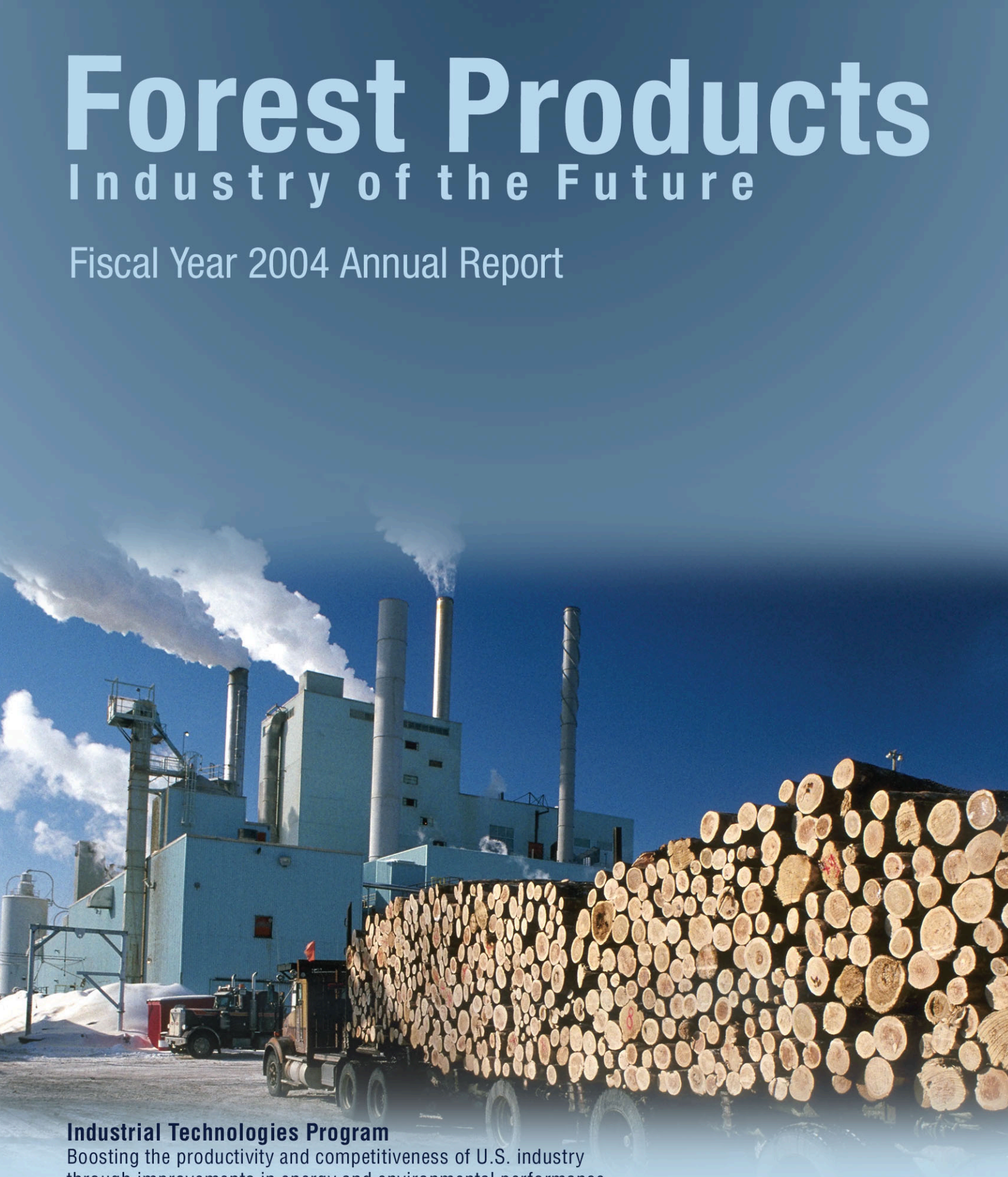
Forest Products
Industry of the Future

Fiscal Year 2004 Annual Report



Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry
through improvements in energy and environmental performance

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

Industrial Technologies Program — Boosting the Productivity and Competitiveness of U.S. Industry

Industry consumes 33 percent of all energy used in the United States. By developing and adopting more energy efficiency technologies, U.S. industry can boost its productivity and competitiveness while strengthening national energy security, improving the environment, and reducing emissions linked to global climate change.

The U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) works in partnership with U.S. industry to increase the efficiency of energy and materials use, both now and in the future. EERE's Industrial Technologies Program (ITP) is working to build the Industries of the Future through a coordinated program of research and development (R&D), validation, and dissemination of energy efficiency technologies and operating practices to reduce energy intensity in the industrial sector. ITP develops, manages, and implements a balanced portfolio that addresses industry requirements throughout the technology development cycle. The primary long-term strategy is to invest in high-risk, high-return R&D. Investments are focused on technologies and practices that provide clear public benefit but for which market barriers prevent adequate private sector investment.

ITP focuses its resources on a small number of energy-intensive materials and process industries that account for over 55 percent of industrial energy consumption.

- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Steel

ITP uses a leveraging strategy that maximizes the energy and environmental benefits of its process-specific technology investments by coordinating and cooperating with energy-intensive industries. By working closely with the private sector, ITP is able to effectively plan and implement comprehensive R&D agendas and help disseminate and share best energy management practices throughout the United States. The ITP public-private partnerships also facilitate voluntary efforts, such as the President's Climate VISION initiative, to encourage industry and government to reduce greenhouse gas emissions.

ITP also conducts R&D projects on enabling technologies that are common to many industrial processes such as industrial energy systems, combustion, materials, and sensors and process control systems. In addition, ITP funds technical assistance activities to stimulate near-term adoption of best energy-saving technologies and practices within industry. These activities include plant assessments, tool development and training, information dissemination, and showcase demonstrations.

New technologies that use energy efficiently also lower emissions and improve productivity. By leveraging technical and financial resources of industry and government, the ITP partnerships have generated significant energy and environmental improvements that benefit the nation and America's businesses. Energy-intensive industries face enormous competitive pressures that make it difficult to make the necessary R&D investments in technology to ensure future efficiency gains. Without a sustained commitment by the private and public sectors to invest in new technology R&D and deployment, the ability to close the gap between U.S. energy supply and demand will be severely compromised.

CONTENTS

EXHIBITS

EXECUTIVE SUMMARY

The U.S. forest products industry plays an important role in our national economy. Thousands of products created from paper, paperboard, lumber, and engineered wood are used by consumers every day. With total shipments valued at more than $243 billion a year, the industry directly employs more than one million people and ranks among the nation's top 10 manufacturing industries. The industry is especially important in many rural economies where the local paper or lumber mill can be the area's largest employer.

After decades as a global leader, the U.S. forest products industry is increasingly challenged by foreign competitors. Over the past 10 years, many forest products companies have been forced to close or idle a large number of mills to reduce costs and remain competitive. Costs for energy consumption and environmental compliance are key for American manufacturers. For example, during the four years spanning 1997-2000, the pulp and paper industry spent about $6 billion per year on energy, or about 4 percent of its net sales, and averaged over $800 million per year on environmental protection capital – close to 14 percent of the average annual capital invested on equipment.

Despite major advances in energy efficiency and productivity over the last several decades, the industry remains one of the most energy-intensive in the United States. While the industry makes extensive use of renewable energy, it is still the third-largest user of fossil fuels in the U.S. industrial sector. Technological advances that can reduce fossil energy use and lower environmental compliance costs are clearly necessary. While the industry recognizes that technical innovation will be critical to its long-term performance, it has limited resources for developing and testing new technologies. Transformational R&D, such as that funded by the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Industrial Technologies Program (ITP), is critical to maintaining the global competitive position of the U.S. forest products industry. Studies sponsored by EERE are quantifying the opportunities for saving energy in the forest products industry.

A Successful Strategy with Industry

DOE's Office of Energy Efficiency and Renewable Energy leads federal development of advanced energy-efficient and environmentally friendly industrial technologies. The forest products industry R&D is a component of the overall EERE strategy, contributing to a reduction in energy intensity of industry, a goal outlined in the National Energy Policy.

EERE/ITP is working to build the Industries of the Future through a strategy that is based on multi-year planning, industry involvement and input during the planning process, and careful analysis and data-based decision making. This strategy not only takes into consideration the interests of the industry as described in their R&D Technology Roadmaps, but also consists of an agenda of analytical studies that provide the basis for decision-making. For instance, the *Forest Product Industry's Agenda 2020* has provided the basis for focusing the R&D by identifying industry research interests. The Footprint study and Bandwidth study, currently under development, will use both government and industry data and information, and industry expertise to provide the next level of prioritization for the portfolio. By using these studies, the portfolio is able to design a multi-year R&D plan based on a focus area, barrier, and pathway approach. In this approach, a limited number of critical technology focus areas are identified along with the technical barriers preventing their successful implementation. A multi-year plan (called a "Pathway") is then developed that will guide the R&D activities leading to successful development of the focus area technology. The "Pathways" are then the basis for solicitations of pre-competitive R&D that addresses both energy efficiency goals outlined in the National Energy Policy and forest products industry research priorities. This successful strategy is evolving to a point where it will provide focus on potentially high-impact research to make revolutionary improvements in the forest products industry.

The DOE's ITP works with pulp, paper, and wood product companies to develop technologies that will increase energy efficiency, reduce environmental impacts and boost productivity. This effort brings together members of the industry and the research community to develop a consensus on common goals and priorities, which are articulated in the *Agenda 2020* vision and roadmap documents.[1] More than 100 collaborative research projects have been funded since 1994.

[1] *Agenda 2020: A Technology Vision and Research Agenda for America's Forest, Wood and Paper Industry*, American Forest & Paper Association, November 1994. *Agenda 2020 The Path Forward: An Implementation Plan*, American Forest & Paper Association, 1999.

Achieving Energy Savings: Portfolio Strategy

ITP supports a diverse Forest Products portfolio of cost-shared, pre-competitive research addressing technology needs that have broad applicability throughout the forest products industry. Projects are focused on developing both revolutionary technologies and making incremental improvements to existing processes, thereby addressing both long-term goals and short-term opportunities to improve energy efficiency. The current portfolio strategy is to focus new research funding on a smaller number of high-risk research projects that have the potential to significantly impact process energy use. Researchers are seeking breakthrough approaches to minimize energy use in the following process areas: enhanced raw materials, next generation mill processes, improved fiber recycling and wood processing. The FY 2004 Forest Products portfolio includes 52 projects, highlights of which are presented below (see Exhibit 5 on page 8 for a complete list of projects). More information about the Forest Products portfolio may be found at: http://www.eere.energy.gov/industry/forest/portfolio.html.

R&D Portfolio Highlights

- DOE conducted a Portfolio Peer Review in May 2004, in conjunction with Paper Summit 2004 and the Technical Association for the Pulp and Paper Industry (TAPPI) Spring Technical and International Environmental Conference. Forty-seven active and emerging projects from the Forest Products portfolio were presented in open technical sessions. A peer review team of nine industry experts met individually with each project team. The project evaluation results from the peer review team and other industry stakeholders were reported to the project teams and were used to identify improvements in the Forest Products portfolio and program strategy.

- Technology using electrohydraulic discharge promises to improve contaminant removal from recycled pulp, which will reduce energy and chemical use while improving pulp quality. A successful trial of this technology was run at Jackson Paper in Sylva, North Carolina; additional trials are being pursued to demonstrate improvements in flotation de-inking and sludge dewatering.

- Online fluidics-controlled headbox technology will create a better paper product, reduce rejects, increase productivity, and significantly reduce fiber costs, water and energy use. A robust system for on-line pilot trials and final commercial implementation was fabricated for laboratory experiments and is being adapted for pilot trials planned for 2005.

- Lateral Corrugating technology will reduce fiber consumption, improve strength, minimize waste, and reduce energy usage in both manufacturing and transportation. The lateral corrugator is being designed and built as a retrofit to conventional pilot corrugating facilities at the Institute of Paper Science and Technology (IPST).

- Low-temperature curing technologies for wood composite resins promise significant reductions in manufacturing energy use and costs. Catalysts and additives for curing improvements have been identified and are now being integrated to improve the quality of the composite wood products.

- Microwave pretreatment technology for lumber promises to reduce drying time by 25 to 50 percent and save a minimum of 30 percent in energy. In FY 2004, research has focused on the effects of microwave treatments on larger sections of wood with excessive moisture variations. Drying models are being completed for different wood species that can be used to guide the application of this technique.

- Ionic liquids used for absorption of VOCs and HAPs will lower emissions and reduce operating energy use and costs. In FY 2004, laboratory results confirmed the solubility of methanol in various ionic liquids and proved that it could be easily removed using a vacuum.

- ITP's Forest Products portfolio also works closely with ITP's BestPractices portfolio to help forest products companies gain access to the latest tools, information, and services available to help optimize their efficiency using best-available technologies and operating practices. Weyerhaeuser became an EERE Allied Partner and identified more than $3 million in annual savings at a BestPractices plant-wide assessment.

- In 2004, ITP supported industry outreach activities, such as the Business Development Executive Program and Energy Challenge, to disseminate research results and encourage energy efficiency throughout the forest products industry. ITP also works with the American Forest and Paper Association (AF&PA) to address climate change. AF&PA has undertaken a series of programs that are expected to reduce the industry's greenhouse gas intensity by 12 percent by 2010, relative to 2000.

INDUSTRY OVERVIEW

The forest products industry produces thousands of products from renewable raw materials that are essential for everyday needs in communication, education, packaging, construction, shelter, sanitation and protection. The U.S. forest products industry is divided into two major categories: Paper Manufacturing (NAICS 322) and Wood Product Manufacturing (NAICS 321). These industries are often grouped together because both rely on the nation's vast forest resources for raw materials. In addition, many companies that produce pulp and paper also produce lumber and wood products in integrated operations.

The U.S. forest products industry is based on wood as a renewable and sustainable raw material. The industry practices recovery and recycling in its operations. Its forests help the global carbon balance by taking up carbon dioxide from the atmosphere. The industry also contributes to land management and natural resource conservation. After decades as a global leader, the industry is increasingly challenged by its traditional competitors (Canada, Scandinavia, Japan), as well as by emerging nations (Brazil, Chile, Indonesia). Technical challenges facing the industry are centered on using recycled materials cost-effectively, meeting environmental regulations and reducing energy costs. Other pressures include the diminishing amount of land available for tree farms and a lack of capital for carrying out long-term research and development projects.

Despite increasing foreign competition, the United States is still the world's leading producer of lumber and wood products used in residential construction and in commercial wood products such as furniture and containers. The United States is also the leader in the pulp and paper business, producing about 28 percent of the world's pulp and 25 percent of total world output of paper and paperboard. Fueling this large manufacturing sector is consumption; as the world's leading consumer of paper and paperboard products, the United States consumed close to 96 million tons in 2001 or about 691 pounds per capita.

Exhibit 1
Forest Products Industry Production

Paper Industry Yearly Production
Pulp = 62.8 million tons
Paper = 45.4 million tons
- Newsprint = 7.2
- Printing-Writing = 26.9
- Packaging & Industrial = 4.4
- Tissue = 6.9

Paperboard = 49 million tons
- Containerboard = 30.6
- Boxboard = 8.8
- Other = 9.6

Wood Industry Yearly Production
Hardwood Lumber = 13.3 billion bf
Softwood Lumber = 34.5 billion bf
Structural Panel = 29 billion ft^2
- Softwood Plywood = 17.8
- OSB = 11.2

Nonstructural Panel = 18.3 billion ft^2
- Hardwood Plywood = 1.8
- Particle Board = 12
- Hardboard = 1.4
- Insulation board = 3.1

Engineered Woods
- Laminated Veneer = 1700 m^3
- Glulam = 550 m^3
- Wood I-joists = 375,000 linear m

As a strong contributor to the nation's economy, the industry produced shipments valued at over $243 billion in 2001, employing close to 1.1 million people in all regions of the country and producing 1.2 percent of the U.S. GDP. The industry operates over 16,000 facilities (4,676 in pulp and paper and 11,663 in lumber and wood) throughout the United States, ranging from large, state-of the-art mills to small, family-owned operations. Exhibit 1 lists annual production of paper and wood industry products.

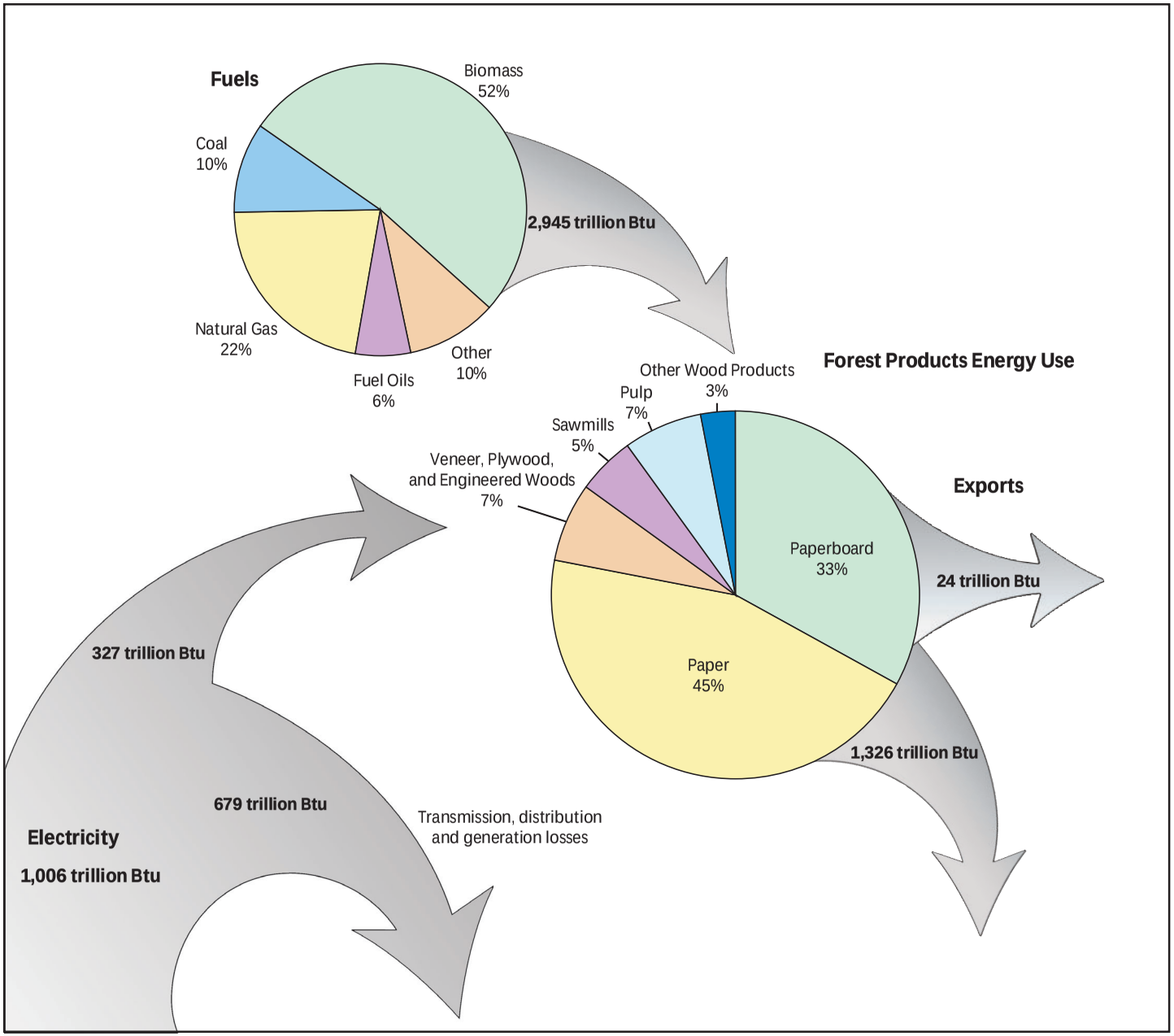
Energy Use

The forest products industry consumed more than 3.2 quads of energy in 1998, which represents over 18 percent of the total U.S. manufacturing energy use. Within the forest products industry, the pulp and paper industry uses the vast majority of the energy, 2.74 quads, while the wood products industry uses only 0.50 quads.

The paper industry's largest use of energy is for boiler fuel to provide process steam and on-site electricity generation. Steam is used by pulp and paper mills for process heat, evaporation and drying, and electricity is used to power process equipment. The wood products industry uses mostly fuel to make steam for lumber drying and curing, as well as to drive equipment such as saws and conveyors. The industry self-generates more than 50 percent of its energy needs from biomass (wood residues and black liquor). In the last 25 years, the pulp and paper industry has reduced its primary energy intensity by about 27 percent by investing in process efficiency improvements, and additional combined heat and power capacity.

Exhibit 2 (on page 3) shows the industry's energy inputs by source. The forest products industry is the largest consumer of residual fuel oils, accounting for 43 percent of total U.S. manufacturing sector use; the second-largest consumer of distillate fuel oils; the third-largest consumer of coal; and the fourth largest natural gas consumer. The industry is also the largest user of wood byproduct fuels (black liquor and wood residues), representing 93 percent of the total U.S. manufacturing use of wood fuels. Electricity provides about 15 percent of the industry's total energy requirements and is expected to grow with increasing use of automation and electric-intensive pollution control equipment. Over 65 percent of the industry's electricity demand is co-generated on-site, making it also the largest co-generator in the manufacturing sector. Inefficiencies in systems that generate, distribute and convert energy contribute to on-site industry-wide average energy losses of over 40 percent.

Exhibit 2
Forest Products Industry Energy Flows



THE CHALLENGE

The forest products industry faces significant challenges in maintaining global competitiveness. The industry is characterized by its concentrated asset base, high capital requirements, and volatile business cycles. Consumer demand and the strength of the national economy control the industry's production and several pressures (listed below) affect its performance and competitiveness.

Pressures on Performance and Competitiveness

Decreased availability of land: Land available for growing commercial wood is diminishing, which drives up prices and creates pressure to use lower-quality wood; this can result in higher energy use.

Increased interest in recycling: Greater demand for recycling will require an increased use of recovered fiber in a broader range of paper products. Upgrading recovered fiber for higher-grade paper products is currently costly and energy-intensive.

Foreign competition: The United States increasingly faces competition from low-cost producers in South America, Africa and the Pacific Rim, and from traditional competitors like Canada and Scandinavia.

More demanding environmental requirements: Compliance with new regulatory initiatives means increases in capital expenditures, operating costs, and energy use.

High capital and energy intensity: Long-term viability demands improvements in energy and capital efficiency for financial performance to reach satisfactory levels.

Both government and industry agree that conservation, or improving the efficiency of energy use, is part of the solution for reducing energy consumption of fuels and electricity in the forest products industry, especially in the long-term. Permanent technology changes, rather than short-term fixes, are needed to revolutionize the way energy is used in forest products manufacture. The industry's high capital intensity and the short-term focus on quarterly results tend to limit the industry's ability to take risks and to invest in new technology research and development. To reduce these risks and lower R&D costs, companies have become willing to collaborate in strategic, pre-competitive areas.

Strategy for Improving Energy Efficiency

DOE's Industrial Technology Program (ITP) works with the forest products industry and supports collaborative, innovative R&D on forest products process technologies, design tools and methodologies; promotes deployment of promising technologies; and encourages the implementation of best practices and state-of-the-art technologies that will help the forest products industry cut energy use, minimize environmental impacts and improve productivity.

Agenda 2020 is an initiative supported by the American Forestry and Paper Association (AF&PA) that has formed alliances with federal agencies (including ITP) to fund cost-shared R&D projects aimed at improving U.S. forest products energy efficiency, industry competitiveness, and environmental performance. AF&PA has traditionally assisted DOE in engaging active industry participation in the Forest Products portfolio. AF&PA task groups also provide valuable industry feedback to ITP's research portfolio. Other forest products industry associations, such as the Technical Association of the Pulp and Paper Industry (TAPPI) and the Institute of Paper Science and Technology (IPST), have also worked closely with the portfolio to communicate the results of research and promote the development of more energy-efficient, environmentally sound technology.

In FY 2004, ITP's Forest Products portfolio underwent a significant reorganization. The changes were part of a larger, comprehensive effort to reorganize EERE in order to sharpen the focus on performance, reduce organizational layers, and streamline operations. The Forest Products R&D portfolio was restructured to target four manufacturing-related focus areas that offer the greatest opportunity for energy savings: (1) *Enhanced Raw Materials*, (2) *Next Generation Mill Processes*, (3) *Improved Fiber Recycling* and (4) *Wood Processing*. Each of these focus areas supports ITP's mission in reducing the energy intensity of industry while enhancing productivity and economic growth.

The *Enhanced Raw Materials* area focuses on advances in genetic engineering that can be harnessed to develop improved feedstock (trees), which can lower energy demands in pulping processes. *Next-Generation Mill Processes* include all of the industrial processes used to produce paper from raw materials, with emphasis on developing breakthrough technologies for more energy-efficient pulping, bleaching, chemical recovery and papermaking. *Improved Fiber Recycling* includes development of innovative, energy- and water-efficient processes to separate, repulp, screen, clean, and de-ink recovered paper products. *Wood Processing* includes R&D to improve the energy efficiency of wood products drying, curing/processing and emissions control.

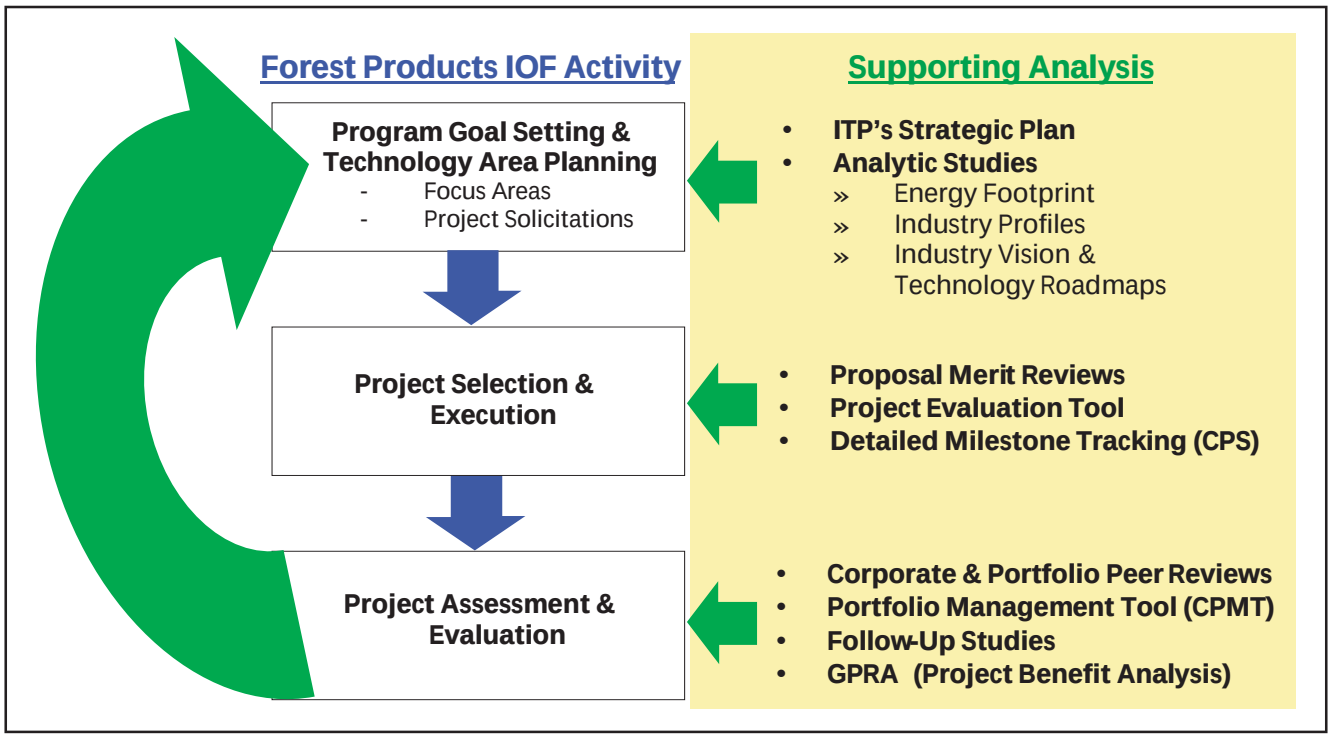
In FY 2005, ITP plans to pursue prototype development of Advanced Water Removal Technologies in the pulp and paper industry that can dramatically lower energy consumption, improve energy intensity, and reduce the capital cost of equipment. ITP also plans to initiate several concept definition studies to determine the technical and commercial feasibility of next generation mill process technologies that would provide substantial energy savings. The objective of these early stage research studies is to define the technology concept, identify technical and developmental hurdles, assess any production scale-up issues, identify potential energy savings, and develop a preliminary commercialization plan based on realistic market and benefit analysis. Successful completion of these early stage research efforts will help DOE and the forest products industry to define the critical research and development pathways and prioritize further public-private investment for next generation energy saving technological development

The Forest Products portfolio is also working with industry through *Agenda 2020* to address industry needs that are outside ITP's mission area. Important partnerships in progress include an Integrated Forest Products Biorefinery initiative with the DOE's Biomass Program and the U.S. Department of Agriculture (USDA). An industry partnership is also being formed with the National Science Foundation (NSF) to focus on educational initiatives that will ensure a technologically advanced forest products workforce.

Portfolio Management

ITP's portfolio management process is summarized in Exhibit 3. ITP's Strategic Plan and analytic studies guide the Forest Products portfolio in setting goals and establishing technology focus areas and priorities. R&D projects for the Forest Products portfolio are selected through an open, competitive solicitation process. Solicitations require at least a 30 percent cost-share for applied research and 50 percent for demonstration

Exhibit 3
Portfolio Management Process



projects. Cost-shares are formed with industry partners (averaged over the duration of the project) and encourage diverse partnerships among manufacturers, suppliers, national labs, universities and others. In-so-far as the budget allows, solicitations are designed to attract proposals for larger, higher-risk projects that have the potential to significantly increase energy efficiency and improve environmental performance and product yield. A merit review process is used to select projects using input from industry stakeholders, retired forest products industry executives, and the energy and environmental impact results from the Project Evaluation Tool. Once projects are selected and executed, their milestones are tracked and reported in Quarterly Status Reports. R&D projects in the current Forest Products portfolio are evaluated using a Portfolio Peer Review process. This process is designed to generate feedback on individual projects as well as the portfolio as a whole, including identifying gaps and opportunities for improving overall balance and performance. Corporate Peer Reviews are also used by ITP to evaluate and improve the portfolio and overall program performance. These reviews along with R&D follow-up studies and the Government Performance and Results Act (GPRA) results guide the decision making and planning that drives the Forest Products portfolio activity.

FY 2004 HIGHLIGHTS & ACCOMPLISHMENTS

ITP supports a diverse Forest Products portfolio of cost-shared, pre-competitive research that addresses high-risk, high-impact needs with broad applications throughout the forest products industry. In FY 2004, the Forest Products portfolio included 52 projects (Exhibit 5). The portfolio includes 28 ongoing (active) projects, 14 projects that were completed and 10 new projects.

Current projects in the Forest Products portfolio are projected to reduce the industry's energy use by 19 trillion Btu/year in 2010 and 130 trillion Btu/year in 2020.

Fact sheets describing projects in the Forest Products portfolio are located on the Web site at: http://www.eere.energy.gov/forest/

The Forest Products portfolio is designed to have the greatest impact on reducing industry energy intensity by funding projects that have significant risk. The portfolio strategy evolves over time as R&D projects are funded and completed, as new opportunities to significantly impact the industry arise, and as national priorities change. The portfolio includes high-risk, high-return R&D, applied research, applied development, demonstrations and technology deployment projects. The current portfolio strategy is to focus new research funding on a smaller number of high-risk research projects that have the potential for a high impact on process energy use. The distribution of project funds by Forest Products portfolio area is shown in Exhibit 4. The target duration of projects is between three and five years. R&D is conducted by forest product companies, industry associations, national laboratories and universities. Industry involvement accelerates the dissemination of research results and technology transfer.

Projects are distributed across the United States, with clustering at national laboratories and areas densely populated with forest products manufacturing facilities. Exhibit 6 (on page 9) shows the distribution of active projects throughout the country.

Exhibit 4
Forest Products Portfolio FY 2004 Distribution of Funds

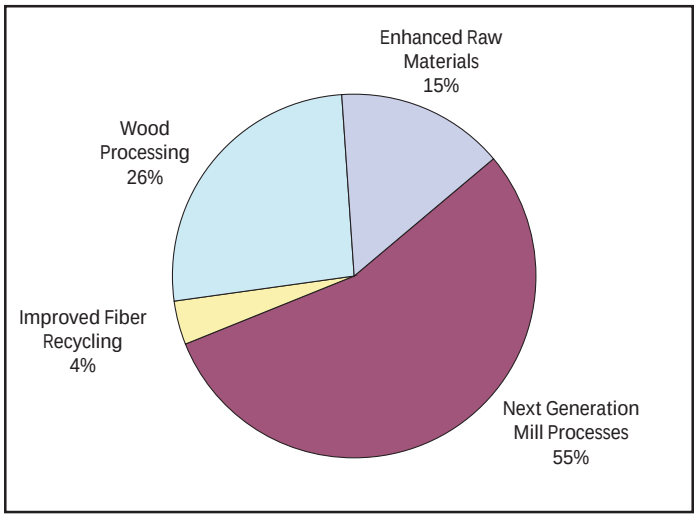


Exhibit 5
Forest Products FY 2004 Portfolio

Enhanced Raw Materials
- Environmental Influences on Wood Chemistry and Density of Populus and Loblolly Pine *(Oak Ridge National Laboratory)*
- Molecular Physiology of Nitrogen Allocation in Poplar *(University of Florida)*
- Development and Validation of Sterility Systems for Trees *(Oregon State University)*
- Accelerated Stem Growth Rates and Improved Fiber Properties *(Institute of Paper Science and Technology)*
- Genetic Augmentation of Syringyl Lignin in Low-Lignin Aspen Trees *(Michigan Technological University)*
- Quantifying and Predicting Wood Quality of Loblolly and Slash Pine *(University of Georgia)*
- Exploiting Genetic Variation of Fiber Components and Morphology *(North Carolina State University)*
- Performance and Value of CAD-Deficient Pine *(North Carolina State University)*
- Improved Wood Properties Through Genetic Manipulation *(Michigan Technological University)*

Next Generation Mill Processes
Pulping & Bleaching
- Corrosion in Kraft Digesters *(Oak Ridge National Laboratory)*
- High Selectivity Oxygen Delignification *(Institute of Paper Science and Technology)*
- Bubble Size Control to Improve Oxygen-Based Bleaching *(Institute of Paper Science and Technology)*
- Novel Pulping Technology: G-GLU Pulping *(Institute of Paper Science and Technology)*
- Higher Selectivity Oxygen Delignification *(Institute of Paper Science and Technology)*
- Yield Improvement and Energy Savings Using Phosphonates as Additives in Kraft Pulping *(University of Minnesota)*
- Increasing Yield and Quality of Low-Temperature, Low-Alkali Kraft Cooks *(Oak Ridge National Laboratory)*
- Steam Cycle Washer for Unbleached Pulp *(Port Townsend Paper Corporation)*
- Hemicellulose Extraction and its Integration in Pulp Production *(University of Maine)*
- High Energy-Efficient Directed Green Liquor Utilization (D-GLU) Pulping *(North Carolina State University)*
- A Novel Alkali Fractionation Technology to Separate Wood Components *(PureVision Technology, Inc.)*

Chemical Recovery/Environmental
- Use of Borate Autocausticizing to Supplement Lime Kiln *(Western Michigan University)*
- Improved Recovery Boiler Performance Through Control of Combustion, Sulfur and Alkali Chemistry *(Brigham Young University)*
- Development of Methane de-NO_x Reburning Process for Wastewood, Sludge and Biomass Fired Stoker Boiler *(Gas Technology Institute)*
- Particle Formation and Deposition in Recovery Boilers *(Sandia National Laboratory)*

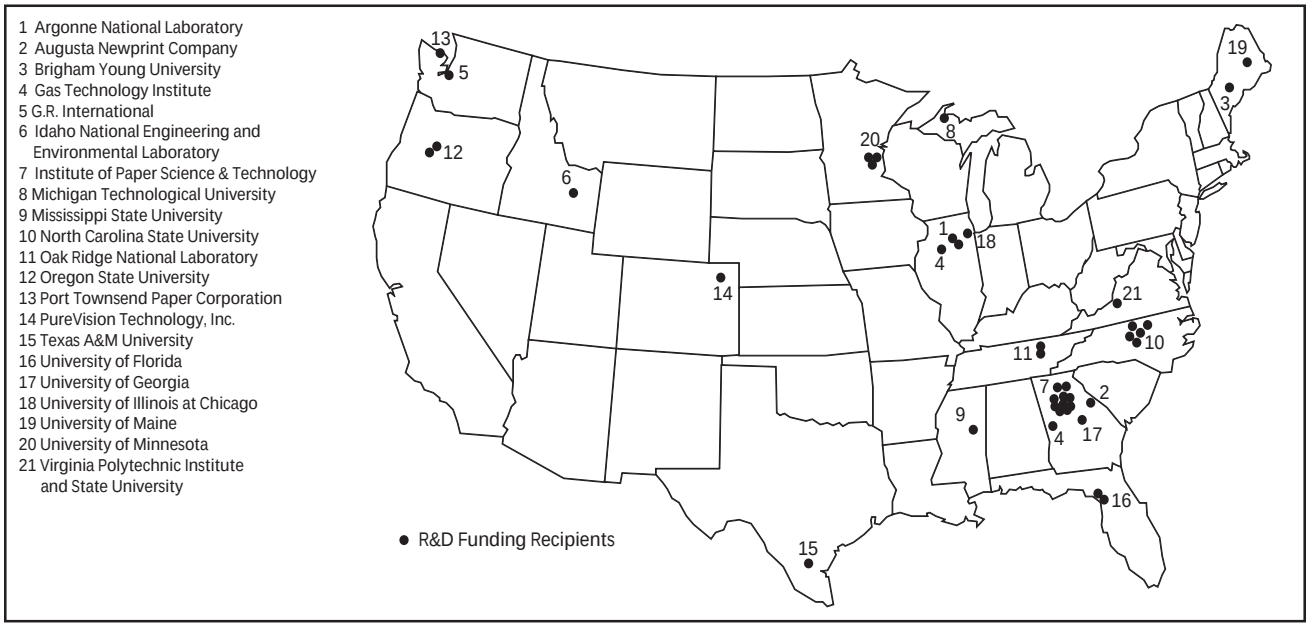
Papermaking
- On-Line Fluidics Controlled Headbox *(Institute of Paper Science and Technology)*
- The Lateral Corrugator *(Institute of Paper Science and Technology)*
- Laboratory Development of a High Capacity Gas-Fired Paper Dryer *(Gas Technology Institute)*
- Fibrous Fillers to Manufacture Ultra High Ash Performance Paper *(G.R. International)*
- Acoustic Forming for Enhanced Dewatering and Formation *(Institute of Paper Science and Technology)*
- Development and Full-Scale Demonstration of Multport Dryer Technology for the Forest Products Industry *(Argonne National Laboratory)*

Process Control
- Guided Acoustic Wave Monitoring of Corrosion and Erosion in Recovery Boiler Tubing (Lawrence *Livermore National Laboratory)*
- Evaluation and Development of a Prototype Electrokinetic Sonic Amplitude (ESA) System *(Pacific Northwest National Laboratory)*
- 3-D Characterization of the Structure of Paper and Paperboard and Their Application to Optimize Drying and Water Removal Processes and End-Use Applications *(University of Minnesota)*
- Laser Ultrasonics Web Stiffness Sensor *(Institute of Paper Science and Technology)*
- Implementation of a TMP Advanced Quality Control System at a Newsprint Manufacturing Plant *(Augusta Newsprint Company)*

Improved Fiber Recycling
- Surfactant Spray - A Novel Technology to Improve Flotation Deinking *(Institute of Paper Science and Technology)*
- Mechatronic Design and Control of a Waste Paper Sorting System *(North Carolina State University)*
- Decontamination of Process Streams Through Electrohydraulic Discharge *(Institute of Paper Science and Technology)*
- Development of Screenable Wax Coatings and Water-Based Pressure Sensitive Adhesives *(Regents of the University of Minnesota)*

Wood Processing
- Implementing Strategies for Drying and Pressing Wood Without Emissions Control *(Institute of Paper Science and Technology)*
- Microwave Pretreatment: In Mill Evaluation, Kiln Schedule and Process Model *(Oak Ridge National Laboratory)*
- Control of Emissions from Wood Waste Burners and Wood Dryers *(University of Washington)*
- Improving Dryer and Press Efficiencies Through Combustion of Hydrocarbon Emissions *(Institute of Paper Science and Technology)*
- Fast Curing of Composite Wood Products *(Institute of Paper Science and Technology)*
- Wireless Microwave Wood Moisture Measurement System for Wood Drying Kilns *(University of Tennessee)*
- Rapid, Low-Temperature Electron, X-Ray and Gamma Beam Curable Resins *(Oak Ridge National Laboratory)*
- VOC and HAP Recovery Using Ionic Liquids *(Oregon State University)*
- An Innovative Titania-Activated Carbon System for Removal of VOCs *(University of Florida)*
- Experimental Assessment of Low-Temperature Plasma Technologies *(University of Illinois – Chicago)*
- Novel Isocyanate-Reactive Adhesives for Structural Wood-Based Composites *(Virginia Polytechnic Institute and State University)*
- Biological Air Emissions Control for an Energy-Efficient Forest Products Industry of the Future *(Texas A&M University- Kingsville)*
- On-Line Oxidation of Volatile Compounds Generated by Sawmill Wood Kilns *(Mississippi State University)*
- Development of Renewable Microbial Polyesters for Cost Effective and Energy-Efficient Wood-Plastic Composites *(Idaho National Engineering and Environmental Laboratory)*
- Disposal of CCA Treated Wood and Production of Chemicals and Fuels *(National Renewable Energy Laboratory)*

Exhibit 6
Active, Ongoing FY 2004 Forest Product Portfolio Research



The FY 2004 Industry Call solicitation, released by DOE in August 2003, focused on high-risk, high-return applied research to address energy-intensive process areas that overlap across the chemicals, forest products, and petroleum refining industries. An on-line energy estimator tool (Project Evaluation Tool) was made available and is required for all applications to demonstrate technology energy savings of at least 5 trillion Btu/year for the forest products industry. The National Laboratory Call solicitation was released in December 2003 and targeted the same areas as the Industry Call. Applications were due for the Industry Call in January 2004 and the Lab Call in April 2004. Selection announcements for eight new projects from the Industry Call and five new projects from the Lab Call were made in July 2004.

Forest Products Portfolio Peer Review

ITP's 2004 Forest Products Portfolio Peer Review was held May 3-6, 2004, in conjunction with Paper Summit 2004 and the TAPPI Spring Technical and International Environmental Conference in Atlanta, Georgia. The Peer Review was designed to:

- Expose a wide public audience to the ongoing research in the Forest Products Industry of the Future portfolio;
- Increase opportunities for networking between the principal investigators and potential research for commercialization partners;
- Generate detailed performance evaluations of each project to give the R&D teams constructive feedback on their projects and assist DOE in ongoing project management; and
- Provide a "big picture" perspective of the overall portfolio and generate feedback on the overall balance and performance of the portfolio to help guide future DOE solicitations.

Technical papers on 47 active and emerging projects from the Forest Products portfolio/Agenda 2020 portfolio were presented in open sessions at the TAPPI conference. Industry stakeholders were encouraged to attend these open sessions and provide feedback on the projects to DOE. The Forest Products portfolio convened three panels, each comprised of three industry experts to evaluate each project. These results were reported to the individual project teams and used to identify many opportunities and to better target the top priorities for saving energy in the forest products industry.

ITP Corporate Peer Review

ITP's Forest Products portfolio also participated in an ITP Corporate Peer Review that was held March 9-10, 2004. The Peer Review brought industry stakeholders and government partners together to review the mission, strategies and future direction of the Industrial Technologies Program. Examples of some of the feedback the Forest Product portfolio received from the portfolio review included:

- More suppliers should be included earlier in the process to enhance deployment.
- Post-completion audits should be conducted to confirm benefits of completed projects (one to five years after project is closed).
- More coordination with the Biomass Program is needed on the black liquor gasification and fuels program.

Forest Products Portfolio R&D Highlights

Decontamination of Process Streams Through Electrohydraulic Discharge – IPST has developed new technology for reducing the impact of adhesive and other contaminants in paper recycling mills and for improving the efficiency of water clarification. This process consists of firing a high-energy spark in a process stream. The underwater spark creates a steam bubble, whose collapse generates an ultrasonic wave. The spark provides many of the benefits of ultrasonic treatment at a fraction of the cost. A full-scale trial was run at Jackson Paper in Sylva, North Carolina. The efficiency of water clarification improved dramatically and the mill pronounced the technology to be a success. However, the mill also wanted the equipment to be upgraded to withstand the stresses of an industrial process. IPST is presently negotiating with two chemical vendors to install and maintain the equipment at various mill sites. Another application presently being pursued full-scale at Stora Enso's Duluth, Minnestota mill involves demonstrating an improvement in flotation de-inking. Additional trials will be run in 2004 in collaboration with Stora Enso and the Electric Power Research Institute to demonstrate the utility of the technology in sludge dewatering. This technology promises to improve contaminant removal from recycled pulp, which will reduce energy and chemical use while improving pulp quality.

Online Fluidics-Controlled Headbox – IPST and the Woodruff School of Mechanical Engineering at the Georgia Institute of Technology is investigating a new technology to modify fiber orientation in the forming of paper that can enhance paper and paperboard quality and lead to energy savings from reduced raw material (fiber) requirements. The static version of the technology (the Vortigen system) has been demonstrated in long-term commercial paper machine trials. The project is now focusing on devising a means for on-line control of the process. Over the last year, a robust system – suitable for on-line pilot trials and final commercial implementation – using four turning vanes fabricated directly from shape memory alloy (SMA) was designed, built, and tested in laboratory experiments; it is now being adapted to two-way SMA actuation. The two-way SMA vanes will be tested in pilot trials in 2005. This technology promises a better paper product, reduced rejects, increased productivity, and significantly reduced fiber costs and water and energy use.

The Lateral Corrugator: An Improved Method For Manufacturing Corrugated Boxes - IPST seeks to develop a commercially viable lateral corrugating process. This includes designing and building a pilot lateral corrugator, testing and evaluating the pilot machine, and developing a strategy for commercialization. The lateral corrugator will be designed and built as a retrofit to conventional pilot corrugating facilities at the IPST Industrial Engineering Center. The construction of the corrugating roll stack for this project is nearing completion. If successful, the lateral corrugator could reduce fiber consumption and improve the compressive strength-to-weight ratio of corrugated shipping containers, thereby reducing energy usage in both manufacturing and transportation. An additional benefit of lateral corrugating is that with cut-to-width sheeting, paper roll management is simplified and corrugator trim waste is minimized, resulting in additional reductions in material consumption, waste generation and energy usage.

Fast Curing of Composite Wood Products – Auburn University, IPST and the Georgia Institute of Technology are working together to develop low-temperature curing technologies for urea-formaldehyde (UF) and phenol-formaldehyde (PF) resins. This objective is being pursued by identifying the rate-limiting curing

reactions and employing this knowledge to develop new catalysts that will accelerate curing reactions at reduced press temperatures and times. Research studies have identified new additives that enhance the curing of UF and PF-resins by 20 to 50 percent. The use of nanoclays has been shown to exhibit unique improvements in UF-board properties, especially as it applies to reducing water absorption and thickness swelling, two key physical properties of composite boards. In addition to these effects, the detrimental effects of wood extractives on composite board properties has been shown to be minimized by enzymatically pretreating wood chips prior to board formation. Current research focuses on integrating these two chemo-enzymatic technologies to improve the quality of composite wood products while significantly reducing the manufacturing energy use and costs.

Microwave Pretreatment: In Mill Evaluation, Kiln Schedule, and Process Model – Microwave pretreatment has been shown to reduce the time needed to dry wood in kilns, especially slow drying hardwoods such as maple and oak. This year, Oak Ridge National Laboratory has concentrated on analysis of the effects of microwave treatments on the drying of larger sections of wood and on wood that has excessive moisture variations. Application of the treatment technique to yellow poplar and pine has also been investigated. Drying models are being completed for different wood species that can be used to guide the application of the technique. Microwave pretreatment technology for lumber promises to reduce drying time by 25 to 50 percent and save a minimum of 30 percent in energy use.

VOC and HAP Recovery Using Ionic Liquids – Oregon State University is investigating the application of ionic liquids in the absorption of volatile and hazardous vapors from wood processing plants. Ionic liquids are salts that are liquids at room temperature. They can absorb a wide variety of organic compounds and can be regenerated with a vacuum and reused. This year, initial laboratory investigations have been performed focusing on the solubility of methanol and alpha pinene in various ionic liquid systems. It has been found that methanol is readily soluble in four of the ionic liquids tested. More importantly, it was confirmed that the methanol could be easily removed by the use of a vacuum. Laboratory investigations will continue in the coming year to confirm the possible application of the technology to the absorption of VOCs and HAPs as a replacement to the energy-intensive thermal oxidation control technology currently used.

Improving Energy Efficiency Today

Plant-wide assessments (PWAs) are cost-shared assessments of plant utility and process-related energy efficiency opportunities across a plant. Plants are eligible for assessments through a competitive solicitation. In FY 2004, Weyerhaeuser completed a PWA at its New Bern, North Carolina, plant that identified more than $3 million in annual savings. These PWA results were shared internally and replication opportunities have been identified at 15 Weyerhaeuser mills. Weyerhaeuser assigned the head of this PWA effort to a new corporate energy group formed to focus on a broader effort using the PWA approach and BestPractices (BP) tools. This success has prompted management to implement three pumping projects identified by the New Bern PWA and to make a commitment for capital to help with additional project implementation. Weyerhaeuser also implemented four projects identified using the BestPractices Pumping System Assessment Tool (PSAT) at their Plymouth, North Carolina, facility, and became an EERE Allied Partner in FY 2004. This success story and others are available on the BestPractices Web site at http://www.oit.doe.gov/bestpractices/pwa_awardees.shtml.

Disseminating Research Results to Industry

The Forest Products portfolio conducts outreach activities to disseminate R&D results and encourage companies to reduce the energy intensities of forest products manufacturing. The Business Development Executive Program, run by the Institute of Paper Science and Technology (IPST) and cost-shared by the Forest Products portfolio, employs retirees from the forest products industry to act as technical liaisons between paper mills and the research programs underway at IPST and DOE. Their mission is to: (1) determine the technological needs of the mills and communicate this to IPST and DOE; (2) inform the mill managers and process operators of emerging technologies, research results, energy efficiency tools, and best practices, etc., that will help make mill processes more efficient and productive; and (3) if indicated, facilitate efforts to improve communications and technology deployment. The goal of this initiative is to efficiently and effectively communicate and demonstrate advanced technology to the U.S. paper industry.

In FY 2004, the Business Development Executives (BDEs) participated in a training session on BestPractices tools and services led by DOE's Southeast Regional Office. The BDEs marketed BestPractices steam training within the pulp and paper industry, helped staff the DOE exhibit booth and recruited speakers for the Mill VIP Day at the 2004 Paper Summit, and continued to promote the utilization of BestPractices tools and services to the forest products industry via personal on-site mill visits and other means.

Energy Challenge – Encouraging Energy Efficiency

Thirteen college teams competed in a paper-made snowboard race on April 3, 2004, at Winter Park Resort in Colorado. The race was the final portion of the 2004 Energy Challenge, a national, collegiate competition that encourages students to design and build full-scale projects out of paper materials. The snowboards were made from materials such as corrugated board, paperboard or other cellulose fiber-based material. Commonly used paper chemicals were also permitted in the finishing and bonding of the board. The U.S. Department of Energy (DOE), the Institute of Paper Science and Technology at Georgia Tech, DOE's National Renewable Energy Laboratory (NREL) and Never Summer Snowboards were this year's sponsors. The purpose of Energy Challenge is to increase interest in science and engineering, and to teach concepts of energy use and waste reduction in the pulp and paper industry.

Competing teams in 2004 included Georgia Institute of Technology, Lamar University, Miami University (Ohio), Mississippi State, North Carolina State, Pasadena City College, Savannah College of Art and Design, Spartan School of Aeronautics (Tulsa, Okla.), State University of New York – College of Environmental Science and Forestry (Syracuse, N.Y.), Temple University, University of Central Florida, University of Colorado-Denver and the University of Maine. The winning teams received cash awards from $5,000 to $15,000. The snowboard race marked the sixth annual Energy Challenge.

Energy Analysis – Targeting Energy Efficiency

GPRA Analysis was completed for projects considered in the FY 2006 budget. The GPRA analysis estimates future benefits of emerging technologies in the Forest Products portfolio based on market penetrations, energy savings and environmental emission reductions.

A draft of the ***Energy and Environmental Profile of the U.S. Forest Products Industry, Volume I: Paper Manufacture*** was completed this year and will be finalized and made available on the ITP Web Site in FY2005. This detailed report benchmarks the energy and environmental characteristics of the key technologies used in the major processes of the pulp and paper industry.

Climate VISION

ITP is working in partnership with the U.S. forest products industry through the AF&PA to address climate change through enhanced research in technology and science, incentives and voluntary efforts from all sectors of the American economy. The members of AF&PA have undertaken a series of programs through which they are collectively committed to meet the President's intensity reduction goals. These programs include inventorying and reporting on greenhouse gases, enhancing sequestration in managed forests and products, developing and implementing improved technologies, improving energy efficiency, use of cogeneration, and increased use of renewable energy and recycling. Based on preliminary calculations, AF&PA expects that these programs will reduce the forest products industry's greenhouse gas intensity by 12 percent by 2010 relative to 2000.

TOOLS, PUBLICATIONS, AND RESOURCES AVAILABLE

EERE offers valuable tools and publications to help forest product companies improve productivity and energy efficiency. Some of these resources are described below. See the Web site at: http://www.eere.energy.gov/industry/forest for a complete listing.

Agenda 2020: A Technology Vision and Research Agenda for America's Forest, Wood and Paper Industry – This document introduces the forest, wood and paper industry's perspective of where the industry stands today. The Vision also explains what is considered a "desired" state for the industry 25 years into the future and provides a description of the technology-related issues that must be addressed to accomplish the industry's vision of the future.

Agenda 2020: The Path Forward: An Implementation Plan –The Forest Products Industry Roadmap identifies critical research targets for the forest products industry in six key areas. Significant industry research needs and the "pathways" to obtain desired results and breakthroughs are described. The "pathways" provide invaluable guidance for individuals who wish to participate in future industry R&D.

Forest Products Industry Analysis Brief – Provides energy and economic information regarding the forest products industry (see http://www.eere.energy.gov/industry/forest/analysis.html)

Energy Footprint of the Forest Products Industry – Identifies sources of energy losses throughout the manufacturing plant (see http://www.eere.energy.gov/industry/forest/analysis.html)

Fact Sheets and Success Stories – Publications describing RD&D projects are available. (see http://www.eere.energy.gov/industry/forest/portfolio.html).

Project Evaluation Tool – Software is available on ITP's Forest Products Web Site that can be used to estimate the potential energy and environmental benefits of a proposed new forest product technology (see http://www.eere.energy.gov/industry/forest).

BestPractices – BestPractices provides a range of software tools, databases and publications that address the energy management areas of steam, compressed air, motor, and process heating systems (see http://www.oit.doe.gov/bestpractices).

HOW TO GET INVOLVED AND CONTACT INFORMATION

Partnership Information

Public-private partnerships are the foundation of ITP's technology delivery strategy. ITP includes its partners in every phase of the technology development process to focus scarce resources where they can have the greatest impact on industrial energy efficiency. To learn more, please visit our Web site at http://www.eere.energy.gov/industry.

- Collaborative, cost-shared research and development projects are a central part of ITP's strategy. Annual solicitations provide technology development opportunities in a variety of energy-intensive industries.

- Industries of the Future partnerships increase energy efficiency in the most energy-intensive industries. In addition to cost-shared research and development projects, industry partners participate in the development of vision and roadmap documents that define long-term goals, technology challenges, and research priorities.

- Allied Partnerships provide an opportunity for ITP to reach a broad audience of potential customers by allying with corporations, trade associations, equipment manufacturers, utilities, and other stakeholders to distribute industrial energy efficiency products and services. By becoming an Allied Partner, an organization can increase its value to clients by helping them achieve plant efficiencies.

- State energy organizations work with ITP in applying technology to assist their local industries. ITP assists states in developing partnerships to mobilize local industries and other stakeholders to improve energy efficiency through best practices, energy assessments, and collaborative research and development.

- EERE's technical programs (of which ITP is one of eleven) give manufacturers access to a diverse portfolio of energy efficiency and renewable energy technologies and bring advanced manufacturing technology to the renewable energy community. For more information, access the EERE home page at http://www.eere.energy.gov.

- The President's Climate VISION (Voluntary Innovative Sector Initiatives: Opportunities Now) effort also offers opportunities for manufacturers to pursue cost-effective actions that will reduce greenhouse gas emissions. See http://www.climatevision.gov for details.

Access to Resources and Expertise

The Industrial Technologies Program provides manufacturers with a wide variety of industrial energy efficiency resources to help your company cut energy use right away. Visit our site at http://www.eere.energy.gov/industry or call the EERE Information Center at 877-337-3463 to access these resources and for more information.

- ITP offers energy management best practices to improve energy efficiency throughout plant operations. Improvements to industrial systems such as compressed air, motors, process heat, and steam can yield enormous savings with little or no capital investment.

- Our suite of powerful system optimization software tools can help plants identify and analyze energy-saving opportunities in a variety of systems.

- Training sessions are held several times per year at sites across the country for companies interested in implementing energy-saving projects in their facilities. DOE software tools are used as part of the training sessions.

- Our extensive library of publications gives companies the resources they need to achieve immediate energy savings.

- Plant-wide energy assessments are available to manufacturers of all sizes interested in cutting their energy use. Cost-shared solicitations are available each year for plant-wide energy assessments. In addition, no-cost, targeted assessments are provided to eligible facilities by teams of engineering faculty and students from 26 university-based Industrial Assessment Centers around the country.

- The DOE Regional Offices provide a nation-wide network of capabilities for implementing ITP's technology delivery strategy. Regional Offices are located in the Southeast, Northeast, Midwest, Central, Mid-Atlantic, and Western regions. Visit http://www.eere.energy.gov/rso.html for more information.

WHERE TO GO FOR MORE INFORMATION

Visit our Web site: http://www.eere.energy.gov/industry/forest

Learn about all EERE programs: http://www.eere.energy.gov

EERE Information Center answers questions on EERE's products, services and 11 technology programs, refers callers to the most appropriate EERE resources, and refers qualified callers to the appropriate expert networks. You may contact the EERE Information Center by calling 1-877-EERE-INF (1-877-337-3463) or by completing the form at this site: http://www.eere.energy.gov/informationcenter. A customer service specialist or energy expert at the EERE Information Center will respond to your inquiry.

For print copies of DOE, EERE and ITP Publications, contact the
Energy Efficiency and Renewable Energy Information Center
P.O. Box 43165
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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and great energy independence for America. By investing in technology breakthroughs today, our nation can look forward to a more resilient economy and secure future.

Far-reaching technology changes will be essential to America's energy future. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a portfolio of energy technologies that will:

- Conserve energy in the residential, commercial, industrial, government, and transportation sectors
- Increase and diversify energy supply, with a focus on renewable domestic sources
- Upgrade our national energy infrastructure
- Facilitate the emergence of hydrogen technologies as a vital new "energy carrier"

The Opportunities

Biomass Program
Using domestic, plant-derived resources to meet our fuel, power, and chemical needs

Building Technologies Program
Homes, schools, and businesses that use less energy, cost less to operate, and ultimately, generate as much power as they use

Distributed Energy & Electric Reliability Program
A more reliable energy infrastructure and reduced need for new power plants

Federal Energy Management Program
Leading by example, saving energy and taxpayer dollars in federal facilities

FreedomCAR & Vehicle Technologies Program
Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle

Geothermal Technologies Program
Tapping the Earth's energy to meet our heat and power needs

Hydrogen, Fuel Cells & Infrastructure Technologies Program
Paving the way toward a hydrogen economy and net-zero carbon energy future

Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

Solar Energy Technology Program
Utilizing the sun's natural energy to generate electricity and provide water and space heating

Weatherization & Intergovernmental Program
Accelerating the use of today's best energy-efficient and renewable technologies in homes, communities, and business

Wind & Hydropower Technologies Program
Harnessing America's abundant natural resources for clean power generation

To learn more, visit www.eere.energy.gov

Forest Products Industry of the Future

Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry

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

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