

**INDUSTRIAL TECHNOLOGIES
INDUSTRY SECTOR
(Dollars in Thousands)**

INDUSTRIES OF THE FUTURE (SPECIFIC)

I. Mission Supporting Goals and Objectives

Mission

The Industries of the Future (IOF) Specific Program develops and delivers advanced technologies to improve the energy efficiency and environmental performance of America's most energy- and waste-intensive industries. To provide the best value and optimum use of public investments, the IOF Specific Program focuses on nine major U.S. industries (aluminum, agriculture, chemicals, forest products, glass, metal casting, mining, steel, and petroleum) that account for roughly 75 percent of industrial energy use and over 75 percent of manufacturing wastes.

Program Goals and Benefits

The IOF strategy aligns Federal R&D resources with the industry's highest energy and environmental priorities as specified in industry-developed visions and technology roadmaps. The IOF strategy is based on the premise that industry is most able to identify its own unique technology needs. OIT then partners with industry (on a 50/50 cost-share basis) to develop technologies that offer significant opportunities for energy savings and waste reduction and also meet strict requirements for Federal investment. Those requirements include funding projects that are pre-competitive, are high priority and high payoff, will result in significant energy and waste reduction, and can be applied throughout an entire industry not just individual firms.

The manufacturing sector was the largest contributor to economic growth between 1992 and 1997. However, the energy-intensive industries are under enormous competitive pressure which severely limits the ability to invest in long-term, broad benefit R&D. Economic conditions have shifted corporate investments from process R&D to product R&D and from energy savings to labor and capital savings. Thus, many fundamental improvements in energy efficiency and environmental performance are simply too expensive and too risky for individual firms to pursue alone.

To achieve the desired energy savings, OIT engages industry at the onset of the process so that new technologies will be more readily adopted on a widespread basis. OIT taps into the financial and technology resources within manufacturers, customers, suppliers, DOE, other Federal agencies, State government agencies, National Laboratories, and universities to tackle critical technology challenges for mutual benefit.

Although OIT's R&D investments are small compared to those of industry, the IOF strategy provides a powerful lever for stimulating and guiding major technology investments by industry and other government agencies. By aligning resources through industry-developed visions and roadmaps, significant advancements in energy efficiency and environmental performance, across the industry, can and are being achieved.

Goals and Performance Measures:

- **Agriculture** - By 2020, through integrated partnerships with growers, manufacturers, academia, non-profits and national labs, develop leap-frog technologies that allow the nascent biobased products industry to achieve a five-fold increase in the market share for chemicals and consumer goods from crops, trees, and wastes.
- **Aluminum** - Continue development of aluminum advanced cell, including inert, non-carbon anodes and cathodes, for primary production of aluminum to reduce energy consumption by 27 percent.
- **Chemical** - Continue efforts to reduce energy consumption, materials use, water consumption, pollutant and toxic dispersion by 30 percent.
- **Forest Products** - By 2010, increase recovered paper utilization rate to 50 percent by 2010 from 38 percent in 1998.
- **Forest Products** - By 2015, reduce unit water effluent levels by 35 percent compared to 1991 levels.
- **Glass** - Continue projects to develop advanced glass melting technology that will reduce the gap between actual energy use and theoretical efficiency by 50 percent.
- **Metal Casting** - Continue development of energy efficiency technologies to increase yield, reduce scrap, and improve melting efficiency to achieve \$300 million in energy savings.
- **Mining** - Continue research on advanced mining and process technologies to reduce energy use and increase productivity.
- **Steel** - Continue technology development efforts to reduce energy used to produce steel.

Benefits:

According to industry feedback from bi-annual Customer Appreciation Days, one of the most important benefits of the IOF partnership is the opportunity for the industry to come together and work on common problems for mutual benefit. This includes the opportunity to collaborate on research and address critical industry issues such as air quality. Companies engaged in the IOF process have indicated that it has improved research focus within the industry and their respective firms, created new technical efforts and partnerships, strengthened relations with the government, and the research community, and improved education and awareness. In sum, the IOF strategy provides a platform for participation that encourages knowledge-sharing and stimulates innovation to ensure globally-competitive and sustainable industries of the future. This budget request will continue activities for eight energy intensive industries. The completion of these projects and their commercialization will provide significant contributions to energy efficiency improvements and reductions in emissions for these energy intensive industries.

Industries of the Future (Specific) Accomplishments

FY 2000 Accomplishments:

- Initiated 12 solicitations with industry in support of the roadmaps developed in the Industries of the Future program.

FY 2001 Ongoing Accomplishments:

- Issue one new solicitation targeted to the Renewables Vision 2020 for Agriculture in support of the goals of the Biobased Products and Bioenergy Initiative.

FY 2002 Planned Accomplishments:

- Commercialize six new energy efficient technologies in partnership with the most energy intensive industries.

II. A. Funding Table: INDUSTRIES OF THE FUTURE (SPECIFIC)

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	\$ Change	% Change
Forest and Paper Products Vision	\$ 11,684	\$ 11,827	\$ 11,827	\$ 0	0.0%
Steel Vision	\$ 10,193	\$ 10,378	\$ 6,329	\$ -4,049	-39.0%
Aluminum Vision	\$ 10,878	\$ 10,928	\$ 4,603	\$ -6,325	-57.9%
Metalcasting Vision	\$ 5,490	\$ 5,559	\$ 3,357	\$ -2,202	-39.6%
Glass Vision	\$ 4,492	\$ 4,594	\$ 2,772	\$ -1,822	-39.7%
Chemicals Vision	\$ 12,165	\$ 12,239	\$ 7,458	\$ -4,781	-39.1%
Petroleum Vision	\$ 1,671	\$ 2,768	\$ 0	\$ -2,768	-100.0%
Mining Vision	\$ 2,698	\$ 3,517	\$ 2,119	\$ -1,398	-39.8%
Agriculture Vision	\$ 3,700	\$ 6,759	\$ 6,759	\$ 0	0.0%
Supporting Industries.	\$ 0	\$ 1,571	\$ 0	\$ -1,571	-100.0%
Technical / Program Management Support.	\$ 2,673	\$ 2,250	\$ 1,200	\$ -1,050	-46.7%
Total, Industries of the Future (Specific)	\$ 65,644	\$ 72,390	\$ 46,424	\$ -25,966	-35.9%

Note: Industries of the Future (Specific) includes \$800 for the State Energy Program Special Projects State Grants in FY 2002, \$1,340 in FY 2001, and \$1200 in FY 2000. Decrease State IOF awards from 14 to 7.

II. B. Laboratory and Facility Funding Table: INDUSTRIES OF THE FUTURE (SPECIFIC)

	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	\$ Change	% Change
Ames	\$ 72	\$ 0	\$ 0	\$ 0	0.0%
Argonne National Lab (East)	\$ 2,904	\$ 2,219	\$ 1,423	\$ -796	-35.9%
Lawrence Livermore National Lab	\$ 347	\$ 400	\$ 257	\$ -143	-35.9%
Idaho National Engineering Lab	\$ 1,020	\$ 796	\$ 510	\$ -286	-35.9%
Lawrence Berkeley Lab	\$ 815	\$ 707	\$ 453	\$ -254	-35.9%
Los Alamos National Laboratory	\$ 1,398	\$ 1,000	\$ 641	\$ -359	-35.9%
National Renewable Energy Lab	\$ 642	\$ 733	\$ 470	\$ -263	-35.9%
Oak Ridge National Lab	\$ 6,661	\$ 4,458	\$ 2,859	\$ -1,599	-35.9%
Pacific Northwest Lab	\$ 2,006	\$ 1,042	\$ 668	\$ -374	-35.9%
Sandia National Laboratories	\$ 3,685	\$ 2,378	\$ 1,525	\$ -853	-35.9%
All Other	\$ 46,094	\$ 58,657	\$ 37,618	\$ -21,039	-35.9%
Total, Industries of the Future (Specific)	<u>\$ 65,644</u>	<u>\$ 72,390</u>	<u>\$ 46,424</u>	<u>\$ -25,966</u>	<u>-35.9%</u>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC)

Program Activity	FY 2000	FY 2001	FY 2002
Forest and Paper Products Vision	Energy Performance	Energy Performance	Energy Performance
	<p>Research in this area was targeted to increase the industry's fuel flexibility, improve process energy efficiency, and ultimately allow the industry to become essentially independent of fossil fuels. Projects focused on fuel flexibility, fuel conversion and electricity production, heat recovery, manufacturing process efficiency, wider use of renewable resources, and environmental impacts of energy production. A reburner technology to improve energy efficiency and decrease NOx emissions in stoker boilers was demonstrated. (\$1,369)</p>	<p>Research is targeted to improve energy efficiency and utilization, develop new techniques to extract maximum energy from waste streams, and increase the industry's fuel flexibility. One of the 12 energy reduction projects is developing a wood chip microwave pretreatment technology to increase the yield, efficiency, and quality of Kraft pulping while decreasing chemical consumption and cooking temperatures. (\$1,431)</p>	<p>Approximately 15 projects will focus on industrial energy efficiency, low level heat recovery. Two technical feasibility studies that will be completed are: the development of an innovative energy efficient paper drying technology; and an assessment of deposit formation in recovery boiler convection passes. In addition, corrosion resistant materials will be developed for use in black liquor gasifiers (\$1,445).</p>
	Environmental Performance	Environmental Performance	Environmental Performance
	<p>Projects focused on improving margins of environmental safety and developing process alternatives consistent with pollution prevention. New, high-efficiency chlorine dioxide delignification procedures were employed in mills. An energy-efficient, low volatile organic compound wood drying technology</p>	<p>Research in this area is targeted to develop advanced pollution prevention technologies, decrease pollution abatement costs, and ensure manufacturing facilities are acceptable to industry workers and local communities. Ten projects are funded. An example of this research included a Volatile</p>	<p>Approximately 15 projects will focus on developing advanced pollution prevention technologies, reducing pollution abatement costs, and ensuring manufacturing facilities are acceptable to industry workers and local communities. Several technical feasibility studies will be completed including the use</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Forest and Paper Products Vision (Cont'd)	was demonstrated in a lumber yard. (\$2,486)	Organic Compound (VOC) reduction model that was used for emissions control in kraft mills. In addition, a technology to extract and collect VOC's from lumber drying processes will be commercially demonstrated eliminating the need for expensive, energy-intensive emissions control technologies. (\$2,508)	of paper mill by-products as an economical source of fiber reinforcement for ready-mixed concrete production, the optimization of oxygen bubble size for oxygen bleaching; and the development of a control strategy to reduce the emissions from wood dust burners and wood dryers. (\$2,975)
	Improved Capital Effectiveness	Improved Capital Effectiveness	Improved Capital Effectiveness
	Research in this area was targeted to reducing the capital requirements per unit of production and sales. Seven projects were funded and focused on system and process efficiency, materials of construction, and fabrication. A study to assess and eliminate corrosion in Kraft digesters was initiated. (\$1,303)	Research in this area is targeted to reducing the capital requirements per unit of production and sales. Twelve projects are funded and focused on system and process efficiency, materials of construction, and fabrication. An example of these projects is a tool to predict the corrosion rates in a kraft chemical recovery boiler. This tool will decrease maintenance downtime and increase the safety of the chemical recovery boiler operation. (\$1,315)	Approximately 12 projects will focus on systems and process efficiency, and materials of construction and fabrication. Feasibility studies will be completed to: understand the formation of soluble scale fouling in concentrators and evaporators; evaluate energy efficient corrugating technologies; and explore the use of natural gas rather than steam in paper drying. (\$1,395)

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
<p>Forest and Paper Products Vision (Cont'd)</p>	<p>Recycling</p> <p>Research in this area was targeted to improving separation technologies, reducing energy usage and fiber deterioration, determining optimal combinations of recycled and virgin fibers, and expanding the use of recycled products. Projects focused on sludge use and disposal, surface chemistry, fiber bonding, sorting and collection methods, improved separation technologies, and environmentally benign pressure-sensitive adhesives. A revolutionary screening device was explored. (\$1,050)</p>	<p>Recycling</p> <p>Research in this area was targeted to improving separation technologies, reducing energy usage and fiber deterioration, determining optimal combinations of recycled and virgin fibers, and expanding the use of recycled products.</p> <p>One of the 8 projects funded is to develop a new screening technology that reduced energy requirements by as much as 80 percent while improving the screen performance and reliability. Screening technologies are used to remove contaminants from recycled fiber. (\$1,059)</p>	<p>Recycling</p> <p>Approximately 10 projects will be funded to reduce energy use and fiber deterioration in recycling, improve separation technologies and expand the use of recycled fibers. Progress will continue on the development of: pressure sensitive adhesives strong enough to remain intact through the pulping process and removable prior to paper making; and an automated, efficient, fast, autonomous waste paper sorting system. A technology to induce frothing from the top of a flotation deinking cell reducing the energy requirements for deinking will be demonstrated. (\$1,475)</p>
	<p>Sensors and Controls</p> <p>Research in this area was targeted to optimize mill operations, evaluate the characteristics of raw materials and final products, and detect emissions. Projects focused on the development of actuators and control devices, process and product models, process measurement, data interpretation, and control system</p>	<p>Sensors and Controls</p> <p>Research in this area is targeted to optimizing mill operations, evaluating the characteristics of raw materials and final products, and detecting emissions. An example of the projects in this area was the development of an intelligent, vision-based apparatus for measuring properties on the wet</p>	<p>Sensors and Controls</p> <p>Approximately 12 projects will be funded focusing on the development of actuators and control devices, process and product measurement and modeling, and data interpretation. Specifically, an acoustic wave monitor for on-line measurement of the amount of corrosion and erosion</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Forest and Paper Products Vision (Cont'd)	effectiveness. A tool and methodology was to be commercialized for characterization of the raw material used in the paper making process. (\$3,867)	end of the paper machine. Knowledge of wet-end process parameters improved the efficiency of water removal and reduced energy requirements in drying, the most energy-intensive paper making process. Eight projects were funded. (\$3,877)	in recovery boiler tubing will be developed as well as a model to diagnose and optimize control of continuous kraft pulp digesters. (\$2,900)
	Sustainable Forestry	Sustainable Forestry	Sustainable Forestry
	Collaborative research in this area was targeted to increase forest growth rates and enhance the fiber quality from trees. Projects focused on biotechnology, tree physiology, and sustainable soil productivity. Marker-aided selection methods for selection of genotypes for cloning were developed. (\$1,609)	Research in this area was targeted to optimize raw material supply by improving wood quality and increasing the yield of wood and fiber per harvested acre. Results reduced costs and increased efficiencies in manufacturing processes for pulp, paper, and wood products. Environmental benefits included increased rates of carbon sequestration in forests and forest products; reduced consumption of pulping and bleaching chemicals; and an increased supply of wood and manufacturing residues to support renewable biomass energy. An example of this research included the development of a process to increase the stem growth rates of loblolly pine and study the	Approximately 6 projects will be funded focusing on biotechnology, tree physiology and sustainable soil productivity. Feasibility studies will be completed that evaluate techniques to improve the uniformity of fibers from loblolly pine with increased stem growth; and the use of molecular breeding to achieve desirable traits in juvenile loblolly pine. (\$1,637)

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Forest and Paper Products Vision (Cont'd)	<p>Participants included: The American Forest and Paper Association and their member companies, National Laboratories, the Institute of Paper Science and Technology, Pulp and Paper Education and Research Alliance members and partners, and others.</p>	<p>molecular mechanisms of cell division to improve the efficiency of wood pulping. Five projects were funded. (\$1,637)</p> <p>Participants include: The American Forest and Paper Association and their member companies, National Laboratories, the Institute of Paper Science and Technology, Pulp and Paper Education and Research Alliance members and partners, and others.</p>	<p>Participants include: The American Forest and Paper Association and their member companies, National Laboratories, the Institute of Paper Science and Technology, Pulp and Paper Education and Research Alliance members and partners, and others.</p>
Total, Forest and Paper Products Vision	\$11,684	\$11,827	\$11,827

Steel Vision	Production Efficiency	Production Efficiency	Production Efficiency
	<p>Collaborative R&D with the industry to develop improved energy-efficient, low-carbon dioxide emission, alternative iron and steel making processes was supported. R&D was initiated on subjects such as advanced shaping technologies and improved process control including sensors for the blast furnace, basic oxygen furnace, and electric arc furnace (EAF). R&D on improved steel quality and</p>	<p>Research to reduce energy while lowering emissions and increasing productivity in steel processing focuses on a wide range of topics as identified in the Steel Industry Technology Roadmap. Currently, key advances are being made through improved sensing and control, increased use of by-products and recycling, and process improvement. These activities will support the industry's reduction of</p>	<p>Design and construct pilot plant demonstrating controlled thermo-mechanical processing for tubes and pipe. Demonstrate an automated steel cleanliness tool using scanning electron microscopy in a plant environment. Assess role of strip casting, based on the structure and properties of strip cast material. (\$4,000)</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Steel Vision (Cont'd)	consistency using lower cost raw materials was continued. (\$3,657)	energy use by 19 percent while increasing its use of recycled steel and by-products to 66 percent of production. Collaborative R&D with the industry to develop improved, energy-efficient, low carbon dioxide emission, alternative iron and steel making processes will be supported. R&D will be conducted to improve the efficiency and productivity of the blast furnace, basic oxygen furnace, and electric arc furnace by developing modifications to hardware and operational practices. These modifications will result from analyses and laboratory studies based on initial efforts in computational fluid dynamics and other design technologies leveraged from the Chemicals Vision. (\$3,725)	
	Recycling R&D	Recycling R&D	Recycling R&D
	R&D on methods of increasing steel production based on recovery of iron units from all waste streams was conducted. R&D improved methods of recovering iron units and other metals (e.g., zinc, lead) from	R&D on methods of increasing steel production based on recovery of iron units from all waste streams will be conducted. R&D will identify methods of increasing the efficiency of recycling steel from	Determine operating practices enhancing recycling of waste oxides in the steelmaking vessel. (\$1,879)

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Steel Vision (Cont'd)	EAF dust and waste oxides. Improved methods for recycling spent refractories were developed. (\$2,860)	in-plant wastes. Processes will be analyzed to identify ways to use other in-plant wastes as feedstock to reduce energy use. (\$2,925)	
	Environmental Engineering	Environmental Engineering	Environmental Engineering
	R&D focused on lowering carbon dioxide and NOx emissions from heating and reheating processes associated with steel production. Research concentrated on advanced burners and burner controls, and on methods to reduce coke use in the blast furnace through hot oxygen injection. (\$3,676)	R&D will develop methods for reducing the amount of consumables used in the steel making process. Consumables such as refractories can become an environmental disposal problem at the end of their lifetime. Efforts will continue to reduce NOx and CO ₂ levels from the various unit operations in the steel mill. (\$3,248)	No activity. (\$0)
	Feasibility Studies on Innovative Steel Production	Feasibility Studies on Innovative Steel Production	Feasibility Studies on Innovative Steel Production
	No activity.	Significant cross-over of technologies between Electric Arc Furnace (EAF) and Basic Oxygen Furnace (BOF) steel making indicate that there are significant opportunities to improve the steel making process by, at a minimum, combining and optimizing the best	Steel Cup Challenge: Continue activities to develop a new steel conversion process based on prior year studies. (\$450)

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Steel Vision (Cont'd)		features of both. The development of a recuperated, continuous (as opposed to batch) steelmaking process could result in saving half the energy currently used in the steel conversion/melting operation. These activities would initiate the feasibility and design studies to develop a new steel conversion process. (\$480)	
	R&D participants in the Steel Vision included: American Iron and Steel Institute, member and associate member companies, Steel Manufacturers Association, member and associate member companies, national laboratories, and universities.	R&D participants in the Steel Vision include: American Iron and Steel Institute, member and associate member companies, Steel Manufacturers Association, member and associate member companies, national laboratories, and universities.	R&D participants in the Steel Vision include: American Iron and Steel Institute, member and associate member companies, Steel Manufacturers Association, member and associate member companies, national laboratories, and universities.
Total, Steel Vision	\$10,193	\$10,378	\$6,329
Aluminum Vision	Primary Production Technologies	Primary Production Technologies	Primary Production Technologies
	An accelerated research program was initiated for the development and implementation of an advanced cell, which would be the most significant advancement in aluminum production technology	The accelerated research program will continue for the development and implementation of an advanced cell with the potential to reduce energy consumption by 27 percent and greenhouse gas emissions by	Continue preparations to demonstrate, in full-scale cell tests, commercial viability of potliners containing additives for improved performance and life. Develop control strategy using sensors for

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Aluminum Vision (Cont'd)	<p>since the development of the Hall-Heroult process in 1886. Activities included pilot cell tests of two novel designs and inert anode/cathode materials combinations, as well as 12 kiloAmpere pilot-cell tests of wettable cathode materials with a drained cathode design. In addition, an investigation was initiated into the feasibility of a novel smelting process based on fuel cell technology. Saltcake recycling was demonstrated at pilot-plant scale, and R&D was conducted to develop sensors and controls to sort aluminum scrap at high speeds. (\$7,227)</p>	<p>5.5 MMTCE over a “business as usual” scenario. Implementation of an advanced cell of this kind would be the most significant advancement in aluminum production technology since the development of the Hall - Heroult process in 1886. Scale up of advanced cell development and testing may be delayed indefinitely due to the energy crisis and resulting shut-down of much of the primary aluminum production capacity in the U.S. Feasibility of using fuel cell technology for development of a non-consumable anode will be evaluated, and a control strategy using sensors will be developed for aluminum smelting cells. A pilot scale demonstration of saltcake recycling technology will be completed. Laser and optical techniques for scrap sorting will be evaluated. (\$7,237)</p>	<p>aluminum smelting cells and continue to prepare for scale up of advanced cell technology. (\$4,603)</p>
	Semi-Fabrication Technologies	Semi-Fabrication Technologies	Semi-Fabrication Technologies
	<p>A vertical flotation melter and a commercial-scale, high-efficiency, low-NOx combustion system for</p>	<p>Year-long tests of potlinings containing additives for improved performance and life will be</p>	<p>No funding requested. (\$0)</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Aluminum Vision (Cont'd)	<p>aluminum scrap remelting was demonstrated. (\$3,651)</p> <p>Participants included: Advanced Refractory Technologies, Alcan, Aluminum Company of America, Argonne National Laboratory, Brooks Rand Laboratories, Century Aluminum, EMEC Consultants, Energy Research Company, Goldendale Aluminum, Kaiser Aluminum Company, Northwest Aluminum, NSA Aluminum, Oak Ridge National Laboratory, Michigan Technological University, Reynolds Metals Company, Worcester Polytechnic Institute.</p>	<p>initiated in full-scale industrial cells. (\$3,691)</p> <p>Participants include: Alcan, Alcoa Inc., Applied Industrial Solutions, Inc., Argonne National Laboratory, Century Aluminum, Cornell University, EMEC Consultants, Energy Research Company, Gas Research Institute, Kaiser Aluminum Company, Michigan Technological, NSA Aluminum, Oak Ridge National Laboratory, Siemens Westinghouse Co., The Ohio State University Research Foundation, West Virginia University.</p>	<p>Participants include: Alcan, Alcoa Inc., Applied Industrial Solutions, Inc., Argonne National Laboratory, Century Aluminum, Cornell University, EMEC Consultants, Energy Research Company, Gas Research Institute, Northwest Aluminum, Oak Ridge National Laboratory, Ohio State University Research Foundation, West Virginia University</p>
Total, Aluminum Vision	\$10,878	\$10,928	\$4,603
Metalcasting Vision	<p>The objective of the metalcasting vision is to support metalcasting as the preferred supplier of net or near-net-shape metal components. Specific challenges to be achieved by the year 2020 include: increasing productivity by 15 percent through the development of advanced manufacturing technologies, reducing energy consumption per unit value of shipments by 20</p>	<p>Continue a balanced portfolio of high-priority research responsive to the goals and challenges identified in the metalcasting vision and metalcasting technology roadmap. Each of the projects is cost shared 50 percent with industry partners. There are over 220 industry partners in at least 30 states working on program-funded research projects.</p>	<p>Continue a balanced portfolio of high-priority research responsive to the goals and challenges identified in the metalcasting vision and metalcasting technology roadmap.</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Metalcasting Vision (Cont'd)	percent, reducing average lead time by 50 percent, achieving 100 percent pre- and post-consumer recycling and 75 percent beneficial reuse of foundry by-products, and increasing industry reinvestment in research, education and marketing programs by 10 percent.	Participants include: University of Alabama-Birmingham, University of Alabama-Tuscaloosa, Case Western Reserve University, Colorado School of Mines, University of Iowa, Iowa State University, Mississippi State University, University of Missouri-Rolla, Ohio State University, Penn State University, Oak Ridge National Laboratory, Tri-State University (Indiana), University of Tennessee, Worcester Polytechnic Institute, and Pacific Northwest National Laboratory.	
	Manufacturing Technologies	Manufacturing Technologies	Manufacturing Technologies
	Research focused on new models, tools and guidelines in order to advance casting technologies to produce high-quality, high-integrity castings. A new guideline for unconventional yield improvement techniques were made available for the steel casting industries. A 10 percent increase in yield alone has the potential benefit of saving 1.8 trillion Btu per year for melting. (\$2,322)	Research continued in development of <u>advanced casting technologies</u> for producing high-quality castings. Research includes Advanced Lost Foam Casting technology and binders (chemicals that hold sand molds together) for iron and steel casting. Technical challenges include the removal of gaseous residuals during metal pouring, better and cheaper foam materials, and rapid prototyping of the patterns. Successful development	Develop new models and alloy properties for semisolid metal processing, and Lost Foam research and Best Practices guide-lines, minimizing die distortion, reducing scrap rate and improving productivity. (\$1,557)

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Metalcasting Vision (Cont'd)	Materials Technologies	and application of Advanced Lost Foam Technology to iron and steel castings alone will have a potential energy efficiency improvement of up to 30 percent, reduce cost by 25 percent, and eliminate binder emissions associated with traditional sand casting methods for steel casting. In addition, research continues in Semi-Solid Metals Processing (SSM) to develop models and characterize material properties in order to produce higher integrity, high volume, light-weight castings, while enabling new castings with thinner walls and reduced machining requirements. (\$2,312)	Materials Technologies
	Activities focused on advancing the use of new and improved materials to produce defect-free, high-quality castings while achieving longer life for mold, refractory lining, and casting dies. Innovative research in new coatings was developed to extend the useful life of casting dies ten fold in comparison with current conventional methods. (\$1,820)	Materials Technologies	Complete materials research on the castability on aluminum die casting alloys, and develop New Heat Treating guidelines to enable U.S. die casters to extend the life of die materials by 20-30 percent. (\$1,450)
		Activities are focused on <u>advancing the use of new and improved materials</u> to produce defect-free, high-quality casting while achieving longer life for mold, refractory lining, and casting dies. Continue to focus on innovative research to develop advanced coatings capable of extending the useful life of casting dies ten fold in	

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Metalcasting Vision (Cont'd)	<p data-bbox="449 651 842 678">Environmental Technologies</p> <p data-bbox="449 727 919 1338">Balanced portfolio included critical research needed to develop design guidelines for advanced modeling design for thin wall iron casting will be available to the metalcasting industry. In addition, a state-of-the-art Neural Network Model for processing and control of cupola furnace was made available. Potential benefits included energy savings of 400 million Btu per year per unit, environmentally enhanced cupola operation in the U.S., decreased coke requirements, reduced carbon, sulfur and manganese losses and elimination of associated emissions. (\$424)</p>	<p data-bbox="963 326 1419 573">comparison with current conventional methods. In addition, R&D efforts will continue on technologies needed to consistently produce machinable, high-strength, thin-walled gray and ductile iron castings. (\$1,822)</p> <p data-bbox="963 651 1356 678">Environmental Technologies</p> <p data-bbox="963 727 1419 1195">Balanced portfolio will include critical research needed to develop design guidelines for thin wall iron casting. Thin-wall iron castings, on the order of 3-5 mm thickness, will enable automotive engineers to design car components with significant reductions in metals required, resulting in tremendous reductions in energy use and environmental burden in both casting production and transportation fuel. (\$475)</p>	<p data-bbox="1476 651 1866 678">Environmental Technologies</p> <p data-bbox="1476 727 1932 899">Make available non-incineration technique as an alternative for ferrous foundries to reduce Volatile Organic Compounds emissions. (\$350)</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Metalcasting Vision (Cont'd)	<p>New Casting Applications</p> <p>New design tools and improvements in casting techniques and models will be developed to enable new applications of advanced casting technologies, which will reduce energy usage, reduce cost, and minimize waste generated. New techniques developed for metal handling enabled U.S. metalcasters to reduce casting defects, improve quality of castings by removing/minimizing oxide defects that require weld repair, and improve the competitiveness of the U.S. metalcasting industry. (\$924)</p>	<p>New Casting Applications</p> <p>New design tools and improvements in casting techniques and models will be developed to enable new applications of advanced casting technologies, which will reduce energy usage, reduce cost and minimize waste generated. New techniques developed for metal handling will enable U.S. metalcasters to reduce casting defects, improve quality of castings by removing/minimizing oxide defects that require weld repair, and improve the competitiveness of the U.S. metalcasting industry. (\$950)</p>	<p>New Casting Applications</p> <p>No funding requested. (\$0)</p>
Total, Metalcasting Vision	\$5,490	\$5,559	\$3,357
Glass Vision	<p>Production Efficiency</p> <p>Modeled refractories (the main structural materials in glass melting furnaces); improved combustion and melting technology; initiated new fundamental knowledge of glass physics; better means of removing heat faster; better understanding of</p>	<p>Production Efficiency</p> <p>Continue modeling of refractories (the main structural materials in glass melting furnaces) and improvement of combustion and melting technology. Transfer fundamental knowledge of glass properties; better means of</p>	<p>Production Efficiency</p> <p>Transfer advanced sensor technologies and handglass cutting techniques to specialty glass. Continue development of feedstock measurement and control technology. Continue to implement national laboratory-based GPLUS</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Glass Vision (Cont'd)	integrated product and process controls. (\$1,825)	removing heat faster. Demonstrate advanced sensor technologies, handglass cutting, and process control technique for auto glass. Initiate feedstock measurement and control technology. Implement national laboratory-based GPLUS program. (\$1,844)	program. (\$670)
	Energy Efficiency/Conservation	Energy Efficiency/Conservation	Energy Efficiency/Conservation
	Combustion of space/glass furnace and control for optimal melter performance was coupled. Developed better refractories; initiated design of research facility to validate new and existing models. (\$1,131)	Continue to perform activities to validate new and existing models. Initiate new technologies that support innovative glassmaking and improved heat recovery. Finalize design of glass furnace combustion and melting research facility. Support activities to promote energy management practices. (\$1,155)	Commission the glass furnace combustion and melting research facility and begin industry tests. Continue to develop new technologies that support innovative glassmaking and improved heat recovery. Support activities to promote energy management practices. (\$970)
	Environmental Protections and Recycling	Environmental Protections and Recycling	Environmental Protections and Recycling
	Pilot-scale testing of high-luminosity, low-NOx burner for glass furnaces. Developed process mechanisms that influence particulates; developed predictive	Demonstrate high-luminosity, low-NOx burner for glass furnaces. Initiate technology to recover and recycle in-process fiberglass waste. Initiate technology to identify and	Refine and transfer high-luminosity, low-NOx burner for glass furnaces. Continue to develop technology to recovery and recycle in-process fiberglass waste; identify and

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Glass Vision (Cont'd)	emissions modeling tools. Supported cullet re-use systems. (\$734)	control emission management mechanisms from glass melting furnaces. Support cullet re-use systems. (\$755)	control emission management mechanisms from glass melting furnaces. Support cullet re-use systems. (\$720)
	Innovative Uses	Innovative Uses	Innovative Uses
	Improved glass properties using integrated ion exchange. Continued innovative glass compositions and processes to enhance performance and new material-design models to improve properties. (\$664)	Initiated new technology for improved coating of flat glass. Continue innovative glass compositions and processes to enhance performance and new material-design models to improve properties. (\$685)	Continue to develop new technology for improved coating of flat glass. Continue innovative glass compositions and processes to enhance performance and new material-design models to improve properties. (\$313)
	Deployment Logistics	Deployment Logistics	Deployment Logistics
	Conducted technical workshops on coatings and combustion. Reviewed technology roadmap assessment. (\$138)	Conduct two technical workshops. Update technology roadmap assessment. Design technology showcase. (\$155)	Update technology roadmap. (\$99)
	Participants included: Praxair, Institute for Glass Technology, Brigham Young University, Accu- Tru Intl., Alfred University-Center for Glass Research, PPG, Air Products, Los Alamos National Laboratory, Oak Ridge National Laboratory, Sandia National	Participants include: Visteon, PPG, Techneglas, Owens Corning, Gallo Glass, Fenton Art Glass, BOC Gases, Praxair, Accu-Tru International, Gas Technology Institute, Alfred University-Center for Glass Research, Mississippi State University, Los Alamos	Participants include: Visteon, PPG, Techneglas, Owens Corning, Gallo Glass, Fenton Art Glass, BOC Gases, Praxair, Accu-Tru International, Gas Technology Institute, Alfred University-Center for Glass Research, Mississippi State University, Los Alamos

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Glass Vision (Cont'd)	Laboratory, Pacific Northwest National Laboratory, Argonne National Laboratory, Ames, and the Federal Energy Technology Center. Visteon, PPG, Techneglas, Owens Corning, Praxair, Air Products, Accu-Tru International, Gas Technology Institute, Brigham Young University, Alfred University-Center for Glass Research, Mississippi State University, Los Alamos National Laboratory, Oak Ridge National Laboratory, Sandia National Laboratories, Pacific Northwest National Laboratories, Argonne National Laboratories, Ames Laboratory, National Energy Technology Laboratory, and the State of West Virginia.	National Laboratory, Oak Ridge National Laboratory, Sandia National Laboratories, Pacific Northwest National Laboratories, Argonne National Laboratories, Ames Laboratory, National Energy Technology Laboratory, and the States of West Virginia, Ohio, and Pennsylvania.	National Laboratory, Oak Ridge National Laboratory, Sandia National Laboratories, Pacific Northwest National Laboratories, Argonne National Laboratories, Ames Laboratory, National Energy Technology Laboratory, and the States of West Virginia, Ohio, Pennsylvania, Florida, and North Carolina.
Total, Glass Vision	\$4,492	\$4,594	\$2,772
Chemicals Vision	New Chemical Sciences and Engineering	New Chemical Sciences and Engineering	New Chemical Science and Engineering
	Conducted second <i>Technology Vision 2020</i> solicitation to support industry-developed roadmaps in: separations catalysis, computational chemistry, materials, and alternative	Continue R&D to support <i>Technology Vision 2020</i> in separations, catalysis, computational chemistry, and alternative synthetic pathways.	Develop new process chemistry, and catalysis technologies. Continue advanced separation technology R&D to decrease the over 2 quadrillion Btu per year of

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Chemicals Vision (Cont'd)	<p>synthetic pathways. Advances in separations technologies such as adsorption, crystallization, distillation, extraction and membranes offer prospects of multi-trillion Btu per year energy savings. Cost shared research on more energy efficient separation processes was conducted on olefin recovery from waste streams, sorbent separation, and advanced electrode ionization. (\$10,070)</p>	<p>Demonstrate advanced electrodeionization separation technology in pilot-scale - potential energy savings of 4 trillion Btu per year by 2020. Conduct full-scale demonstration of novel membrane-based process to recover propylene from propane - energy savings from displaced feedstock are estimated to be 23 trillion Btu per year by 2020. (\$9,989)</p>	<p>energy required to separate, process, and refine chemicals. (\$6,358)</p>
	<p>Manufacturing and Operations</p> <p>Supported projects that addressed technology roadmap for materials of construction including: new materials for high-temperature, corrosive environments, improved models for predicted material behavior, new/improved materials, and better joining and fabricating methods. Facilitated development of technology roadmap for manufacturing and operations. (\$898)</p>	<p>Manufacturing and Operations</p> <p>Conduct solicitation to support development and implementation of energy saving technologies identified in technology roadmap for manufacturing and operations. Continue R&D to develop: new materials for high-temperature, corrosive environments, improved models for predicted material behavior, new/improved materials, and better joining and fabricating methods. (\$975)</p>	<p>Manufacturing and Operations</p> <p>Assist, with American Institute of Chemical Engineers, about 5 chemical plants in incorporating new best practices and emerging technologies. (\$400)</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Chemicals Vision (Cont'd)	<p data-bbox="449 321 842 354">Computational Technologies</p> <p data-bbox="449 394 919 1084">Continued CFD consortium projects to establish an industrial user center, commercialize a sensor for multiphase measurements, begin testing beta-version of multiphase computer model and released visualization package. Computational technologies can optimize process energy requirements and shorten the lead time from research to plant design by several years. Cost shared research was conducted on simulating industrial scale turbulent gas solid flows and adapting multiphase computational fluid dynamics to fluid-particle processes. Completed design of experimental test loop. (\$1,197)</p> <p data-bbox="449 1166 919 1485">Consortium participants included: Dow, DuPont, Dow Corning, Exxon Chemicals, Chevron, Fluent, AEA Technology, Silicon Graphics, Westinghouse, FETC, Sandia National Laboratory, Lawrence Berkeley National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, and</p>	<p data-bbox="961 321 1354 354">Computational Technologies</p> <p data-bbox="961 394 1432 1011">Continue advancement of multiphase CFD consortium projects. Computational technologies can optimize process energy requirements and shorten the lead time from research to plant design by several years. Conduct R&D on simulating industrial scale turbulent gas solid flows and adapting multiphase computational fluid dynamics to fluid-particle processes. Complete installation of experimental test loop. Complete improvements to MIFX software code. Annual energy savings are estimated to be 100 trillion Btu per year by 2020. (\$1,275)</p> <p data-bbox="961 1166 1432 1485">Participants include: Praxair, Air Products, Honeywell Reaction Engineering, Sandia National Laboratory, DuPont, Dow Corning, Exxon Chemicals, Chevron, Fluent, Aspen Technology Fluent, OLI Systems, AIChE, University of Texas, Rchm and Haas, NTEC, Membrane Technology Research,</p>	<p data-bbox="1474 321 1866 354">Computational Technologies</p> <p data-bbox="1474 394 1944 605">Continue advancement of multiphase CFD consortium projects to develop effective modeling tools for materials handling to reduce energy consumption and downtime. (\$700)</p> <p data-bbox="1474 1166 1944 1485">Participants include: Praxair, Air Products, Honeywell Reaction Engineering, Sandia National Laboratory, DuPont, Dow Corning, Exxon Chemicals, Chevron, Fluent, Aspen Technology Fluent, OLI Systems, AIChE, University of Texas, Rchm and Haas, NTEC, Membrane Technology Research,</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Chemicals Vision (Cont'd)	Pacific Northwest National Laboratory, et al.	Argonne National Laboratory, Oak Ridge National Laboratory	Argonne National Laboratory, Oak Ridge National Laboratory
Total, Chemicals Vision	\$12,165	\$12,239	\$7,458
Petroleum Vision	<p>The Petroleum industry developed a vision and technology roadmap, signed a compact, and worked with DOE to implement the roadmap. Conducted a competitive solicitation to initiate projects in accordance with the Petroleum industry vision and roadmap.</p> <p>Projects included remote sensing of equipment leaks, which is expected to reduce fugitive emissions, saving 12 trillion Btu annually; biocatalytic desulfurization of gasoline, expected to lower desulfurization energy use by over 20 trillion Btu/year; and an advanced fluid catalytic cracking model which can guide industry to savings in excess of 6 trillion Btu/year. (\$1,671)</p>	<p>The Petroleum industry vision and roadmap focus on environment, process improvement and energy efficiency. A competitive solicitation began in FY 2000 initiates activities to address key needs in these areas. FY 2001 funding will continue to address downstream petroleum needs.</p> <p>Continue cost shared projects including energy saving separations technologies to develop membranes to replace distillation, global on-stream inspection and a gas chromatograph controller to improve process efficiency, a rotary burner to significantly reduce NOx in heaters and boilers while lowering energy use, and broadening enzyme selectivity and improving activity for biological desulfurization. Complete project on developing and demonstrating a</p>	No activity. (\$0)

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
		portable hydrocarbon leak detector. (\$2,768)	
Total, Petroleum Vision	\$1,671	\$2,768	\$0
Mining Vision	Characterization and Processing	Characterization and Processing	Characterization and Processing
	Leveraged research funds with industrial cost sharing as well as state and other federal funding to support the industry's vision and roadmap. Developed technologies for exploration, mining, and processing which demonstrate accountable benefits for specific sectors of the Mining industry. Technologies that could be funded included real-time mineral content sensors, mining technologies for difficult conditions (deeper mines, thinner seams, lower-grade ores), and new materials for transportation and handling. (Major mining and mineral processing companies, equipment manufacturers, universities, and national laboratories.) (\$2,698)	Continue to leverage research funds with industrial cost sharing as well as state and other federal funding to support the industry's vision. Facilitate interagency roadmaps for technologies such as exploration and excavation. Will develop technologies for resource characterization, mining, and processing which demonstrate accountable benefits for the US mining industry. Technologies funded include advanced minerals characterization, integrated mining systems, and low-energy metals processing, expected to save over five trillion Btu annually. (Major mining and mineral processing companies, equipment manufacturers, universities, and national laboratories.) (\$3,517)	Will leverage research funds with industrial cost sharing as well as state & other federal funding to support the industry's vision. Will facilitate interagency roadmaps for technologies such as exploration and remediation. Will develop technologies for mineral processing, mine development and operation, and exploration which demonstrate accountable benefits for the U.S. mining industry. Will continue research on advanced mining and processing technologies to support industry needs. (Major mining and mineral processing companies, equipment manufacturers, universities, and national laboratories.) (\$2,119)
Total, Mining Vision	\$2,698	\$3,517	\$2,119

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Agriculture Vision	<p>Conducted R&D building on results from the initial solicitation in FY 1999 and began filling the many technology gaps identified by the technology roadmaps which were not addressed by the first solicitation. Used a more flexible and creative solicitation process that increased the number of proposals and outside funding; built new multi-disciplinary and cross-industry partnerships; and encouraged highly innovative ideas. Launched a new educational initiative to promote multi-disciplinary research at Universities and Colleges and provided stipends to select graduate students.</p> <p>In response to the Biomass Research and Development Act of 2000, the program looked to begin integrating technology, markets and policies for using local crops, trees, and agricultural wastes to make transportation fuels, electrical power and biobased industrial chemicals and consumer goods in “biorefineries” across the country. (\$3,700)</p>	<p>Progress in achieving industry’s ambitious target of a five-fold increase in market share for renewable bioproducts will begin to build momentum by adding to farmers’ incomes, creating new jobs in rural communities and markets overseas, and reducing industry’s costs of production.</p> <p>Support project R&D from first two solicitations and issue new request for proposals that builds on the “lessons learned” from earlier solicitations. Emphasis will be on projects that show clear linkages across the highest priorities in the roadmap. Projects should emphasize an integrated and coordinated approach to make better use of public and private funding, and accelerate progress toward industry’s ambitious goal of 10 percent of the market for chemical feedstocks from plant material by 2020. Solicitation process broadens our base of partners in the agricultural, chemical, and forestry communities. Continues to provide support to those higher education institutions with winning proposals</p>	<p>Using portfolio analysis, and industry’s broader vision and roadmap for bioenergy and biobased products, seek new R&D projects to address specific technology gaps. These would begin to focus on more in-depth integrated approaches and systems to biobased products and bioenergy. (\$6,759)</p> <p>Participants include: National Corn Growers Association, American Soybean Association/United Soybean Board, National Association of Wheat Growers, American Forest and Paper Association, Corn Refiners Association, Agricultural Research Institute, National Association of State Universities and Land-grant Colleges, Dow Chemical Co., Dupont, Rohm and Haas Co., Genencor International, Cargill Dow Polymers</p>

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Agriculture Vision (Cont'd)		for new multidisciplinary approaches from FY 2000 and runs second solicitation to broaden participation in the Renewables 2020 education initiative. Seeks deeper collaboration on R&D decisionmaking and public outreach with other parts of the Department of Energy, the Department of Agriculture, and other pertinent agencies in the Federal government as well as State government. (\$6,759)	
Total, Agriculture Vision		\$3,700	\$6,759
Supporting Industries	No activity (\$0)	Issue competitive solicitations to the IOF supporting industries to support technology R&D not covered by other IOF-specific programs that can help provide significant cost and energy savings. For instance, Forging and Heat Treating industries directly support the Steel and Aluminum industries and have developed visions and roadmaps that can be correlated to the priority needs of the Industries of the Future. (\$1,571)	No activity. (\$0)

III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Total, Supporting Industries	\$0	\$1,571	\$0
Technical/Prog. Management Support	Provide critical technical and program management support services. (\$2,673)	Provide critical technical and program management support services. (\$2,250)	Provide critical technical and program management support services. (\$1,200)
Total, Technical/Prog. Management Support	\$2,673	\$2,250	\$1,200
TOTAL, INDUSTRIES OF THE FUTURE (SPECIFIC)	\$65,644	\$72,390	\$46,424