Microbial & Biochemical Sciences (Jeffries & Illman)**
- **Durability & Wood Protection (TenWolde, White, Clausen)**
- **Forest Materials Modification (Williams, Rowell, Frihart)**
- **Fiber & Chemical Sciences (Rudie, Zhu)**
- **Atalla and Rowell are pioneering scientists**

# Research Programs

- **Lumber, including engineered wood composites**
- **Biorefining**
- **Pulping**
- **Economics**
- **Energy**

# Lumber and Engineered Wood

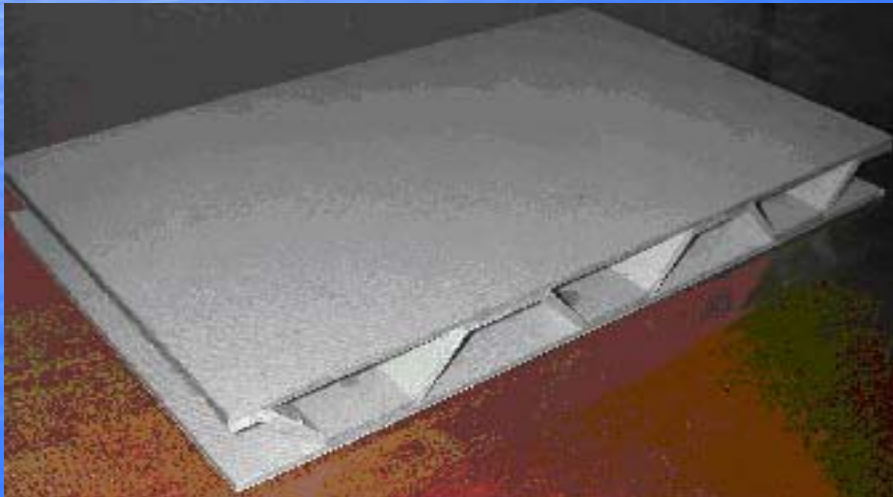
- **Grading and evaluation of properties**
- **New products and processing**
- **Units**
  - **Composites Sciences Research (Winandy)**
  - **Engineered Properties and Structures (Ross)**

# Composites Science Research

- **3D Engineered Fiberboard**
- **Laminated I-joists**
- **WPC from invasive species**
- **Protein-Based Soy adhesives**

# 3-D Engineered Fiberboard

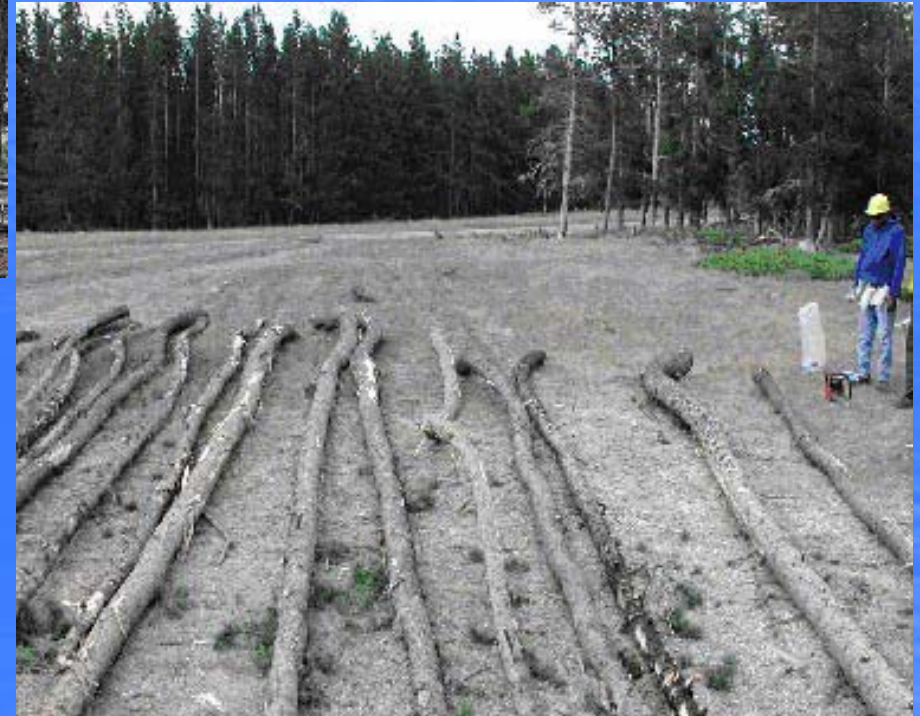
- **New processing methods to better utilize small diameter and underutilized species**
  - **Whole tree fiberization**
  - **Fibers used to create 3-D structural panels**
  - **Wet formed mats, formed over 3D pressing molds**



# Lam I-Joists

- **New processing methods to better utilize small diameter and underutilized species**
  - **Curve sawing of curved pine (2%)**
  - **Microwave drying and straightening**
  - **Processed into 2 by 4 studs, then converted into laminated I-beam**

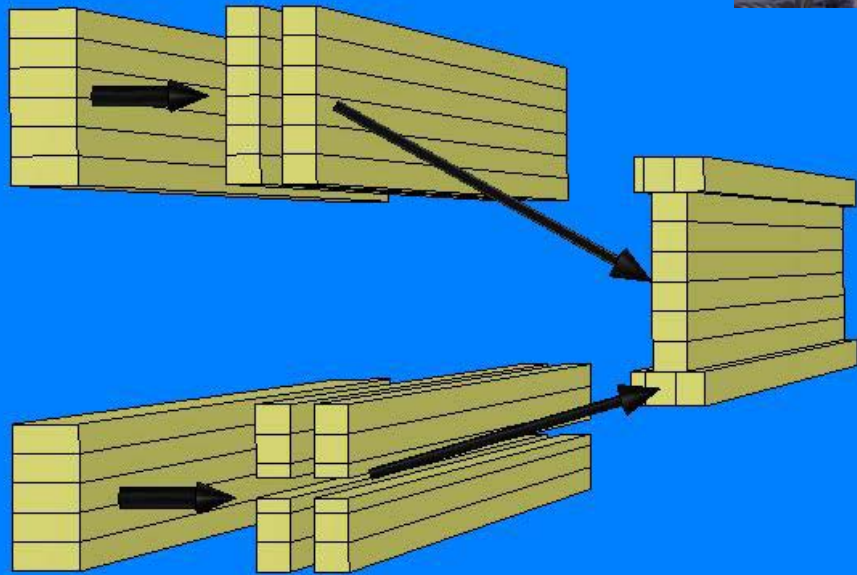
# Curved Pine – Curved Logs



**Big Horn National Forest**



# Laminated I-joists



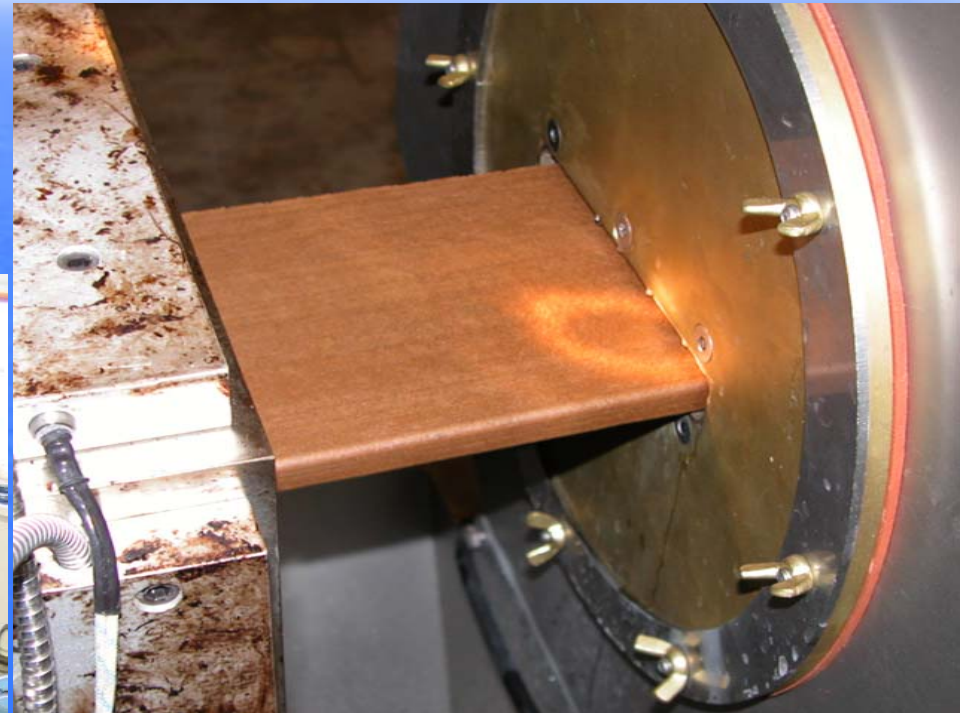
# Value-added Biofiber Composites

- Salt-cedar
- Juniper
- Chicken-feather  
Fibers
- Guayule Bagasse
- Kenaf
- Sugarcane  
Bagasse



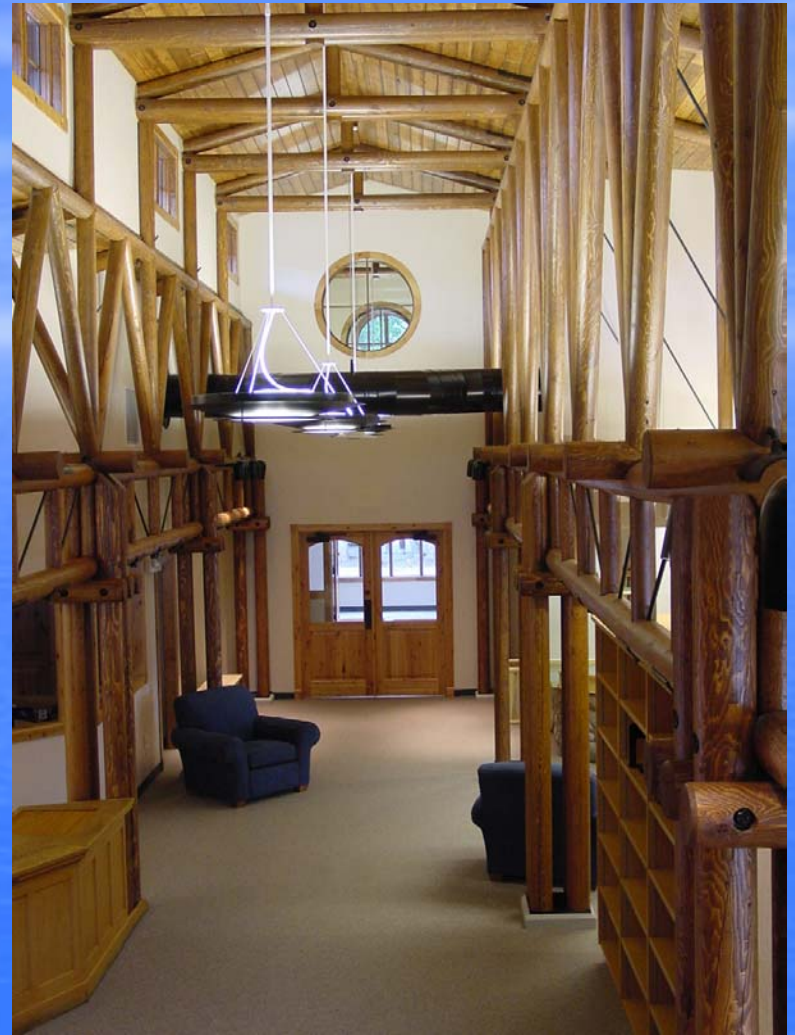
Chicken-feather fiber MDF

# New biofiber-plastic composite extruder used for research on utilization of exotic/invasive species & small diameter trees



# Engineering Properties

- **Improved use of ponderosa pine in glulam beams**
- **Structural grading of lodgepole pine logs**
- **Use of ponderosa pine in guardrails**

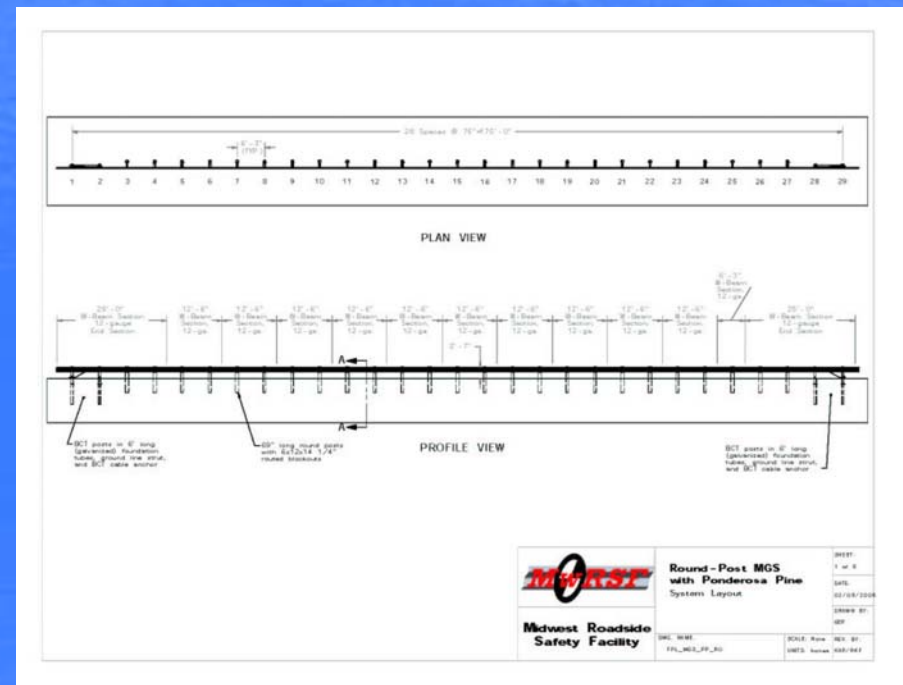
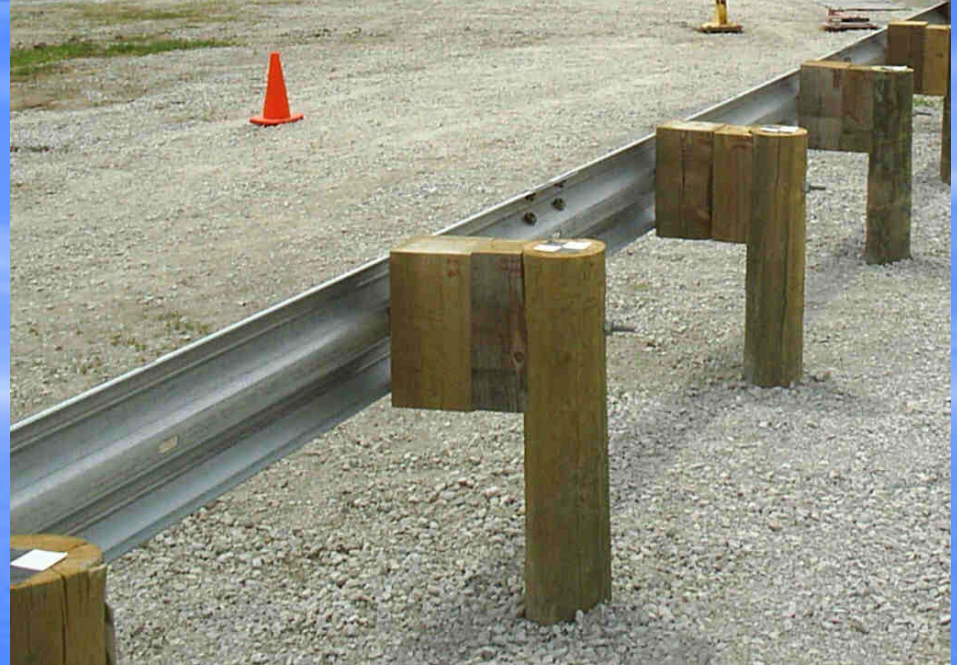


**15 engineered roundwood  
structures**

**Glulam standard approved AITC**

# Guardrails

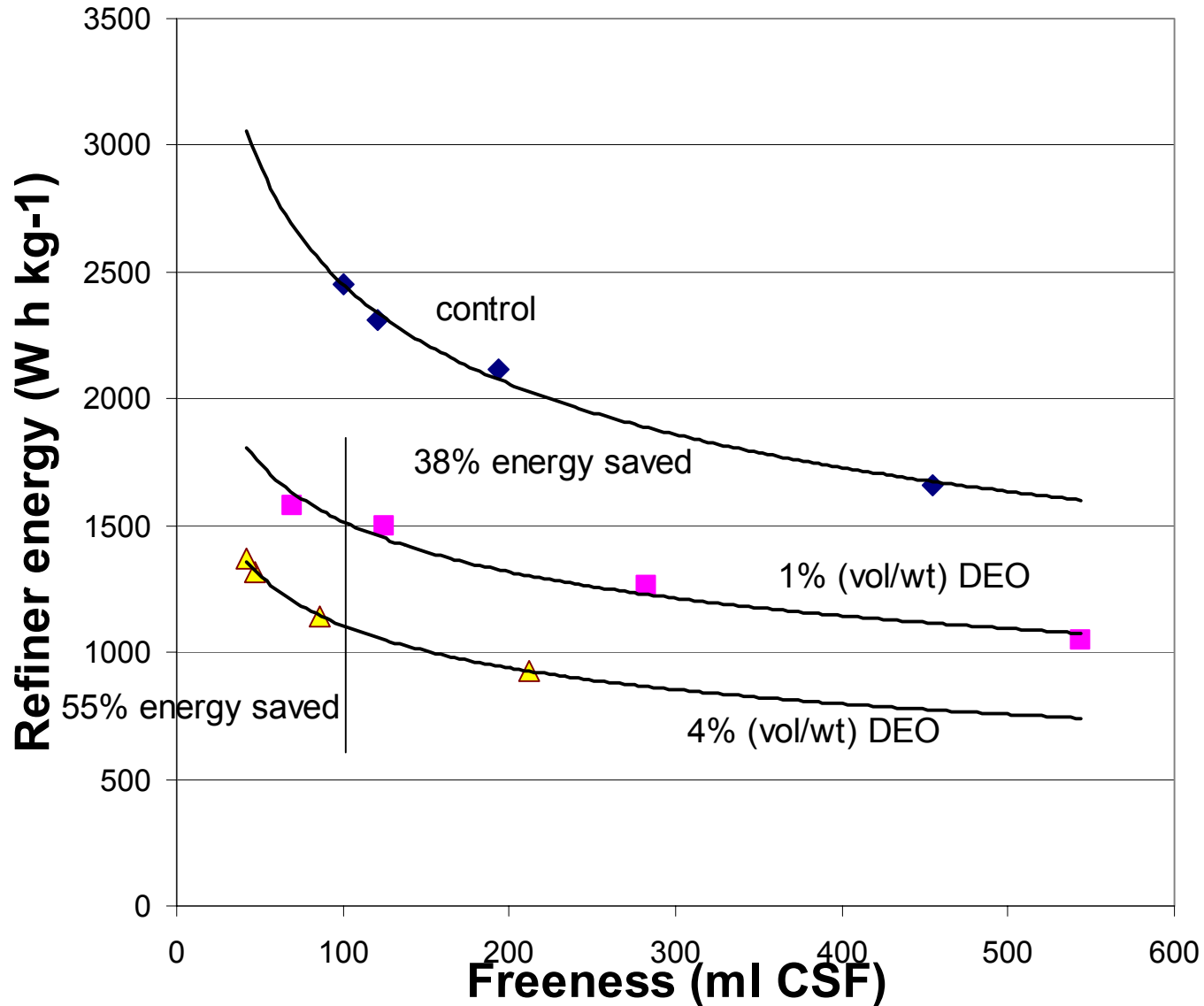
- Completed property assignment and evaluation of 3 species, DF, PP, SP
- Completed full scale crash test of ponderosa pine
- Full-scale crash test of DF scheduled for end of month



# Biorefining

- **Developing newer, more efficient pretreatment systems using diethyl oxalate (Kenealy)**
  - Saves energy in TMP
  - Produces stronger paper
  - Provides fermentable sugars
- **Yeast biocatalyst development (Jeffries)**
  - sequenced the *P. stipitis* genome
- **Metabolic pathway engineering (Jeffries)**
  - Array analysis, modeling, transformation
  - and multi-gene expression technology

# Energy savings-Pine

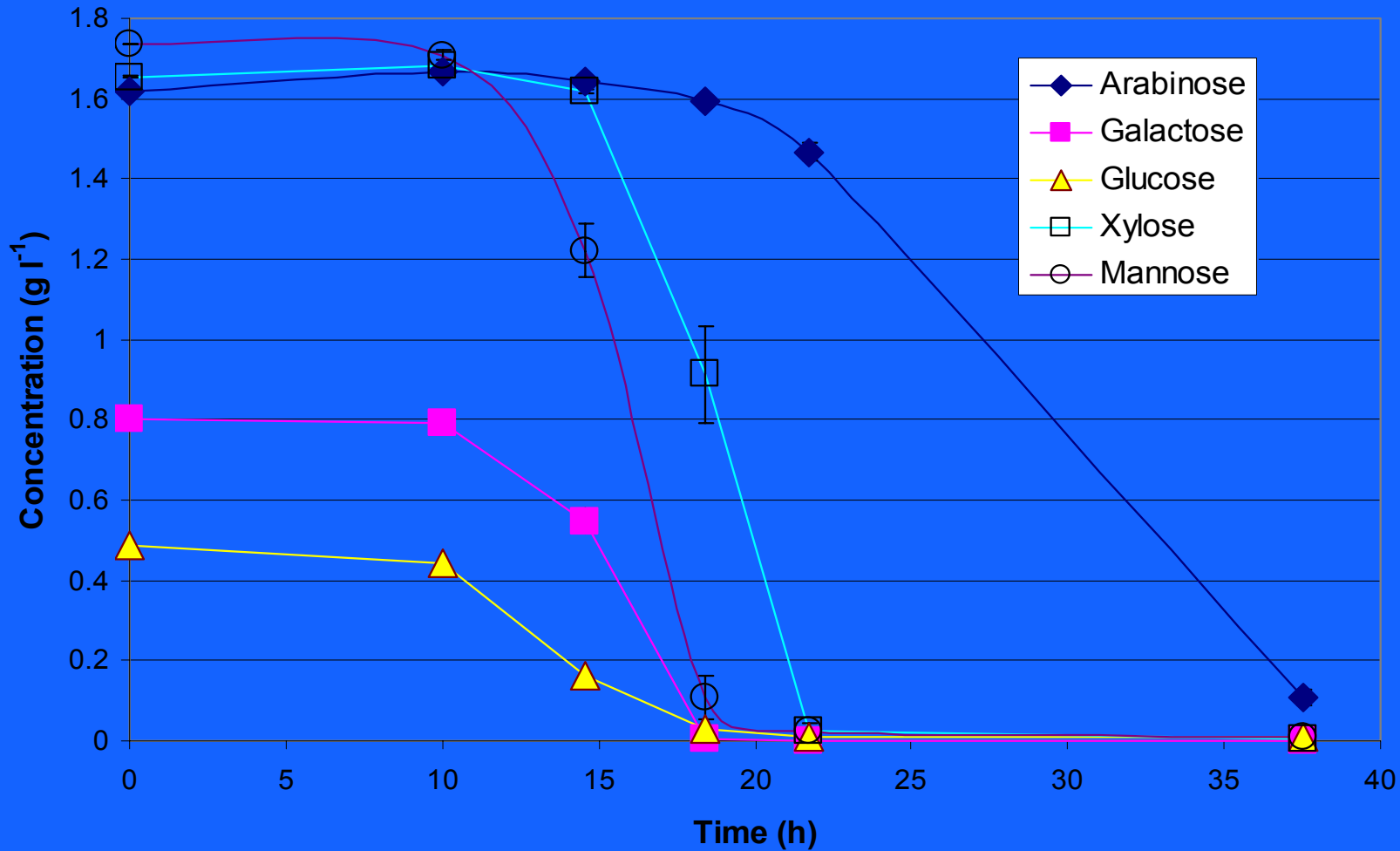




# Handsheet properties

| Conditions |         | ISO % | Opacity | Scattering |
|------------|---------|-------|---------|------------|
| Pine       | Control | 44.7  | 94.4    | 39.5       |
|            | 1 DEO%  | 45.2  | 96.6    | 45.5       |
|            | 4 DEO%  | 46.1  | 98.8    | 62.3       |

*P. stipitis* Shake flask experiment pH adjusted, YNB added



| Sugars (from pine)                 | Arab | Gal | Glu | Xyl | Man |
|------------------------------------|------|-----|-----|-----|-----|
| % monosaccharide                   | 89   | 38  | 25  | 56  | 30  |
| % total used- <i>P. stipitis</i>   | 80   | 45  | 66  | 93  | 48  |
| % total used- <i>S. cerevisiae</i> | 5    | 46  | 44  | 6   | 35  |

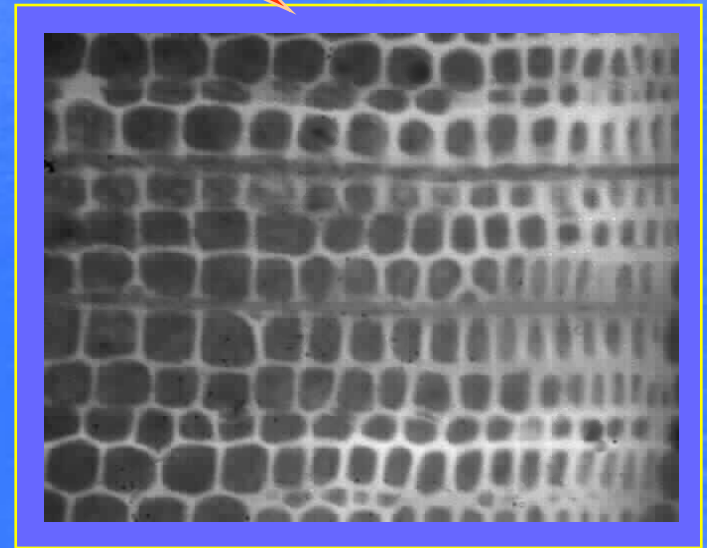
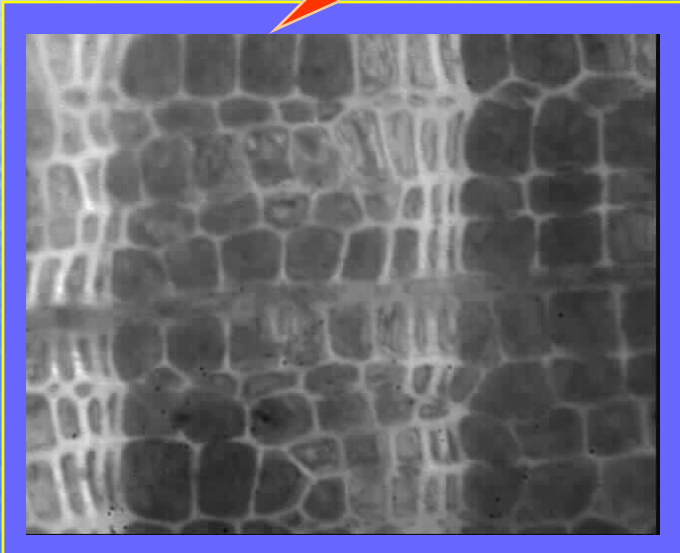
# FPL has 1, 10, 60 and 300 L instrumented bioreactors



# Pulping Small Diameter

- **Fundamental properties**
- **Pilot scale studies**
- **Commercialization at pulp mill**
- **JY Zhu and many partners such as Ponderay Valley Fiber, Eini Lowell, etc**

# Background



# Industry Pilot Scale Study

- **Using mill normal chips (PNC)**
- **Mixed with 25% Suppressed growth chips provided by PVF off Colville NF**
- **Refining at Andritz (Springfield, OH) facility**
- ***TAPPI J. 5(4), 2006***
- **Equivalent or better pulp were obtained**

# The Residual Chip Trials

## Trials I

- 30% substitution of mill residual chips
- Control: 70% residual chips + 30 whole log chips
- 8 hours

## Trials II

- Control: 70% residual chips + 30 whole log chips
- 50% substitution of mill residual chips
- < 2 hours

## Summary

- Equivalent or better TMP produced when thinning materials substituted for normal mill chip
- Equivalent or less energy were used during mill trials

# Economics (Skog)

- **Fuel Treatment Evaluator**
  - **Simulates uneven-aged and even-aged silvicultural treatments on timberland in 12 western states**
  - **Simulates treatment to reduce forest fire hazard to specific target levels and identifies volume of biomass removed, harvesting costs and estimated biomass revenue**



# Energy

- **Gasification strategies being studied**
- **5kW BioMax system attached to demonstration house, 15, 25, and 50kW systems developed, ready to deploy**
- **Woody Biomass Utilization Grant program for lowering NFS cost/acre**
  - **Assessment of impact of grant program on regional cost reductions to NFS (Bilek)**

## How to Get the Program

“Wood Fueled Boiler Financial Feasibility” is a simple spreadsheet program designed for a personal computer. Both the program and the instruction manual can be downloaded from the following web site:

[http://forest.wisc.edu/fe\\_publications.htm](http://forest.wisc.edu/fe_publications.htm)



**WOOD FUELED BOILER  
FINANCIAL FEASIBILITY  
USER'S MANUAL**



**UW**  
**Extension**

**THIS MANUAL WAS PREPARED BY**

Funding for this manual was provided by  
the **USDA Forest Service State** and

**Private Forestry, Morgantown, West Virginia.**

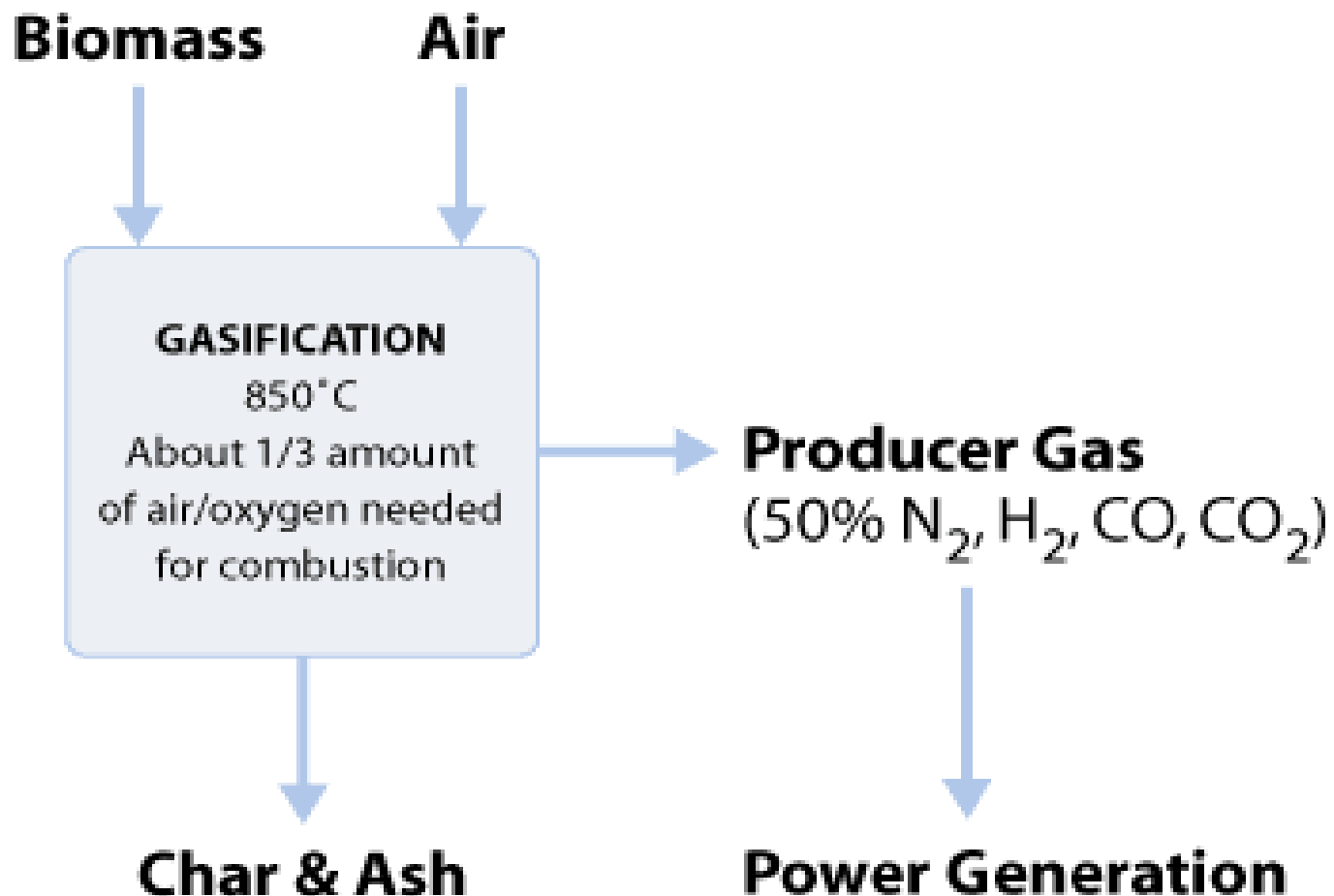
# **BioMax 5, 25, 50 kW Combined Heat and Power System**



Utility-grade heat  
and power for  
homes, small  
enterprises, and  
rural villages

## Small Modular Applications

# Biomass Gasification via Partial Oxidation (Auto Thermal)



# Biomax 50

- 50 kWe combined heat and power
- Thermal energy for heat
- Thermal energy for absorption chiller
- Electricity: 8.1 liter GM turbocharged stationary engine with genset
- 24/6 operation
- No additional staffing
- transparent
- Seeking funding for other prime movers
- 1.5 tons/day green chips consumption



**BioMax 50**

VENTX PRO

# Biomass Energy Technical Hurdles

- **Operational and economic viability**
- **Feedstock integration**
- **System automation**
- **Securing permits in US markets**
- **Commercialization**
- **Demonstrations Mt Shasta, CA; Big Bear Discovery Center San Bernardino, CA; MWCC Daycare Center**

# QUESTIONS?

