U.S. Department of Energy
Energy Efficiency and Renewable Energy

Forest Products Portfolio Strategy

Drew Ronneberg

Industrial Technologies Program

April 5, 2006

Outline

- Mission and Budget
- Goals
- Opportunities for Improving Energy Efficiency
- Portfolio Focus Areas
- RFPs and the Merit Review Process
- Portfolio Management

Mission and Budget

ITP's Mission: To reduce the energy intensity of manufacturing

What are our resources?

Industrial Technologies Program Funding ($ millions)				
FY03 Approp	**FY04** Approp	**FY05** Approp	**FY06** Approp	**FY07** Request
10.5	**7.4**	**6.2**	**3.7**	**2.8**

- With the reduced budget, we need to:
  - Focus on our core mission and largest opportunities
  - Base our strategy on sound analysis
  - Produce results

Reconciling Public Sector and Private Sector Goals

Program Goals

Maximize Public Benefit

- Reduce the energy intensity of manufacturing process (ITP goal)
- Target savings of natural gas (ITP goal)
- Reduce steam demand by 15% by 2015
- Help enable black liquor gasification
- Help enable the biorefinery

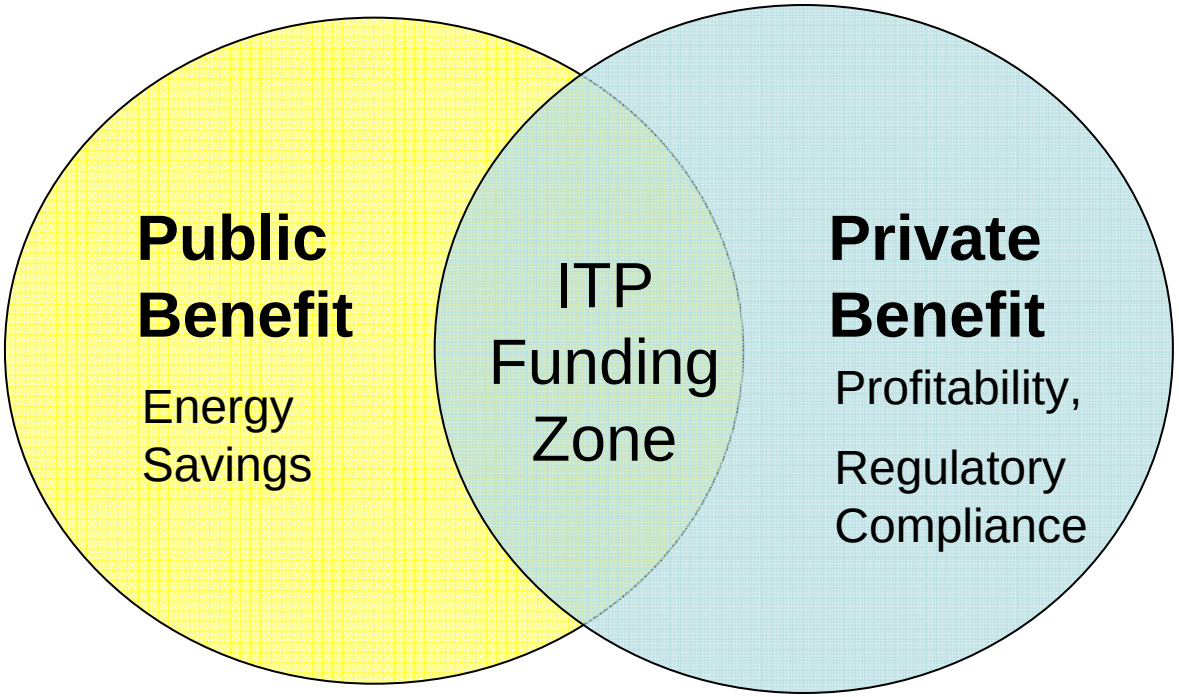
Industry Goals

- Reduce manufacturing costs
- Expand markets for existing products
- Expand markets for new products

Industry priorities are spelled out in roadmaps

Portfolio Goals

Key to a Successful Partnership



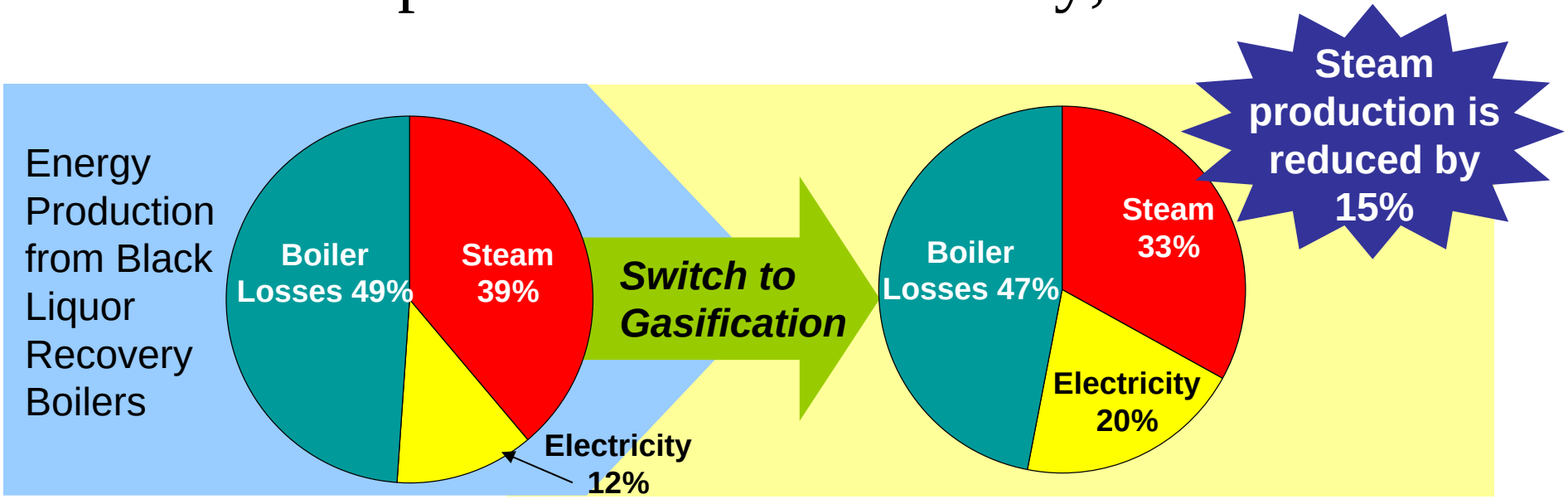
Only commercialized technologies save energy

Goals – Reducing Steam Demand

- Best energy saving opportunity (DOE perspective)
  - Black liquor
  - Natural gas
- Saves money (Industry perspective)
  - Reduces feedstock requirements
- Enables gasification by reducing the “steam deficit”
- Enables better economics for the biorefinery

Portfolio Goals – Reducing Steam Demand

Gasifiers produce more electricity, less steam



Steam loss can be made up by
<u>reducing steam demand or purchasing more fuel</u>

Based on Eric Larsen Study- Cost-Benefit Assessment of Biomass Gasification

Portfolio Goals – Reducing Steam Demand

Enables better economics for the biorefinery

- Allows black liquor to be used for higher value chemicals without purchasing additional fuel for papermaking.
- Makes Value Prior to Pulping schemes more economically attractive

	Without Steam Reduction	**With Steam Reduction**	
Raw Material	Additional Wood	Black Liquor	Hemis diverted from recovery
Cost of Raw Materials for Biorefinery	$50-60/ ton	Approx $0/ton	Approx $0/ton

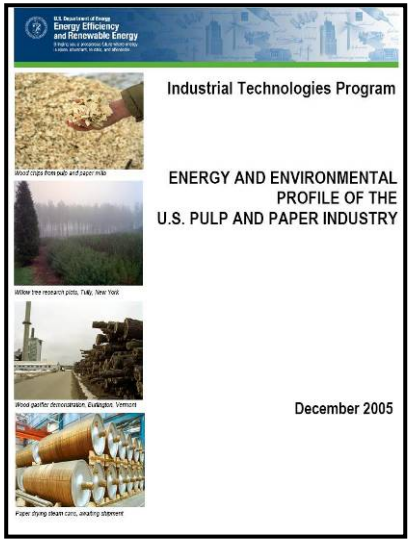
Free feedstock is the most economical feedstock $$$

Energy Savings Opportunity Analysis

Energy Savings Opportunity - Analysis

Energy and Environmental Profile
(provided on website)

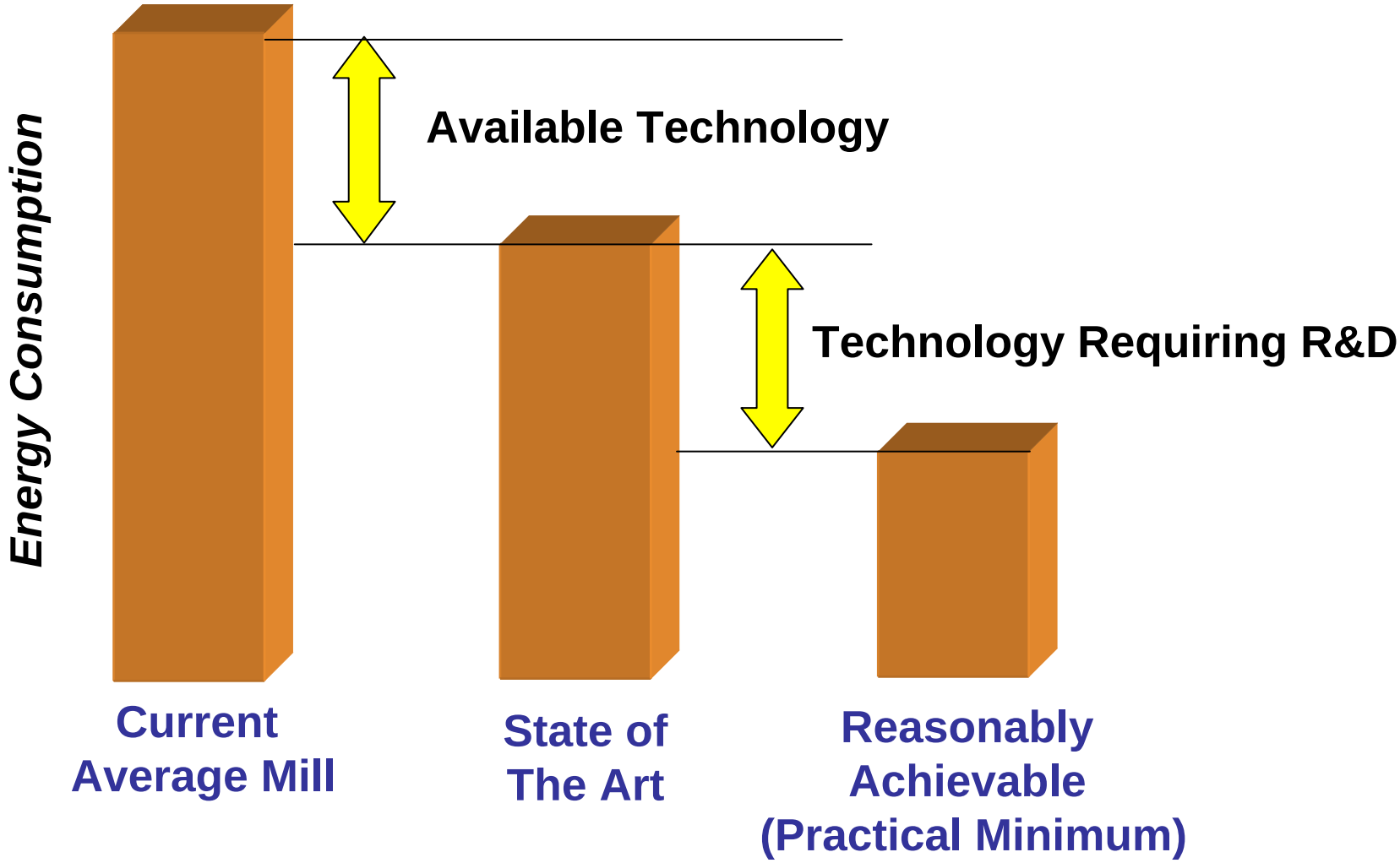
Bandwidth Study
(ongoing – conducted by Jacobs and IPST)



Answers questions:

- What is the average mill's energy consumption by unit process?
- What is the SOA mill's energy consumption by unit process?
- What is a mill's practical energy minimum by unit process?

Energy Savings Opportunity - Bandwidth

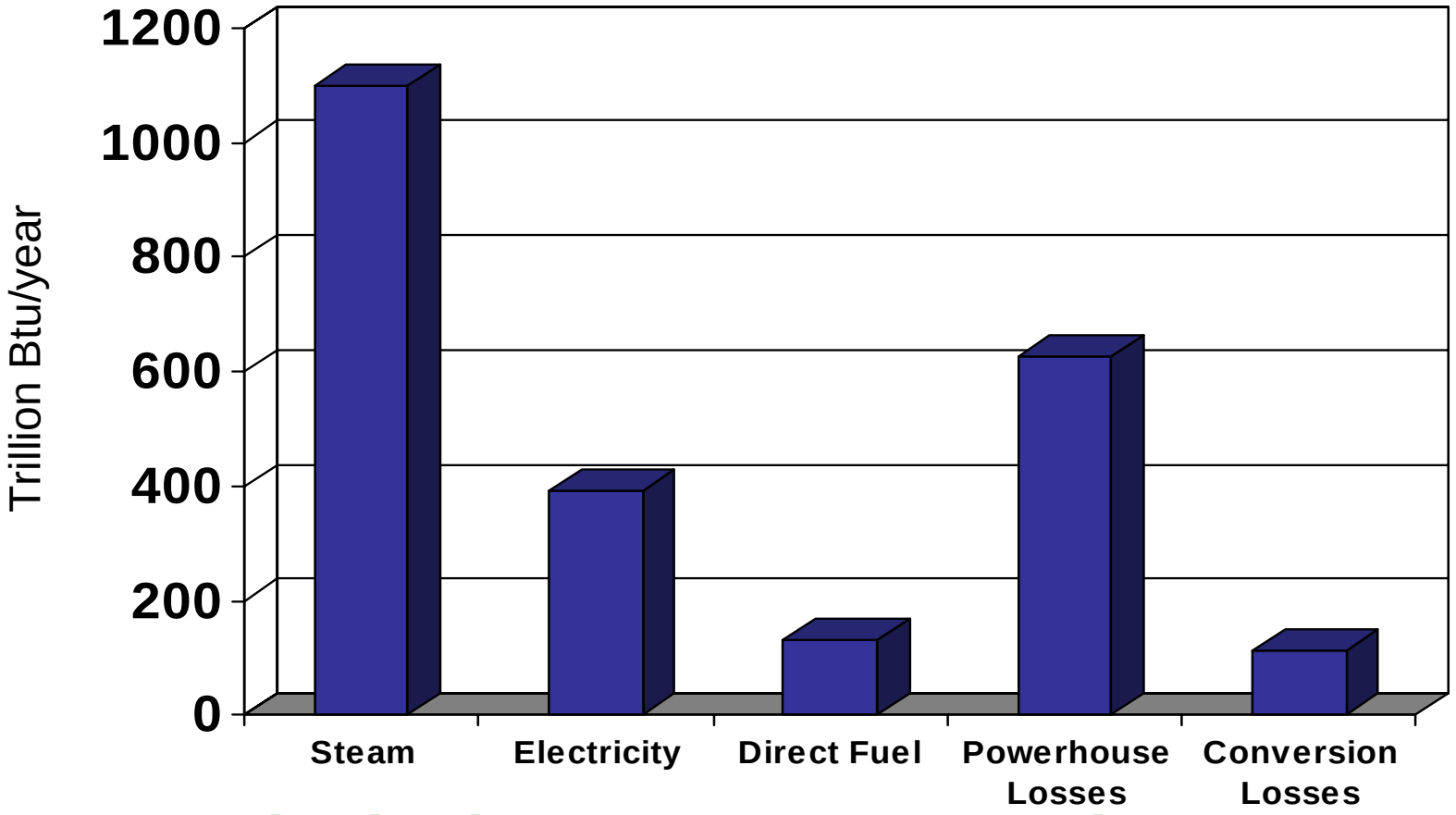


Energy Savings Opportunity

Methods to reducing energy demand

- Reduce steam demand
- Reduce electricity demand
- Reduce demand for direct fuel
- Increase overall efficiency of power house

Energy Consumption in the Pulp and Paper Industry



Steam is the largest energy carrier

Areas of Greatest Energy Savings Potential

- Reduce thermal drying in papermaking by increasing press solids to 70%
- Reduce evaporator load by cooking/washing with less water or devising alternative means of concentrating black liquor (membranes)
- Alternative pulping technologies
- Lime kiln elimination/alternative fuel firing

Portfolio Focus Areas and the Barrier Pathway Model

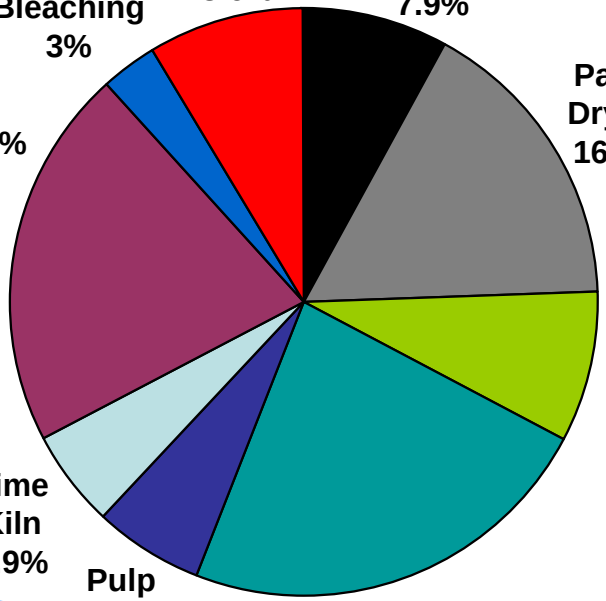
Portfolio Focus Areas

Improved Fiber Recycling

Advanced Water Removal

High Efficiency Pulping

Innovative Wood Drying & Curing



Portfolio Management - Barrier-Pathway Model

Advanced Water Removal

Barriers

- Weak black liquor must be concentrated prior to chemical recovery
- Dewatering technologies are unable to dewater fibrous paper webs beyond 45-50%
- Press rewetting of the paper web prior to drying

Pathways

- Develop non-evaporative technology to concentrate weak black liquor
- Develop a high consistency pulp washer for unbleached pulp to reduce the weak black liquor evaporation load
- Develop a non-evaporative technology that reduces the paper drying load

Metrics (End State)

- Demonstrate a 50% reduction in the weak black liquor evaporation load in a pulp mill field test.
- Demonstrate a non-evaporative technology that dewaters the paper web to 70% dryness and reduces the evaporative drying energy requirement by 40%.
- Technology transfer of R&D results to industry

Priority Portfolio Focus Areas

Advanced Water Removal

Aimed at developing non-evaporative water removal technologies that will reduce the steam load for a pulp and paper mill

- Non-Evaporative Weak Black Liquor Concentration
- High Consistency Pulp Washing
- Non-Evaporative Paper Dewatering

High Efficiency Pulping

Targeted towards developing technologies that will reduce the energy intensity of chemical pulping

- Reduce Energy-Intensity of Kraft Pulping
- Develop alternatives to Kraft Pulping
- Lime Kiln Elimination

Portfolio Focus Areas

Innovative Wood Drying and Curing – Aimed at the development of wood products drying, curing, and VOC mitigation technologies that will reduce the energy intensity of the wood products sector

- Low Energy Drying
- Low-Temp Curing Resins
- VOC mitigation technologies

Improved Fiber Recycling – Targets the development of technologies that will increase the amount of fiber that can be utilized or recovered from waste paper

- Automated, high-volume fiber characterization
- Screenable water-based and wax coatings
- Improve the quality of recycled fibers

RFPs and Merit Review

Merit Review – RFPs Then and Now

THEN: Older RFPs were very broad –
"Give me all your good ideas"

NOW: Recent RFPs have been narrowly focused on areas with greatest energy savings potential

FY05
Solicitation: Sought non-thermal technologies for increasing press solids prior to the drying section of the paper machine

Merit Review

- All projects are selected through a merit review process managed by DOE
- Merit Reviews have a strong focus on energy savings
- Reviewers are:
  - Recently retired industry personnel to avoid conflicts of interest
  - Nominated by industry groups (AF&PA and TAPPI)

Improved Portfolio Management

Portfolio Management – Research Stages

Funding Distinct Stages of Research

- In the past we have funded projects that were designed to go from concept definition to commercialization
- These types of projects tend to be expensive and multiyear
- It is difficult to terminate projects for a number of reasons

Portfolio Management – Research Stages

- **Stage 1** – Preliminary Investigation and Analysis: Scoping studies to identify research topics; technical and market assessments; idea generation.
- **Stage 2** – Concept Definition: early stage research to explore and define technical concept; laboratory scale research.
- **Stage 3** – Concept Development: development and testing of prototype technology or process; predictive modeling or simulation of performance; evaluation of scalability; demonstration of concept feasibility at the prototype or bench scale.
- **Stage 4** – Technology Development: pilot scale development and testing of technology or process; field testing and validation of technology.

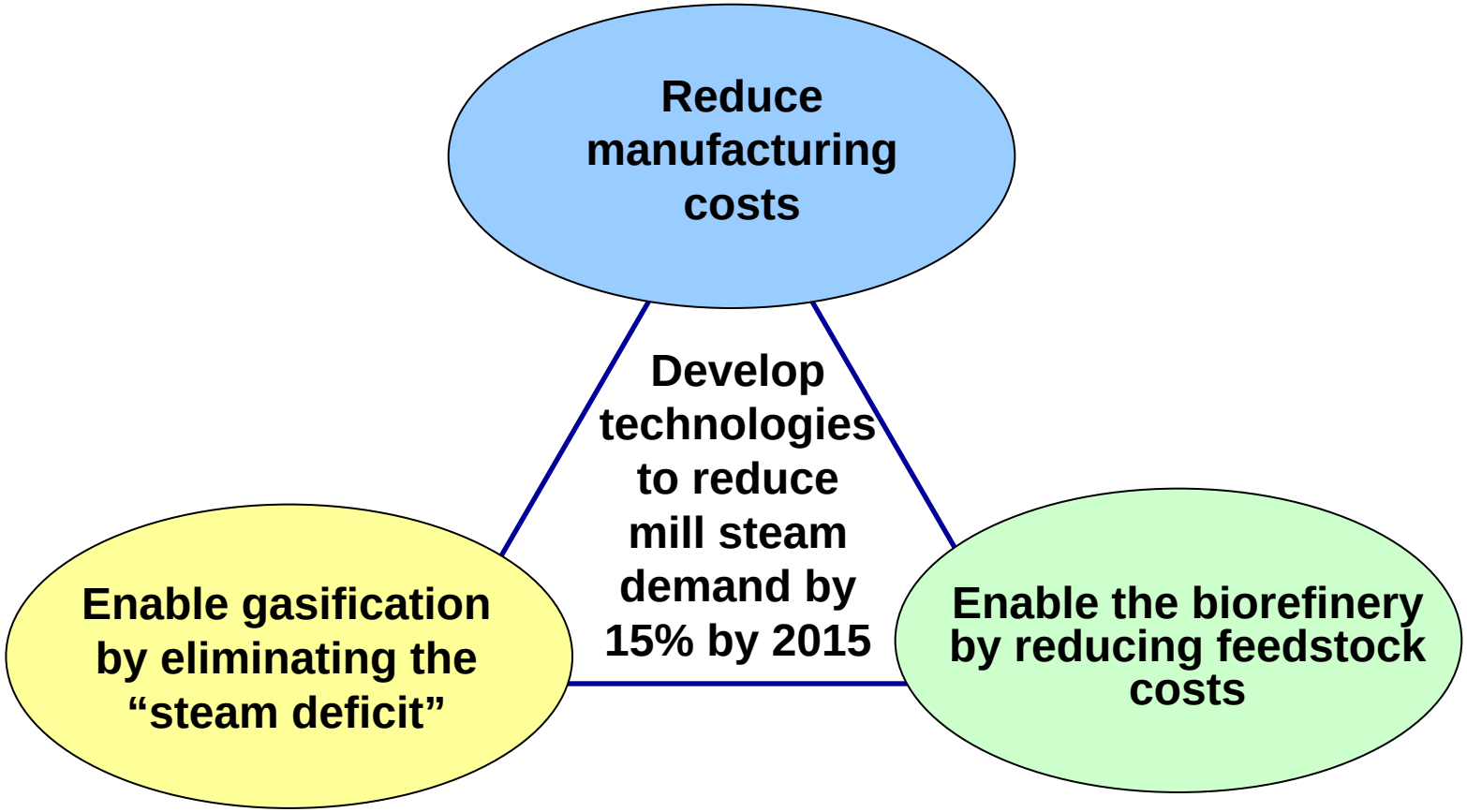
Conclusion

- ITP will focus on developing technologies to reduce steam demand by 15% by 2015
- Future RFPs will focus on Advanced Dewatering and High Efficiency Pulping
- ITP will solicit targeted RFPs and fund distinct stages of research
- ITP has the right strategy for its level of funding

Acknowledgements

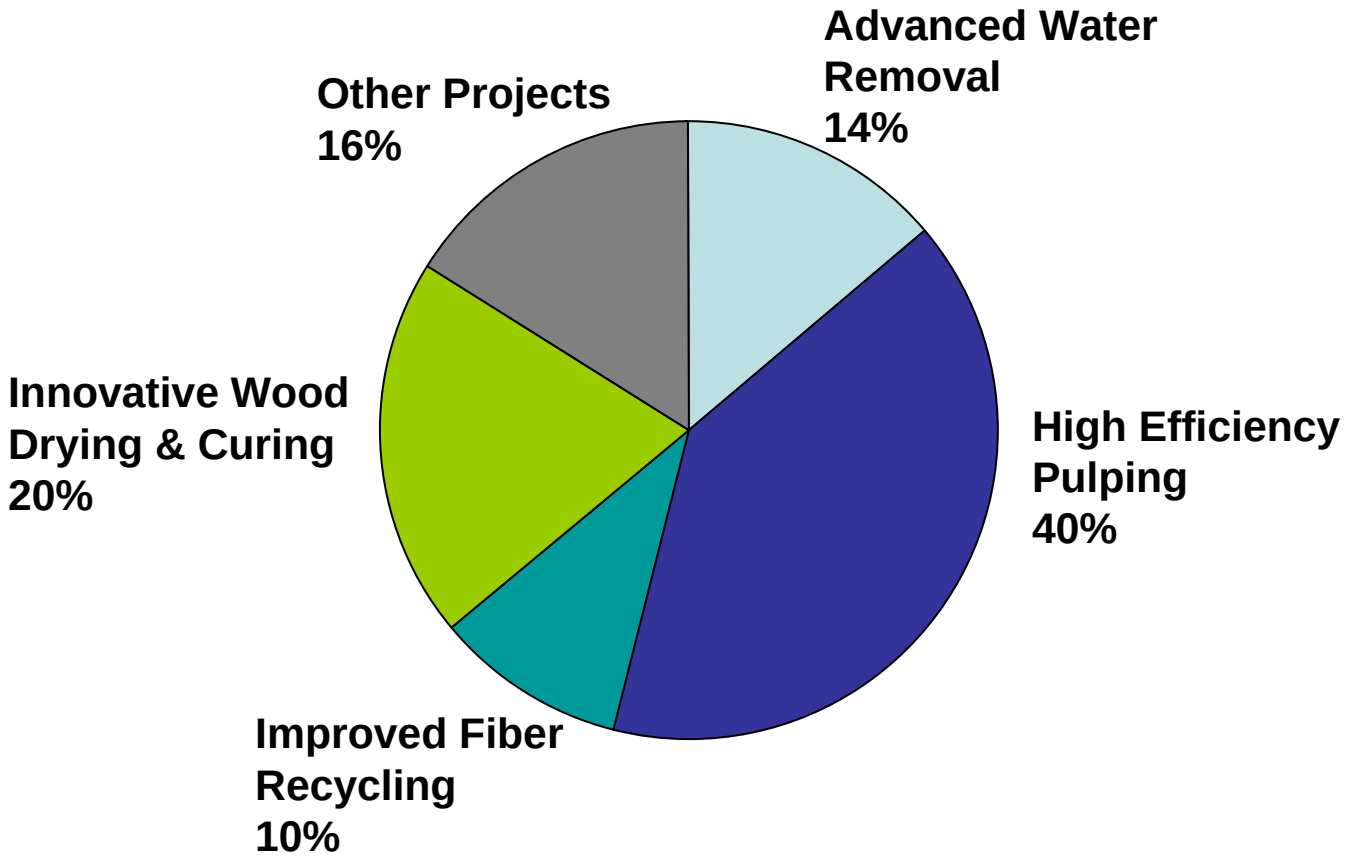
- Golden Field Office
  - Joe Springer
  - Gibson Asuquo
  - Tim Ramsey
- Energetics
  - Melanie Miller
  - Winnie Kwok
  - Shawna McQueen
- Idaho National Laboratory
  - Elmer Fleishman

Take-home message

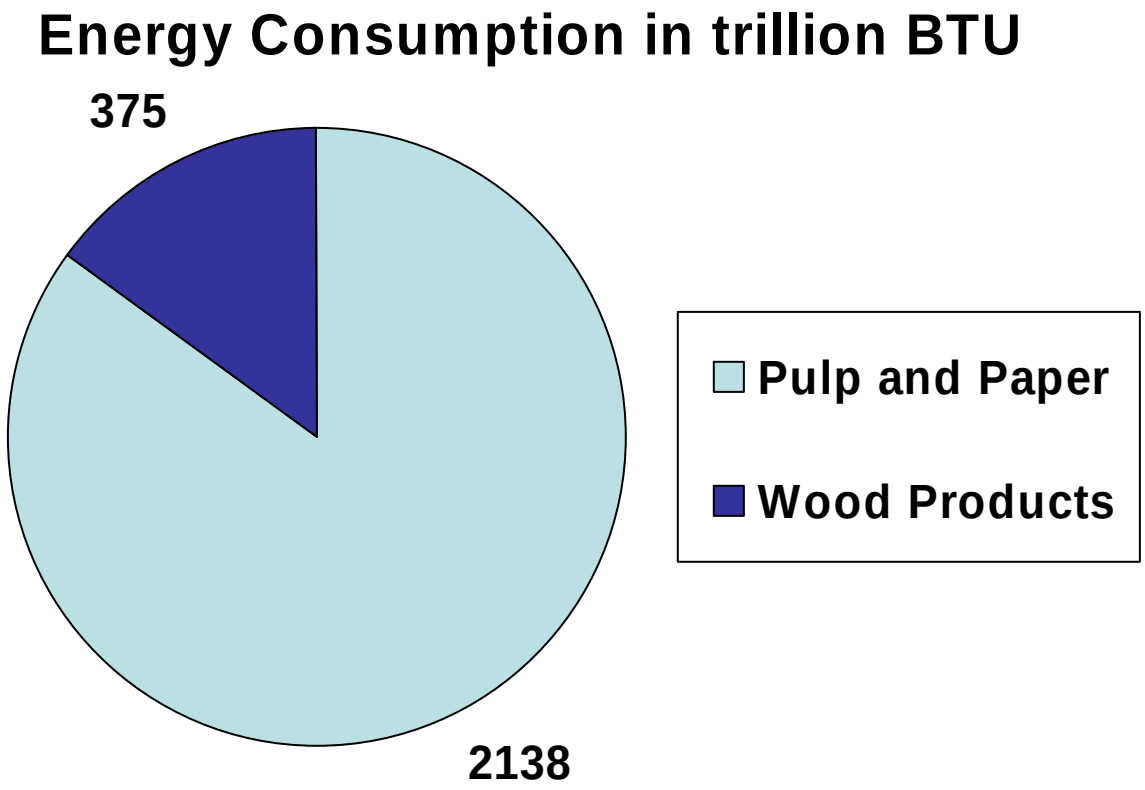


Backup Slides

Percentage of FY06 Funds by Focus Area

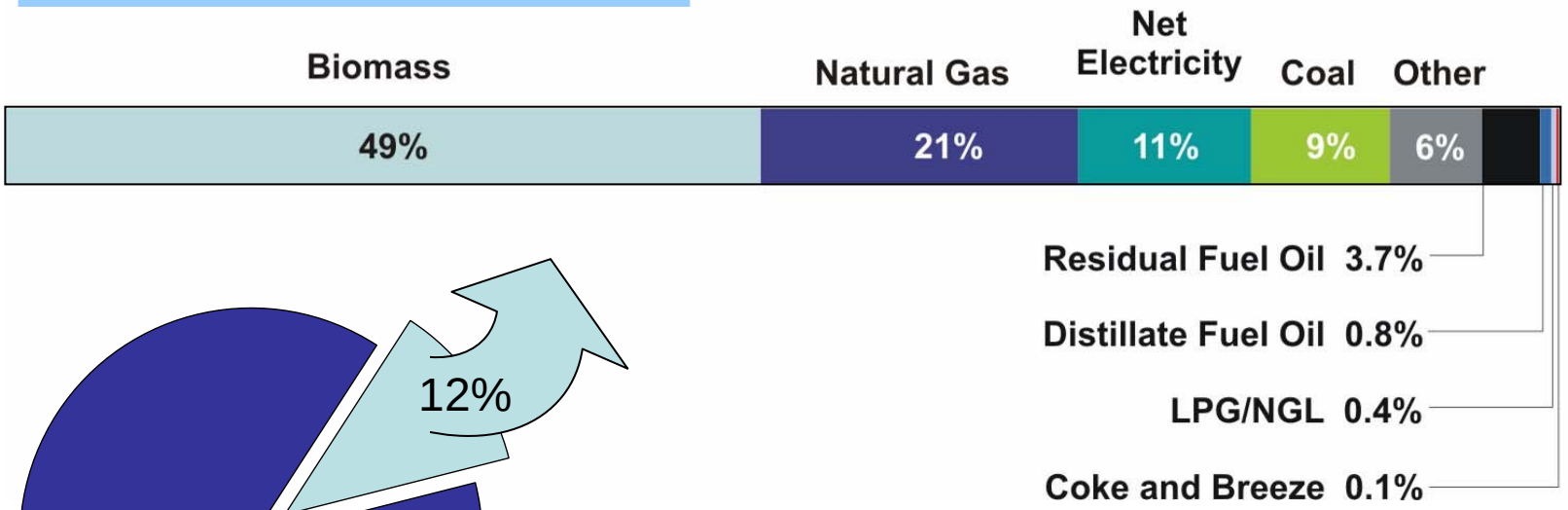


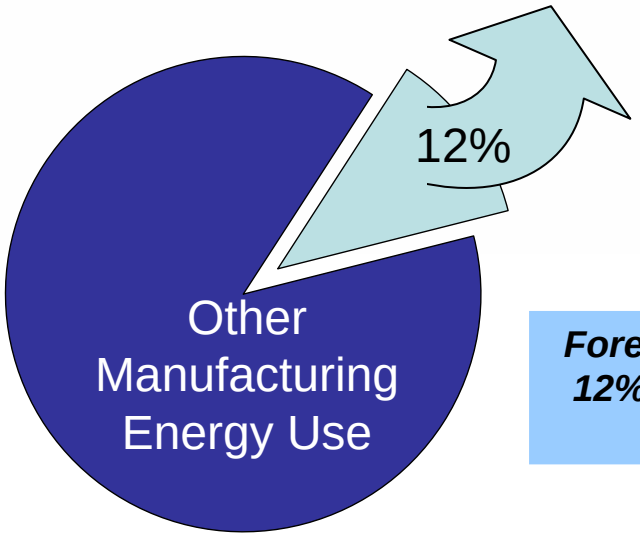
Energy Consumption in The Forest Products Industry



U.S. Forest Products Manufacturing Energy Use

U.S. Forest Products Manufacturing Energy is 49% Biomass





Forest Products Manufacturing Consumes 12% (2002 = 2740 Trillion Btu) of the Total U.S. Manufacturing Energy Use

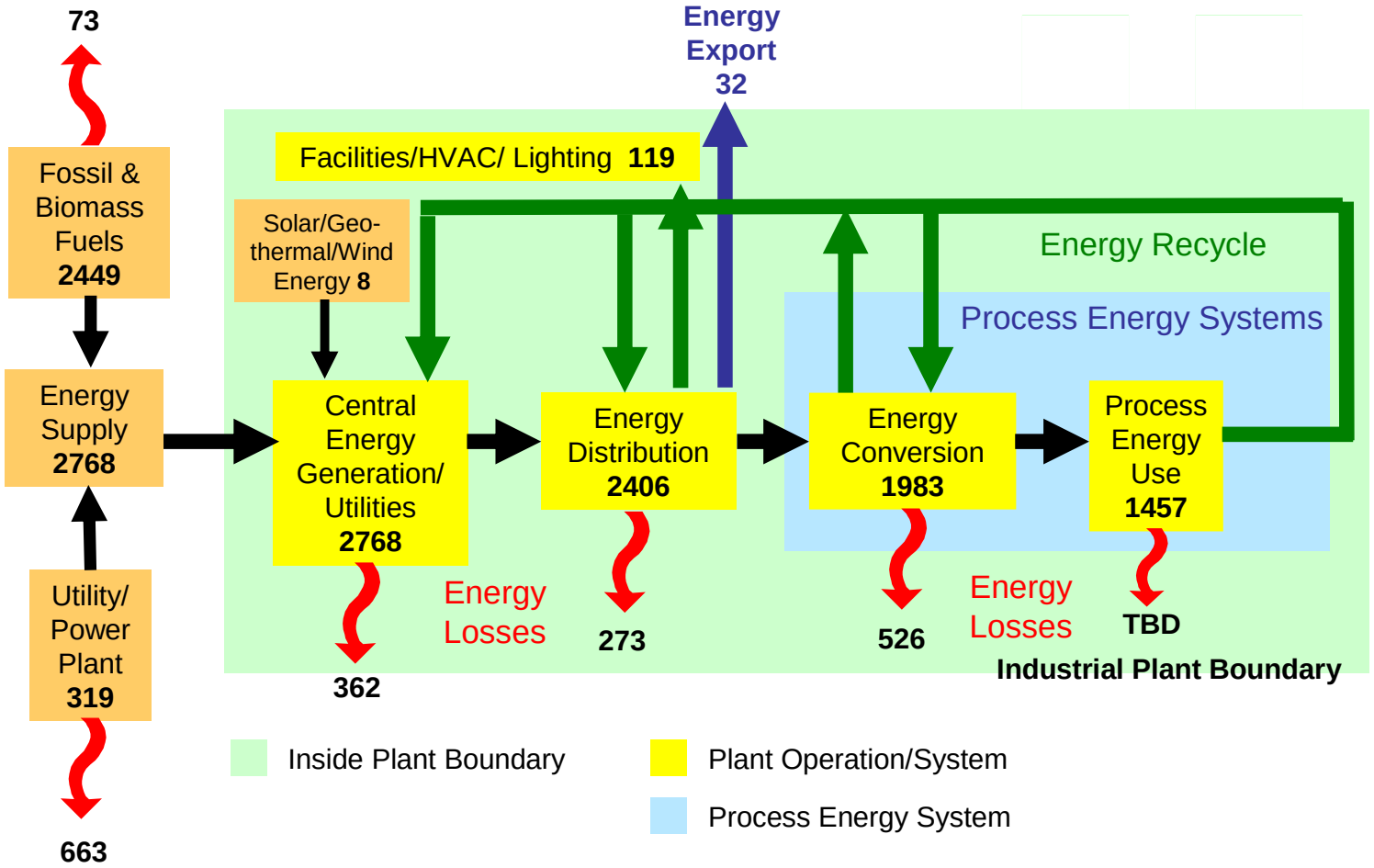
Portfolio Focus Areas - History

- Initial organization mirrored AF&PA task groups
- In 2003, transition to 4 categories:
  - Raw Materials
  - Mill Processes
  - Recycling
  - Wood Products

- In 2005, transition to 4 focus areas that target the energy-intensive manufacturing processes.

Footprint Analysis

NAICS 321 and 322 Forest Products
Total Energy Input: 3504 Trillion Btu, MECS 2002



Management by Milestone

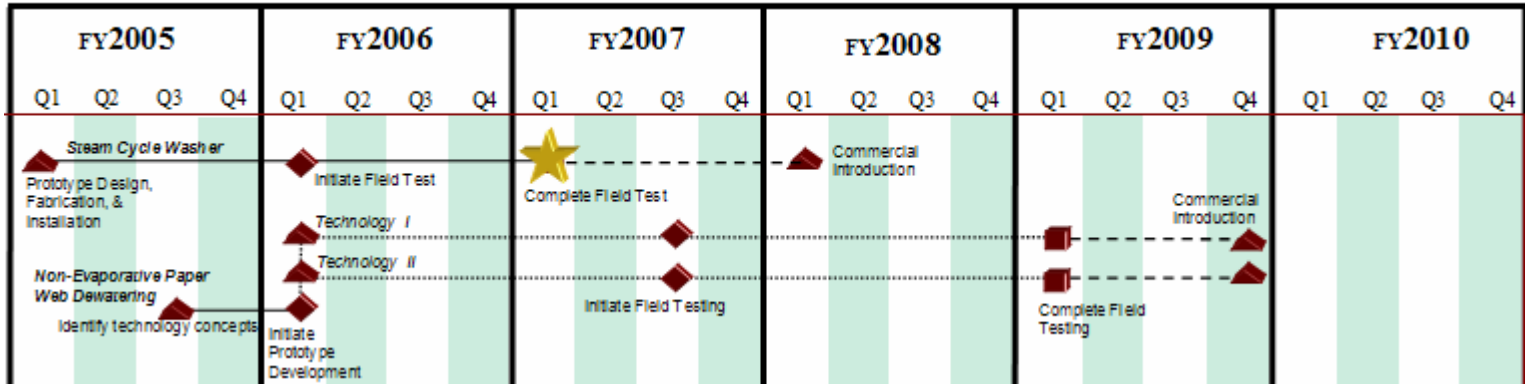
Advanced Water Removal

Milestones (Washer for Unbleached Pulp)

Milestone ID	Title	Plan Complete	Actual Complete	Importance	Status
21934	Finish design of steam cycle washer.	9/30/2005		High Tech Mgr	On Track
21936	Complete fabrication of steam cycle washer	12/30/2005		High Tech Mgr	On Track
21938	Complete field validation of steam cycle washer	3/30/2007		Pgm Mgr	On Track

Linked with MYPP Milestones

Project Milestones in CPS



Advanced Water Remoal - Multiyear Program Plan Milestone Chart

Barrier-Pathway Approach

High Efficiency Pulping

Barriers

- Chemical pulping is energy and capital intensive with significant environmental impacts
- Chemical pulp yields are low due to cellulose and hemicellulose dissolution
- Lime kilns are energy intensive

Pathways

- Develop a technology that will reduce the energy intensity of the current kraft pulping process
- Develop and alternative pulping process that will reduce the energy intensity of chemical pulping
- Develop autocausticization technologies in recovery boilers and gasifers

Metrics (End State)

- Demonstrate a 20% reduction in the energy intensity of chemical pulping at a mill
- Demonstrate kiln-free pulping technology
- Technology transfer of R&D results to industry

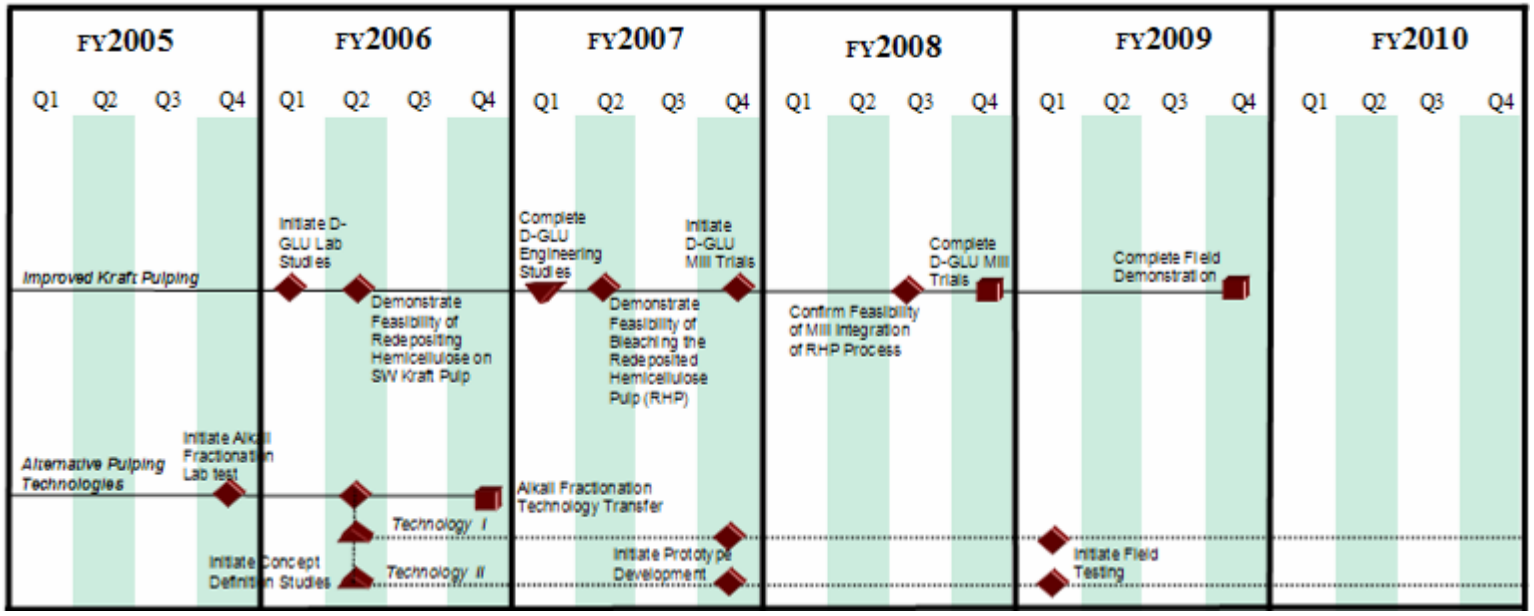
➢ ***The FY05 solicitation identifies sulfite pulping with gasification, highly selective pulping, and improved causticizing technologies as areas for concept definition studies***

High Efficiency Pulping Milestones

Milestones (Hemicellulose extraction and its Integration in Pu)					
Milestone ID	Title	Plan Complete	Actual Complete	Importance	Status
21835	Demonstrate the feasibility of redepositing hemicelluloses on softwood kraft pulp	3/1/2006		Mod Tech Mgr	On Track
21837	Demonstrate the feasibility of bleaching pulp with redepositied hemicelluloses	3/1/2007		High Tech Mgr	On Track
21838	Proof of feasibility of hemicellulose redeposition at a typical mill	6/30/2008		Pgm Mgr	On Track

Linked with MYPP Milestones

Project Milestones in CPS



High Efficiency Pulping - Multiyear Program Plan Milestone Chart

Barrier-Pathway Approach

Improved Fiber Recycling

Barriers

- Contamination and mix of fiber types hinders fiber recycling
- PSAs and wax coatings are problem contaminants that can not be efficiently separated from the recycling stream
- Fiber strength is degraded during recycling

Pathways

- Develop an automated, high-volume fiber characterization and sorting system for recovered paper
- Develop screenable water-based PSAs and wax coatings
- Develop a technology to improve the quality of recycled fibers

Metrics (End State)

- Demonstrate a 10% increase in the economic recovery of recycled fiber at a recycled fiber mill
- Technology transfer of R&D results to industry

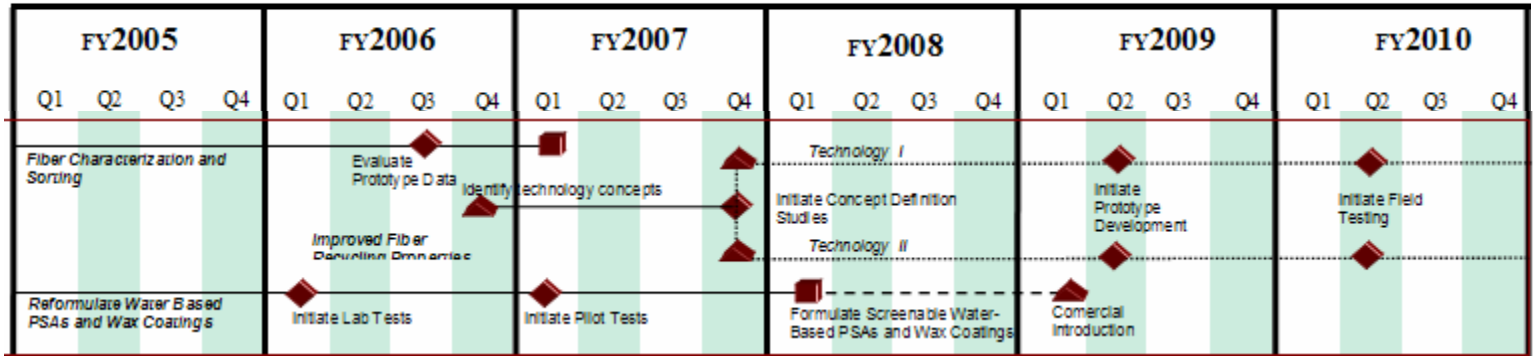
➢ ***Planned FY06 solicitation will include concept definition studies to improve the quality of recycled fiber***

Improved Fiber Recycling Milestones

Milestones (Mechatronic Design and Control of a Waste Paper So)					
Milestone ID	Title	Plan Complete	Actual Complete	Importance	Status
16865	Proof of feasibility	1/27/2007		High Tech Mgr	On Track
22004	Complete evaluation sensing techniques for food packaging, waxed OCC, coated OCC and high adhesive paper.	3/31/2006		Mod Tech Mgr	On Track
22005	Incorporate and test array of lignin/floss/color sensors and decision-making algorithm.	3/31/2006		Mod Tech Mgr	On Track

Project Milestones in CPS

Linked with MYPP Milestones



Improved Fiber Recycling - Multiyear Program Plan Milestone Chart

Barrier-Pathway Approach

Innovative Wood Drying and Curing

Barriers

- Current VOC and HAP emission control systems (ie. RTOs) for forest product mills are energy intensive
- Current lumber drying and curing processes are energy intensive.

Pathways

- Develop an alternative, energy efficient technology to reduce VOC and HAP emissions
- Develop a technology to reduce the energy intensity of wood drying
- Develop a cold-setting LVL adhesive that reduces the energy intensity of LVL curing

Metrics (End State)

- Demonstrate an emissions technology or strategy that reduces the energy intensity of emissions control by 20%
- Demonstrate a wood drying technology that reduces the energy intensity of wood drying by 20%
- Demonstrate a technology that reduces the energy intensity of LVL curing by 50%

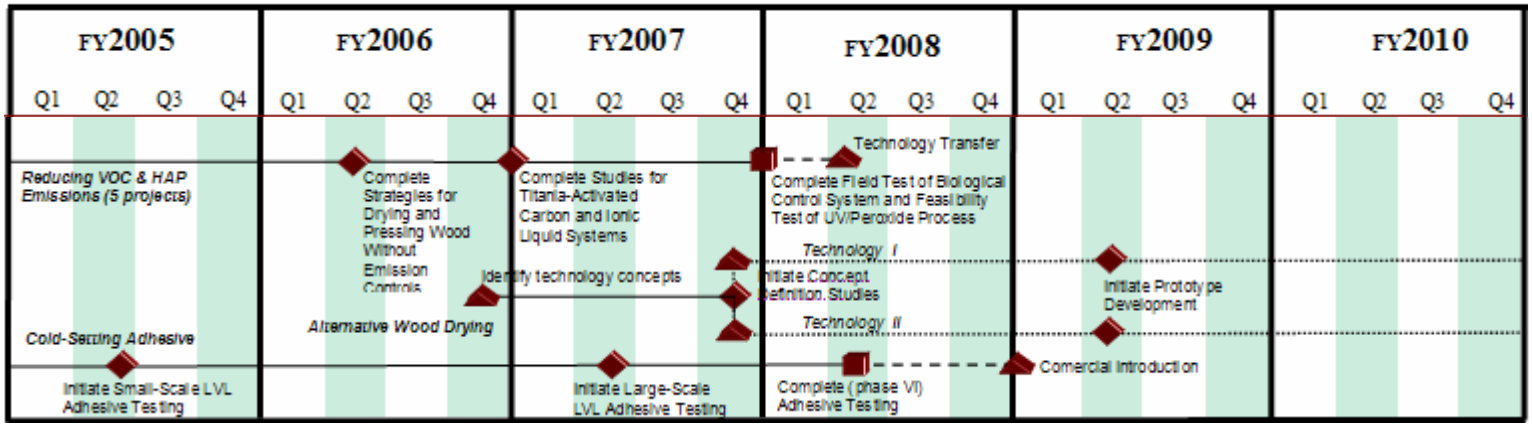
➢ ***Planned FY06 solicitation will include concept definition studies to reduce the energy intensity of wood drying***

Innovative Wood Drying and Curing Milestones

Milestones (Low VOC Drying of Lumber and Wood Panel Products)					
Milestone ID	Title	Plan Complete	Actual Complete	Importance	Status
11711	Pilot demonstration of low VOC drying at Louisiana Pacific's Sherwood OR mill	6/14/2002	6/14/2002	Mod Tech Mgr	Complete
11744	pilot study of low VOC drying technology for OSB at University of Kentucky.	5/5/2002	4/30/2002	Mod Tech Mgr	Complete
16699	Validate control method for VOC emissions.	3/31/2006		High Tech Mgr	On Track

Project Milestones in CPS

Linked with MYPP Milestones



Innovative Wood Drying and Curing - Multiyear Program Plan Milestone Chart

Forest Products Portfolio by Focus Area

- **Advanced Water Removal**
  - Steam Cycle Washer for Unbleached Pulp, *Port Townsend/INEEL*
- **High Efficiency Pulping**
  - Hemicellulose Extraction and Its Integration in Pulp Production, *University of Maine/NREL*
  - Highly Efficient Directed Green Liquor Utilization (D-GLU) Pulping, *Georgia Tech University*
  - Increasing Yield and Quality of Low-Temperature, Low-Alkali Kraft Cooks With Microwave Pretreatment. *Oak Ridge National Lab*
  - Dominant Negative Mutations to promote Sterility in Forest Trees*, Oregon State University*
  - Performance and Value of CAD-Deficient Pine*, North Carolina State University*
  - Engineering of Syringyl Lignin in Softwood Species through Expression of Hardwood Syringyl Monolignol Pathway Genes*, North Carolina State University*
- **Improved Fiber Recycling**
  - Mechatronic Control of Waste Paper Sorting, *North Carolina State University*
  - Development of Screenable Wax Coating and Water-Based Pressure Sensitive Adhesives, *University of Minnesota*

Forest Products Portfolio by Focus Area

- **Innovative Wood Drying and Curing**
  - Low VOC Drying of Lumber, *Georgia Tech University*
  - VOC and HAP Recovery Using Ionic Liquids, *Oregon State University*
  - Novel Isocyanate Reactive Adhesives for Structural Wood-Based Composites, *Virginia Tech University*
  - Biological Air Emissions Control, *Texas A&M University*
  - On-Line Oxidation of Volatile Compounds Generated by Sawmill Wood Kilns, *Mississippi State University*
  - An Innovative Titania-Activated Carbon System for Removal of VOCs and HAPs with In-Situ Regeneration Capabilities, *University of Florida*
  - Development of Renewable Microbial Polyesters for Wood-Plastics Composites*, Idaho National Lab*
  - Rapid, Low Temperature Electron Bean Curable Resins*, Oak Ridge National Laboratory*
  - Novel Isocyanate-Reactive Adhesives for Structural Wood-Based Composites*, Virginia Tech*

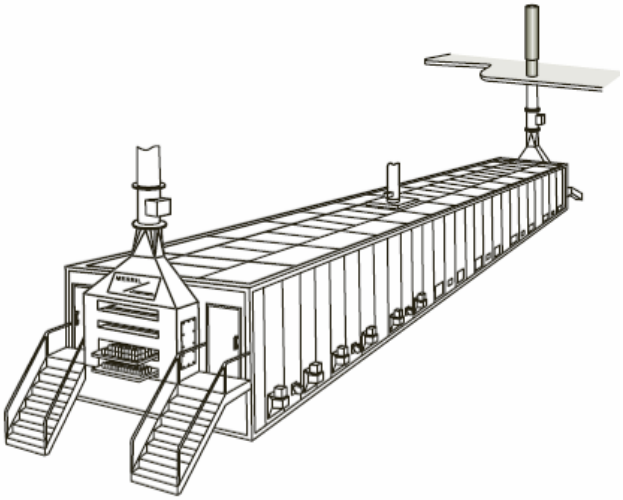
Forest Products Portfolio by Focus Area

- **Other Projects**
  - On-Line Fluidics Controlled Headbox, *Georgia Tech*
  - Lateral Corrugator, *Georgia Tech*
  - Fibrous Fillers to Manufacture Ultra High Ash/Performance Paper, *GR International*
  - Contactless Real-Time Monitoring of Paper Mechanical Behavior During Papermaking, *Georgia Tech, LBNL*
  - Development of METHANE deNOx Reburning Process, *Gas Technology Institute*
  - Design and Demonstration of Multiport Cylinder Dryers, *Argonne National Laboratory*
  - Improved Recovery Boiler Performance Through Control of Combustion, Sulfur and Alkali Chemistry, *Brigham Young University*

Forest Products Portfolio Accomplishments

Thermodyne™ Evaporator

- *Molded Pulp Products Dryer*
- *Uses up to 50% less energy compared to conventional dryers and recovers an additional 40% of the energy consumed*
- *Reduces scorching the product with higher drying temperatures*
- *Reduces case hardening and warping*
- *Reduces VOC emissions*
- *Commercialized by Merrill A*

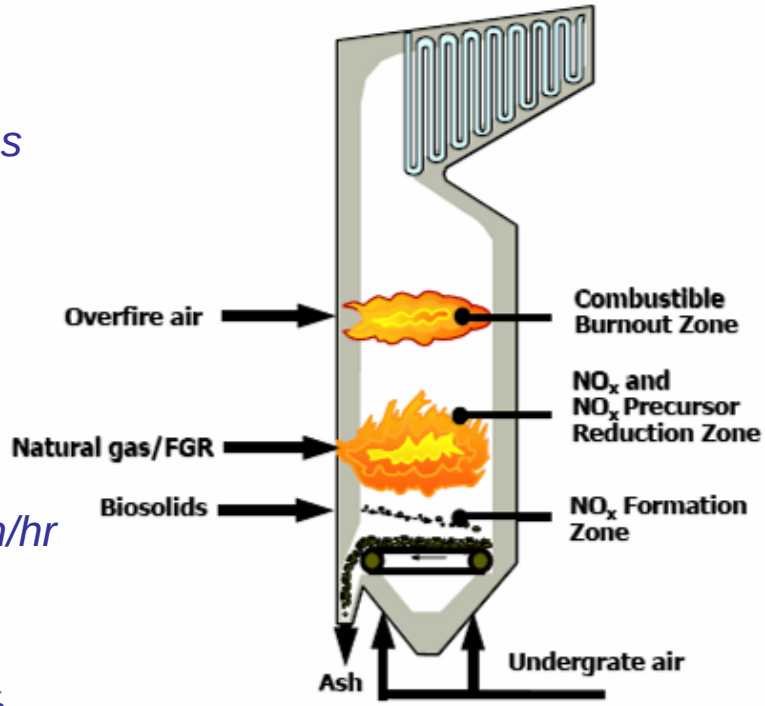


Apple Tray Drying

Forest Products Portfolio Accomplishments

METHANE DE-NOx® Reburning Process

- *Retrofit reburning technololgy for wood waste, sludge, and biomass fired stoker boilers*
- *3 Technology patents held by the Institute of Gas Technology, commercial licensee: ESA Environmental Solutions*
- *Received a 1997 R&D Award for environmental and performance potential*
- *Received AF&PA's 1999 Environmental and Energy Achievement Award by demonstrating:*
  - *Increased sludge firing rate from 1.2-1.3 ton/hr to 4 ton/hr*
  - *Increased thermal efficiency by 1-2%*
  - *Reduced NOx emissions by more than 50%*
  - *Reduced natural gas input by 25%*



METHANE DE-NOx® uses fuel and air staging for combustion improvement and reduced NOx emissions

Forest Products Portfolio Accomplishments

Detection and Control of Deposition on Pendant Tubes in Kraft Chemical Recovery Boilers

- *Hand-held infrared inspection system for instantaneous thermal imaging within high-temperature particle laden environments*
- *Enables detection of deposits and blockages, monitoring efficiency of cleaning operations, and locating hot spots and fixture damage*
- *Benefits: Fuel savings, reduced NO_x emissions, improved safety, and reduced maintenance costs*
- *pyrOptix was commercialized by Enertechnix, Inc. in 2002*

pyrOptix

Case Examples:

A faulty sootblower is revealed to have lost it's head

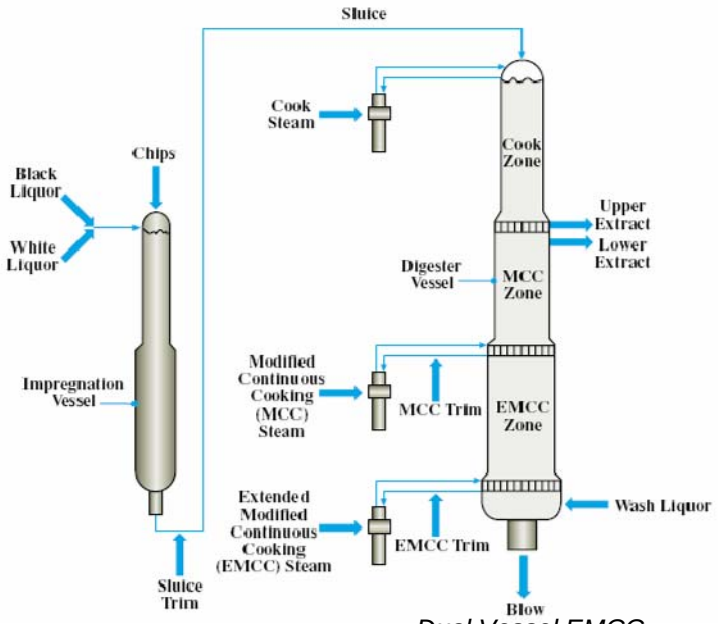
Blockages and deposits can be tracked and measured

Hotspots can be seen.

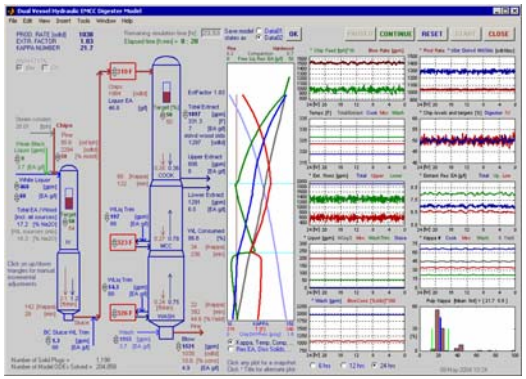
Forest Products Portfolio Accomplishments

Continuous Digester Control Technology

- *Computer-based model and control system for continuous digester operation*
- *Manages production rate changes and grade swings between hardwood and softwood feedstocks*
- *Benefits: minimizes chemical use, improves productivity and process reliability, and improves product quality*
- *Commercialized in 2003 and marketed by IETek Integrated Engineering Technologies*



Dual Vessel EMCC Continuous Digester



Sample Simulation Results