

Industrial Technologies Program

Improving the Energy Performance of U.S. Industry

2006



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**
Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

The U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) invests in a diverse portfolio of energy technologies in order to achieve a stronger economy, a cleaner environment, and greater energy independence for America.

The Industrial Technologies Program is part of EERE. It works in collaboration with U.S. industry to develop technologies and practices that improve industrial energy efficiency and environmental performance.

“Rising energy costs and oil prices . . . are challenging our country to reestablish our energy independence with a renewed sense of urgency and national purpose.”

Alexander Karsner,
Assistant Secretary,
Energy Efficiency and Renewable Energy,
U.S. Department of Energy

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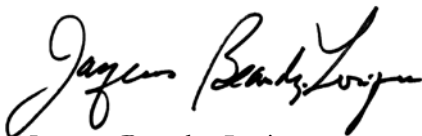
Welcome

Dear Stakeholder,

A robust industrial sector relies on a secure and affordable energy supply. While all Americans are feeling the pinch of high energy prices, impacts on industry are especially acute. High energy prices not only hurt competitiveness—they have the potential to push critical U.S. manufacturing operations offshore.

The Industrial Technologies Program is actively working through public-private partnerships to address the enormous energy challenges now facing American industry. We've established an impressive track record for moving innovative technologies through commercialization and onto the floors of industrial plants, where they're at work saving energy today. We were recently notified that eight of our newest technologies have been selected to receive the prestigious R&D 100 Award in 2006. Equally notable are the significant savings identified this year through the plant energy assessments we conducted as part of DOE's Easy Ways to Save Energy initiative.

The novel challenges confronting industry and the evolving energy picture prompted a reexamination of our strategies for technology development and delivery. I believe we have identified a number of exciting opportunities to build on our strengths, expand into new areas, and boost program impacts to support national goals. We are proud to be serving our country under the guidance of the DOE Office of Energy Efficiency and Renewable Energy. I invite you to learn more about our current program and new directions.



Jacques Beaudry-Losique
Program Manager,
Industrial Technologies Program,
Energy Efficiency and Renewable Energy,
U.S. Department of Energy

Industry is critical to America's energy security. As the largest energy-consuming sector of the economy, it holds tremendous potential for helping to achieve our national energy goals.

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Who We Are

Reducing U.S. industrial energy consumption is essential to achieving national energy security.

The Industrial Technologies Program (ITP) is the key federal program addressing industrial energy consumption. Together with our industry partners, we develop real-world energy solutions that lift industrial energy efficiency and flexibility to new levels. Our technological breakthroughs catalyze changes in industrial processes, reducing demand for energy in ways the market alone cannot achieve.

Industry accounts for a third of our Nation's energy use. ITP works with this vital sector to reduce its energy intensity both today and tomorrow. We support cost-shared research and development (R&D) to address the top energy challenges facing industry, and we foster the adoption of today's advanced technologies and best energy management practices.

ITP plays a critical role in our nation's efforts to

- Save energy
- Increase fuel flexibility
- Reduce emissions and waste
- Promote economic growth and competitiveness

MISSION

Enhancing the nation's energy security, competitiveness, and environment by transforming the way U.S. industry uses energy.

VISION

American industry leads the world in high-impact, clean, efficient, and flexible energy technologies and practices.

“America is addicted to oil, which is often imported from unstable parts of the world. The best way to break this addiction is through technology.”

President George W. Bush,
2006 State of the Union Address

ITP's Current R&D Portfolio

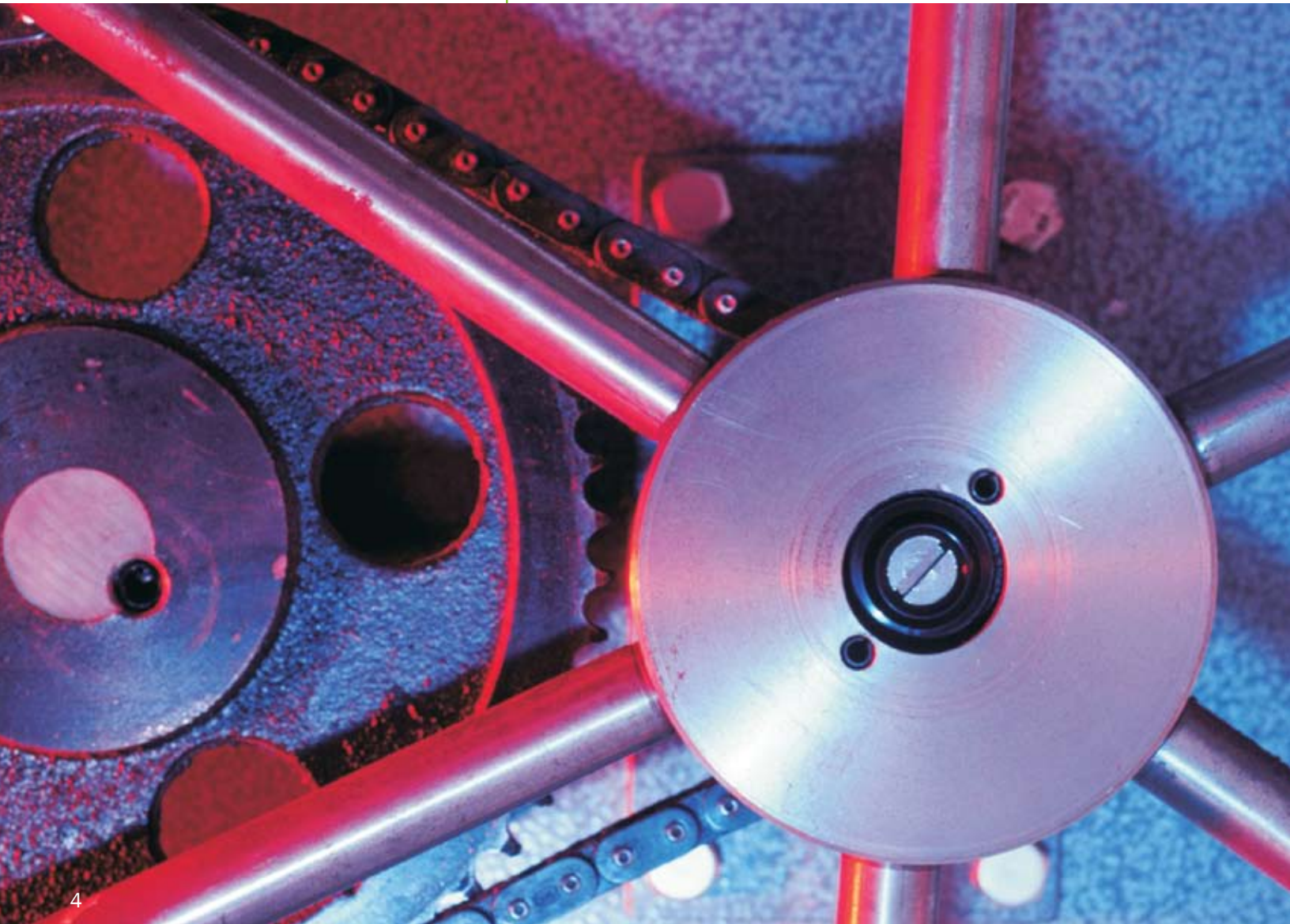
Process-specific
R&D for energy-
intensive industries

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

Crosscutting
R&D applicable
to all industries

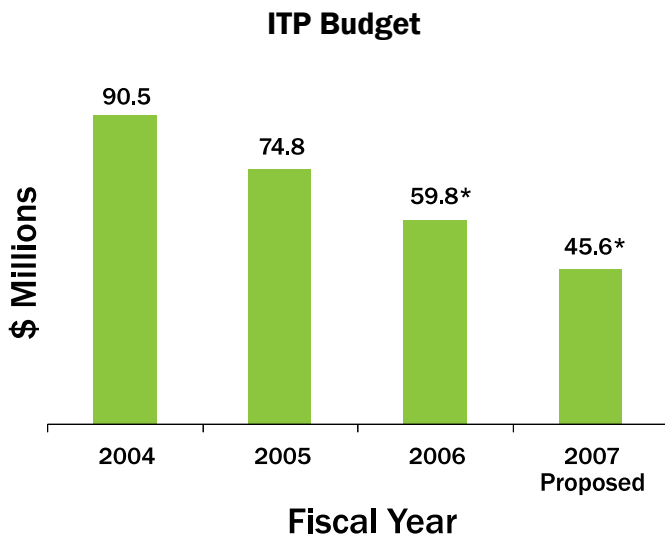
- ✓ Materials
- ✓ Combustion
- ✓ Sensors and
Automation
- ✓ Inventions &
Innovation

The keystone of our strategy is our partnership with industry. We work with industry to identify R&D priorities, and to conduct technical and market analyses that help identify technology areas with large potential for energy savings. We collaborate with industry, academia, national laboratories, and others to conduct R&D and accelerate commercialization of innovative technology solutions. Peer reviews led by industry experts ensure that the Program makes prudent investments. ITP shares project R&D costs with industry and helps companies position their technologies for commercial success.



As an applied R&D program, ITP fills a critical gap, turning knowledge from basic scientific research into highly efficient technologies that industry needs and will use. The challenges we address are some of the toughest facing the nation. We undertake these high-risk projects because they offer huge, widespread benefits if successful. Our program strategy is designed to maximize our impacts with relatively modest funding.

ITP also provides resources to foster the adoption of highly efficient technologies that can reduce the energy demand of daily operations throughout industry. To dramatically enhance our impacts and effectiveness, we work with a network of energy experts to provide fast-paced Energy Savings Assessments that reach hundreds of facilities each year. We also provide industry with tools and training to reduce plant energy consumption with minimal investment.



* Includes Inventions and Innovation



“With ITP’s help, Rohm and Haas significantly reduced its energy intensity over the past ten years. We intend to further decrease the energy intensity of our products, and we’re counting on ITP to help us achieve our goals.”

Thomas L. Archibald,
Vice President,
Rohm and Haas



Accomplishments

The Industrial Technologies Program has helped reduce industrial energy consumption through the success of its diverse R&D portfolio and technical assistance to manufacturing plants across the nation.

We are proud of the cutting-edge technologies and energy-saving practices that have emerged from our program. These technical accomplishments and innovations have made a real difference to our country.

ITP's proven track record includes the following successes:

- More than 170 technologies have entered commercial markets through R&D projects that we cost-shared with industry
- Nearly 5 quads of energy (equal to \$23 billion) have been saved since the program's inception; 366 trillion Btu were saved in 2004 alone
- 31 ITP-sponsored technologies won *R&D 100 Awards* between 1991 and 2005, and eight more in 2006
- 156 patents were issued for ITP-sponsored R&D between 1994 and 2005
- Over 13,000 U.S. manufacturing plants have been improved through our Technology Delivery efforts

We attribute our success to our top-flight partnership strategy, in-depth understanding of industry priorities, effective management, and dedicated staff.

“Our partnership with ITP helped conserve energy in our plants and develop...advanced, high-strength steels that have enabled the safe, lightweight design of more fuel-efficient cars. These types of projects and related energy savings benefit the entire supply chain and the public at large.”

John P. Surma,
Chairman and CEO,
United States Steel Corporation



In 2006

ITP continued on the path to success with notable advances in research, development, and technology delivery, including the Save Energy Now initiative launched last year.

- ✓ Our R&D portfolio led to significant technological breakthroughs that will help industry improve energy efficiency, reduce emissions, and remain competitive. Our successes include eight award-winning projects.
- ✓ We reached out to industrial energy users of all sizes through our technology delivery efforts via training, software tools, publications, and energy assessments.

Eight ITP-sponsored projects won *R&D 100 Awards* in 2006



R&D Magazine bestows awards each year to the 100 most promising new technologies, products, and processes entering the market. The awards—also known as the “Oscars of Invention”—are a widely recognized mark of excellence for the most innovative and commercially viable scientific ideas judged on technical significance, uniqueness, and usefulness.



Isothermal Melting Process

This revolutionary way to melt aluminum cuts energy use by more than half while reducing emissions by more than 80%.

Project Partners: Apogee Technology, Aleris International



TMA® 6301 and TMA® 4701

More durable and heat-resistant cast austenitic stainless steels were developed using a computer-aided design methodology that reduces the time required for the development of new alloys by over 50%.

Project Partners: Oak Ridge National Laboratory, Duraloy, Nucor Steel



Data Transmission System™ (DTS)

Data communication system using two-way radio frequency enables mining operators to compile data 300 times faster than conventional systems to increase operating accuracy and lower operating costs.

Project Partners: Stolar Research Corporation, CONSOL Energy Inc., Canyon Fuel Company LLC, West Virginia University

Metal Infusion Surface Treatment (MIST)

On-site treatment infuses up to 51 elements into surfaces of metal and alloy equipment, then provides nanostructure coating to increase service life tenfold.

Project Partners: C3 International, Oak Ridge National Laboratory, Vitek Performance



Multiport Dryer

This affordable retrofit to paper drying cylinders significantly increases heat transfer to the paper web to increase productivity by 20-50% while reducing energy consumption.

Project Partners: Argonne National Laboratory, University of Illinois at Chicago, Kadant Johnson Inc., International Paper



HotEye™ Steel Bar Inspection

Fully automatic, in-line, machine vision inspection system provides accurate, timely information on steel surface defects to lower energy use by reducing reworking of defective product.

Project Partner: OG Technologies, University of Michigan, University of Wisconsin



Alloys Resistant to Metal Dusting Degradation

New alloys could enable more energy-efficient hydrogen production by resisting corrosion in hydrocarbon-containing atmospheres with temperatures of up to 816°C.

Project Partners: Argonne National Laboratory, Materials Technology Institute



Laser-Ultrasonic Web Stiffness Sensor

Novel technology enables non-contact, real-time measurement of paper stiffness and shear strength during paper production, to ensure optimum paper quality and efficient use of trees, chemicals, and energy.

Project Partners: Lawrence Berkeley National Laboratory, Institute of Paper Science and Technology at Georgia Institute of Technology



“I congratulate the researchers who have won these awards, which highlight the power and promise of DOE’s investments in science and technology. Through the efforts of dedicated and innovative scientists and engineers . . . DOE is helping to enhance our nation’s energy, economic, and national security.”

Samuel W. Bodman,
Secretary,
U.S. Department of Energy



Technical Accomplishments in 2006

We invest in a balanced R&D portfolio based on industry input and our own rigorous analysis. In 2006, our cost-shared projects led to major technical accomplishments. The following examples illustrate our progress in turning scientific innovations into real-world energy solutions.

Equipment

- Demonstrated the ability to achieve 94% thermal efficiency with a first-generation Super Boiler at a rubber gasket manufacturing plant.
- Completed development of an Advanced Process Heater that maximizes heat transfer and delivers a uniform heat profile at 95% thermal efficiency with NOx emissions below 10 ppm.
- Completed pilot-scale testing of a submerged combustion melter for glass to achieve a 23% reduction in energy consumption and 55% reduction in capital costs.
- Completed plant-scale demonstration of a front-end system that extends the oxygen-enriched fuel technology to further reduce energy consumption in this portion of glass making by 50%.

- Completed an endurance test on a new aluminum-bronze hood for a basic oxygen furnace that saves energy by minimizing production downtime.
- Demonstrated in-line, machine vision inspection system for detecting defects that reduces the steel surface defect rejection rate at a steel mill by 50% and the energy required to rework out-of-spec product.
- Demonstrated the operation of a lignin sensor that efficiently detects different grades of paper in a Multiwave™ paper sorting system.
- Demonstrated a vulcanized splice integrity detection system that decreases unexpected conveyor belt failures by 70% in underground and surface coal mines and provides 2% energy savings by increasing mine productivity.

Process

- Developed and validated in an industrial setting a new weld overlay that resists corrosion, wear, and cross-buildup and extends service life five-fold over current stainless steel.
- Developed an advanced, multi-layered thin film, thermoelectric material (germanium silver antimony telluride, or “GAST”) that enables energy efficient waste heat recovery in industrial processes.



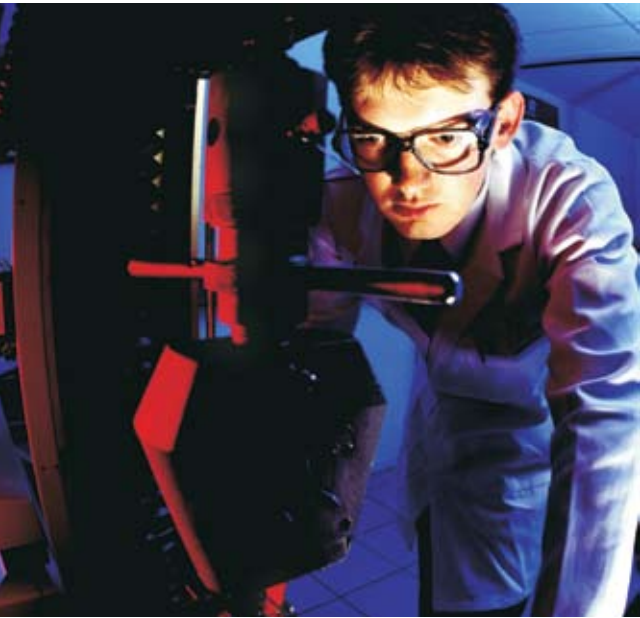
- Demonstrated 100% improvement in hardness of stainless steel alloys, as well as improved wear and corrosion resistance, based on a new surface hardening technology, Low-Temperature Colossal Super-Saturation (LTCSS).
- Completed the feasibility assessment of a new production process for converting iron ore and coal into iron pellets with significantly improved energy efficiency.
- Demonstrated at the laboratory scale a biocatalytic process that uses synthetic gas as an alternative to natural gas in the production of acetic acid.
- Demonstrated at the laboratory scale a multi-channel, micro-reactor technology for in-situ production of pharmaceutical chemicals in concentrations adequate for many applications.
- Conducted an in-plant demonstration of a low-cost process modification that reduces volatile organic compounds (VOC) emissions from wood processing by more than 60%.



Scientific Knowledge

- Developed the software package CorrosionAnalyzer, that predicts the corrosion of fabricated components in chemical processing equipment to reduce downtime, boosting productivity and efficiency.
- Demonstrated industry-acceptable accuracy of the Galvanizing Energy Profiler and Decision Support System (GEPDSS) at several galvanizing lines.
- Completed the concept definition for a continuous melt, refine, and cast technology for next-generation, energy-efficient steel production.
- Completed the development of a wireless sensor protocol to reduce industrial motor energy use by 5 to 10% through real-time identification of motor efficiency.
- Validated a laboratory test of a miniaturized instrument that realized 2% energy savings in the energy-intensive ethylene production process by improving process control and avoiding upsets.





Outreach

In the past year, ITP provided a variety of resources to help plants save more energy:

- Over 350 manufacturing facilities had their energy systems assessed by teams from our Industrial Assessment Centers
- 9,930 plants, utilities, suppliers, and states received the Save Energy Now CD containing valuable ITP software tools
- 90 training sessions were conducted to help plant personnel analyze energy-saving opportunities using DOE software tools
- 16,364 users downloaded software tools from ITP's website
- ITP developed and released two new resources to help industry better manage and save energy: the Quick Plant Energy Profiler (PEP) tool and the Pump Systems Sourcebook



Energy Savings Assessments: Rapid Progress toward Industrial Energy Efficiency

DOE Secretary Samuel W. Bodman launched the national “Easy Ways to Save Energy” campaign in 2005. The campaign promotes simple yet effective energy choices, assists industry and the government in reducing energy use, and supports national goals for energy security.

Save Energy Now

Through the Save Energy Now initiative, ITP offered 200 no-cost Energy Savings Assessments (ESAs) to the nation’s largest energy-consuming plants in 2006. ESAs help energy-intensive manufacturing facilities identify immediate opportunities to save energy and money. Over the course of a three-day assessment, DOE energy experts introduce the plant staff to software tools that identify ways to increase energy efficiency with simple yet effective adjustments to operating practices. Save Energy Now also provides webcasts, software tools, publications, training, and other technical resources to help plants save energy.

The first 105 of the 200 planned ESAs conducted since November 2005 yielded impressive results:

- 30.3 trillion Btu in potential natural gas savings each year (equivalent to the natural gas consumed by 420,900 U.S. homes)
- \$273.8 million in total potential energy cost savings each year
- \$1.8 million in annual savings were achieved from just 11 plants in the first 30 days following the assessment



Secretary Samuel W. Bodman toured the Caterpillar plant in Peoria, IL, on April 6, 2006, to participate in an Industrial Technologies Program Energy Savings Assessment (ESA).

“DOE’s Energy Saving Teams are playing a key role in assessing and recommending energy efficiency strategies for some of the largest industrial facilities across the nation.”

Samuel W. Bodman,
Secretary,
U.S. Department of Energy



“The Department of Energy...qualified specialist provided a fresh perspective and found new ideas and energy savings opportunities that applied to our system.”

Marc Montemayor,
System Engineer,
Texas Instruments Incorporated

Rohm and Haas impressed with ease of use of DOE’s Steam System Assessment Tool

The Rohm and Haas Company received a 2006 Energy Savings Assessment for its Morton Salt facility in Grand Saline, Texas. The DOE energy savings team used the Steam System Assessment Tool to help plant staff identify tremendous potential natural gas savings that can be achieved with simple operating adjustments, including:

- Near-term: 10% savings through idling a turbine generator undergoing repair and lowering steam pressure.
- Mid-term: 85% gas savings by minimizing steam use for evaporation.

Boral Brick finds savings opportunities in process heating system

During the March 2006 Energy Savings Assessment at the Boral Brick Plant in Augusta, Georgia, plant personnel learned and applied DOE software to examine the efficiency of their dryers and tunnel kilns. They used the software to identify specific opportunities and then quantify the associated potential natural gas and cost savings. The bulk of the opportunities they identified can be implemented in one to two years:

- Preheat combustion air
- Insulate hot exposed parts
- Improve insulation of furnace structure

Collectively, these mid-term actions can reduce the plant’s natural gas use and associated costs by 4.8%.

Dow hosts steam assessment at its largest manufacturing site

A DOE energy expert worked with the Dow team at its facility in Freeport, Texas, to examine three areas for improvement: steam generation, steam utilization, and insulation. The team learned to use DOE's Steam System Assessment Tool to develop approximate models of the plant's actual steam systems, then quantified opportunities for energy, cost, and emissions savings. The assessment evaluated various steam generation and acquisition options as well as improvements in steam venting. Recommended improvements included replacing the plant's steam turbine with an electric motor to reduce venting and improve boiler efficiency.

“While [Dow] has long been a leader in energy efficiency, with DOE's help we found yet more cost-effective opportunities to save energy.”

John Dearborn,
Global Business Vice President,
The Dow Chemical Company





Challenges and Opportunities

Threats to U.S. energy and economic security can be mitigated by advanced technologies.

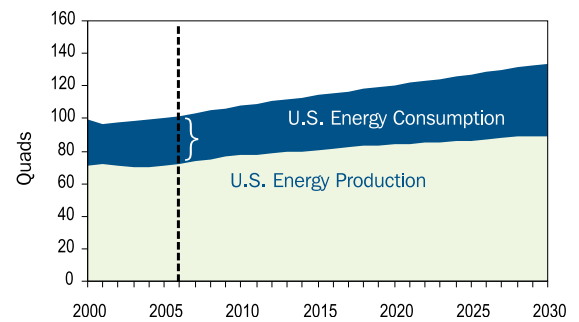
The widening gap between our domestic energy production and total energy use constitutes a growing threat to national security and economic growth. U.S. reliance on imported oil and natural gas is increasing even as developing nations place larger demands on global fuel supplies—continuing the upward pressure on prices.

Industry uses more energy than any other sector of the economy, and the Energy Information Administration projects that it will continue to grow steadily. Reducing energy intensity in this vital sector can contribute to our national energy security.

Energy Security: Already constrained supplies of critical fuels are also vulnerable to natural and man-made interruptions. Unexpected interruptions can create short-term supply problems, as occurred when natural gas processing centers sustained hurricane damage in 2005. Unfortunately, three-quarters of the world's natural gas reserves are located in politically unstable areas.

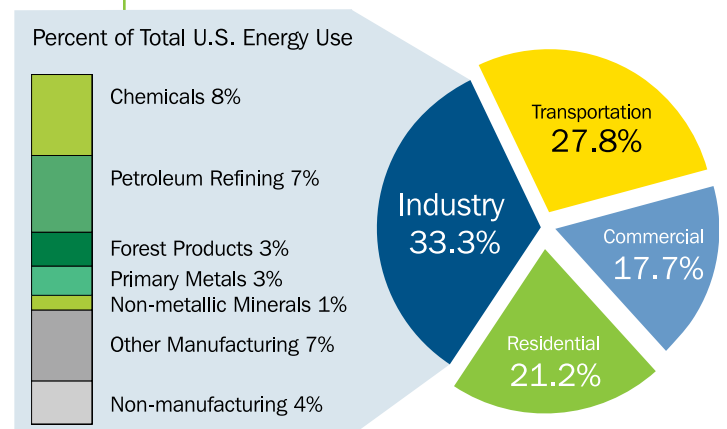
Economic Security: Economic growth in industry depends on the availability of affordable, reliable fuel sources. Rising fuel prices hurt our ability to remain competitive in global markets. U.S. industry uses natural gas as a fuel and a feedstock, but domestic production has not kept pace with our national demand—prompting higher prices. Many foreign countries enjoy natural gas prices that are significantly lower than ours, giving them a competitive edge.

The gap between the energy we produce and the amount we use continues to widen.



EIA Annual Energy Outlook, 2006

Industry consumes more energy than any other sector of the U.S. economy.



EIA Annual Energy Review 2005; estimates based on MECS and AEO data

The challenge for U.S. industry is to remain competitive in global markets despite high costs for energy, labor, and environmental compliance.



Environmental Responsibility: The combustion of fossil fuels is a primary source of greenhouse gases and is a major contributor of air, water, and land pollution. About two-thirds of industrial greenhouse gas emissions come directly from production processes, while the rest result from the sector's electricity demand.

Despite these challenges, U.S. companies remain underinvested in energy efficiency. Companies are under pressure to deliver financial returns to shareholders, and many corporate R&D budgets for efficiency improvements have shrunk. Investments in energy-efficient technology compete for scarce capital with other priorities, including compliance with environmental regulations. Paradoxically, high energy bills further reduce the funds available for capital spending. Many companies also lack the skills and resources necessary to capture the real savings attainable today.

U.S. Industry Used 33.4 Quads in 2004 (*Quadrillion Btu*)

- 37% of U.S. natural gas demand
- 29% of U.S. electricity demand
- 30% of U.S. greenhouse gas emissions
- More energy than the entire economy of any other G8 nation

EIA Annual Energy Review 2005

EIA International Energy Annual 2004

EIA Emissions of Greenhouse Gases in the United States 2004

Large opportunities to save energy still exist in U.S. industry. Putting current knowledge to use and continuing research can make a difference.

American industry can increase our nation's resilience in the face of current and future energy challenges. Advances in energy efficiency, fuel flexibility, and innovative technologies can enhance our energy security, economic growth, and environmental quality. Good starting points for reducing industry's energy consumption and reliance on natural gas include:

- **More Efficient Operating and Maintenance Practices:** Improved and more energy-efficient operating practices can be adopted rapidly at negligible cost to enhance operating efficiency in manufacturing facilities in the near- to mid-term.
- **Increased Adoption of State-of-the-Art Technology:** Energy efficiency can be improved in the near- and mid-term by increasing industry's adoption of advanced technologies currently available. Waste heat recovery, combined heat and power (CHP), and advanced boiler technologies offer huge opportunities to save energy.
- **Fuel and Feedstock Flexibility:** Manufacturers need the flexibility to adapt to dynamic energy prices and supply issues. Much of industry's natural gas is used for boilers and process heaters, which present primary fuel switching opportunities.
- **Development of Next-Generation Technology:** Progress toward long-term national goals for energy and the environment rely on continuous technology innovation. The technologies required to address today's challenges can require a decade or more to progress from basic science to commercialization.



Given today's energy challenges, U.S. industry requires continuous technological innovation.



Moving Ahead: Strategies for Success

ITP is exploring new strategies to help industry stay competitive today while preparing for future challenges.

National energy security will require widespread industry adoption of innovative technologies and practices that reduce energy demand. The Industrial Technologies Program leads Federal efforts to expedite novel technology research and accelerate market introduction of dramatically more efficient industrial technologies and practices. Over the next few years, we will build on our accumulated knowledge and strategic partnerships to take full advantage of new opportunities to accelerate and broaden our impacts on industrial energy use.

New challenges call for innovative solutions. We must accelerate the development of energy-efficient technologies ready to enter the market in the near-term, while conducting groundbreaking research on revolutionary technologies for the future. Our applied R&D focus effectively turns knowledge and concepts initiated by others into real-world energy solutions. In addition, novel strategies to expand our partner base will boost program impacts by expediting technology commercialization and adoption of efficient energy management practices. We are currently evaluating a number of opportunities to help industry respond to energy challenges today and tomorrow. Some of these options are highlighted on the following pages.

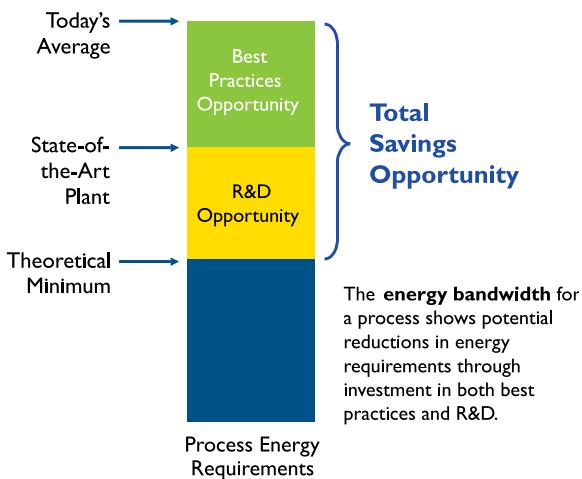
“With energy prices at all-time highs, energy efficiency improvements are one of the most critical steps we need to implement in our country... Industrial energy consumers use a large percentage of the nation’s energy, and energy efficiency projects in our sector can, in aggregate, make a big impact in our nation’s energy intensity.”

Ray L. Ratheal,
Director,
Energy Policy and Planning,
Eastman Chemical Company



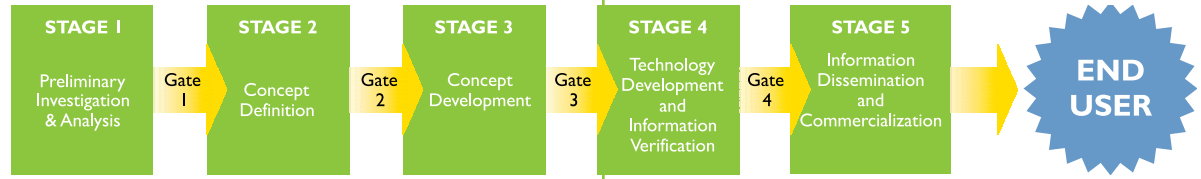


Energy Bandwidth Analyses
of energy-intensive industries are
used to prioritize opportunities



- **Investigate cross-cutting R&D** to save energy in the top energy-consuming processes used across industry. By focusing on a small number of widely used technology areas (see examples on next page), ITP could achieve large energy benefits throughout the manufacturing supply chain.
- **Exploit fuel and feedstock flexibility** to give manufacturers options for responding to energy price and supply pressures. ITP will seek to develop alternative fuel and feedstock technologies to replace oil and natural gas in the long term while supporting near-term deployment activities to reduce the impacts of fuel price hikes. Increasing the range of fuel options available to industry will foster energy independence and economic resilience.
- **Invest in “next-generation” technologies** adaptable to processes throughout industry that could dramatically change the way products are manufactured. Mass-scale nano manufacturing, process-integrated predictive tools, and wireless real-time sensor systems are just a few of the technologies that could bring new, cost-competitive options to American industry.
- **Strengthen our planning and analysis** to identify opportunities with the greatest potential for energy savings and develop a robust market transformation strategy. Thorough analysis of industry market barriers and challenges will allow more effective investment decisions with a higher impact.
- **Institute rigorous stage-gate project and portfolio management procedures** to assure sound project management and funding decisions. ITP has developed its own program management guidelines based on the conventional Stage-Gate™ concept of R.G. Cooper and Associates. Projects are examined at

critical gates throughout the R&D cycle based on



carefully defined technical and business criteria. This program management tool provides ITP managers a straightforward pathway for evaluating progress and imposes discipline in project management, raising the potential for commercial success of its R&D portfolio.

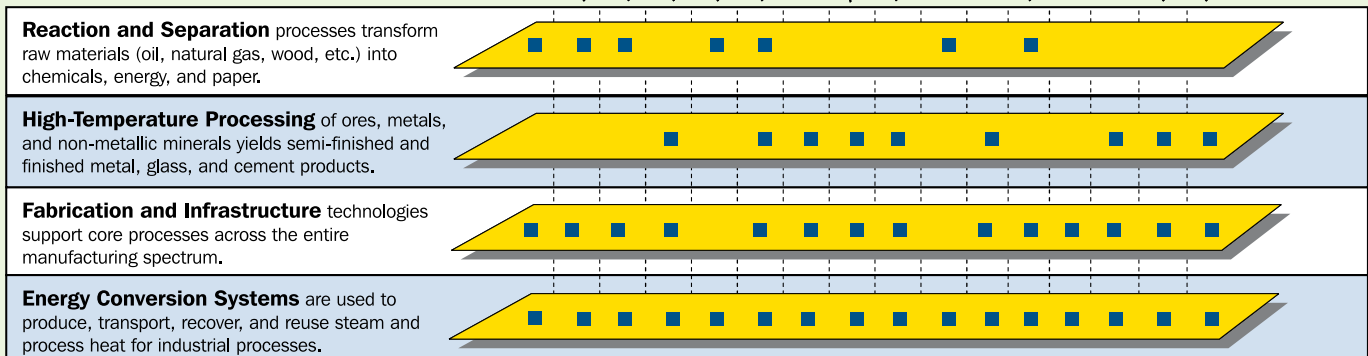
- **Emphasize commercialization planning** throughout the R&D life cycle. ITP will work with its R&D partners to develop robust commercialization strategies and provide other support to ensure the market success of promising new technologies.
- **Encourage private investment in energy efficiency** through new partnerships and strategies to reach industry. ITP will expand its alliance with equipment manufacturers who are well positioned to drive new technology to the market and publicize it to their customers. We will also challenge private industry to increase their investment in advanced technologies, energy management and best operating practices, and the replacement of older, inefficient equipment.

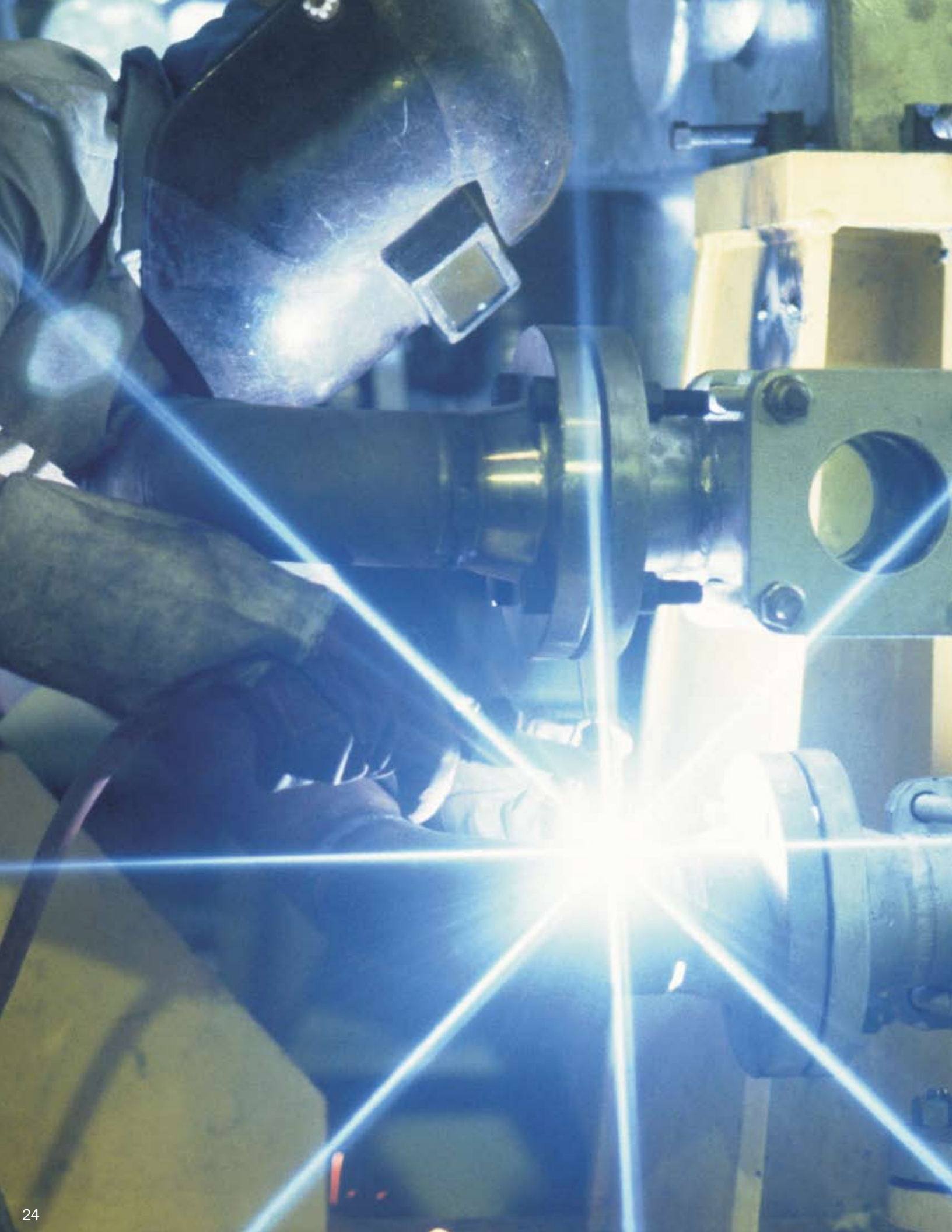
Stage-Gate Management™:
Each stage is designed to reduce levels of uncertainty and risk

ITP has identified four cross-cutting technology areas where R&D could achieve large energy benefits in multiple industries

Industries (Ranked by Fuel and Electricity Use)

- Chemicals (1)
- Petroleum Refining (2)
- Forest Products (3)
- Iron & Steel Mills (4)
- Food & Beverage (5)
- Mining (6)
- Transportation Equip. (7)
- Alumina & Aluminum (8)
- Fabricated Metals (9)
- Textiles (10)
- Cement (11)
- Plastics & Rubber (12)
- Computers, Electronics (13)
- Glass & Glass Products (14)
- Foundries (15)
- Heavy Machinery (16)





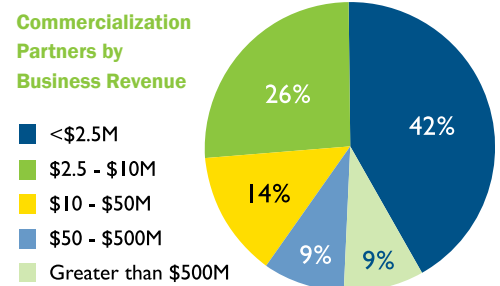
Technology Highlights

ITP's investment in high-risk, high-value R&D has yielded over 170 technologies now available in the market.

At ITP, we are proud of our role in bringing together top talent from all sectors to solve some of the toughest challenges facing industry. Our collaborative, cost-shared partnerships have generated many technology advances that have been commercialized by our industry partners, including many small businesses. These energy-saving technologies are now in use across industry, increasing productivity and reducing emissions nationwide.

Examples of ITP-sponsored technologies that can improve manufacturing energy efficiency and economic competitiveness are described on the following pages.

Almost half of our commercialization partners are small entrepreneurial companies



Technologies that successfully moved from ITP cost-shared R&D into the market are presented in *Energy Technology Solutions: Public-Private Partnerships Transforming Industry*. This document highlights each technology's energy savings and lists distributor contact information. Please view this document online at

http://www1.eere.energy.gov/industry/bestpractices/pdfs/itp_successes.pdf

Significant Technologies in 2006



Super Boiler

- Gas-fired package boiler incorporating innovative concepts in burner, heat transfer, heat recovery, and control components
- Capable of achieving thermal efficiencies $\geq 94\%$
- Firetube boiler in demonstration phase; efforts underway for development of high-pressure watertube boiler

Project partners: Gas Technology Institute; Cleaver-Brooks, Inc.; GTI Sustaining Membership Program; Pacific Northwest National Laboratory; Southern California Gas Company; Utilization Technology Development Company; California Energy Commission; South Coast Air Quality Management District; California Air Resources Board; Specification Rubber Products; Clement Pappas & Company



Isothermal Melting (ITM) Process: A Revolutionary Aluminum Melting Technology



“The Isothermal Melter . . . has resulted in a quantum leap in energy efficiency for aluminum melting . . . [and] funding provided by DOE was absolutely critical to the success of the project.”

Denis Ray, VP-Manufacturing,
Rolled Products,
Aleris International, Inc.

- Continuous flow system uses immersion heaters that convert electricity to melting energy with 98% efficiency
- Reduces energy input and floor space by more than 50% compared with conventional furnaces
- Eliminates in-plant emissions

Project partners: Apogee Technology, Inc.; Aleris International; General Motors; Commonwealth Aluminum; Drexel University

Celebrating Success

An April 2006 ribbon-cutting ceremony in Ohio highlighted the ITM technology’s scale-up for use at a General Motors facility.

Commercially Available



Cokeless Ironmaking: Mesabi Nugget Technology

- Produces high-quality iron nuggets from low-grade ore and pulverized coal
- Single process replaces coke oven/blast furnace ironmaking
- Saves up to 30% of the energy used in integrated steelmaking and 10% in EAF steelmaking

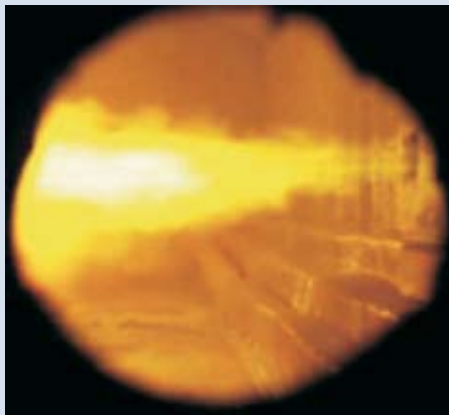
Available from: Mesabi Nugget, LLC; Kobe Steel



Oxy-Fuel Firing for Glass Melting

- Uses oxygen instead of air in high-temperature combustion processes employed in glass melting furnaces
- Reduces fuel use by 15-45%; NOx emissions by up to 90%
- Benefits all major glass sectors

Available from:
Air Liquide, Air Products,
BOC Gases, Praxair



Forced Internal Recirculation (FIR) Burner: Minimizing NOx Formation

- Single burner integrating combustion air/natural gas premixing, air staging, and forced internal recirculation
- Reduces NOx emissions to less than 10 ppm; CO to less than 25 ppm
- Accommodates a variety of combustion-chamber configurations



Available from: Johnston Boiler Company

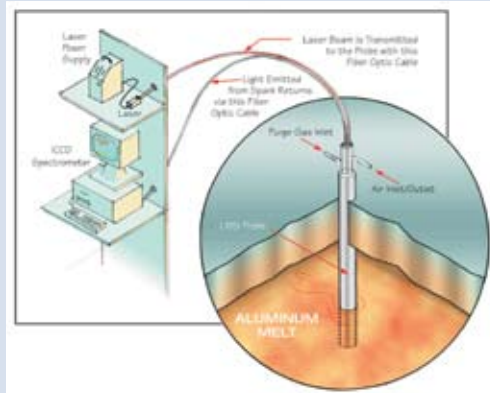
Commercially Available



Laser-Induced Breakdown Spectroscopy

- Enables in-situ, real-time measurements of melt constituents in a process furnace
- Eliminates off-line measurements and reduces furnace idle time, saving energy
- Used in aluminum furnaces; great potential in glass and molten metal industries

Available from: Energy Research Company



Sanicro-38 Improved Composite Tubes for Kraft Recovery Boilers



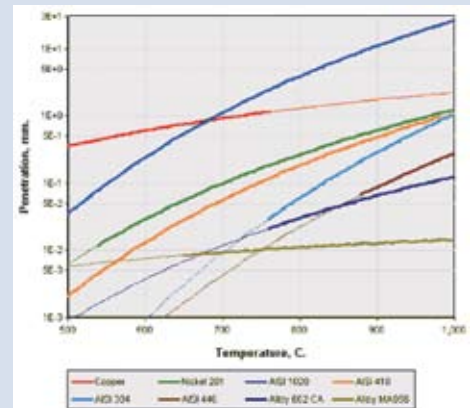
- Tubing alloys resist cracking in aggressive, corrosive environments
- No recovery boiler floor cracking reported in tubes in service over 10 years
- Used worldwide in Kraft recovery boiler installations; over 80,000 meters of tubing sold

Available from: Sandvik Materials Technology

ASSET: Alloy Selection System for Elevated Temperatures: Software Predicting Corrosion Rates

- Accurately predicts corrosion mechanisms and rates using extensive thermochemical calculations and corrosion data
- Helps equipment designers identify suitable alloys to use
- Avoids expensive trial-and-error approach
- ITP investment currently applied to enhancing software capabilities

Licenses available from: Shell Global Solutions (US)



Emerging



Steam Cycle Washer for Unbleached Pulp

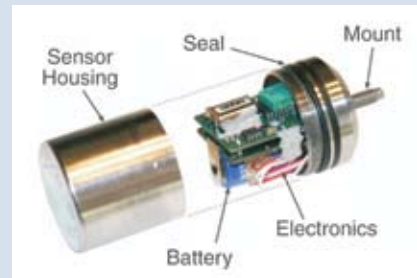


- High-consistency pulp washer decreases water content from black liquor stream and cuts evaporator load in half
- Reduces electricity use by up to 21%
- Commercial-scale demonstration in 2007

Project partners: Port Townsend Paper Company, 21st Century Pulp & Paper, Idaho National Laboratory

Distributed Wireless Multisensor to Reduce Motor Energy Use

- Wireless sensor suite allows continuous electric motor monitoring
- Avoids unscheduled downtime due to failed motors
- Field testing underway in 2006
- Multiple industrial applications: petrochemical, metals, forest products, mining, metal casting, power generation



Project partners: General Electric Global Research; Sensicast Systems

Submerged Combustion Melting

- Intense melting and mixing process fires flames directly into the molten glass bath
- Over 20% energy savings and low capital costs
- Applicable to melting other inorganic materials at high temperatures
- Pilot-scale testing in progress

Project partners: Gas Technology Institute; Corning Incorporated; PPG Industries Inc.; Owens Corning; Schott Glass Technologies, Inc.; Johns Manville; Fluent, Inc; A.C. Leadbetter and Son, Inc.; Praxair, Inc.; Combustion Tec/Eclipse; NYSERDA





Technology Delivery

ITP's Technology Delivery provides resources to help manufacturers identify the most cost-effective opportunities to save energy using today's technology and management practices.

Opportunities for quick-payback process improvements that save energy can be found in most plants today. We deliver a range of valuable resources to help plants save energy:

- Energy software decision tools focus on energy-intensive systems used throughout industry, such as steam, compressed air, motors, pumping, insulation, process heating, and combined heat and power.
- Energy efficiency training by qualified specialists enables plants to take full advantage of the software tools.
- Case studies, tip sheets, and other information help plants improve energy management and calculate the value of energy-saving investments.
- DOE-supported Energy Savings Assessments (ESAs) identify immediate and long-term opportunities to save energy and cut costs in large- and medium-size manufacturing plants.
- Our university-based Industrial Assessment Centers identify near-term energy savings at eligible mid-size plants while providing hands-on experience for future scientists and engineers. These centers are proud to support the President's American Competitiveness Initiative.

OPPORTUNITY

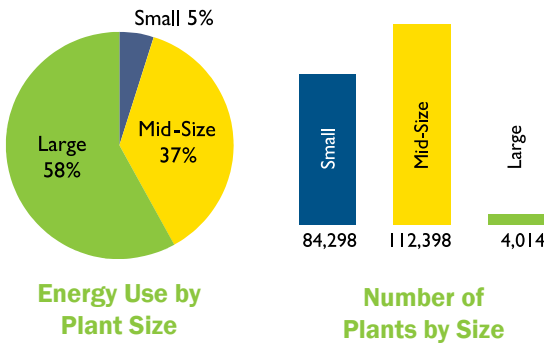
Most manufacturers can cut their energy bills by 10 to 20% using proven energy management methods.

STRATEGY & TARGETS

- Focus on the largest plants that use the most energy
- Reach as many plants as possible
- Help plants that lack dedicated staff for energy management
- Partner with manufacturers, suppliers, and other stakeholders to develop and distribute resources
- Encourage companies to replicate accomplishments and share results
- Focus on national priorities such as reducing natural gas demand

ITP makes strategic investments in plant efficiency

The Largest 4,014 Manufacturing Plants Use 58% of the Energy

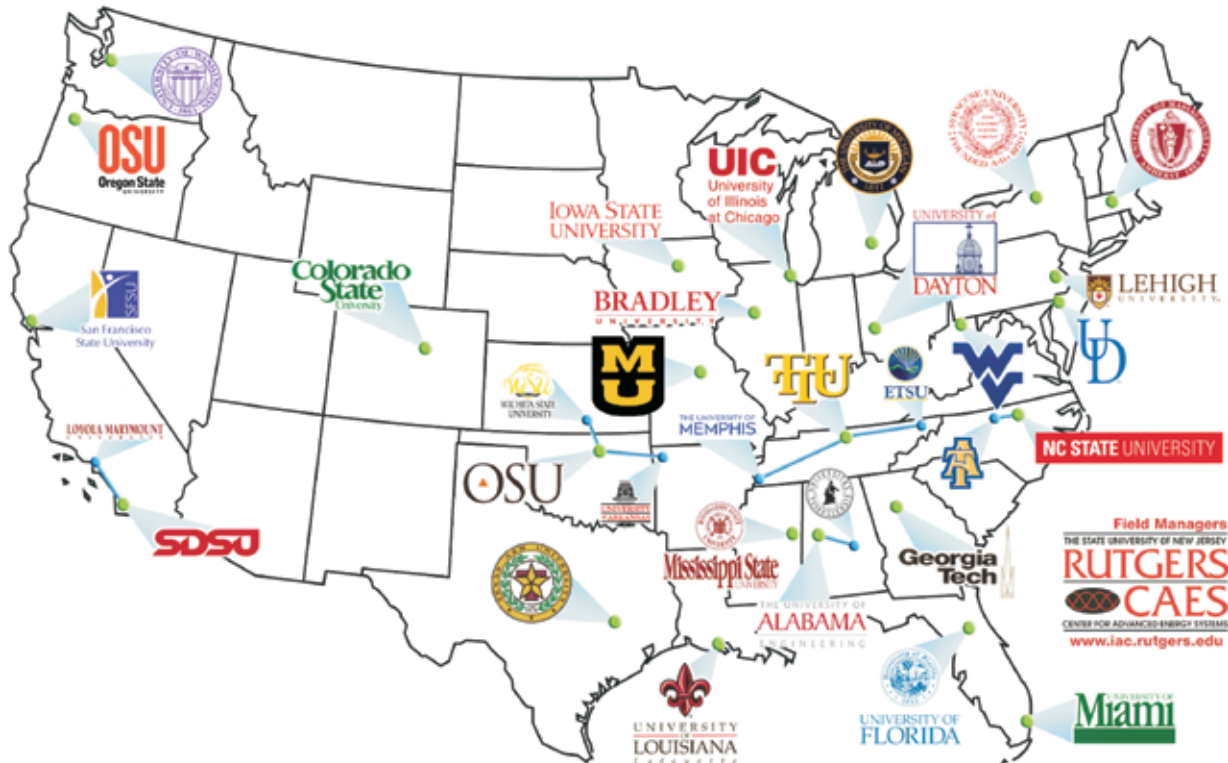


Allied Partners Extend ITP's Reach

Allied Partners disseminate new technologies, promote software tools, and encourage participation in training. ITP's nearly 200 Allied Partners include manufacturers, trade associations, industrial service and equipment providers, utilities, and other organizations committed to improving industrial energy efficiency.

ITP's university-based Industrial Assessment Centers

provide no-cost energy assessments to medium-sized manufacturers. These assessments identify opportunities to improve productivity, reduce waste, and save energy. Average annual savings potential is \$55,000 for each manufacturer.



Case Study – International Paper Finds the DOE Energy Savings Assessments User Friendly and Easily Replicable



In 2006, International Paper worked with a

DOE expert to complete a steam Energy Saving Assessment at its facility in Atlanta, Georgia. The assessment identified an energy saving potential of 7% annually with a modest capital expenditure and a one-year payback. If natural gas and fuel oil prices increase, savings could increase to 11-16%. International Paper found that the assessment process was straightforward and that DOE's Steam System Assessment Tool was manageable to learn. In June of 2006, International Paper replicated the process at two of its Florida plants, identifying 15-20% in potential energy cost savings with a one-and-a-half-year payback.

The largest benefits identified for the Florida plants include:

- Fuel substitution
- Stack economizer installation
- Feedwater heat recovery using boiler blowdown
- Blowdown flash to deaerator
- Reduction of excess oxygen in combustion process

The company plans to continue replicating these assessments to find additional savings opportunities at many of its other facilities.



U.S. companies are using DOE resources to identify opportunities for quick-payback process improvements that save energy.

Tools and technical information are available at no cost on-line or through the EERE Information Center. Call 1-877-337-3463 or visit www.energysavers.gov/industrymanagers.html



The Easy Ways to Save Energy Initiative

ITP is identifying opportunities to save large amounts of energy at some of our nation's largest energy-using manufacturing plants.

3M Company Abbott Laboratories Abitibi Consolidated AFG Industries, Inc. Air Products and Chemicals Alabama River Newsprint Albemarle Corporation Alcoa Alsip Paper Condominium Association Amalgamated Sugar American Crystal Sugar Company Anheuser-Busch Packaging Group Arrow United Industries Ash Grove Cement Company Associated Milk Producers ATK Alliant Techsystems Automotive Components Holdings, LLC Bar Corporation Barrick Gold of North America BASF Corporation Bayer Bekaert Bemis Company, Inc. Bodycote Thermal Processing, Inc Boise Cascade Corporation Boral Bowater Broin Companies California Portland Cement Company Cardinal Glass Industries Cargill Caterpillar Inc C-E Minerals Cellu Tissue Holdings CF Industries, Inc Con Agra Foods Corning Incorporated CraftMaster Manufacturing, Inc. Cri-Tech Inc Cytec Industries DaimlerChrysler Dairyman's Land O' Lakes Dal Tile Corp Degussa Corporation Dixie Crystals Domtar Industries Inc Dow Chemical Company DuPont Eastman Chemical Company Eastman Kodak Company Eka Chemicals Inc. FMC Corporation Foremost Farms USA Formosa Plastics FR Countermeasures Inc. Freescale Semiconductor, Inc. GAF Materials Corporation GD OTS Red Lion Operations General Motors George Weston Bakeries Georgia-Pacific Gerdau Ameristeel GlaxoSmithKline Pharmaceuticals Goodyear Tire & Rubber GW Bakeries Holcim (US) Inc. Honda Manufacturing of Alabama Hormel Foods Corporation Hydro Aluminum Imperial Sugar Innovene Intel Corp International Paper J.R. Simplot Jenkins Brick Kaiser Aluminum Kellogg Company Kimberly-Clark Corp. Kohler Co. Kraft Foods Lanxess La-Z-Boy Inc. Lehigh Cement Company Leprino Foods Company Logan Aluminum Inc. Lone Star Steel Lubrizol Lucent Technologies Lyondell Chemical Company MeadWestvaco Mercury Marine Michael Foods Minerals Technologies Inc. Mittal Steel USA National Starch and Chemical Company NewPage Corporation Norandal USA Northrop Grumman Corporation ES Nucor Steel Nebraska Ohio Valley Aluminum Co. OSRAM SYLVANIA Products Owens Corning Packaging Corp of America Pfizer Inc Potlatch Corporation PPG Industries, Inc. PQ Corporation Praxair, Inc. Quad/Graphics Rahr Malting Company Raytheon Company Republic Engineered Products Roche Rohm and Haas Company Saint-Gobain Sappi Fine Paper Saputo Cheese USA, Inc SCA Tissue North America Shaw Industries Sherwin Alumina, L.P. Smurfit-Stone Container Corporation Solutia, Inc. Solvay Group Sonoco Southern Lime Spartan Steel Coating LLC Sterling Chemicals, Inc. Stora Enso Kimberly Mill Sunoco Superior Industries International Inc. Tembec Terra Nitrogen Company, LP Texas Instruments Texas Petrochemicals LP The Belden Brick Company The Dixie Group The Newark Group ThyssenKrupp Waupaca Treetop Foods Union Carbide, a subsidiary of Dow Chemical Company United States Gypsum United States Steel Corporation UOP US Magnesium LLC Valero Energy Corp. W.L. Gore & Associates, Inc. W.R. Grace WaferTech Wausau Paper Welch Foods, Inc. West Linn Paper Company Weyerhaeuser White Birch Paper Company Wise Alloys Wolverine Tube Inc World



A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. 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 diverse portfolio of energy technologies.

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov

Visit the DOE website at
www.eere.energy.gov/industry