vision

Results for Today. Leadership for Tomorrow.

U.S. manufacturers are becoming more competitive and energy-efficient through Industries of the Future partnerships.

Office of Industrial Technologies

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

"There are basic industries that a vigilant government does not neglect….The Industries of the Future program is government at its best."

Senator Robert Byrd, West Virginia

Table of Contents

For more information, please contact the OIT Clearinghouse at (800) 862-2086.

www.oit.doe.gov

Developing and deploying advanced, energy-efficient technologies for continued economic growth

Industry consumes 36 percent of all energy used in the United States. By developing and adopting more energy-efficient 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 **Office of Industrial Technologies** (OIT) works in partnership with U.S. industry to increase the efficiency of energy and materials use, both now and in the future. Through an innovative, industry-driven strategy known as **Industries of the Future**, OIT helps industry develop and apply advanced, energy-efficient technologies. The strategy maximizes the energy and environmental benefits of OIT's technology investments by leveraging resources through the formation of public-private partnerships focusing on nine energy-intensive industries:

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

Collectively, these streamlined, technology-intensive industries produce $1 trillion in annual shipments, account for 5 percent of the GDP, and supply more than 90 percent of the materials used in our finished products. The materials they produce are vital to our growing high-tech economy.

Collaboration for competitiveness

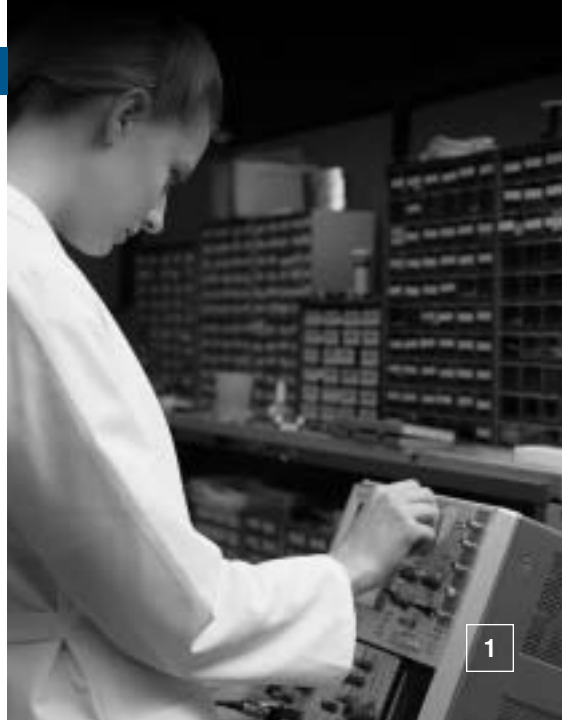
Through the Industries of the Future strategy, OIT has established formal partnerships with nine energy-intensive industries. Each of these industries has developed a broad "vision" of its future and one or more roadmaps reflecting industry consensus on R&D priorities and other activities needed to achieve its vision. The strategy has also generated

- *Alignment of public-private investment with industry's R&D priorities*
- *Dozens of commercially successful technologies*
- *Better industry access to federal laboratory facilities*
- *Streamlined contracting processes for industry partners*
- *New industry associations to facilitate and administer collaborative R&D*

A Role for Government

Manufacturing firms within the same industry face common technological hurdles to improving efficiency. Many of these hurdles involve basic, energy-intensive processes integral to the industry. Due to the complex technologies involved, meaningful advances in these processes require costly research and development (R&D) efforts that are now beyond the reach of many individual firms.

The Office of Industrial Technologies brings such firms together in a neutral environment, facilitates consensus building, and supports collaborative R&D to address priority needs. By concentrating on high-risk, high-payoff research in precompetitive areas, U.S. firms are finding that they can collaborate effectively to accelerate the pace of technology development.



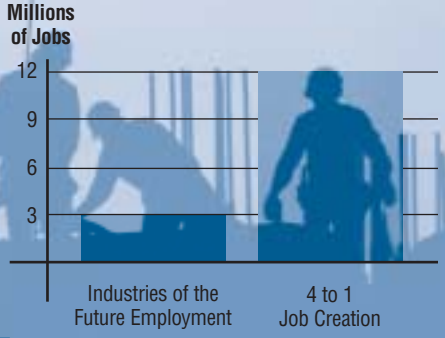
Industries under pressure

While OIT's partner industries run streamlined, technologically sophisticated operations, they still face tough economic, technological, and environmental challenges, including

- *Low profit margins, limiting availability of R&D funds*
- *Direct price competition with foreign firms that employ cheap labor or receive heavy government support or dispensations*
- *Rising costs of R&D as processes and products become more complex and sophisticated*
- *Dependence on capital-intensive equipment*
- *Increased need to distinguish products to gain market edge*
- *Growing pressure to restrict emissions and effluents*

Employment Impact

The nine Industries of the Future directly employ over 3 million people. The Economic Policy Institute estimates that each of these jobs generates 4 additional jobs in supporting industries and downstream economic activities.



Accelerating technology advances

Companies collaborate to get more R&D from their available resources. By spreading the costs and combining expertise, partners are able to tackle projects that would be too complex, costly, or time-consuming to undertake on their own. At the same time, the quantity, quality, efficiency, and speed of technology development and deployment are markedly increased.

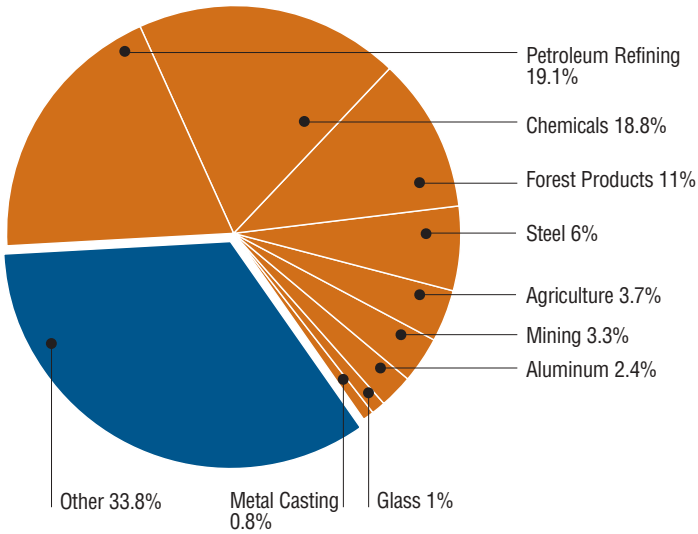
Collaborative partnerships help to focus resources on vital, higher-risk research and ensure that the resulting technologies will become successfully commercialized and put to use—cleaning the air, conserving resources, strengthening our economy, and improving quality of life.

"From its inception, Agenda 2020 [Forest Products industry vision] has been a real catalyst for our industry. It has helped the industry for the first time in its 300 years come together with a real consensus on its long-term research priorities."

W. Henson Moore, President and CEO
American Forest and Paper Association

Energy-Intensive Industries

OIT's energy-intensive partner industries account for about two-thirds of all energy used in U.S. industry.



Total industrial energy use = 34.1 quadrillion Btu

Source: EIA, OIT estimates

The Industries of the Future strategy

OIT's innovative Industries of the Future strategy helps industries define their long-term goals and identify their most critical needs for the future. Manufacturers, suppliers, and customers are encouraged to develop collaborative partnerships with academia, national laboratories, government, and other organizations to share the costs and risks of R&D and solve precompetitive problems.

The approach takes full advantage of the unique insight and resources that industry itself can bring to the R&D process. Industry leadership of the process engenders strong industry commitment to the R&D and helps promote widespread adoption of the resulting energy-efficient technologies.

The Industries of the Future model is simple and flexible. OIT facilitates the process, but the industries themselves take the lead.

Industries We Depend On

	Jobs	Sales ($ billions)
Aluminum	85,300	32.7
Chemicals	877,100	418.3
Forest Products	1,231,200	253.1
Glass	150,400	27.2
Metal Casting	227,100	29.1
Mining	280,000	69.7
Petroleum	64,800	157.1
Steel	153,000	55.0
TOTAL	**3,068,900**	**1,042.2**

Vision

Setting Broad Goals

Leaders from each industry come together to anticipate the likely economic, regulatory, and market pressures on their industry over the next 20 years. On the basis of these projections, they jointly develop a unified vision of their desired future. They define their long-term goals and the capabilities they will need to survive and prosper.

Roadmap

Defining Priorities

Based on the broad goals identified in the vision, each industry develops a detailed R&D agenda, or roadmap, that specifies the steps needed to achieve the vision. The roadmaps lay out a logical, prioritized sequence of activities and R&D for the long term. They identify discrete areas of technology research, provide performance targets and milestones, and, in some cases, suggest appropriate roles for government and other research partners.

Implementation

Enabling Partnerships

Completed roadmaps catalyze collaborative partnerships that may include private companies, suppliers, trade associations, national laboratories, private research institutions, government agencies, and other organizations. These partnerships can investigate promising, complex technologies that would be too costly for individual firms to undertake. OIT facilitates the planning, serves as a clearinghouse for potential partners, and cost-shares projects that help achieve its energy and environmental goals.

New Technology Strategy

Adapting to a Dynamic Environment

Industries review and update their roadmaps periodically to reflect new trends and developments. OIT also constantly adapts and refreshes its activities to further leverage R&D funds and serve emerging industry needs and interests. Examples include inter-industry workshops, showcases, topic-focused roadmaps, and challenges to promote development of revolutionary new technologies.

Technology for today

U.S. manufacturers can also take advantage of OIT assistance to make their operations more efficient and productive using today's technologies and practices. As the near-term component of the Industries of the Future strategy, OIT's BestPractices program emphasizes continuous improvement and a plant-wide, systems approach. The program provides plant assessments of energy use, waste, and productivity; delivers information on emerging technologies available for plant trials; and offers publications, software decision tools, and training to assist plant personnel in identifying the best opportunities for energy and cost savings.

results

Achieving substantial, measurable benefits for industry and the nation

Through the Industries of the Future partnerships, OIT provides about $150 million annually to support roughly 600 active projects. These projects involve over 2,000 partners engaged in R&D, technology demonstrations, and BestPractices activities.

OIT recognizes the importance of accurate technology follow-up and assesses the progress of all technologies supported by its R&D programs. OIT rigorously tracks technology adoption, estimates the associated energy savings, and publishes the results in its *IMPACTS* annual report (available through the OIT Clearinghouse). Recent tracking results indicate R&D projects have achieved cumulative energy savings in excess of 1.6 of quadrillion (10^{15}) Btu.

Industry impacts

In 1999 alone, OIT's Industries of the Future activities helped reduce industrial energy use by 189 trillion Btu—valued at about $820 million.

*Cumulative energy savings from OIT programs exceed **1.6 quadrillion Btu**—worth about $6.5 billion.*

While direct energy savings are substantial, even larger benefits accrue in industrial productivity, waste minimization, and the environment. In 1999, the waste reduction and productivity benefits of OIT's Industrial Assessment Centers alone were three times the energy benefits.

"Our goal is to take the technology developed by OIT and its many partners and adapt it to the day-to-day operations of our companies so we can provide better and higher-quality products to our customers."

Joseph Ponteri, President and CEO
Global Metal Technologies, Inc.
(parent company of Lester Precision Die Casting)

OIT Cumulative Costs vs. Cumulative Energy Savings

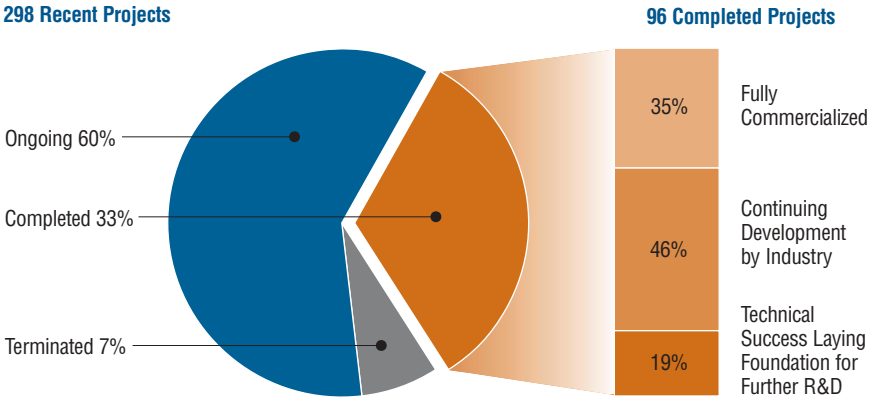
Using BestPractices

Industrial firms across the country are taking advantage of OIT's portfolio of BestPractices tools and assistance to improve energy efficiency and environmental performance right away.

Since OIT began **plant-wide assessments** in large plants last year, over 32 plants have submitted proposals, and 13 assessments have been competitively awarded. Independent third parties have already documented potential energy and related cost savings of $18 million in the five assessments completed. OIT's **Industrial Assessment Centers** have conducted over 9,600 site visits to small and mid-sized plants since 1981 and have identified about 68,000 energy-saving measures that can save the plants up to $740 million. So far, these plants have implemented about half of all recommendations.

Over 10,000 individuals have attended BestPractices training sessions to learn how to use energy-saving software and tools or to receive instruction on energy systems management. The OIT Clearinghouse (800-862-2086) provides technical advice, publications, and other support, annually handling about 5,000 calls.

Status of Recent OIT R&D Projects



The Industries of the Future process has helped ensure that R&D results are adopted and put to use on plant floors across the nation.

Showcasing success

Showcases are public events that highlight the best energy-management practices and latest energy-efficient technologies emerging from OIT-sponsored R&D. These popular events afford members of an industry the opportunity to attend briefings, watch demonstrations, and tour plants to see advanced processes and practices in use.

Burns Harbor Steel Showcase (1998). *Bethlehem Steel's flagship mill in Burns Harbor, Indiana, hosted the first showcase, at which participants learned about advanced sensing technologies, advanced materials, efficient motor and steam systems, low-NOx combustion, solid waste reduction, and pollution reduction techniques.*

Lester Precision Die Casting Showcase (1999). *Over 200 members of industry attended the Lester Precision Diecasting Showcase in Twinsburg, Ohio, where they learned about energy-saving practices and emerging technologies that can save energy, reduce costs, and boost productivity in the metal casting industry. Projects implemented at the Lester facility have the potential to save that plant 30 billion Btu per year.*

Pittsburgh Regional Steel Showcase (2000). *U.S. Steel's Edgar Thomson Plant (division of USX) and Weirton Steel hosted this two-day event, which incorporated technical presentations, technology-focused plant tours, and a Congressional field hearing on issues of importance to U.S. steelmakers. Other event organizers included Bethlehem Steel, Timken Company, the American Iron and Steel Institute, the Steel Manufacturers Association, the Pennsylvania Departments of Environmental Protection and Economic Development, the National Energy Technology Laboratory, and Koppel Steel.*

Intermetallic Alloys—a crosscutting technology benefitting many industries

Many energy-intensive industries have identified a priority need for materials that resist corrosion and fatigue in harsh, high-temperature environments. With the support of OIT's Industrial Materials program, investigators at Oak Ridge National Laboratory have developed an array of intermetallic alloys, including a variety of aluminide and silicide materials, that address these needs.

***Steel**. Nickel-aluminides are increasing tenfold the service life of furnace trays and fixtures. Furnace transfer rolls made from these alloys are increasing productivity and product quality in steel plate mills.*

***Metal Casting**. Nickel aluminide dies that last 20 times longer than conventional materials are now fully commercialized.*

***Chemicals**. Ethylene furnace tubes with interior coatings of iron and nickel aluminide promise greater resistance to carburization and coking problems.*

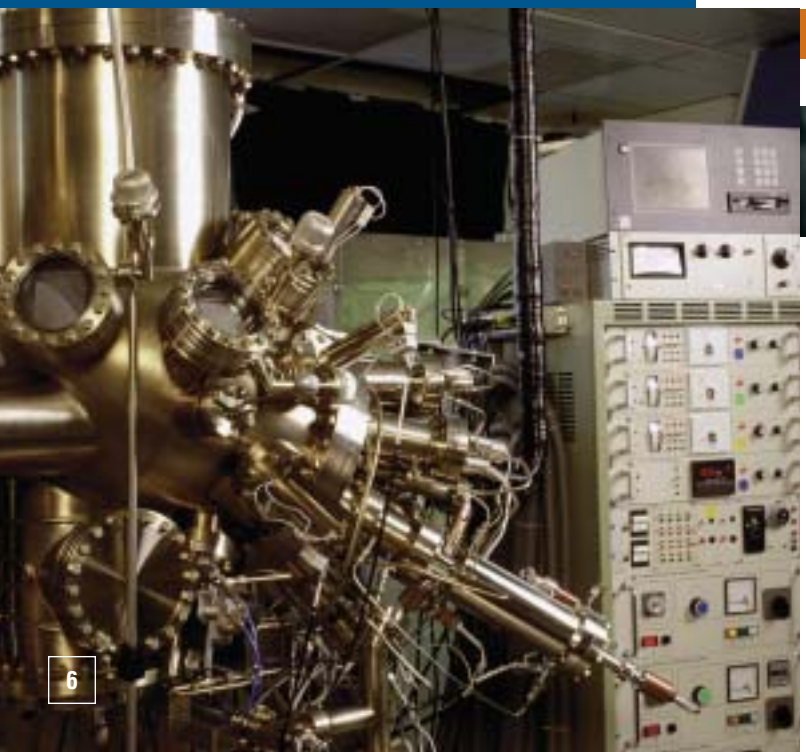
***Other**. Intermetallic alloys are being tested by more than 20 companies for applications in the metal casting, steel, chemical, glass, refining, forest products, forging, and heat treating industries.*

Collaborative, integrated approach has far-reaching impacts

Industry leadership of the Industries of the Future process has helped to extend the reach of partnership activities and speed roadmap implementation. Broader industry involvement, the formation of new organizations, and new educational initiatives are all helping to accelerate progress.

Supporting industries. Industries that traditionally support the nine Industries of the Future have recognized the far-reaching benefits of the process and have conducted their own vision and roadmapping efforts. These industries include forging, heat treating, welding, powdered metals, ceramics, and carbon products.

New industry organizations. As companies came together to work on their industry vision and roadmap, they discovered many common needs. As a result, some companies formed new, industry-wide associations to coordinate and facilitate collaborative R&D. Examples include the Glass Manufacturing Industry Council and the Cast Metals Coalition.



Emerging or Commercially Available Technologies from the

Agriculture

- Anaerobic Pump
- Reactor/Separator for Ethanol and Other Chemical Precursors from Cellulosics
- Sensor System to Monitor Gaseous Nitrogen Transfer
- Membrane Process for Lactate Esters
- Soy-Based Engine Oils
- Precision Farming for Agriculture
- Energy-Efficient Irrigation

Aluminum

- Aluminum Scrap Decoater
- Molten Aluminum Explosion Prevention
- Oxygen-Enhanced Combustion
- Novel Technique for Increasing Corrosion Resistance of Aluminum and Aluminum Alloys
- Aluminum Bridge Deck System
- Aluminum Roofing System
- On-Site Process for Recovering Waste Aluminum
- Recycling of Aluminum Dross/Saltcake
- Aluminum-Rich Concentrate from Municipal Wastes

Chemicals

- Absorption Chillers for Distillation Columns
- Waste Heat-Driven Process Chiller
- Advanced Membrane Materials
- Membrane Vapor Separation (VapoSep)
- Recovery of Thermoplastics via Froth Flotation
- Ultrasonic Tank Cleaning
- Oxidative Cracking of Hydrocarbons to Ethylene
- Advanced Electrodeionization technology
- Novel Catalytic Reactor

Educational initiatives. Many Industries of the Future roadmaps identified the need to attract talented college graduates. OIT has pursued several initiatives to expand learning and work experience opportunities for qualified students.

Agriculture: Biobased Products. The U.S. Department of Energy's 1999 Biobased Products Educational Initiative promotes multidisciplinary, graduate-level education and research programs to support the emerging biobased products industry. The initiative fosters curriculum development and provides stipends for deserving graduate students.

Steel. OIT and the Steel Manufacturers Association are offering fellowships to attract talented undergraduate students in engineering and applied sciences to the steel industry. Selected students gain insight and useful work experience by working with industry mentors on roadmap-related projects.

Metal Casting. The Metal Casting Industry of the Future works with over 20 universities nationwide, training dozens of students in the latest advances in metal casting.

Industrial Assessment Centers. Engineering students at 26 universities across the country work with their professors in conducting energy, environmental, and waste audits in manufacturing plants.

Computational Fluid Dynamics—an exemplary partnership

Chemical, petroleum, and other industries use multi-phase (gas-solid or gas-liquid-solid) flows to transport fine solids, but such flows are complex, difficult to predict, and often lead to costly inefficiencies. Computational Fluid Dynamics (CFD) simulates the movement of particles in gas flows, offering a solution to the leading cause of downtime in many plants.

Computational Fluid Dynamics can enhance solids handling and processing in many industrial operations.

With OIT support, top petrochemical companies, national labs, and universities have joined forces to develop effective modeling tools for materials handling. The Multi-Phase Fluid Dynamics Research Consortium (MFDRC) is working to generate more accurate, reliable, and cost-effective CFD tools for industry applications. It undertakes a balanced program of fundamental research and technology development.

Industries of the Future Partnerships

Forest Products

- Feedstock-to Product Characterization Tools
- Methane De-NOx Reburning Process
- Acoustic Separation
- Mechanical Alternatives to Chemicals in Recycle Mills
- On-Line Fluidics Controlled Headbox
- Fiber-Optic Sensor for Measuring Paper Basis Weight
- Steam Reforming Black Liquor Gasification
- Low-VOC Drying of Lumber

Glass

- Oxy-Fuel Firing
- Advanced Combustion Space Model for Glass Melting
- In-Situ Whisker-Reinforced Glass Ceramic
- Ultraviolet Curing of Fiberglass Sleeving
- Oxygen-Enriched Air Staging
- Advanced Temperature Measurement System
- Electric Rotary Furnace for Glass Molding of Precision Optical Blanks
- Single-Crystal Whisker Electric Light Filament

Metal Casting

- CastView Software
- Lost Foam Process
- Aluminum Alloy Microstructure Performance Interaction
- Cupola Process Control
- Laser-based Laminated Object Manufacturing
- Precision Pattern Production
- Die Life Extension
- Energy Saving Manual with Software

Mining

- Hydride Fuel Cell Mining Vehicles
- Mine Compatible Laser Analysis Instrument for Ore Grading
- Robotics Technology for Improving Mining Productivity
- Selective Flocculation of Fine Mineral Particles
- 3D Simulation of Charge Motion in Grinding Mills
- Drilling and Blasting Optimization
- Development and Deployment of Machine Fluid Analysis
- Crosswell System for Imaging Ahead of Mining
- Magnetic Elutriation Technology For Processing Iron Ore

Petroleum

- Waste Heat Process Chiller
- Fouling Minimization
- Gasoline Biodesulfurization
- Robotics Inspection System
- FIR Burner
- Radiation Stabilized Burner
- Low-Profile Fluid Catalytic Converter (FCC)
- Computational Fluid Dynamic Model of FCC
- Gas Imaging for Leak Detection
- Advanced Process Analysis for Refining

Steel

- Nickel Aluminide Steel Rolls
- Oxy-Fuel-Fired Combustion System
- Oscillating Combustion
- Galvanneal Temperature Sensor
- Hydrochloric Acid Recovery System
- Hot Blast Stove Process Model
- Microstructure Engineering in Hot Strip Mills

resources

Programs and tools for more productive and energy-efficient operations

In response to the needs of its industrial partners, OIT has developed new ways to work with industry and has implemented innovative approaches to R&D management and procurement. In addition to facilitating the development of new technologies that address the needs of specific Industries of the Future, OIT cost-shares the development of crosscutting technologies that enable more efficient energy use across many industries. For the near term, OIT's BestPractices program provides a host of industry programs and services that can deliver immediate benefits. Finally, OIT's Financial Assistance programs provide a needed boost to help launch innovative concepts and demonstrate emerging technologies.

Focus on cost-shared R&D funding

OIT's primary mission is to stimulate the development of industrial technologies and processes that will help U.S. industry save energy and improve environmental performance. OIT contributes about $150 million annually to support promising technologies that address priority needs identified in industry roadmaps. OIT's support is matched almost equally by funding from industry.

Industry challenges. To encourage "stretch" R&D efforts on leapfrog technologies, OIT is seeking proposals for conceptual designs that will revolutionize industrial processes in some of the Industries of the Future. Cost-shared funding for concept development will be awarded to collaborative, industry-led partnerships.

Streamlined solicitations. OIT understands industry's need to seize opportunities and move quickly in today's competitive global markets. OIT recently streamlined its solicitation process so that partners submitting successful R&D proposals can get funds faster and initiate work sooner. Although processes vary slightly to fit existing industry structures, most solicitations entail a sequence of activities similar to the one outlined below.

RFP

Requests for Proposals (RFPs) are announced on the OIT Web site and in the *Commerce Business Daily* newsletter. Cooperative partnerships among industry, academia, and national labs are encouraged to submit proposals for the precompetitive R&D described in the RFPs.

Industry Review

A panel of industry experts generally reviews the proposals received from prospective R&D teams. Selection criteria are based on priorities established in the technology roadmaps and the broader OIT and DOE missions to promote energy efficiency and a clean environment. OIT makes the final award decision, taking into account industry's recommendations.

Funding

Selected projects are eligible to receive financial support from the government, with OIT providing about 50 percent of the required funding.

BestPractices brings technical solutions for today's challenges

While many promising technologies are in the R&D pipeline for the future, BestPractices offers a wide range of near-term technology solutions for industrial processes and plant-wide operations. BestPractices tools and assistance can help plants improve their motor, steam, compressed air, combined heat and power, and process heating systems. Through a comprehensive systems approach, energy use can often be reduced by up to 30 percent in just three years.

BestPractices' plant assessments help manufacturers identify the best opportunities for saving energy and cutting costs. **Plant-wide assessments** assist *large* manufacturers in developing a comprehensive strategy for increasing efficiency, reducing emissions, and boosting productivity. Grants of up to $100,000 in matching funds are awarded through a competitive solicitation process, and a case study helps spread the word on attainable benefits. *Small and mid-sized* plants may be eligible to take advantage of OIT's **Industrial Assessment Centers**, which provide no-cost energy, waste, and environmental assessments through a network of engineering universities.

Also integral to the program is the network of **Allied Partners**—national industrial associations, private companies, state agencies, and public organizations that have voluntarily agreed to help deliver OIT's energy efficiency products and services as part of their regular service to industry. Partners provide training and technical assistance and distribute publications, software, and decision-support tools. Efforts led by Allied Partners have achieved an estimated $8.7 million in annual industrial energy savings in motor systems alone.

For more information, please contact the OIT Clearinghouse at (800) 862-2086.

www.oit.doe.gov

Access to national laboratories

The Laboratory Coordinating Council (LCC) helps Industries of the Future partners identify and use the unique resources of DOE's national laboratory system. The LCC provides a single point of contact for initiating work with any of the 17 laboratories and their specialized research facilities, including

- *Combustion Research Facility*
- *High-Temperature Materials Laboratory*
- *Metals Processing Laboratory User Center*
- *Surface Modification and Characterization Research Center*
- *Bioprocessing Research Facility*
- *National Center for Electron Microscopy*
- *Acoustic/Ultrasonic Laboratory*
- *Slurry Heat Transfer Facility*
- *Reactor Simulation Facility*
- *Advanced Materials Fabrication Facility*
- *National Bioenergy Center*

States Industries of the Future

States can play an important role in encouraging industrial innovation and adoption of energy-efficient technologies. Since energy-intensive industries are key to the economies of most states, there is a natural basis for partnerships between state governments and the industries within their borders. This relationship has been widely recognized and has given rise to an extensive network of partnerships among state agencies, industry associations, and regional agencies. The Industries of the Future strategy capitalizes on these networks and seeks to expand them to

- *Broaden the reach of national technology investments*
- *Increase results (energy efficiency, resource productivity, pollution prevention)*
- *Foster new partnerships*
- *Coordinate national and state industrial activities*
- *Enhance state economic development*
- *Reach smaller companies*

Crosscutting R&D enables improvements in multiple industries

The Industries of the Future strategy embraces efficiency enhancements to technologies that are widely used in a broad cross-section of U.S. industry. Given the breadth of use of these technologies, even a small improvement in their efficiency can mean substantial energy and cost savings. OIT's **Industrial Materials of the Future** program works with the national laboratories and collaborative industry partnerships to develop and commercialize new and improved materials to provide superior strength and corrosion resistance in high-temperature industrial environments. The **Combustion** program seeks to improve energy efficiency, reduce emissions, enhance fuel flexibility, and otherwise meet industry's future combustion needs by working with the combustion community to develop cost-effective technologies. The **Sensors and Controls** program is working to provide integrated measurement systems for operator-independent control of plant processes. Research is extending sensor reach and accuracy in harsh environments and improving the integration and processing of sensor data to enable on-line, automated assessment and adjustment of system parameters.

Facilitating innovation and demonstration

OIT's Financial Assistance programs accelerate innovative technology development and application. Its **Inventions and Innovation** program awards grants of up to $200,000 to help individuals or small businesses establish technical performance, conduct early development activities, and initiate commercialization plans for innovative, energy-saving ideas and inventions. OIT's **NICE³** (National Industrial Competitiveness through Energy, Environment, and Economics) program provides cost-shared grants of up to $500,000 to small businesses in industry-state partnerships for demonstrations of clean and energy-efficient technologies.

Easy access to information

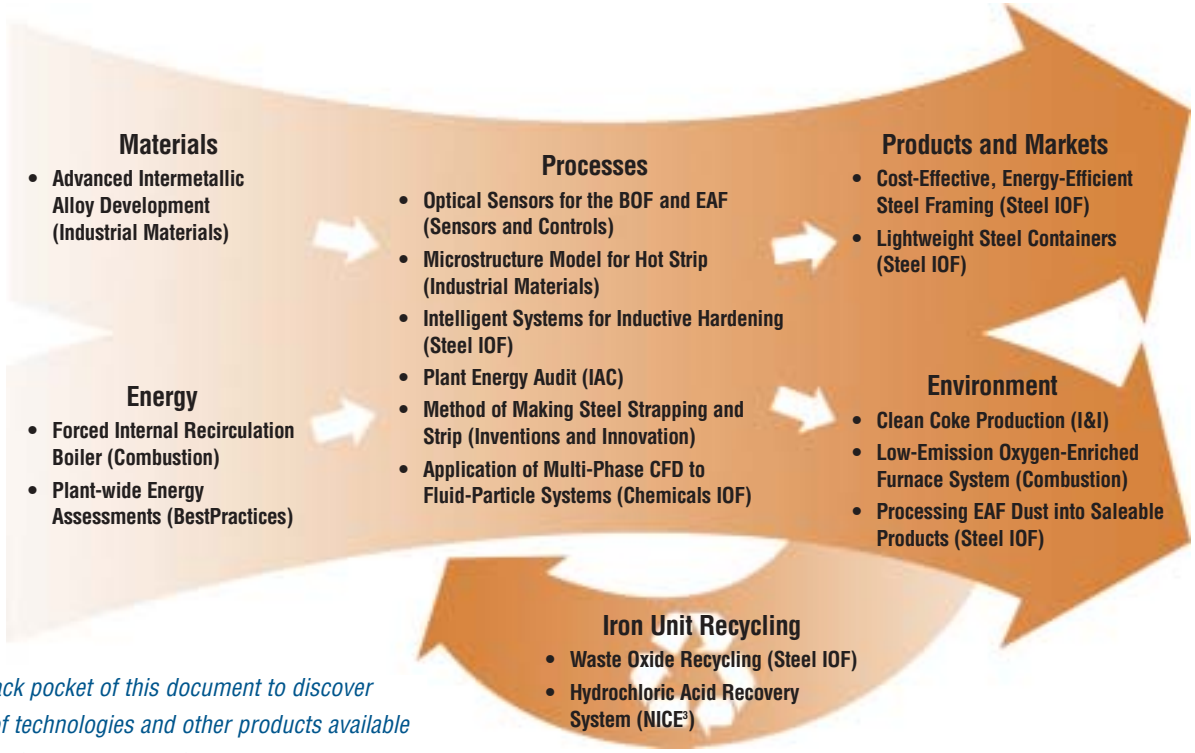
The Industries of the Future strategy has produced a wealth of information of use to our most energy-intensive industries. OIT plays a unique and pivotal role in providing unbiased technical data, training materials, networking opportunities, and coordination with other federal agencies. To facilitate all of these functions, OIT operates the **OIT Clearinghouse**, which provides an on-call staff of engineers, energy specialists, and information technicians (800-862-2086). OIT further creates networking opportunities for cross-industry pollination of ideas and matching of potential partners by sponsoring an **Industrial Energy Efficiency Expo**. This biennial event attracts steadily growing numbers of exhibitors and participants. Further information on OIT's information resources is provided at the back of this document.

Bringing it all together to meet industry needs

The full portfolio of OIT products and services is designed to help Industries of the Future participants identify steps to reduce energy use and increase productivity. Tools, technologies, training, and technical guidance can be selectively applied according to the needs of each plant or industry customer.

A steel mill, for example, might request an audit to identify its biggest opportunities to save energy. Based on audit results, the mill might use BestPractices software to explore its options, request specialized training, or apply for a grant to demonstrate an emerging technology. The solution to a long-standing processing problem at the mill may have emerged from a Steel R&D partnership, but might just as easily come from Chemicals or Mining R&D partnerships, or from OIT's Combustion or Sensors and Controls programs. As shown in the diagram below, the Steel Industry of the Future strategy has produced a robust portfolio to assist interested steel mills in improving the efficiency of their energy and materials use (process inputs at left) as well as its processing operations (center). Improvements in these areas also often affect processing outputs (right), including products, type and volume of emissions, effluents, and waste. Frequently, advanced processes help facilitate recycling (bottom) to close the loop on energy and materials use.

Steel Industry: How it benefits from multiple OIT programs and resources



Look in the back pocket of this document to discover the portfolio of technologies and other products available to assist each of the Industries of the Future.

(OIT source programs are identified in parentheses.)

benefits

Partnerships that bring value to companies, industries, and the nation

Making a difference for a company

OIT partnerships are developing advanced technologies for the future and increasing the efficiency of industrial energy use today. Manufacturers, suppliers, and vendors can benefit by

- Reducing the cost and risk of precompetitive R&D
- Acquiring a stronger voice in directing R&D
- Staying at the forefront of technology and expanding their technical knowledge base
- Leveraging available funds and information resources
- Protecting proprietary technologies and capabilities
- Gaining access to complementary technical expertise and facilities that can help today, as well as in the future
- Acquiring new patents or licensing agreements
- Potentially launching new products or spin-off companies

Advancements that help an entire industry

Through the Industries of the Future strategy, partners are able to maximize and leverage their resources to tackle projects that would otherwise be beyond their reach. Once commercialized, the resulting technologies benefit all members of industry by

- Saving energy and materials
- Facilitating cost-effective compliance with environmental regulations
- Increasing productivity and reducing waste
- Enhancing product quality
- Reducing production costs (and creating a ripple effect throughout the U.S. economy)
- Boosting competitiveness in the global marketplace

Impact on local communities and the nation

As industry adopts more efficient industrial technologies, all U.S. citizens benefit through

- More reliable and affordable products for home and work
- Creation of new jobs
- A cleaner, healthier environment
- Increased national energy security
- A more robust economy

How to move forward

There are many ways your company can get involved in or learn more about OIT programs and services.

OIT Clearinghouse

Call (800) 862-2086 for more information about OIT's many products, services, and programs.

Web Site

Visit the OIT Web site at www.oit.doe.gov for updated and comprehensive information, as well as postings on solicitations.

Information Resources Catalog

Order a free catalog of all OIT publications, CD-ROMs, tools, and videos by calling the OIT Clearinghouse.

Newsletters

Request a free subscription to The OIT Times *and* Energy Matters *newsletters by calling the OIT Clearinghouse.*

Brochures, Project Fact Sheets, and Case Studies

Learn about specific Industries of the Future teams as well as various projects through brochures, fact sheets, and case studies available from the OIT Clearinghouse and Web site.

Industrial Projects Locator (IPLocator)

Request this electronic database that provides useful information on more than 8,000 current and recent RD&D and technical assistance projects throughout the federal government.

OIT's Agriculture Partnership Portfolio

Plant Science & Production

- Pine Gene Discovery Project
- Molecular Physiology of Nitrogen Allocation in Poplar Trees
- Energy Efficient Irrigation
- Precision Farming For Agriculture
- Diagnosis of Soil Limitations to Productivity
- Nutrient Limitations in Southern Pine
- Growth Traits in Pinus Taeda L
- Genes to Accelerate Pine Development
- Negative Mutations of Floral Genes
- Genetic Variation of Fiber Components
- Regulation of Crown Architecture

Processing

- Catalytic Upgrading of Glucose
- Products from Wheat-milling Byproducts
- Chemicals from Lignocellulose
- Industrial Chemicals from Levulinic Acid
- Separator for Ethanol From Cellulosics
- Novel Membrane Process for Lactate Esters
- Production of Succinic Acid from Biomass
- Lactic Acid From Renewable Resources
- Corn Fiber to Polyols
- Clean Fractionation for Cellulose Plastics
- Hydrolysis of Lignocellulose
- Industrial Membrane Filtration
- Yeast for Fermentation of Biomass to Chemicals
- Propanediol From Fermentation-Derived Malonic Acid
- Isosorbide Production Using Solid Acid Catalysts
- Separation Process for Bio-Based Succinic Acid
- Butyric Acid and Butanol From Biomass
- Reversible Chemical Association Separation
- Continuous Saccharification of Ligno-Cellulose
- Membrane Reactor for Fischer Tropsch Synthesis
- Novel Catalyst for CH_4 to CO Conversion

Utilization

- Improved Catalytic Enzymes
- Utilization of Corn-based Polymers
- Soy-based 2-Cycle Engine Oils
- Plastics and Fibers from Biobased Succinic Acid
- Vegetable Oils as Polymer Building Blocks
- Renewable Fine Chemicals
- High Value Products From Wheat

Energy

- Efficient Steam Systems
- Advanced, Efficient Motor Systems
- Efficient Compressed Air Systems
- Black Liquor Gasification
- Energy and Waste Audits
- Anaerobic Pump
- Irrigation Valve Energy Saver
- DSP Power Electronics Systems for Renewable Energy Systems

Environment

- Paper Mill Sludge and Agriculture Waste Utilization
- Low Temperature Catalytic Gasification of Aqueous Streams

Recycling

- Electrodeionization for Recovery and Recycling of Waste and Water
- Use of Residual Solids for Concrete
- Ceramic Membranes with CO_2 Transport Channel

OIT Cost: $32 million

Cost Share: $26 million

Total Cost: $58 million

Revised 1/9/01

OIT's Aluminum Partnership Portfolio

Plain Text: Direct Projects
Italicized Text: Related Projects

Materials

- *Intermetallic Alloys*
- *CFCC Immersion Tube*
- *Brazing and Spot Welding*
- Numerical Methods
- Wetted Cathodes for Smelting
- Textures in AL Alloys
- Plastic Deformation
- Inert Metal Anodes
- *Ceramic Anode Application*
- *Corrosion Resistance*
- *Metal Powder Products*
- *MPLUS*

Manufacturing

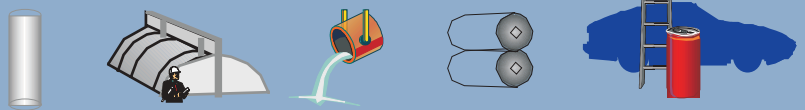
- Inert Anode Life
- Wettable Cathode
- Flotation Melter
- Low-NOx Melting
- *Clean Casting*
- Chlorine Reduction
- *Intelligent Extruder*
- Selective Adsorption
- Spray Rolling Al Strip
- Semi-solids Processing
- *Advanced Lost Foam*
- *Steel Reheating*
- *Furnace Fan*
- *Sensor for Process Control*
- Potlining Additives
- *Real-time Measurement of Melt Constituents*
- *Thermal Imaging Control of Furnaces & Combustors*
- Coolant Characteristics of DC Casting
- Rolling Process Design Tool
- *Die Casting Visualization Tool*
- *Die Life Extension*
- *Filtering Molten Metal*
- *Radiant Burner*
- Non-consumable Anode for Electrowinning
- Explosion Prevention
- Advanced Anodes & Cathodes
- Modeling of DC Casting
- In-Line Annealed Cast AL
- *Coated Recuperator*
- Intelligent Potroom Operation
- Molten Salt Detection/Removal
- AL Carbothermic Technology
- *Meta-Lax Stress Relief*

New Products & Markets

- *Laser-Based Ultrasonic System*
- *Microsmooth Al Wheels*
- *Composite Reinforced Al Conductor*
- *Reflective Al Chips*

Energy

- Oxidative Melt Loss Reduction
- Isothermal Melting
- Manufacturing of AL Extrusions
- Energy Efficient AL Melting
- Plant Energy Audits (25+)
- Motor Challenge (Alcoa)



Refining | Reduction & Melting | Casting | Rolling & Extrusion | Finished Products

Environment & Recycling

- Spent Potliner to Glass Fiber Products
- Automotive Scrap Sorting
- High Efficiency, Low-Dross Combustion
- *On-line Emissions Monitoring*
- Saltcake Recycling
- Decoating Scrap AL
- Processing & Recycling of AL Wastes
- *Reduced Emissions Through Control of Die Casting Lubricants*

Project Type	OIT	Cost-share	Total
Direct	$42M	$31M	$73M
Direct & Related	$52M	$40M	$92M

OIT's Forest Products Partnership Portfolio

Sustainable Forestry

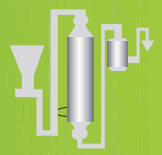
- Diagnosis of Soil Limitations to Productivity
- Regulation of Crown Architecture
- Sustainability of High Intensity Forest Mgmt.
- Molecular Physiology of Nitrogen Allocation
- Dominant Negative Mutations of Floral Genes
- Pine Gene Discovery Project
- Sustaining the Productivity of Intensively Managed Forests
- Carbon & Nutrient Allocation and Physiology in Pine
- Search for Major Genes to Accelerate Pine Development
- Nutrient Limitations in Intensively Managed Southern Pine
- Improved Fiber Properties of Loblolly Pine
- Growth Traits in Pinus Taeda L.
- Genetic Augmentation of Syringyl Lignin
- Wood Quality under Intensive Forest Management

Energy Performance

- Multiport Cylinder Dryers
- Microwave Treatment for Rapid Wood Drying
- Steam Reforming BLG Demonstration
- Moisture Distribution and Flow During Drying
- Convection-Pass Deposits in Recovery Boilers
- Gas Cleanup for Combined Cycle Systems
- Methane de-NOx
- Development of Materials for Gasification
- Intermediate-Sized, Entrained Particles
- Black Liquor Gasification Kinetics
- Catalysts for the Destruction of Tars in Gasification
- Increasing Yield of Kraft Cooks Using Microwaves
- Uniform Web Drying Using Microwaves
- 3-D Characterization of the Structure of Paper
- Plantwide Assessments
  - Inland Paper, Rome, Georgia
  - Georgia-Pacific, Palatka, FL
  - Carustar Industries, multiple mills
  - Boise Cascade, International Falls, MN
  - Appleton Papers, Inc.
  - Weyerhaeuser Company
- Multi-Phase Computational Fluid Dynamics
- BestPractices Steam Program
- Energy Saving Lightweight Refractory
- Biomass for Industrial Turbines Cogeneration
- High-Heat, Low-NOx Combustion System
- Models/Diagnostic Monitors of Refractories
- Improved Refractories Using Engineered Particles

Capital Effectiveness

- Control of Soluble Scale Fouling in Concentrators
- Roll Surfaces and Web Transfer Systems
- Continuous Process for Displacement Dewatering
- Use of Borate Autocausticizing
- Improving Dryer and Press Efficiencies
- Directed Green Liquor Utilization (D-Glu) Pulping
- Corrosion in Kraft Digesters
- The Lateral Corrugator
- High Capacity Gas-Fired Paper Dryer
- Fast Curing of Composite Wood Products
- Composite Tubes for Kraft Recovery Boilers
- Corrosion Monitoring System
- Clean Fractionation - Cellulose for Plastics Production
- Composites and Coatings



Pulping

Papermaking

Converting
(Finished Product)

Sensors & Controls

- Contactless Monitoring of Paper
- Wood Chip Moisture Content
- Linescan Camera for Moisture Measurement
- Wireless Microwave Wood Moisture Measurement
- CFD Modeling of Advanced Black Liquor Nozzles Deposition on Pendant Tubes of Kraft Chemical Boilers
- On-Line Monitoring of Carryover in Recovery Boilers
- Ultrasonic Instrument to Characterize Pulp
- Monitoring Corrosion and Erosion in Recovery Boiler Tubing
- Field Mobile NIR for Standing Wood
- On-Line Fluidics Controlled Headbox
- Soft Sensing and Diagnosis for Continuous Digesters
- Prototype ESA System
- Distributed Fiber Optic Sensor
- Non-Contact Laser Acoustic Sensor
- Advanced Sensors for Industry/Agriculture – Phase II

New Products

- Production of Succinic Acid from Wood Wastes and Plants
- Chemicals from Lignocellulose
- Utilization of Corn-Based Polymers
- Catalytic Upgrading of Glucose
- Advanced Intermetallic Alloy Development
- CFCCs Technology Development
- Fabrication and Testing of Prototype Ceramic Furnace Coil
- CFCCs for Industrial Applications
- Advanced Wireless Sensors for the IOFs

Environmental Performance

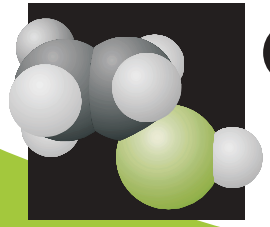
- Polyoxometalate Bleaching
- Energy Efficient Kraft Pulping
- VOC Control in Kraft Mills
- Low-VOC Drying of Lumber
- Understanding Residual Lignin for Improved Pulping and Bleaching
- Reducing Emissions of VOCs
- Reducing VOC Press Emissions from OSB
- Mill Biobleaching Technologies
- Water Recycling/Removal Using Hydrogels
- Use of Residual Solids for Concrete
- Plasma Technologies for VOCs
- High Selectivity Oxygen Delignification
- NPE Removal Using Mesoporous Supports
- Bubble Size Control for Oxygen Bleaching
- Control of Emissions from Wood Burners and Dryers

Recycling

- Acoustic Separation Technology
- Revolutionary Screening Device for Recycling
- Cationic Pressure Sensitive Adhesives
- Replacing Chemicals in Recycle Mills
- Preventing Strength Loss of Kraft Fiber
- Surfactant Spray to Improve Flotation Deinking
- Mechatronic Control of Waste Paper Sorting
- Screenable Pressure Sensitive Adhesives
- Plastics from Cellulose
- Energy and Environmental Innovations for Chemically Preserved Wood Wastes

Total direct project funding from OIT $62M

Total relevant funding from OIT $41M



OIT's Chemical Partnership Portfolio

Materials

- Corrosion Monitoring System
- Alloy Selection System
- Alloys for Ethylene Production
- Metal Dusting Phenomena
- Mixed Solvent Corrosion
- Membrane Module Tubesheet
- Membrane for p-Xylene Separation
- Succinic Acid from Lignocellulose
- Separation of Hydrogen/Light Hydrocarbon Gases
- Materials for Electrochemical Reactors
- Membrane Reactor Designs for Olefin Production
- Oil Refinery Pipe Hangers
- Phase Transfer Catalysis
- Selective Inorganic Thin Films
- Carbon Membranes for Light Gas Separations
- Laser-Ultrasonic Measurement of Seamless Tubes
- Evaluation of High Molybdenum Stainless Steel
- Acoustic Monitoring of Corrosion in Recovery Boilers
- Biocatalytic Processing of Lignocellulosic Feedstocks

Chemical Processing Technology

- Catalytic Hydrogenation Reactor Retrofit
- Integrated Workbench for Gas Phase Thermodynamics
- Separation of Hydrogen/Light Hydrocarbon Gas Mixtures
- Advanced Membrane Materials
- Nanoscale Catalysts
- Direct Production of Silicones From Sand
- Oxidative Cracking of Hydrocarbons to Ethylene
- Selective Oxidation of Aromatic Compounds
- Multi-Phase Computational Fluid Dynamics
- Instrumentation for Multi-Phase Flows
- Intelligent Extruder
- Development of Non-Aqueous Enzymes
- Sorbents for Gas Separation
- New Catalyst Oxidation of Feedstock
- Electrochemical Reactors for Chlor-Alkali
- Selective Catalytic Dehydrogenation of Alkanes to Olefins
- Clean Fractionation: Cellulose for Plastics
- Sonic-Assisted Membrane Processing
- Hydrocarbon Leak Detector
- Low-Profile Catalytic Cracking Demonstration
- Sensor System for Gaseous Nitrogen Transfer
- Separation of Aromatic Isomers
- Solid State Sensors to Monitor Hydrogen
- Supercritical Fluid Purification
- Advanced Refining Process Analysis
- Advanced Wireless Sensors
- Bubble Control in Oxygen-Based Bleaching
- Olefin Recovery from Chemical Industry Waste Streams Stations
- Laser Ultrasonic Furnace Tube Coke Monitor
- Sensor Fusion for Intelligent Process Control
- Regenerability of Catalysts for Destruction of Tars

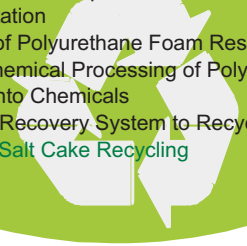
New Products & Markets

Energy Efficiency

- Practical Minimum Energy
- Plant-Wide Assessments
- Metrics of Chemical Industry Performance
- Total Cost Accounting for Chemical Manufacturing
- Industrial Assessment Centers
- Efficient Motor, Steam, and Compressed Air Systems
- Low NOx Boilers and Burners
- Thermal Imaging Control of Furnaces

Environment & Recycling

- PSA Technology to Product Recovery
- Electrodeionization for Product Purification
- Olefin Recovery from Chemical Waste Streams
- Solvent Vapor Recovery
- Thermal Swing Absorption for Producing Oxygen
- Methanol Recovery from Hydrogen Peroxide
- Coupled Physical/Chemical & Biofiltration
- Selective Surface Flow Membrane
- Nylon 6 Carpet Recycling
- VapoSep Membrane Vapor Recovery
- VOC Control in Kraft Mills
- Recovery of Thermoplastics via Froth Floatation
- Recovery of Polyurethane Foam Residue
- Flexible Chemical Processing of Polymeric Materials into Chemicals
- Integrated Recovery System to Recycle Solvents
- Aluminum Salt Cake Recycling



Direct: $145 million

Relevant: $39 million

OIT's Glass Partnership Portfolio

Materials

- Molybdenum Disilicide ($MoSi_2$) Composites for Glass Sensors
- CFCC Burners for Heating & Drying Applications
- Intermetallic Alloy Development
- Acoustic Monitoring of Corrosion/Erosion in Recovery Boiler Tubing
- Tunable Diode Laser Sensors for Combustion
- Electrochemical Extraction of Oxygen from Air
- Corrosive Resistant Recuperator for Metals Industry
- Monolithic Refractory Material

Production Efficiency

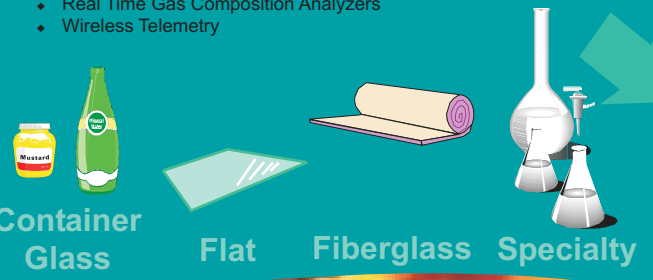
- Auto Glass Process Control
- Advanced Combustion Space Models
- Coupled Glass Combustion Space/Glass Bath Furnace Simulation
- Advanced Process Control for Glass Production
- Diagnostics and Modeling of Refractory Corrosion
- Measurement and Control of Glass Feedstocks
- Enhanced Cutting/Finishing of Handglass
- Online Sensor for Monitoring Cure of Coatings
- Sensor Fusion for Intelligent Process Control
- Producing Glass Fiber
- Intelligent Control of the Cupola Furnace
- Sensors for Die Casting
- Diagnostics and Control of Furnaces via Flame Image Analysis
- High Temperature Micromachined Sensor for Gas Streams
- Real Time Gas Composition Analyzers
- Wireless Telemetry

Innovative Uses

- Integrated Ion-Exchange Systems for High-Strength Glass
- Process Optimization for On-Line Coating of Float Glass
- Novel Frequency Selective Solar Glazing System
- Enabling Tool for Innovative Glass Applications
- Composites and Coatings
- Microwave and Plasma Processing
- Fiber Optic Sensor for Online Paper Weight Measurement
- Optical Sensors for Improved BOF Operations
- Fiber Optic Sensor for Industrial Process Measurement
- Optical Coupling of Infrared Analyzers
- Inventions and Innovations

Energy Efficiency

- Combustion & Melting Test Research Facility
- Batch/Cullet Preheater
- High-Temperature Properties Measurement
- Rotary Electric Glass Furnace
- Laser Diagnostics for Oxygen Enhanced Glass Synthesis
- Vertical Floatation Melter
- Energy Conserving Tool for Combustion Dependent Industries
- Aluminum Melting Using Oxygen Enhanced Combustion
- Laser Ultrasonics for Property Measurement
- Innovative High Temperature Natural Gas Furnace
- In-Situ Real Time Measurement of Melt Constituents
- Thermal Imaging Control of Furnaces
- Rotary Burner
- Plant Energy Audits
- BestPractices



Environmental

- High-Luminosity, Low NOx Burner
- GPLUS
- Monitoring/Control of Alkali Volatilization and Batch Carryover
- Oscillating Combustion
- Very Low Emissions Burner (Forced Internal Recirculation)
- Multi-Phase Fluid Dynamics Research Consortium
- Integrated Low Emission Process Heater System
- VOC Control in Kraft Mills
- Plasma Treatment for VOCs
- Novel Low NOx Burners for Steel Boilers
- Hot Oxygen Injection into Blast Furnace
- Oxy-Fuel Burners for Steel Reheating
- Reduced VOC Emissions
- Online Emissions Sensors
- Dilute Oxygen Combustion
- Miniature Oxygen Sensor

Recycling

- In-House Recovery/Recycling of Glass Manufacturing Waste
- Converting Spent Potliner to Glass Fiber Products
- New Method of Manufacturing Ceramic Products from Waste Glass

Total Project Funding
Direct = $39 million
Relevant = $64 million
Total = $103 million

OIT's Metalcasting Partnership Portfolio

Materials

- ZCA-9 Creep Restnt. Alloy Dev.
- Clean, Machinable thin-walled gray & ductile iron
- Wave Celerity & Quality of die cast product
- Surface Eng. Coatings for Dies
- Age Strengthening of Gray Iron
- Intermetallic alloy for ethylene reactors
- Metallic reinforcement in squeeze casting
- Porosity prevention in Fe casting
- Heat Treatment - Steel Castings
- Clean Metal Casting
- Cast, High Alloy Components Database
- Improved Grain Refinement
- Fatigue Properties of Al alloys
- Steel Macro inclusions atlas
- Die-casting copper motor rotors
- Semi-solid Aluminum alloys
- Real-time Measurement of Melt Constituents
- Grain refinement in PM copper

Manufacturing

- Die Life Extension
- Sensors for Die Casting
- Advanced Lost Foam Technology
- RSP tooling in die casting
- Modeling bead expansion in white side
- Clean Cast Steel
- Optimization of Comp. & HT of Die Steels
- Computer Modeling of Shot Sleeves
- Energy Consumption in Die Casting Operations
- Investment Shell Cracking
- Ergonomic Improvements in Foundries
- Unconventional Yield Studies
- Optical Sensor in electric arc steel making
- Semi-Solid and Squeeze Casting
- Heat transfer and casting distortion
- Removal of residual in the steel ladle
- Advanced Process Control for Steel
- Rapid Tooling using Optimized Cooling
- Sand/mold/core enhancements to improve finish
- High speed measurement of internal die cavity temperature

Products & Markets

- Development of a Fatigue Properties Database for Modern Design Methods
- Qualitative reasoning for die casting
- Thin section steel castings
- Evaluation of high molybdenum stainless steel
- Cast particulate metal matrix components
- Thin-wall iron castings
- Filtering Molten metal
- Ceramic composite for metal casting
- Service performance of duplex stainless steel

Energy

- High Efficiency, Low NOx Melting
- Energy Efficient High temperature gas furnace
- Cupola Sensing & Control
- Foundry Energy Assessments
- BestPractices Assessments
- IAC assessments
- Steel Foundry Refractory Lining Optimization

Environment & Recycling

- Reducing foundry emissions and green sand waste
- Recovery & Regeneration in Heat Treating
- Foundry Emissions Characterization & Modeling
- Non-incineration treatment to reduce benzene and VOC emissions
- Technical data to validate performance of foundry byproducts
- Flotation melter and scrap dryer
- Novel method to process furnace dust into saleable product
- Recover and reuse sulfur dioxide

Metal Casting R&D Investment (million dollars)

Project Type	OIT	Cost-share	Total
Direct	$15.3	$17.6	$32.9
Direct and Related	$43.8	$34.7	$78.5

Last updated 01/11/01

OIT's Petroleum Partnership Portfolio

Project Area	OIT	Cost Share	Total
¤ Petroleum & • Direct	$36M	$ 35M	$71M
Related	$25M	$24M	$49M
		Total	$120M

Safety & Reliability

¤ Mechanical Integrity Global Inspection
¤ Gas Imaging for Leak Detection
- Corrosion Monitoring System
- Metal Dusting Phenomena
- Intermetallic Alloy for Ethylene Reactors
- Alloy Selection for High Temperatures

Advanced Wireless Sensors
Controlled Processing of Tube and Pipe
Acoustic Wave Boiler Tube Monitoring

Energy Efficiency

¤ Energy Saving Separations Technologies
- Advanced Materials For Reducing Energy
- Refinery Process Heater System
- Flame Image Analysis and Control
- Thermal Image Control for Combustion
- Laser Sensor for Refinery Operations
- BestPractices: Motors, Pumps, Steam

Efficient High Temperature Natural Gas Furnace
Dilute Oxygen Combustion
High Heat Low NOx Combustion

Process Improvement

¤Enzyme Selectivity for Desulfurization
¤ Micro Gas Chromatograph Controller
¤ Gasoline Biodesulfurization Process
- Multi-phase Computational Fluid Dynamics
- Gas Phase Thermodynamics Modeling
- Catalytic Hydrogenation Retrofit Reactor
- New Nanoscale Catalysts Based Carbides
- Selective Catalytic Oxidative Dehydrogenation
- Oxidative Cracking of Hydrocarbons To Ethylene
- Alkane Functionalization Catalysts
- Selective Surface Flow Membrane
- Catalytic Hydrogen Selective Membrane
- Advanced Process Analysis for Refining
- Low Profile Catalytic Cracking
- Laser Ultrasonic Tube Coke Monitor
- Membrane Reactor for Olefins
- Furnace Pipe Hangers in Refineries

New Products & Markets

Advanced Sorbents for Gas Separations
Advanced Industrial Materials
Improved Membrane Module Tube Sheets
BioCatalysis Under Extreme Conditions
Carbon Membranes for Gas Separations
Ceramic Membrane for Residual Oil
High Temperature Facilitated Membranes
Reactive Distillation for High Octane Fuels
Hydrogen Recovery Membrane Materials
Improved Alkylation Contactor
Multiphase Flow Measurement
Gel Absorption Azerotrope Separation
Phase Transfer Catalysis
Aromatic Isomer Separation
Hydrogen - Light Hydrocarbon Separation
Catalysis Stability and Regeneration
Thermal Swing Absorption for O_2

Environment

¤ Rotary Burner Demonstration
- Low NOx - Low Swirl Burner
- Internal Recirculation Burner
- Novel Low NOx Burners

Recycling & Recovery

- Membrane To Recover Olefins From Gaseous Streams
- Electrodeionization For Product Recycling and Recovery
- PSA Product Recovery from Residuals

OIT's Steel Partnership Portfolio

Plain Text: Direct Projects
Italicized Text: Related Projects

Production Efficiency

- BF Hot Oxygen Injection
- Dephosphorization with DRI/HBI
- High Productivity RHR Ironmaking
- Optical Sensors for the BOF and EAF
- Post Combustion Optimization
- Thermal Behavior of Slags
- Real-time Melt Measurement
- Galvanneal Steel Temp Measurement
- Steel Cleanliness Analysis Tool
- Inclusion Removal in the Tundish
- Molten Metal Flow Control
- Clean Cast Steel
- Strip Casting Study
- Furnace Thermal Imaging
- Steel Reheating
- Transfer Bar Edge Heating
- Intermetallics for the Steel Industry
- Enhanced Operation of Highly Varying Loads
- Clog-Resistant Submerged Entry Nozzles
- Improved Refractories
- Controlled Tube/Pipe Processing
- Laser Ultrasonics for Seamless Pipe
- Value Chain Analysis
- *Intermetallic Alloy Development*
- *Heat Treating Furnace Fan*
- *Spray Rolling*
- *Computational Fluid Dynamics*
- *Improved Refractories for Glass*
- *Industrial Assessment Center Program*
- *Composite Electrodes*
- *Extraction of Oxygen from Air*
- *Energy-Efficient Electric Rotary Furnace*
- *Miniature, Oxygen Sensor*
- *Super-Alloy with Improved Weldability and Oxidation Resistance*
- *Rotary Burner*
- *Steel Foundry Refractory Lining Optimization — Electric Arc Furnaces*
- *Advanced Abrasion Resistant Materials*
- *Advanced Materials and New Manufacturing Techniques*
- *Composite Wear Resistant Components*
- *Comminution Circuit Optimization*
- *Selective Processing of Fine Mineral Particles*
- *Software for Simulating Efficient Grinding Mills*
- *Advanced Wireless Sensors*
- *Laser for Harsh Combustion Environments*

Environment

- Low-NOx Burners for Steel Industry Boilers
- Low-emission, Oxygen-enriched Furnace
- Dilute Oxygen Combustion
- NOx Reduction with Oscillating Combustion
- Optical Sensor for EAF Post-Combustion
- Non-Cr Passivation for Electrolytic Tin Plate
- *Forced Internal Recirculation Burner*
- *Super Boiler*
- *Control of Natural Gas Fired Furnaces*

Ironmaking | Steelmaking | Casting | Forming/ Finishing

Steel Processing Efficiency

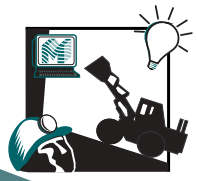
- Cold Work Embrittlement of IF Steels
- Intelligent Induction Hardening
- Making Steel Strapping/Strip
- Cost-Effective, Efficient Steel Framing
- Deformation Behavior of Lightweight Steel Structures
- Surface Quality of Automotive Sheet Steels
- Improved HSLA Sheet Steels
- Behavior of Multiphase Sheet Steels
- Resistance Spot Welding for Transformation-Hardened Steels
- Laser-assisted Arc Welding
- Steel Foam Materials and Structures
- Lightweight Steel Containers
- SMA/DOE Education Initiative
- *Fault Warning Device*
- *Full-Strength Pipe Connection*
- *Heat Treatment Procedure for Steel Casting*
- *Optimization of Die Steels*
- *Performance of Stainless Steel Castings*
- *Thin-Section Steel Castings*
- *Yield Improvement in Steel Castings*
- *Die Casting Die Lubricants*

Recycling

- Effect of Residuals in Carbon Steel
- Recycling Waste Oxides in Steelmaking Furnaces
- Steelmaking Using Biomass and Waste Oxides
- EAF Refractory Service Life/Recycling
- Particulate Briquetting
- EAF Dust to Saleable Products
- Acid Pickle Liquor Regeneration

Funding Summary

Project Type	OIT	Cost-share	Total
Direct	$48M	$33M	$81M
Direct and Related	$76M	$55M	$131M



OIT's Mining Partnership Portfolio

Materials & Equipment

- Teleoperation & Robotics
- Fluid Analysis Systems
- Crosswell System for Imaging Ahead of Mining
- Electromagnetic Wave Detection and Imaging
- Computerized Roof Bolt Design System
- Mapping with Natural-Induced Polarization
- Fuel Cell Mining Vehicles
- 24-Channel Geophone Array for Boreholes
- Fibrous Monolithic Composites
- Hybrid Pressure Casting Process and Coating Treatments
- CastCon Process
- *Tough-coated Hard Powders*
- *Variable Wall Mining with Dual Duct Ventilation*
- *Ramex Tunneler*
- *Improving Refractory Service Life and Recycling*
- *Wear-Resistant Intermetallic Alloys*

Production Efficiency

- Laser-Induced Spectroscopy for Ore Grading
- 3-D Grinding Mill Software
- X-ray Spectroscopy for Drilling and Blasting
- Calibration Methods for On-line Analyzers
- Dense-Medium Cyclone Design
- Real-Time Coal/Ore Sensor
- Projectile-based Excavation
- Comminution Circuit Optimization
- *Filtering Molten Metal*
- *Density Separation in Fluidized Beds*
- *Advanced Blast Furnace Control*
- *Clog-Resistant Submerged Entry Nozzles*
- *On-line, Non-Destructive Measurement of Properties*
- *Alkane Functionalization Catalysis*
- *Multi-phase Computational Fluid Dynamics*
- *CFD for Multi-Phase Flow*
- *Thermal Imaging Control of Furnaces and Combustors*
- *Remote Automatic Material On-line Sensor*

New Products & Markets

- High-Temperature Superconductors for Underground Communications
- Wireless Mine-wide Telecommunications
- *Baghouse Dust to Chemicals*
- *Underground Telemetry Communications*
- *Carbon Products*

Mine-Site Energy

- Plant–wide Assessments
- Process Heating
- Motor and Pump Systems
- Steam and Compressed Air Systems
- Safe and Low-Cost Hydrogen Storage for Fuel Cell Mining Vehicles

Environment

- Selective Flocculation of Fine Particles
- Dewatering Fines
- Air-Sparged Hydrocyclone Treatment of Cyanide Solutions
- *Magnetic Elutriation for Iron Ore Processing*
- *Oscillating Combustion to Reduce NOx*

Recycling

- By-product Recovery
- *Briquetting Blast Furnace Feedstock*
- *Recycling Waste Oxides into Primary Process*

Mining R&D Investment (Million dollars)

	OIT	Cost Share	Total
Direct	$9	$9	$18
Related	$15	$8	$23

For more information, contact the
OIT Clearinghouse at (800) 862-2086
or visit www.oit.doe.gov

Please send any comments, questions, or suggestions to webmaster.oit@ee.doe.gov

Office of Industrial Technologies
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

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February 2001
DOE/GO-102001-1164