DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
ENERGY EFFICIENCY AND RENEWABLE ENERGY
(Tabular dollars in thousands, Narrative in whole dollars)

INDUSTRY SECTOR

PROGRAM MISSION

Sector Mission, Situation, Goals and Strategic Approach:

Mission

The mission of the Office of Industrial Technologies is to improve the energy efficiency, environmental performance, and productivity of energy-intensive industries by rapidly developing and delivering advanced science and technology options which will:

- ➜ lower raw material and depletable energy use per unit output;
- ➜ improve labor and capital productivity; and
- ➜ reduce the generation of wastes and pollutants.

These industries include: Forest Products, Steel, Glass, Aluminum, Chemicals, Metal Casting, Agriculture, Petroleum, and Mining.

Situation

Industry's efficient use of energy is critical to the U.S. energy economy. Industry consumed some 35 quads (quadrillion British thermal units) of primary energy in 1997--about 38% of all energy used in the U.S. This energy use is concentrated in a relatively small number of industries. Pulp and paper, primary metals, chemicals, petroleum, glass, agriculture, and mining industries account for roughly three-quarters of all energy consumed by U.S. industry.

Efficient energy use and waste disposal are important to industry in terms of operating costs. Industry spent about $120 billion on energy in 1997 and approximately $29 billion for pollution abatement and control. This represents less than 5% of total costs of operation for all of industry; however, for materials and process industries, the percentage of costs attributable to energy and waste is higher, ranging from about 7% to over 30%. Because of their intensive energy use, these industries consider energy costs to be an important driver of investment and operating decisions.

Concerns about generation of pollution and the levels and types of industrial wastes are increasing. Industry generated 14 billion tons of waste in 1994, including over 200 million tons of hazardous and toxic wastes. The manufacturing sector alone accounts for about 65% of all industrial wastes, and almost all of the hazardous and toxic wastes. Within manufacturing, materials and process industries account for about 80% of the hazardous and toxic wastes and about 95% of non-hazardous waste. These wastes often impose expensive clean up and disposal costs, but offer the potential for recovering the "embedded" energy and materials value.

Manufacturing jobs are important to the economy. About 18 million people are employed in manufacturing in the United States. Manufacturing jobs are higher-paying and higher-skilled compared to many jobs in service industries. Manufacturing jobs are also a strong stimulus to the economy – 4 jobs are created for every manufacturing job created. Manufacturing jobs have increased from 18.1 million jobs in 1992 to 18.7 million in 1998. This resurgence follows a decline from a level of 19.6 million jobs in 1974 and has paralleled increasing U.S. industrial competitiveness and a thriving economy.

Goals and Strategic Approach

A reasonably ambitious goal for U.S. industry for the year 2010 is a 25% reduction in energy consumption per unit of output. Advanced technologies can improve industrial productivity, not only through reducing energy cost expenditures, but also through productivity enhancements and innovative solutions for environmental requirements. In fact, the value of the non-energy productivity improvements often exceeds the energy cost savings. For example, the use of super-hard Nickel Aluminide (a DOE-developed technology) in rolls in a pre-heating furnace of a steel mill has resulted in both energy and productivity improvements. The rolls last at least 3, and perhaps as much as 10, times longer than conventional rolls, requiring replacement on a much less frequent basis. This in turn conserves energy by avoiding disruptions to the furnace cycle (shut downs and cold starts), and has improved productivity by keeping the furnace operational for a much longer period of time. The sum of these savings can also be expected to preserve and increase industrial jobs by helping the international competitiveness of U.S. industry.

In the Industries of the Future program, OIT acts initially as a facilitator, assisting industry in coming together in order to collectively identify issues and develop an industry-wide vision for the long term future. OIT facilitates and assists in the development of industry roadmaps which identify and prioritize efforts needed to achieve each industry’s vision. OIT collaborates with the private sector to share the cost of the generic, pre-competitive activities which meet industry priority needs and the Department’s key missions. In doing so, OIT brings to bear the unique expertise and facilities of the National Laboratories to address key technological and scientific problems.

The Office of Industrial Technologies portfolio responds to the vision goals and roadmap targets through Industries of the Future (Specific) and Industries of the Future (Crosscutting) programs.

- The Industries of the Future (Specific) program develops promising new process-related technologies with industry and other organizations to address needs identified in industry-wide developed visions and roadmaps. These technologies are chosen for their pre-competitive nature; ultimate impact on energy and waste reduction; high priority and high risk; and wide-spread applicability. Project costs are almost always shared with industry on roughly a 50/50 basis.

- The Industries of the Future (Crosscutting) develops technologies which are useful to multiple industries simultaneously. The program delivers information and tools to help plant managers make informed decisions on technology choices today that result in energy, waste and dollar savings. The program supports research to develop power generation equipment, combustion equipment, and sensors and controls. OIT also develops advanced materials which address a multitude of wear and corrosion problems. In addition, OIT supports new ideas from inventors, and fund grants for demonstration of technologies that will be viable in the near term.

These two programs provide an integrated set of options responsive to the near, mid and long term goals and objectives of industry as set forth in their visions and roadmaps. They are also responsive to the national goals of improved energy efficiency, expanded adoption of pollution prevention, increased productivity, and more globally competitive industries.

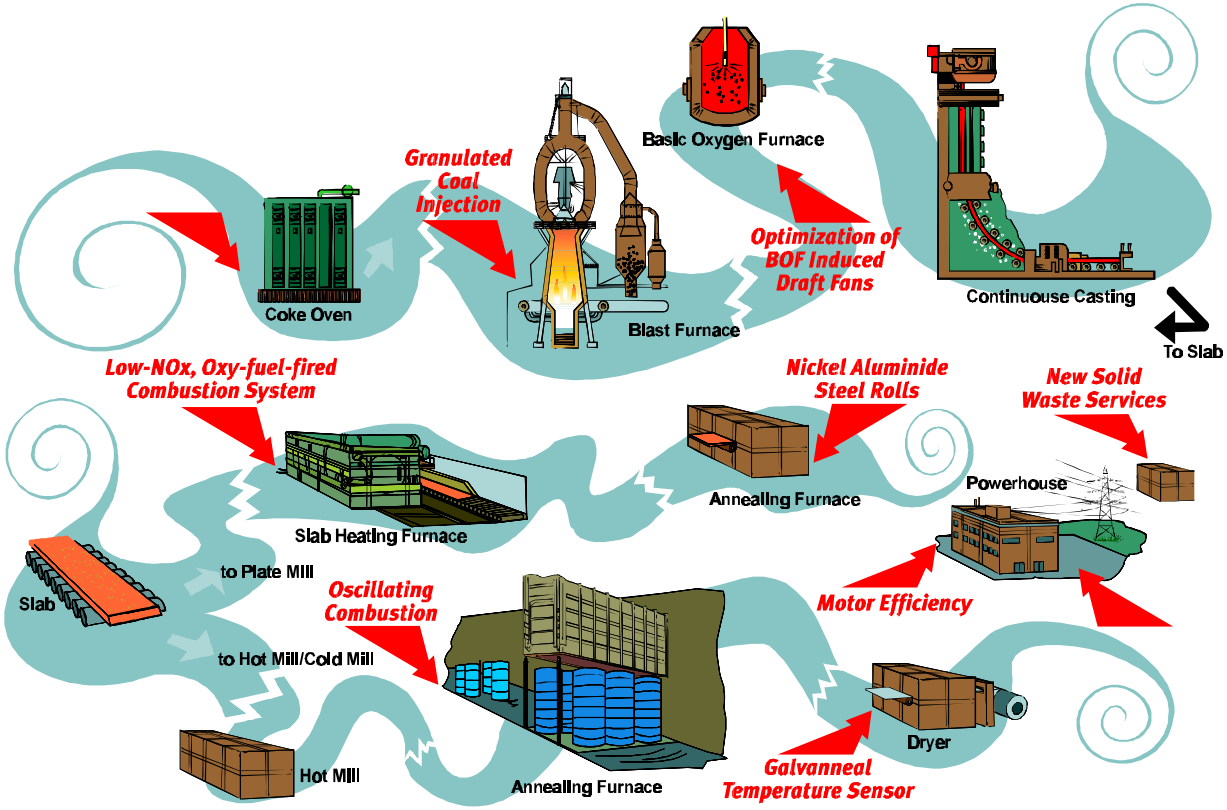
Industries of the Future Successes

OIT has funded 15 technologies which have become *R&D 100 Award* winners over the last 8 years. Nine of these were achieved in the last four years under the Industries of the Future.

114 OIT technologies have been successfully commercialized since 1976, fully one-fourth since the inception of the Industries of the Future four years ago. In addition, another 120 technologies developed under the Industries of the Future will be ready for commercialization within the next two years.

Integrated Delivery

OIT's newest endeavor to improve the delivery of the full range of programs to its customers is Integrated Delivery. A premier example of Integrated Delivery was implemented at Burns Harbor, Indiana, at the flagship steel mill of Bethlehem Steel. DOE technologies and information assistance for several OIT programs were demonstrated in an operating plant environment, as shown in the following schematic, to hundreds of people in the industry.



Integrated Delivery

OIT is increasingly delivering programs at the corporate, management, technical, and plant levels of U.S. industry. OIT calls this mechanism Integrated Delivery. Involvement of the States in the Industries of the Future is part of this effort.

- ✔ An example of Integrated Delivery is the hosting of a plant-level showcase of multiple technologies and information assistance programs by an industrial firm. Demonstrations to other companies show how successful the technologies and systems approaches are and increase awareness of and confidence in advanced technologies.

- ✔ The State-level Industries of the Future (IOF) provides grants to States through the State Energy Program, managed by the Office of Building Technology, State and Community Programs. These grants enable States to

work within their boundaries on IOF-related activities. The goal is to increase the awareness of the IOF process at the State government level and increase the involvement of more companies in each of the IOF industries in their vision and technology roadmap efforts.

OIT executes research, development and demonstration primarily through competitive solicitations, guided by industry-developed technology roadmaps to ensure focusing on key needs and best performers. This approach matches DOE's economic, environmental, and science and technology goals with the needs and expectations of technology users in the private sector. It also targets Federal R&D investments to market requirements. OIT is establishing partnerships with industry and government to develop the advanced manufacturing and process technologies which have the best chance of strengthening U.S. materials and process industries. Many of the individual firms in these industries are small or medium sized and do not have the resources to pursue the often expensive and lengthy research needed to develop advanced technologies. These advanced technological options can preserve existing industry jobs as well as create new jobs, and can result in increased exports. They can also provide strong economic and environmental benefits without the market dislocations which regulatory approaches often entail.

Climate Change

The research and development OIT executes is focused on energy, environment, and improving industrial productivity. Since improvements in energy efficiency have a direct relationship to carbon dioxide reductions, OIT’s research constitutes a key element of the Administration’s goal of reducing climate change gases in the industrial sector. OIT is an integral part of the White House efforts to improve climate change through its consultations with chief executive officers of U.S. industry, many of whom are long-standing partners with OIT.

Linkage to CNES Goals and Objectives

The Industries of the Future directly supports Goal I, Objective 2 of the Comprehensive National Energy Strategy, which is to significantly increase energy efficiency in the transportation, industrial and buildings sectors by 2010. The program also directly supports the DOE Strategic Plan, in particular Energy Resources Objective 3, which is to increase the efficiency and productivity of energy use, while limiting environmental impacts.

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
ENERGY CONSERVATION
(Dollars in thousands)

PROGRAM FUNDING PROFILE

Industry Sector

Activity	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Base	FY 2000 Request	Program Change Request vs. Base Dollar	Program Change Request vs. Base Percent
Industries of the Future (Specific) Operating Expenses	$ 52,156	$ 57,456	$ 57,456	$ 74,000	$+16,544	+29%
Industries of the Future (Crosscutting) Operating Expenses	74,055	100,052	100,052	87,600	-12,452	-12%
Management and Planning Operating Expenses	7,700	8,351	8,351	9,400	+1,049	+13%
TOTAL	$ 133,911	$ 165,859	$ 165,859	$171,000	$ +5,141	+ 3%
Summary						
Operating Expenses	$ 133,911	$ 165,859	$ 165,859	$171,000	$ 5,141	+3%
Total Program	$133,911[a]	$ 165,859	$ 165,859	$171,000	$ +5,141	+3%
Staffing (FTEs)						
HQ FTEs	58	61	61	59		
Field FTEs	10	11	11	10		
Total FTEs	68	72	72	69		

[a]/ Reflects adjustment for approved reprogrammings 98-R-6 of $-2,156.0 thousand for the Small Business Innovative Research (SBIR) program and $-130.0 thousand for the Small Business Technology Transfer Pilot Program (STTR) activities.

DEPARTMENT OF ENERGY
FY 2000 CONGRESSIONAL BUDGET REQUEST
ENERGY CONSERVATION
(Dollars in thousands)

SUMMARY OF CHANGES

Industry Sector

FY 1999 Enacted	$ 165,859
- Non-Discretionary	0
FY 2000 Base	$ 165,859
Industries of the Future (Specific)	
- Forest and Paper Products Vision - The $9,113,000 increase will fund projects in support of the energy performance area of Agenda 2020, specifically the EERE Bioenergy and Black Liquor Gasification Initiative, which will have a significant positive impact on carbon emissions.	+9,113
- Steel Vision - The increase will maintain the FY 1999 level of effort.	+100
- Aluminum Vision - The $3,077,000 increase will fund projects in support of the primary sector of the aluminum technology roadmap, specifically low-carbon technologies.	+3,077
- Metal Casting Vision - The increase will maintain the FY 1999 level of effort.	+54
- Glass Vision - The increase will maintain the FY 1999 level of effort.	+45
- Chemicals Vision - The increase will maintain the FY 1999 level of effort.	+117
- Mining Vision - The increase will allow initiation of activities outlined in the technology roadmap.	+1,019
- Agriculture Vision - The increase will fund projects in support of industry=s strategic visions in biobased industrial feedstocks and the EERE Bioenergy Initiative.	+2,019
- Petroleum Refining Vision - The increase will fund the Petroleum Refinery Vision activities in FY 1999.	+1,000

Industries of the Future (Crosscutting)

- Enabling Technologies - The increase will expand the number of combustion and sensors/controls multi-industry projects, reaching all vision industries.	+2,782
- Distributed Generation - The decrease is part of the planned successful completion of the ATS Program. Energy technologies for industrial power R&D will be continued.	-19,716
- Financial Assistance - The increase will fund additional Financial Assistance awards.	+1,301
- Technical Assistance - The increase will be used to implement integrated delivery through plant showcases; and motor, steam, compressed air, and combined heat and power programs. These will provide technical assistance and information to 3000 of the most energy-intensive industrial facilities and will establish working partnerships with 100 Industry of the Future plant sites.	+3,181

Management and Planning

- Evaluation and Planning - The increase will support improved tracking of successful technologies, and strategic planning in FY 2000.	+798
- Program Direction - The increase will support on-board FTEs.	+251
FY 2000 Congressional Budget Request	$ 171,000

Authorizations:
P.L. 102-486, "Energy Policy Act of 1992"
P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-385, "Energy Conservation and Production Act" (ECPA) (1976)
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-618, "Energy Tax Act of 1978"
P.L. 95-619, "National Energy Conservation Policy Act" (NECPA) (1978)
P.L. 95-620, "Powerplants and Industrial Fuel Use Act of 1978"
P.L. 96-294, "Energy Security Act" (1980)
P.L. 100-12, "National Appliance Energy Conservation Act of 1987"
P.L. 100-615, "Federal Energy Management Improvement Act of 1988"
P.L. 101-218, "Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989"
P.L. 101-549, "Clean Air Act Amendments of 1990"
P.L. 101-575, "Solar, Wind, Waste, and Geothermal Power Production Incentives Act of 1990"
P.L. 93-577, "Federal Non-nuclear Energy Research and Development Act of 1974"

INDUSTRIAL TECHNOLOGIES
INDUSTRY SECTOR
(dollars in thousands)

INDUSTRIES OF THE FUTURE (SPECIFIC)

I. Mission Supporting Goals and Objectives:

I. A. Program Strategy

OIT's Industry of the Future (IOF) strategy aligns its resources with its principal customers -- the energy- and waste-intensive industries which have developed an industry-wide consensus on improving their energy and environmental performance. These industries: steel, aluminum, glass, metalcasting, forest products, chemicals, petroleum, agriculture, and mining account for roughly three-quarters of all U.S. industrial energy use and for 75% to 90% of manufacturing wastes for most waste streams.

The Industries of the Future strategy provides the catalyst for tapping into America's vast capabilities in R&D for the development and deployment of advanced energy and material efficient technologies. The program fosters synergism among different DOE organizations and other government agencies. IOF focuses R&D on technologies that are responsive to the needs of each industry and provides benefits at a national level.

The IOF process begins with the development of an industry-wide vision which projects what changes need to be instituted over the next 20 to 25 years for the industry to remain competitive through improved energy efficiency and environmental performance. A technology roadmap is then prepared to define the technologies which must be pursued for this change to occur. OIT works with industry partners to implement the roadmaps.

Many promising fundamental improvements in the energy, waste, and capital-intensive industries are simply too expensive and too risky for individual private firms to pursue alone. OIT acts as a catalyst in drawing together many firms with national laboratories and other interested parties in order to pool risk, investment, and know-how in developing these promising technologies. The Industries of the Future strategy makes government more responsive and effective. The strategy facilitates integrated planning and implementation by all participants. It fosters cooperative planning among different DOE organizations and other government agencies. Finally, it results in R&D focused on technologies that are responsive to the unique challenges each industry faces. Industry partners have emphasized that the Federal participation has acted as a catalyst in the process especially by lending an objective influence, adding credibility, and fostering cooperation between normally competing firms.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont=d)

OIT executes the R&D defined by the roadmaps through competitive solicitations which culminate in cooperative agreements with industrial partners, CRADA=s with National Laboratories, and grants with state organizations and universities. In FY 2000, OIT will spend about $1,200,000 on specific state projects through the State Energy Program Special Projects solicitation, which is a collaborative effort with the Office of Building Technology, State and Community programs. These activities are directed toward developing partnerships between states, energy-intensive industries in those states and the Federal government in order to implement Industries of the Future at the state level. In FY 1998, grants to 20 states focused on implementing Industries of the Future in specific states taking a variety of approaches appropriate to state needs, state industries and available resources. In FY 1999, a solicitation was issued for follow-on or new projects. Approximately 20 grants are expected to be made to states to increase the involvement of states and their industries in implementing Industries of the Future visions and roadmaps, and deploying advanced technologies.

I. B. Program Benefits

Aluminum, Chemicals, Forest Products, Glass, Metalcasting, Steel, Agriculture, Petroleum Refining, and Mining Visions

The Industries of the Future (specific) current portfolio is expected to directly improve energy efficiency by over 3.0 quadrillion Btu by 2020 and reduce carbon emissions by more than 50 million tons or more. This would be far more than enough to fully operate the entire U.S. iron and steel industry, which consists of about 250 steel mills and blast furnaces, for one year. They annually produce about 100 million tons of steel. In addition, productivity will be improved in the industrial sector, thereby maintaining a strong U.S. industrial base and competitiveness in the global arena.

The industries which are the targets of OIT=s vision of the future strategy account for a value in shipments of approximately one trillion dollars, and total direct employment of 3 million. An additional 12 million jobs are supported through supplier industries. They expend over $40 billion in capital per year. The estimated benefits include those realized directly by the process industries and those from the commercialization of the developed technologies and products used in the end use sector. The estimates are:

Industries of the Future (Specific)	2000[1/]	2010	2020
Total Primary Energy Displaced (quads)	.00	0.71	3.13
Energy Cost Savings ($ billions)	.00	2.49	9.80
Carbon Reductions (million metric tons)	.00	13.33	60.45

[1/] Contributions from prior research and development projects are not shown.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont=d)

I. C. Performance Measures

Pre-1998 Accomplishments

Visions of the Future were completed with the Forest Products, Steel, Metalcasting, Glass, Aluminum, and Chemical Industries. These partnerships between government and industry were signed by the Secretary of Energy and representatives of the industries. Technology roadmaps were initiated for each of the industries that have completed their visions.

1998 Accomplishments

- The Forest Products industry identified 4 projects as near term technical successes including, the development of an improved clorine dioxide deligninifiation process; the development of a feedstock to product characterization tool; volatile organic compound control model for Kraft Mills; and marker-aided selection methods. Also the Forest Product industry commercialized the refiner disc gap and wear sensor project, and completed 16 projects and conducted demonstrations of three new technologies.

- The Steel industry, through the American Iron and Steel Institute, initiated 10 R&D projects to address critical R&D needs identified in the Steel industry Technology Roadmap. In collaboration with the Steel Manufacturer=s Association, two additional projects were initiated, one to improve refractory performance and recycling, and one to conduct roadmap R&D by university students. Various technologies were under test in steel plants including a galvanneal temperature sensor, an off-gas sensor, and two different types of low-NOx combustors. The first example of OIT=s new effort in using an Integrated Delivery System was the Steel Technology Showcase held at Bethlehem Steel Corporation=s Burns Harbor Division.

- The Aluminum industry facilitated the development of a technology roadmap for the automotive sector.

- The Aluminum industry demonstrated a decoating system for aluminum scrap that reduces energy use by 50% and doubles product yield. In addition, they conducted a second test of the inert anode cell, acquired and set up the full-scale electrodialysis unit for saltcake recycling, and awarded five new cost-shared projects to support implementation of *Aluminum Industry Technology Roadmap*.

- The Metalcasting industry completed and published its technology road map in January 1998.

- In the Metalcasting industry, the Clean Steel Castings project resulted in a significant reduction in defective castings, thereby creating energy savings in the steel casting industry.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont=d)

$ In the Glass industry, five projects were awarded as a result of a competitive solicitation.

$ With the Glass industry, OIT published Federal Agency Leveraging Workshop Summary results, conducted a ADoing Business with National Labs@ workshop, and facilitated the organization/start-up of the Glass Manufacturers Industry Council (GMIC).

$ As an important step toward emission reduction in the Glass industry, emission mechanisms from glass and raw materials were identified, and volatile and particulate emissions were also quantified.

$ The Chemical industry initiated work on 17 new projects selected competitively in the areas of catalysis, separations, bioprocessing and computational fluid dynamics. In addition, the entire research portfolio was reviewed to ensure that research and development was supported by industry and based on Vision 2020.

$ The Mining industry completed its vision and signed a compact with the Department of Energy. The industry began work on its technology road map.

$ The Agriculture industry completed and published its vision, *Plant/Crop-based Renewable Resources 2020*. Representatives from a unique coalition of the agricultural, chemical and forestry communities signed a compact with the Departments of Energy and Agriculture. Industry partners created an Executive Steering Committee to informally oversee their R&D collaboration with government, academia and non-profit groups. About 100 experts from across the country attended two technology roadmap workshops held in Indianapolis, Indiana.

$ Work was initiated on facilitating selected State-wide Industry of the Future strategies.

1999 Planned Accomplishments

$ The Forest Products industry will initiate 20 new projects in support of Agenda 2020, and will complete 26 projects with 5 projects identified as near term technical successes.

$ The Steel industry will revise and re-issue the Steel Vision (first issued in May 1995) and sign a new R&D compact with the DOE. In collaboration with the American Iron and Steel Institute, five new R&D projects will be initiated to address critical R&D needs.

$ A second generation galvanneal temperature sensor will be tested at a steel plant while the remainder of the Advanced Process Control projects will be completed and transferred to the industry for commercialization.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont=d)

$ The Aluminum industry will develop improved cathodes and connectors for the inert anode technology, and will conduct the first pilot cell test for a wettable cathode. It will complete the pilot scale vitrification tests to produce glass fiber from spent aluminum potliners and will demonstrate a commercial-scale, high-efficiency, low NOx combustion system for aluminum scrap pre-melting.

$ In the Metalcasting industry, two technologies will be disseminated which have the potential to save nearly two trillion Btu per year. Two metal casting energy technology showcase demonstrations will feature the benefits of Lost Foam Casting and Clean Steel technologies developed from the program.

$ The Glass industry will conduct a competitive solicitation for awarding new research projects to the National Laboratories.

$ The Glass industry will improve combustion efficiency and emission reductions by developing a robust sensor for measuring exhaust gases, identifying new sensing techniques for in-process measurement of emissions, and developing refractory models to determine life and defect generation.

$ In the Chemical industry, roadmaps will be completed for chemical industry R&D priority areas.

$ As a result of workshops held in FY 1998, the Chemical industry will publish technology roadmaps in separations, materials of construction, materials technology, computational fluid dynamics, computational chemistry, and alternative synthetic pathways.

$ The Mining industry will widely distribute its vision *The Future Begins with Mining*, and will publish a crosscutting technology roadmap. The Mining industry will initiate several projects that support the implementation of the technology roadmap.

$ Agriculture=s first technology roadmap will be published. New partners continue to sign the compact and join the partnership. Agriculture will issue its first solicitation for new R&D projects; industry partners will review the proposals and recommend a portfolio to OIT. The industry-established Executive Steering Committee will continue to evolve into a more formal oversight group.

$ Agriculture Team efforts will be more fully integrated with other biomass R&D in the Office of Energy Efficiency and Renewable Energy and elsewhere in the Federal Government, through the EERE Bioenergy Initiative.

2000 Planned Accomplishments

$ The Forest Products industry will initiate 20 new projects in support of Agenda 2020, with plans to complete 9 projects and identify 5 projects as near term technical successes.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont=d)

$ A competitive solicitation will be conducted in partnership with the forest products industry seeking demonstration efforts of advanced biomass or black liquor gasification technologies, as part of the EERE Bioenergy Initiative.

$ The Steel industry will develop residual element removal methods for the steel ladle and inclusion removal methods for the tundish. The Steel industry will initiate five new projects in support of the Steel Industry Technology Roadmap. Technology for hot oxygen injection into the blast furnace will be commercialized.

$ The Aluminum industry will develop improved anode and cathode materials for inert anode technology. Two different novel cell designs and electrode materials combinations will be investigated through long term pilot scale tests, and a full-size test of a wettable cathode will be performed.

$ In Metalcasting, new Molding Design guidelines for thin wall iron casting will be available to the metal casting industry, an advanced Neural Network Model for Cupola Process Control will be demonstrated. This automatic control technology will lead to lower material and processing costs and has the potential to save 400 million Btu per year, per unit as well as reduce carbon dioxide emission due to decreased coke requirements.

$ The Industry Vision *Glass: A Clear Vision for a Bright Future* will be re-visited and updated, and a competitive program solicitation and two major technology workshops will be conducted.

$ The Chemical industry will award new projects based on industry technology roadmaps in separations, materials of construction, materials technology, computational fluid dynamics, computational chemistry, and alternative synthetic pathways.

$ The Mining industry will begin 4 projects that support the technology roadmap.

$ The Agriculture industry will issue a second solicitation for projects in high-priority areas of the roadmap and better integrate its R&D with the new Bioenergy Initiative of the Office of Energy Efficiency and Renewable Energy (EERE).

$ The Petroleum industry will conduct a solicitation for new research projects.

2001-2004 Planned Accomplishments

$ The IOF strategy will continue through the out years. As the market, government regulations, and technology advances drive the industry to reassess their position in the global economy and how their industries must change to be competitive in the future, the IOF strategy will

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont=d)

continue to evolve. The Technology Roadmaps phase of the IOF strategy will be updated by industry. The OIT vision teams will continue their role as facilitators of the processes and as central contacts for industry on federal opportunities for partnering. Research will be conducted based heavily on industry-specific competitions and the industry-developed roadmaps.

$ The Forest Products industry will demonstrate biomass and black liquor gasification technologies in the mill environment leading to the initial commercialization of these technologies by 2008.

$ The Aluminum industry will conduct bench and pilot tests for optimum cell materials and conditions for use with inert anode technology (2001), leading to commercial-scale tests of inert anode technology (2004).

$ In Metalcasting, New Lost Foam Casting techniques and binders developed for iron and steel casting will be available. Successful development and application of Advanced Lost Foam Technology to iron and steel castings alone will have a potential energy efficiency improvement of up to 30% over conventional casting methods, reduce cost by 25%, and eliminate binder emission associated with traditional sand casting methods for steel casting.

$ The Glass industry will initiate roughly 16 new technologies, including work on high temperature sensors for measuring flow temperature and gas composition, use of microwaves and ultrasonic waves for controlling glass shape and other critical process variables, predictive emission modeling tools, refractories for melting systems, and low-cost high temperature refractory metals.

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

Program Activity	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request	$ Change	% Change
Forest and Paper Products Vision	$ 11,808	$ 11,963	$ 21,076	$+9,113	+76.2%
Steel Vision	9,547	10,527	10,627	+100	+0.9%
Aluminum Vision	7,203	8,101	11,178	+3,077	+38.0%
Metal Casting Vision	5,391	5,743	5,797	+54	+0.9%
Glass Vision	3,883	4,785	4,830	+45	+0.9%
Chemicals Vision	11,384	12,375	12,492	+117	+0.9%
Mining Vision	0	1,981	3,000	+1,019	+51.4%
Agriculture Vision	0	1,981	4,000	+2,019	+101.9%
Petroleum Refining Vision	2,940	0	1,000	+1,000	>100%
Total, Industries of the Future (Specific)	$ 52,156	$ 57,456	$ 74,000	$+16,544	+28.8%

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

	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request	$ Change	% Change
Ames	$ 196	$ 52	$ 0	$ -52	-100.0%
Argonne National Lab (East)	5,288	3,620	1,992	-1,628	-45.0%
Brookhaven National Lab	148	0	0	0	0.0%
Idaho National Engineering Lab	626	150	105	-45	-30.0%
Lawrence Berkeley Lab	868	957	623	-334	-34.9%

Los Alamos National Laboratory	1,559	2,364	2,184	-180	-7.6%
National Renewable Energy Lab.....	2,206	1,507	1,800	293	+19.4%
Oak Ridge National Lab.....	3,241	3,710	3,452	-258	-7.0%
Pacific Northwest Lab.....	1,339	950	1,327	+377	0.0%
Sandia National Laboratories	2,298	2,639	2,570	-69	-2.6%
All Other.....	34,387	41,507	59,947	+18,440	+44.4%
Total, Industries of the Future (Specific) .	$ 52,156	$ 57,456	$ 74,000	$+16,544	+28.8%

III. Performance Summary: (New BA in thousands of dollars)

Activity	FY 1998	FY 1999	FY 2000
Industries of the Future (Specific)			
Forest and Paper Product Vision	Examples of specific R&D projects and the benefits include: R&D Activities: SUSTAINABLE FOREST MANAGEMENT: A project was completed to identify the biochemical properties of loblolly pine that are associated with improved photosynthesis and carbohydrate use. This data will be used to improve the growth rate of trees, specifically loblolly pine. ($1,100)	Examples of specific R&D projects and the benefits include: R&D Activities: SUSTAINABLE FOREST MANAGEMENT: A study is continuing which will improve the understanding of mechanisms controlling tree growth and recommend refined silvicultural practices aimed at maximizing wood and fiber production through resource management. ($1,500)	Examples of specific R&D projects and the benefits include: R&D Activities: SUSTAINABLE FOREST MANAGEMENT: Research in this area is targeted to increase the forest growth rates and enhance the fiber quality from trees. Projects will focus on biotechnology, tree physiology, and sustainable soil productivity. Marker aided selection methods for selection of genotypes for cloning will be commercialized. ($1,100)
Forest and Paper Product Vision (Cont'd)	ENVIRONMENTAL PERFORMANCE: Physical/chemical, Biofiltration Technologies - A cost-effective technology was developed to eliminate air emissions of both VOCs and Hazardous Air Pollutants (HAPs) in the forest products industry using physical, chemical, and biofiltration technologies; and	ENVIRONMENTAL PERFORMANCE: The Low Lignin Content Pulp project is developing advanced control systems specifically targeted at producing low lignin pulps of greatly enhanced bleachability offering a route to integrated pulping and bleaching for an environmentally neutral mill of the	ENVIRONMENTAL PERFORMANCE: Research in this area is targeted to develop advanced pollution prevention technologies, decrease pollution abatement costs, ensure manufacturing facilities are acceptable to industry workers and local communities. Projects will focus on improving margins of

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

Activity	FY 1998	FY 1999	FY 2000
	the Recycling of Bleach Plant Filtrates Project developed a technology to remove inorganic non-process elements from bleach plant effluent using electrodialysis to eliminate water-borne bleach waste steams released from the plant. ($4,000)	future. ($4,000)	environmental safety, and developing process alternatives consistent with pollution prevention. New high efficiency chlorine dioxide delignification procedures will be employed in mills. An energy efficient, low volatile organic compound wood drying technology will be demonstrated in a lumber yard. Polyoxometalate Bleaching will develop a new bleaching technology to save energy, allow mills to eliminate water discharge, and eliminate the need for chlorine use in bleaching. ($3,500)
Forest and Paper Product Vision (Cont=d)	ENERGY PERFORMANCE: A study was completed to evaluate the formation and catalytic destruction of organic tars formed during black liquor gasification at the bench scale. Destruction and removal of tars and other condensables have been identified by the industry as critical issue in low temperature gasification technologies. ($4,000)	ENERGY PERFORMANCE: The Multiport Cylinder Dryers project is demonstrating a technology to have steam flow through multiport passages that are in close proximity to the cylinder drying surface increasing the drying rate over conventional drying cylinders. ($3,200)	ENERGY PERFORMANCE: Research in this area is 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 will focus on fuel flexibility, fuel conversion and electricity production, heat recovery, manufacturing process efficiency, wider use of renewable resources, environmental impacts of energy production. Demonstration efforts

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

Activity	FY 1998	FY 1999	FY 2000
			associated with bioenergy and black liquor gasification technologies will be initiated to support energy self sufficiency and reduce carbon dioxide emissions. This activity will be coordinated with the EERE Bioenergy Initiative. The implementation of black liquor gasification technologies offer the potential to achieve 10% higher energy efficiencies, eliminate 30 to 60 million metric tons of carbon equivalent, produce twice the electric power generation per pound of black liquor, lower environmental emissions, and improve safety and capital effectiveness. A reburner technology to improve energy efficiency and decrease NOx emissions in Stoker boilers will be demonstrated. ($11,500)
Forest and Paper Product Vision (Cont=d)			
Forest and Paper Product Vision (Cont=d)	IMPROVED CAPITAL EFFECTIVENESS: A new bleaching technology was demonstrated on the bench scale employing an initial rapid chlorine dioxide bleaching stage followed by	IMPROVED CAPITAL EFFECTIVENESS: A project is continuing that will provide the basis for improving the design of new high solids concentrators, modifying the design of existing	IMPROVED CAPITAL EFFECTIVENESS: Research in this area is targeted to reducing the capital requirements per unit of production and sales. Projects will focus on system and process efficiency, materials of construction, and fabrication. A study to assess

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

Activity	FY 1998	FY 1999	FY 2000
	subsequent simplified bleaching stages leading to significant reduction in chlorinated organic compounds in the bleach plant effluent and reduced capital. ($500)	high solid concentrators, and improving operating strategies to minimize sodium carbonate and sodium sulfate fouling in concentrators. ($500)	and eliminate corrosion in Kraft digesters will be initiated. ($1,500)
	RECYCLING: A study was completed to evaluate revolutionary cleaning processes to permit higher concentrations of wax and adhesives in recycled paper. These processes support the nation=s goals to increase the amount of paper recycled to 50%. ($500)	RECYCLING: Applications will be evaluated to use mechanically initiated shock waves in recycling processes: shocking starch tanks to replace biocides, dispersing contaminants in recycle process waters, removing contaminants from recycled papers, and refining fibers. ($600)	RECYCLING: Research in this area is 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 will focus 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 will be developed. ($1,000)
	SENSORS AND CONTROL: A sensor was commercialized that will use eddy current induction to measure the gap between operating refiner disks, minimizing downtime and increasing the overall efficiency	SENSORS AND CONTROL: This is the first year of a two-year project to develop a real time, on-line, ultrasonic instrument to characterize pulp fiber changes and paper stock composition. ($2,163)	SENSORS AND CONTROLS: Research in this area is targeted to optimize mill operations, evaluate the characteristics of raw materials and final products, and detect emissions. Projects will focus on the development of actuators and control devices, process and product models, process

Activity	FY 1998	FY 1999	FY 2000
	of the refining process. ($1,708)		measurement, data actuators and control devices, process and product models, process measurement, data interpretation, and control system effectiveness. A tool and methodology will be commercialized for characterization of the raw material to the products in the paper making process. ($2,476) Participants include: The American Forest and Paper Association and their member companies, National Laboratories, the Institute of Paper Science and Technology, the Pulp and Paper Education and Research Alliance Members and Partners, and others.
	$11,808	$11,963	$21,076
Steel Vision	PRODUCTION EFFICIENCY: Nickel aluminides completed testing in steel forming and finishing (rolling) operations at U.S. plant host sites. R&D was completed on the advanced process controls for	PRODUCTION EFFICIENCY: Collaborative R&D with the industry to improve the efficiency of steel making, casting, and rolling processes is continuing. R&D initiated in late FY98 continues on	PRODUCTION EFFICIENCY: Collaborative R&D with the industry to improve the efficiency of energy efficient, low carbon dioxide emission alternate iron making processes and steel making

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

Activity	FY 1998	FY 1999	FY 2000
	the basic oxygen furnace and the galvanneal line. Various control modifications were developed and assessed under field conditions to improve the productivity and efficiency of these operations. ($6,000)	subjects such as advanced casting technologies and improved materials properties. ($4,000)	processes will be supported. R&D on subjects such as advanced near net shape casting technologies, improved process control including sensors for the blast furnace, basic oxygen furnace, and electric arc furnace and improved steel quality and consistency using lower cost raw materials will be completed. ($3,627)
Steel Visison (Con=t)			
Steel Vision (Cont=d)			
	RECYCLING R&D: R&D determined the effects of residual elements and the removal of residuals in the ladle. This allowed the increased use of scrap previously unavailable because of contaminating elements in the scrap. ($1,000)	RECYCLING R&D: R&D on methods of increasing the rate of steel scrap recycling from currently marginally tapped waste streams continues. Follow-on activities are conducted in collaboration with the Electric Power Research Institute (EPRI) to minimize electric arc furnace dust emissions. Other R&D projects are responsive to the R&D needs identified in the chapter "Iron Unit Recycling" of the Iron and Steel Industry Technology Roadmap. ($2,527)	RECYCLING R&D: R&D on methods of increasing steel production based on recovery of iron units from all waste streams will be conducted. ($3,000) R&D will improve methods of recovering iron units, other metals (e.g., zinc, lead), and oil from by product residues and, in certain cases, hazardous wastes produced in ironmaking and steelmaking operations. R&D will include improved methods for detection of radioactive sources in scrap; the basis for the R&D will be existing National Laboratory Technologies modified for use by the scrap recycling industry and electric arc

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

Activity	FY 1998	FY 1999	FY 2000
			users.
	ENVIRONMENTAL ENGINEERING: R&D on methods of using advanced combustors to lower nitrogen oxide (NOx) and other emissions from combustion processes associated with steel production were conducted. ($2,547)	ENVIRONMENTAL ENGINEERING: R&D on methods to lower emissions per unit of output associated with steel production in the blast furnace continues. ($4,000)	ENVIRONMENTAL ENGINEERING: R&D will focus on lowering carbon dioxide and NOx emissions from heating and reheating processes associated with steel production. Research will concentrate on advanced burners and burner sensing controls, and processes such as near net shape strip casting that reduce reheating requirements. ($4,000) Participants in the Steel Vision include: American Iron and Steel Institute (member and associate member companies); the Steel Manufacturers Association (member and associate member companies); National laboratories, universities.
	$9,547	$10,527	$10,627
Aluminum Vision	PRIMARY PRODUCTION TECHNOLOGIES: Core R&D included completion of plant testing of sensors, evaluation of inert	PRIMARY PRODUCTION TECHNOLOGIES: R&D includes continued evaluation of inert/wettable electrode material and	PRIMARY PRODUCTION TECHNOLOGIES: Accelerated research program will be initiated for the development and

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

Activity	FY 1998	FY 1999	FY 2000
 Aluminum Vision (Cont=d)	electrode materials for primary aluminum production, and development of an aluminum saltcake recovery process. ($5,181)	advanced cell designs for primary aluminum production, and development of robust sensors and controls for harsh environments. A pilot-scale plant for saltcake recycling is being designed and built. R&D is being initiated to develop methods of recycling aluminum scrap and waste, and to improve the operational efficiency of cell potlining materials. ($5,831)	implementation of an advanced cell with the potential to reduce energy consumption by 27% and greenhouse gas emissions by 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. Activities will include pilot cell tests of two different novel Hall-Heroult cell 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, investigations will be initiated into the feasibility of at least one alternative (non Hall-Heroult), high efficiency smelting process. Saltcake recycling will be demonstrated at pilot-plant scale and R&D will be conducted to develop sensors and controls to sort aluminum scrap at high speeds. ($9,000)
	SEMI-FABRICATION	SEMI-FABRICATION	SEMI-FABRICATION

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

Activity	FY 1998	FY 1999	FY 2000
	TECHNOLOGIES: A spray forming pilot unit was designed and candidate alloys and processing parameters optimized to increase the use of recycled aluminum in auto sheet products with reduced material and energy costs. (PNGV=$1.0M) ($2,022)	TECHNOLOGIES: R&D to develop semisolid forming techniques will continue and a new grain refining process will be demonstrated. ($2,270)	TECHNOLOGIES: A commercial-scale high-efficiency, low NOx combustion system for aluminum scrap remelting will be demonstrated. ($2,178)
Aluminum Vision (Cont=d)			PARTICIPANTS: R&D participants include 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.
	$7,203	$8,101	$11,178
Metal Casting			Introduction: Continue a balanced

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

Activity	FY 1998	FY 1999	FY 2000
Vision			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% with industry partners. There are over 150 industry partners in at least 28 States across the U.S. working on program-funded research projects. The continued research projects from previous year-s competitive solicitations include the following education institutions and National Laboratory: University of Alabama-Birmingham, University of Alabama-Tuscaloosa, Case Western Reserve University, Idaho State University, University of Iowa, University of Michigan, Mississippi State University, University of Missouri-Rolla, Ohio State University, Penn State University, Oak Ridge National Laboratory, University of Wisconsin-Milwaukee, and Worcester Polytechnical Institute.
Metal Casting Vision (Cont-d)			
	MANUFACTURING	MANUFACTURING	MANUFACTURING TECHNOLOGIES: Research will

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

Activity	FY 1998	FY 1999	FY 2000
Metal Casting Vision (Cont'd)	TECHNOLOGIES: Technologies in thin wall casting targeted the automotive market with strong recyclable cast components which would offset the use of other more expensive metals. The benefits of this project include reduced energy consumption in the iron casting process, transportation fuel savings in automobile applications and 50% reduction in machining scraps. ($5,391)	TECHNOLOGIES: Tools and new sensors are developed to improve die-cavity filling for higher quality castings, extend die life, and minimize part distortion for die-casting process used for aluminum, magnesium, and zinc alloys. ($3,197) MATERIALS TECHNOLOGIES: Activities are focused on advancing the use of new and improved materials for castings. Research will establish methodologies and structural characterization as well as data needed for production of quality castings utilizing cast particulate metal matrixes. R&D efforts will continue on technologies needed to consistently produce machinable, high strength, thin-walled gray and ductile iron castings. ($2,046) ENVIRONMENTAL TECHNOLOGIES: Begin	focus 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 will be available for the steel casting industries. A 10% increase in yield alone has the potential benefit of energy savings of 1.8 trillion Btus per year for melting. ($2,400) MATERIALS TECHNOLOGIES: Activities are focused on advancing the use of new and improved materials to produce defect-free, high quality casting while achieving longer life for mold, refractory lining, and casting dies. Innovative research developed in new coatings will be developed to extend the useful life of casting dies ten fold in comparison with current conventional methods. ($1,897) ENVIRONMENTAL TECHNOLOGIES: Balanced portfolio will include critical

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

Activity	FY 1998	FY 1999	FY 2000
Metal Casting Vision (Cont'd)		developments in new waste characterization, reduction, reuse, and alternate use of foundry waste. R&D will continue to advance the Lost Foam Casting Process, which requires less metal to be melted than other processes. An estimated 30% percent reduction in energy requirements for melting alone could save about 37 trillion Btu per year. ($500)	research needed to develop design guidelines for advanced modeling design for thin wall iron casting will be available to the metal casting industry. In addition, a state-of-the-art Neural Network Model for processing and control of cupola furnace will be available. Potential benefits include energy savings of 400 million Btu per year per unit, revitalization of environmentally enhanced cupola operation in the U.S., decreased coke requirements, reduced carbon, sulfur and manganese losses and elimination of associated emissions. ($500) NEW CASTING APPLICATIONS: New design tools, 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

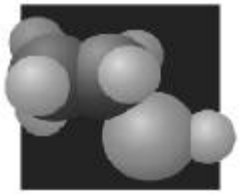
III. Performance Summary: INDUSTRIES OF THE FUTURE (SPECIFIC) (Cont'd)

Activity	FY 1998	FY 1999	FY 2000
			defects that require weld repair and improve the competitiveness of the U.S. metal casting industry. ($1,000)
Metal Casting Vision (Cont'd)			
	$5,391	$5,743	$5,797
Glass Vision	PRODUCTION EFFICIENCY: Completed Molybdenum Disilicide as a Coating and Structural Component in Glass Furnaces. Continued Refractory Materials and Creep Assessment, Initiated Advanced Sensor, Modeling, and Properties Development. ($1,729)	PRODUCTION EFFICIENCY: Controls for process optimization for desired glass properties; furnace refractory thickness and temperature, on-line stress measurements; and process simulation models that actually simulate the glass manufacturing process. ($2,099)	PRODUCTION EFFICIENCY: Modeling of refractories in glass furnaces; improvement of combustion and melting technology initiate new fundamental knowledge of glass physics; better means of removing heat faster; better understanding of integrated product and process controls. ($2,314)
	ENERGY EFFICIENCY/ CONSERVATION: Completed Advanced Combustion Space Modeling, initiated Optimized Electric Boost. Completed Thermal Swing Adsorption. ($1,355)	ENERGY EFFICIENCY/ CONSERVATION: Glass furnaces with lower net production cost; in-situ testing of furnace refractories; and combustion laboratory characterization of	ENERGY EFFICIENCY/ CONSERVATION: Combustion of space/glass furnace and control for optimal melter performance will be coupled. Develop better refractories; develop user facility to

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

Activity	FY 1998	FY 1999	FY 2000
		flames from different burner configurations. ($1,700)	validate new and existing models. ($1,282)
Glass Vision (Cont=d)	ENVIRONMENTAL PROTECTIONS AND RECYCLING: Completed High Heat Transfer/Low Emissions Gas Combustion System; initiated Non-Hazardous Waste Refractory Materials; initiated Solid Waste Reuse in Glass Manufacture. Completed Cullet/Batch Preheater. ($475)	ENVIRONMENTAL PROTECTIONS AND RECYCLING: Using prior-year funds, initiate/continue projects: improved oxy-fuel firing technology to reduce air emissions; alternate raw materials, batch preparation, and/or furnace designs with lower particulate and gaseous emissions. ($0)	ENVIRONMENTAL PROTECTIONS AND RECYCLING: Will complete non-hazardous waste refractory materials and solid waste reuse. Develop process mechanisms that influence particulates; develop predictive emissions modeling tools. ($250)
	INNOVATIVE USES: Completed Chemical Vapor Deposition. ($124)	INNOVATIVE USES: Explore innovative glass compositions and processes to enhance performance and new material-design models to improve properties. ($286)	INNOVATIVE USES: Improvement of glass properties using integrated ion exchange. Will continue innovative glass compositions and processes to enhance performance and new material-design models to improve properties. ($184)
	DEPLOYMENT LOGISTICS: Completed Coating & Composition Workshop. ($200)	DEPLOYMENT LOGISTICS: Conduct two technical workshops. Conduct technology roadmap assessment. ($700)	DEPLOYMENT LOGISTICS: Will conduct two technical workshops. Review/update technology roadmap assessment. ($800)
			Participants in the Glass vision

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

Activity	FY 1998	FY 1999	FY 2000
Glass Vision (Cont'd)			include: 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 Laboratory, Pacific Northwest National Laboratory, Argonne National Laboratory, Ames, and the Federal Energy Technology Center.
	$3,883	$4,785	$4,830
Chemicals Vision  Chemicals Vision	NEW CHEMICAL SCIENCES AND ENGINEERING: R&D accomplishments included: Tested a pallet-sized membrane polyphosphazene technology system; scaled up bio-process for production of di-acid to collect operating and process performance data; demonstrated a clean biomass fractionation process for cellulose-	NEW CHEMICAL SCIENCES AND ENGINEERING: Support for 17 R&D projects awarded to support the implementation of the chemical industry's vision *Technology Vision 2020* and the associated technology roadmaps covering catalysis, bioprocessing, and separation. Total project awards over two years amount to	NEW CHEMICAL SCIENCES AND ENGINEERING: Make second *Technology Vision 2020* solicitation awards corresponding to technology priority areas such as separations, materials, and alternative synthetic pathways. Advances in high energy consuming separations technologies such as adsorption, crystallization,

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

Activity	FY 1998	FY 1999	FY 2000
(Cont=d)	based plastics, with near zero co-product contamination that eliminates the need for chlorine-based bleaching; developed an inorganic thin-film membrane that operates at ambient rather than cryogenic temperatures for high energy efficient separation of tonnage-weight commodity chemicals; and demonstrated a retrofit membrane-based separation/recovery process for hydrocarbon fractions that are currently vented or flared. Supported the development of technology roadmaps in catalysis, alternative reaction pathways, and polymer research working with the Council of Chemical Research, American Institute of Chemical Engineers, and the American Chemical Society. ($10,384)	about $15 million in federal funds and up to $7.5 million in private resources. Some industrial partners are: General Electric, Dow, Raytheon, Applied CarboChemicals, Arkenol, and Praxair. Awards include projects such as: selective catalytic oxidative dehydrogenation of alkanes to olefins, direct production of silicones to sand, and advanced sorbents as a versatile platform for gas separation. ($10,375)	distillation, extraction and membrane separation offer prospects of multi-trillion Btu per year energy savings. Cost shared research on lower energy separation processes will be conducted on olefin recovery from waste streams, sorbent separation, and selective surface membranes. Alternative synthetic pathways for chemicals offer the potential for multi-trillion Btu per year energy savings. Towards that goal cost shared research will be conducted in catalysts for the production of commodity chemicals, selective oxidative conversion of alkanes to olefins, and a new electrochemical reactor process. ($10,192)
Chemicals Vision (Cont=d)	MANUFACTURING AND OPERATIONS: Supported development of materials of construction technology roadmap working with Materials Technology Institute of the Chemical Process	MANUFACTURING AND OPERATIONS: Support development of materials technologies technology roadmap working with Materials Technology Institute of the Chemical Process	MANUFACTURING AND OPERATIONS: Will support chemical process industries= projects corresponding to *Technology Vision 2020*, AMaterials of Construction@ roadmap. Focus areas included:

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

Activity	FY 1998	FY 1999	FY 2000
Chemicals Vision (Cont=d)	Industries, Inc. ($0) COMPUTATIONAL TECHNOLOGIES: Supported the development of technology roadmaps in computational fluid dynamics and computational chemistry. Awarded two cost-shared computational fluid dynamics projects to industry-government consortiums involving five national laboratories; chemical companies such as Dow Chemical, Dow Corning, Chevron, and DuPont; and computing companies Fluent Technologies and Cray Research. ($1,000)	Industries, Inc. Conduct R&D to develop a new electrochemical reactor for the production of chlor-alkali which could reduce the total annual U.S. electric power consumption and associated carbon dioxide emissions by 0.6%. ($1,000) COMPUTATIONAL TECHNOLOGIES: Launch two computational fluid dynamics (CFD) projects through industry-lab consortiums: 1) simulation of a chemical production facility and; 2) development/validation of a turbulent multiphase fluid flow model. ($1,000)	new materials for high-temperature, corrosive environments, improved models for predicted material behavior, new/improved materials, and better joining and fabricating methods. ($1,000) COMPUTATIONAL TECHNOLOGIES: Continue CFD consortium projects to establish an industrial user center, commercialize a sensor for multiphase measurements, begin testing beta-version of multiphase computer model and release 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 will be conducted on simulating industrial scale turbulent gas solid flows and adapting multi-phase computational fluid dynamics to fluid-particle processes. ($1,300) Participants in the Chemical Vision: General Electric, Dow, Cray

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

Activity	FY 1998	FY 1999	FY 2000
			Computers, Akzo Nobel, Amoco, Air Products and Chemicals, Praxair, Rensalear, Hyperion Catalysis International, Membrane Research Technology Inc., Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory, Argonne National Laboratory.
	$11,384	$12,375	$12,492
Mining Vision 	No activities.	TRANSFERRED FROM ALUMINUM VISION: Implement the industry=s vision and roadmap through improvement of current processes for low cost and efficient production, exploration and resource characterization, safe and efficient extraction and processing, and responsible emission and by-product management. Develop technologies for exploration, mining, and processing which demonstrate crosscutting benefits for the entire Mining industry.	Will leverage research funds with industrial cost sharing as well as state and other federal funding to support the industry=s vision and roadmap. Will develop technologies for exploration, mining, and processing which demonstrate accountable benefits for specific sectors of the Mining industry. Technologies that could be funded include real-time mineral content sensors, mining technologies for
Mining Vision (Cont=d)			

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

Activity	FY 1998	FY 1999	FY 2000
		Initiate planning for advanced product development and improved communication and education.	difficult conditions (deeper mines, thinner seams, lower-grade ores), and new materials for transportation and handling.
	$0	$1,981	$3,000
Agriculture Vision 	No activities.	TRANSFERRED FROM CHEMICALS VISION: Begin to execute research in biobased renewable feedstocks which supports the first Agriculture industry vision.	
Agriculture Vision (Cont-d)		BIOBASED INDUSTRIAL FEEDSTOCKS: R&D focusing on increased or expanded use of the current base of renewable bio-resources; and promoting, developing and implementing new and innovative processing technologies. Solicitation will target highest priorities in plant processing and utilization categories identified as key barriers in industry technology roadmap. Begin to	BIOBASED INDUSTRIAL FEEDSTOCKS: Conduct R&D building on results from the initial solicitation in FY 1999 and filling the many technology gaps identified by the technology roadmaps which were not addressed by the first solicitation. Solicitation focus broadened to highest priorities in all four categories in industry-s roadmap: processing and utilization, as well as plant science

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

Activity	FY 1998	FY 1999	FY 2000
		integrate R&D approach with other biomass efforts for making fuels and power under the new EERE Bioenergy Initiative.	and production. Industry emphasis will be on projects that show clear linkages across these categories in order to make better use of public and private funding and faster progress toward industry=s ambitious goal of winning 10% of the market for industrial chemical feedstocks from plant material by 2020. As part of the EERE team implementing the Bioenergy Initiative, also bring R&D into alignment with new vision and technology roadmap for overall biomass industry. The Bioenergy Initiative looks to integrate 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 Abiorefineries@ across the country.
	$0	$1,981	$4,000
Petroleum Refining Vision	Research activities with the	The industry is preparing an	The Petroleum industry has agreed

Activity	FY 1998	FY 1999	FY 2000
	Petroleum Refining industry were brought to an orderly close during FY98 due to the industry's reluctance to proceed with the development of an industry vision and technology roadmaps.	industry-wide vision, and will use the vision as the basis for a technology roadmap, which will be initiated in FY 1999. The industry will sign a compact to work with the Department. While not yet released by the industry, the vision is expected to focus on energy efficiency, safety and reliability, and the environment.	to develop a vision and technology roadmap and will work with DOE to implement the roadmap. In FY 2000, a competitive solicitation will be conducted which will initiate projects in accordance with the Petroleum industry roadmap. Possible projects could include remote sensing of equipment leaks, which is expected to reduce these fugitive emissions, saving 12 billion Btu annually; biocatalytic desulfurization of gasoline, expected to lower desulfurization energy use by over 20 billion Btu/year; and an advanced fluid catalytic cracking model which can guide industry to savings in excess of 6 billion Btu/year.
	$2,940	$0	$1,000
Industries of the Future (Specific) Total	$52,156	$57,456	$74,000

INDUSTRIAL TECHNOLOGIES
INDUSTRY SECTOR
(dollars in thousands)

INDUSTRIES OF THE FUTURE (CROSSCUTTING)

I. Mission Supporting Goals and Objectives:

I. A. Statement of Mission:

The industry visions and technology roadmaps developed by OIT=s industry partners have identified the need to address technology, systems analysis, and materials needs common to more than one of the vision industries. The Industries of the Future (Crosscutting) objective is to work with IOF industry partners and supplies to: 1) conduct cost-shared R&D to develop crosscutting technologies which have applications across all of the vision industries; and 2) to provide the tools and technical assistance industry needs to speed the implementation of energy efficient, clean manufacturing technologies. Technologies such as advanced materials and coatings, high efficiency combustion systems, sensors and controls, and new distributed generation systems can be most efficiently developed by using R&D resources in specialized programs designed to address these crosscutting needs. To support the implementation of new energy efficient technologies, and to meet industry needs for better, more accessible technical assistance and tools -- OIT will provide industry with technical and financial assistance that is delivered in an integrated fashion through the National Competitiveness through the Energy, Environment, and Economics ($NICE^3$), Inventions, motors, compressed air, steam, and combined heat and power activities.

The goal of the IOF Crosscutting program is to significantly improve the resource efficiency and competitiveness of energy and waste intensive U.S. industries by developing and implementing the crosscutting technologies, practices, and materials that can lower raw material and depletable energy use per unit produced; improve productivity; and reduce the generation of wastes and pollutants. Working in collaboration with industry, national laboratories, and university partners, the IOF Crosscutting Program goal is to save almost 1 quadrillion Btu of energy in the year 2010.

In FY 2000, OIT will spend a total of about $1,600,000 of IOF crosscutting funds on specific projects through the Special Project State Grants, which is a collaborative effort with the Office of Building Technology, State and Community programs. These activities are directed toward developing partnerships between states, energy-intensive industries in those states and the Federal government in order to implement IOF at the state level. In FY1998, grants to 20 states focused on implementing IOF in specific states taking a variety of approaches appropriate to state needs, state industries and available resources. In FY 1999, a solicitation was issued for follow-on or new projects. Approximately 20 grants are expected to be made to states to increase the involvement of states and their industries in implementing IOF and deploying advanced industrial technologies.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont'd)

The IOF Crosscutting planning units include enabling technologies, distributed generation, financial assistance and technical assistance.

Enabling Technologies: Addresses the critical technology challenges IOF industries face for developing: 1) new, advanced industrial materials and ceramics that can reduce energy use, lower emissions, increase component life, optimize process operating conditions, and reduce down time; 2) high-efficiency, clean combustion technology that can produce uniform, high-quality end products at high production rates; and 3) sensors/control systems that can operate in high temperatures and harsh environments while increasing process efficiency.

Distributed Generation:
Industrial end users need and want new options for producing on-site electricity or to produce two forms of power such as electricity and steam from the same fuel source. This program seeks to develop: 1) new high-efficiency, industrial power generation/cogeneration systems including Advanced Turbine Systems (ATS), microturbines, and reciprocating engines and; 2) industrial distributed generation systems (including combined heat and power technology). ATS systems are expected to be 15% more energy efficient, 80% cleaner, and still reduce the cost of electricity by 10%. The figure shows an ATS engine.

Financial Assistance: In FY 2000, OIT will launch an integrated delivery of grant services. The goal of the program, which includes the Inventions and Innovation (I&I) Program and the NICE^3 Program, is to provide critical financial assistance in the form of grants to: 1) speed the development of new energy efficient technologies and 2) leverage industry and other resources to demonstrate and promote the benefits of energy savings, pollution prevention, and cost savings possible through the adoption of clean, energy-efficient industrial technology. By reducing overhead activities and running parallel solicitations, additional worthy projects will be supported, and it will be easier for industry and states to participate. The programs use regional centers to more effectively leverage local resources and to better tailor assistance to specific regional needs and situations.

Whyco Technologies is a good example of a NICE^3 success story. With an innovative, perforated plating barrel, the company reduced its energy use by 15%, eliminated more than 255 tons per year of solid waste, and reduced waste water by more than 17,000 gallons per day. The resulting cost savings total more than $500,000 annually. With a $390,000 grant from DOE and over $690,000 if its own money, Whyco was able to commercially manufacture and sell over 175 of these barrels since June 1997. Customers have realized significant environmental benefits as well as lower chemical and pollution-related costs.

Compressed air systems in U.S. manufacturing account for $1.5 billion per year of energy costs. One independent inventor, funded through the Inventions and Innovations Program, helped develop an improved, compress air powered, stamping press process - the Aerocylinder. A U.S. Car manufacturer saved $198,970 per year in energy costs after implementing the new Aerocylinder at one plant, and expects annual, company-wide savings to reach $17 million. By replacing conventional air cylinders with this new, I&I supported invention, U.S. manufacturers can expect savings in the billions.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont=d)

Technical Assistance: In FY 2000, the integrated delivery program will provide a means of bringing the full range of OIT tools, technical assistance and technology to thousands of plant sites. OIT calls this mechanism integrated delivery because information and technology are delivered at the corporate, managerial, technical, and plant levels of U. S. industry. This new approach will have an important role in launching new industrial technologies from the research and development stage to the manufacturing plant where the technology can be used to boost the productivity and competitiveness of U.S. industry. In this integrated delivery process, OIT works with industrial firms to host a plant-level showcase of as many OIT and DOE technologies as possible. The showcase demonstrates successful technologies to other companies and increases awareness of and confidence in these technologies. Two examples of the way this process works are:

Recommendations by Industrial Assessment Center students at San Diego State University helped Precision Products of Rancho Cucamonga, California, reduce costs by $81,450 per year. One suggestion alone to filter and reuse its blasting water saved over $7,800 a year with a one-time investment of only $750.

By installing new energy-efficient motors in both existing and new assembly lines, one engine manufacturer saved an estimated $208,000 per year in annual motor system energy costs, and reduced carbon emissions by over 200 tons per year. This upgrade was a direct result of Motor Challenge partnerships and tools such as the MotorMaster+ software which helps companies to compare motor systems and estimate their investment costs vs. energy savings.

1) At Bethlehem Steel=s Burns Harbor Plant, OIT and plant site personnel developed an ongoing partnership that allowed OIT to deliver its applicable programs, technical assistance, tools, and expertise in an integrated fashion. Through the aggressive use of these services, the plant achieved significant energy, environmental, and productivity gains and has become an industrial showcase of energy efficiency in steel production.

2) Working with the American Foundrymen=s Society and three manufacturing plants, OIT developed a showcase for a new metal casting technology known as the lost-foam process. This is an improved, energy efficient casting process that relies on foam patterns to produce metal castings of higher-quality and in more complex shapes than can be achieved in most other casting technologies. By providing technical assistance, and showcasing the foam pattern manufacturer and two plants currently using the new process (a cast-iron caster and an aluminum caster), OIT and its industrial partners were able to demonstrate throughout the metal casting industry the value of this new technology.

The goal of the integrated delivery program is to facilitate and promote the introduction to industry of near-term and emerging energy efficiency, renewable energy, and pollution prevention technologies. This initiative was developed to respond to OIT=s industry partners= requests for a simpler, integrated package of industrial energy efficiency technologies, technical and financial services that is both flexible and

I. <u>Mission Supporting Goals and Objectives</u>: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont=d)

easy to access. The strategy and implementation plans for this coordinated, integrated delivery approach will concentrate on outreach and technical assistance to IOF companies and plants. In addition to deploying specific emerging technology from the R&D technology portfolio, OIT will depend heavily upon the technology resources offered from several core OIT technical assistance programs. These programs include: Combined Heat & Power (CHP), Motors, Steam, Compressed Air, and the Industrial Assessment Centers (IACs).

The Motor, Steam and Compressed Air Programs will help U.S. manufacturers by providing credible technical information and assistance that helps them lower energy bills with little to no capital investment. These programs alone could help manufacturers save over 150 trillion Btu in 2010, which also increases U.S. productivity and competitiveness while preventing over 3.0 MMTCE emissions of greenhouse gases. The CHP goal is to double the amount of CHP installed capacity in the U.S., approximately 46 gigawatts by 2010.

I. B. Program Benefits

Industries of the Future (Crosscutting)	2000	2010	2020
Total Primary Energy Displaced (Quads)	.26	.76	1.37
Energy Cost Savings ($Billions)	1.07	3.5	6.44
Carbon Reductions (Million metric tons)	5.22	16.05	32.3

Productivity improvements could result in other cost savings equal to or greater than the energy cost savings. To put these benefits into perspective, the energy savings alone (in 2000) are almost enough to provide all the energy that the State of New Hampshire uses in one year (1995 data, New Hampshire used .285 quads).

I. C. Performance Goals

Enabling Technologies:

-- Demonstrate the capabilities of a next-generation, intelligent sensors/control system for application in harsh environments to achieve an increase in process efficiency of up to 15 percent and a reduction in emissions by as much as 10 percent.

I. <u>Mission Supporting Goals and Objectives</u>: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont=d)

-- Demonstrate and characterize low emission combustion systems which provide a beyond-compliance route to meet the 1990 - 2000 Clean Air Act requirements at the lowest cost, and obtain improved efficiencies.

-- Develop improved iron-aluminides exhibiting greater strength and corrosion resistance.

Distributed Generation:
-- Introduce commercial gas turbines that will increase efficiency from 29% to 43%, lower nitrogen oxide (NOx) emissions from 30 to 40 parts per million (ppm) to less than 10 ppm, lower carbon monoxide (CO) to less than 20 ppm, reduce the cost of electricity by 10% and encourage the expanded use of combined heat and power.

-- Demonstrate ceramic component durability for improving performance of microturbines.

Financial Assistance:
-- In FY 2000, NICE^3 and Inventions and Innovation Program solicitation schedules will be concurrent to better coordinate the combined effort, and to ensure that the 50 most deserving technologies are supported. Twelve new technologies from this group are expected to enter the marketplace within 5 to 7 years.

Technical Assistance:
-- Starting in FY 2000, OIT, in a collaboration with IOF industry partners, will implement a delivery system which brings the full range of OIT tools, technical assistance and technology to thousands of plant sites in the Steel, Aluminum, Chemicals, Forest Products, Metal Casting, Glass, Agriculture, Mining and Petroleum industries. As a result of the successful implementation of this strategy, by 2010, nearly $1 billion, over 4 million metric tons of carbon equivalent (MMTCE), and over 200 trillion Btu of energy will be saved annually by U.S. Industry by 2010 (or about 3% of all industrial sector energy usage).

I. D. Accomplishment Summary:

FY 1998

A. Enabling Technologies:
-- Initiated field testing of Continuous Fiber Ceramic Composites (CFCC) radiant burner screens and immersion tube burners at industrial sites.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont=d)

-- Deployed nickel aluminide to many segments of industry. This material offers long-term durability, better product quality, lower energy consumption, higher strength, and ultimately, less downtime and fewer repairs.

-- Demonstrated 6 ppm NOx burner on an operating industrial boiler for over five months.

-- Demonstrated oscillating combustion on steel, metal casting and glass furnaces which showed up to 10% efficiency gain and 50% emissions reduction.

-- Combustion system users and manufacturers completed the combustion vision, setting long-term goals for the combustion community.

-- With instrumentation and control manufacturer societies, developed and published a measurement and process control technology program plan to address needs identified in individual IOF roadmaps.

-- Demonstrated advanced ported radiant burner at industrial facility, realizing 9 ppm NOx or less, while increasing overall efficiency and lowering cost relative to Aend of pipe@ systems now used.

B. Distributed Generation:

-- Completed Ceramic Stationary Gas Turbine field test (4000 hr) at 1850 degrees Fahrenheit with CFCC combustor liners.

-- Completed low sulfur casting technology development for single crystal gas turbine blades.

-- Initiated thermal barrier coating bench-scale testing.

-- Completed rig tests of Advanced Turbine Systems (ATS) full-scale engine.

-- Prepared for first field evaluation of ATS engines.

C. Financial Assistance:

-- Inventions and Innovation Program completed biannual survey (conducted by Oak Ridge National Laboratory), and found 31 new I&I technologies entered the market (with sales in the 1996/1997 time frame). Indications are that 5 additional grantees have completed the objectives stated in their statements of work in 1998 and are now considered technical successes and are expected to enter the marketplace within the next two years.

I. <u>Mission Supporting Goals and Objectives</u>: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont=d)

-- In FY 1998 the Inventions and Innovation program (I&I) underwent a strategic review and re-design, modeled after the DOE Strategic Alignment Process. This process was initiated as a means to better deliver the program services to the desired audience of independent inventors and small businesses and to provide a program that is more responsive and flexible, while still expanding resource efficiencies. The re-design was successfully completed and implementation largely begun.

-- NICE^3 awarded 10 new grants this year which included 6 IOF projects. The program participation base was expanded with two new states/territories receiving awards this year (Maine and Puerto Rico). To date, 35 states have received NICE^3 grants.

-- I&I and NICE^3 used regional centers to support participation by small and medium sized companies. The program expanded its deployment base by establishing regional centers to help worthy applicants leverage the resources necessary to successfully achieve technical and commercialization goals.

-- NICE^3 completed a Process Action Team effort, focusing on streamlining the solicitation and providing greater customer satisfaction.

D. Technical Assistance:

-- Industrial Assessment Centers Program Critical Review initiated. Completed 750 assessments, trained 280 engineering students, provided pilot training program for a state funded Industrial Assessment Center (IAC), and tested expanded IAC site visits to 2 and 3 day level.

-- Initiated partnership with Bethlehem Steel=s Burns Harbor Plant. Provided integrated delivery of OIT technology, tools, and technical assistance services to develop energy efficiency strategies that will make this plant a showcase of efficiency for the steel industry.

-- Worked with American Foundrymen=s Society and three manufacturing plants to showcase new energy efficient lost foam process.

-- Motor Challenge became more highly leveraged by expanding 3 key partnerships with the largest industrial motor manufacturer in the United States, the largest chemical manufacturer, and the Technical Association of the Pulp and Paper Industry, with over 33,000 members. Through the clearinghouse, video-conferencing, trade articles, and other Motor Challenge outreach mechanisms, OIT was able to reach over 5,000 new users.

-- Steam Challenge was initiated in conjunction with the Steel and Forest Products industries, the first two Showcase Demonstration stories.

-- Nine industry partners and DOE pooled $300,000 in resources to formulate the Compressed Air Program strategy.

I. <u>Mission Supporting Goals and Objectives</u>: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont=d)

FY 1999

A. Enabling Technologies:

-- Demonstrate performance of CFCC combustor liners in retro-fitted commercial industrial gas turbine.

-- Develop and publish codes and standards for CFCC for use in design and testing.

-- Fabricate and test representative CFCC components, including turbine tip shroud in gas turbine engine test rig and immersion tubes for use in the metalcasting industry.

-- Continue deployment of nickel aluminide to all segments of industry.

-- Develop new iron aluminide materials for die casting and boiler tube applications.

-- Complete whirl burner scoping, prepare package for transfer of technology to industry.

-- Produce complete analysis of effectiveness of fuel injection recirculation.

-- Complete development of strong polymers by magnetic field polymerization.

-- Extend oscillating combustion to rotary hearth furnace and continuous steel plate reheat furnace.

-- Determine the optimum process cycle for making intermetallic composites by reactive metal penetration (RMP) and measure properties as a function of temperature.

-- Complete combustion technology roadmap by combustion system users and manufacturers to guide industry-wide combustion activities, including those of OIT.

-- Initiate new generation of combustion projects to meet industry-generated vision and roadmap targets.

B. Distributed Generation:

-- Initiate field test evaluation of advanced thermal barrier coating systems in ATS.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont=d)

-- Complete ATS full scale engine test.

-- Field test the catalytic combustion system with less than five ppm NOx.

-- Complete studies on state-of-the-art micro turbines and reciprocating engines for power generation and back-up power.

-- DOE and industry Combined Heat and Power Teams form and hold broad stakeholder meetings for CHP information dissemination.

C. Financial Assistance:

-- For the first time, financial assistance provided by the I&I Program through a competitive solicitation. This process will reduce the time from initial contact to award from two years to under one year, and allow the program to support the most worthy applicants.

-- NICE^3 and I&I issued competitive solicitations on concurrent schedules.

D. Technical Assistance:

-- Continue work on integrated delivery of OIT technology, tools, and technical assistance through partnerships similar to Burns Harbor with one showcase planned for each industry. Continue work with American Foundrymen=s Society and metal casting plants to showcase lost foam and other energy efficient technologies. Plans have been initiated for replicating results at other plant sites.

-- Recognizing that less than 3.5% of the U.S. manufacturing establishments consume over 71% of all manufacturing energy, the Motor, Steam, and Compressed Air programs embark upon a mission to bring their message to the roughly 15,000 plants making up this high consumption group. Five hundred of these plants are targeted for special intensive partnership relationships. FY99 is devoted to creating the Steam and Compressed Air Challenge information resources and refining the integration of technical assistance activities, while developing credible new tools, information and assistance.

-- Industrial Assessment Centers provide support to IOF integrated delivery showcase initiative. Implement recommendations of Program Critical Review. An additional 175 engineering students are trained and an additional 750 industrial assessments are underway. IACs will continue coordinating efforts with the National Institute of Standards and Technologies (NIST) Manufacturing Extension Program centers.

FY 2000

A. Enabling Technologies:

-- Develop new iron aluminide materials for die casting, and boiler tube applications.

I. Mission Supporting Goals and Objectives: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont'd)

-- Demonstrate CFCC immersion tubes at a metalcasting production facility.

-- Demonstrate use of an integrated ultrasonic measurement system for in-process monitoring of a steel manufacturing process.

-- Complete whirl burner package for transfer of technology to industry.

-- Complete development of the process for uniform metal droplet manufacturing and deploy to industry.

B. Distributed Generation:
-- Deliver and demonstrate first commercial Solar ATS engine at customer site.

-- Complete demonstration of the durability of next generation thermal barrier coating systems in an industrial gas turbine engine.

-- Complete Phase I feasibility studies for 50% efficient reciprocating engines and 40% efficient microturbines.

C. Financial Assistance:
-- OIT will fully implement integrated delivery of financial assistance services (I&I and NICE^3) issuing concurrent solicitation schedules. Regional network of service providers works with state and local programs to better leverage DOE funds. The NICE^3 and the I&I programs are expected to issue 45 to 50 new grants designed to address pressing energy and environmental issues.

-- NICE^3 and I&I Programs will continue to focus on IOF sectors. More states and territories will be added to the portfolio of participants.

D. Technical Assistance:
-- Six IOF plant sites will participate with OIT in integrated delivery effort designed to produce plants that are showcases for energy efficiency and clean production.

-- Motor, Steam, Compressed Air, and Combined Heat and Power Programs will contact and provide technical information and technical assistance to 3,000 of the 15,000 end-users in the highest (top 3.5%) energy consumption group. From among the 3,000, they will establish partnerships with 50 IOF Plant Sites to provide integrated delivery of tools and technical assistance.

-- Industrial Assessment Centers will continue to provide support to IOF integrated delivery showcase initiative. IACs will provide critical, sector specific information on near term technical solutions that are based on actual program assessment data. IACs will continue to work

with regional resources including the NIST Manufacturing Extension Program and community colleges. IACs will help replication of IOF technology through the assessment process.

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

Program Activity	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request	$ Change	% Change
Enabling Technologies	$ 14,182	$ 19,218	$ 22,000	$+2,782	+14.5%
Distributed Generation	33,921	51,016	31,300	-19,716	-38.6%
Financial Assistance	10,757	10,699	12,000	+1,301	+12.2%
Technical Assistance	15,195	19,119	22,300	+3,181	+16.6%
Total, Industries of the Future (Crosscutting)	$ 74,055	$ 100,052	$ 87,600	$ -12,452	-12.4%

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

Program Activity	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request	$ Change	% Change
Argonne National Laboratory (East)	275	275	275	0	0.0%
Idaho National Engineering Laboratory	50	100	100	0	0.0%
Lawrence Berkeley National Laboratory	700	850	950	+100	11.8%
Los Alamos National Laboratory	1,100	1,100	1,100	0	0.0%
National Renewable Energy Laboratory	1,540	1,050	840	-210	-20.0%
Oak Ridge National Laboratory	9,640	12,998	12,073	-925	-7.1%
Pacific Northwest National Laboratory	440	550	600	+50	+9.1%
Sandia National Laboratories	750	810	820	+10	+1.2%
All Other	59,560	82,319	70,842	-11,477	-13.9%
Total, Industries of the Future	$ 74,055	$ 100,052	$ 87,600	$ -12,452	-12.4%

(Crosscutting)					

III. Performance Summary: (New BA in thousands of dollars)

Activity	FY 1998	FY 1999	FY 2000
Industries of the Future (Crosscutting)			
Enabling Technologies	**Engineered Ceramics/ Continuous Fiber Ceramic Composites (CFCCs)**: Continued long term field demonstration and testing of components, environmental exposure of components, material analysis, data collection, and database establishment. Continued long term tests of representative components in gas turbine, coal exhaust, and combustion environments. Began some pilot scale process development activities. Began batch production of burners, diesel valve guides, and filters.	**Engineered Ceramics/CFCCs**: Continued long term field demonstration and testing of components, environmental exposure of CFCC components, material analysis, data collection, and database establishment. Continue sub-scale engine testing of CFCC liners for long-term durability. Initiate sub-scale component testing, including burners, immersion tubes and filters, for IOF participants.	**Engineered Ceramics/CFCCs**: The collaborative team among the program, industry, national laboratories, and universities will develop long term testing of CFCCs with superior high temperature strength and fatigue resistance, corrosion resistance, and wear resistance for various applications in the Vision Industries. Develop and demonstrate processing methods for reliable and cost-effective ceramic composite scaled-up to sizes and shapes consistent with industry needs for key near-term and intermediate term applications. Applications include gas turbine components, immersion tubes for molten metals, hot gas filters, radiant burners, heat exchangers, and refinery pipe hangers. Long term testing and exposure of representative CFCC components such as hot gas filters, gas turbine combustor liners, and radiant
Enabling Technologies (Cont=d)	Continued work on conducting performance evaluations, test methods, fiber interfaces, coatings, joining, design standards, and materials needs assessments.	Focus work on CFCC processing technologies that will allow for tight tolerances as required by industrial applications. Continue to coordinate CFCC research with OIT's Vision Industries, DOE, DoD, NASA, and others.	
Enabling Technologies (Cont=d)	Continued to coordinate CFCC	Assess relevance of ceramic technology projects initiated under prior funding from the	
Enabling Technologies (Cont=d)			
Enabling Technologies (Cont=d)			
Enabling Technologies (Cont=d)			

Activity	FY 1998	FY 1999	FY 2000
	research with OIT's Vision Industries, DOE, DoD, NASA, and others. ($8,256)	Transportation programs for development of the next-generation microturbines. Conclude efforts which do not have relevance, redirect and/or continue funding projects which can enable microturbines to meet low emission levels (less than 9 parts per million NOx) and have long life (greater than 40,000 hours) while meeting high efficiency targets (up to 40%). Conduct concept design studies for high efficiency, low emission advanced microturbine generators with the microturbine engine manufacturers to further quantify the benefits of advanced ceramics and identify other potential technology pathways to achieve next generation microturbine goals. ($11,293)	burners will be performed under application conditions for hundreds to thousands of hours. The supporting technology infrastructure is an integrated effort which addresses the design methodologies for advanced ceramics (including CFCCs), the role of material characteristics on mechanical performance, testing techniques for accurately evaluating their performance, and the development of a data base which includes composite life and long-term reliability in appropriate environments. These efforts help build the scientific foundation for the successful design, fabrication, characterization, and utilization of advanced ceramics for industrial and distributed power applications.
Enabling Technologies (Cont=d) Enabling Technologies (Cont=d)			Develop and demonstrate advanced ceramics and coatings for extended operation in the next-generation microturbines and industrial gas turbines, building upon ceramic technologies developed under prior U. S. government funded programs. Advanced ceramics and coatings

Activity	FY 1998	FY 1999	FY 2000
			will enable advanced engines, such as microturbines, to meet low emission levels and have long life while meeting high efficiency targets. Advanced microturbine generators with ceramic materials have the potential for less than 9 parts per million NOx and would be able to use natural gas, waste/exhaust gases and liquid fuels including diesel, methanol, and ethanol. Target applications of ceramics includes high-speed rotor, combustor and heat recovery (recuperation) systems. ($12,000) Participants include: Allied Signal Ceramics, Dow Corning, Dupont Lanxide, General Electric, McDermott Technologies, Textron Systems, Oak Ridge National Laboratory, Argonne National Laboratory.
	Advanced Industrial Materials: Identification of new industrial applications for nickel, iron, and titanium aluminides was made and applications engineering was done to adapt these materials to those uses. Developed new	**Advanced Industrial Materials**: Following on successful identification of new industrial applications for, and demonstration of, nickel and iron aluminides in FY 1997, the effort will continue at an	**Advanced Industrial Materials**: The Advanced Industrial Materials (AIM) Program will continue development and deployment of advanced intermetallic alloys, other high temperature alloys, polymers, membrane materials, and metal

Activity	FY 1998	FY 1999	FY 2000
	iron-chromium alloys for contact with molten glass, new coatings for flat glass, and new chromium silicides for industrial applications. The process for polymerization of plastics in magnetic fields was transferred to the Chemical Industry Vision for commercialization. Work to develop superior gas separation membranes using liquid crystal polymers was continued. Development of composites by molten metal infiltration was also continued with emphasis on intermetallic alloy matrices. Work continued on uniform metal droplets with emphasis on high temperature alloys, steel, and aluminum for the primary metals and powder metals industries. ($5,926)	accelerated pace to deploy these materials in a wider range of applications over all the Vision Industries. Additional work will include titanium aluminides, which have superior specific strengths at high temperatures, in order to ready them for industrial trials. Development of chromium silicides, iron-chromium alloys, and iron-chromium-silicon alloys for molten glass contact applications and uses in corrosive atmospheres in the chemical and refinery industries continues, and new applications can be identified. Cooperative research and development agreements (CRADAs) with Dow Chemical and Amoco, to develop superior organic and inorganic membranes for gas and liquid separations and an electrochemical reaction cell for improvement of energy efficiency in the chloralkali process, is completed. Development of metal matrix composites by reactive metal infiltration under terms of a CRADA with Reynolds Metals and A.P. Green Industries continue with completion scheduled for FY 2000. Work also continues on uniform	matrix composites for the IOF. These materials are designed to meet specific needs to improve productivity, product quality and energy efficiency in the Vision Industries. The focus of intermetallic alloy research and development will shift from nickel aluminide, which is a mature material being demonstrated by industry, to more rapid development of iron aluminides, molybdenum and other silicides, and titanium aluminides. Standardized test methods and physical process data bases will be developed to enable qualification of these materials in industrial applications. The process for production of uniform spherical metal powders over a wide range of steels and intermetallic alloys will be scaled up, in cooperation with industry partners. Work on development of inorganic membranes and electrochemical reactors for harsh chemical environments will be turned over to the Chemical Industry Team for industrial demonstration. Work on metal matrix composites, with superior strength and wear

Activity	FY 1998	FY 1999	FY 2000
		metal droplets and spray coatings, with emphasis on high temperature alloys, steel, and aluminum, for the primary, secondary, and powder metallurgy industries. ($5,944)	resistance will be completed. Activities of the Metals Processing Laboratory (MPlus) at Oak Ridge National Laboratory will be enhanced for the benefit of the industries and universities engaged in development of new and improved high temperature alloys for use in corrosive environments in the vision industries. ($6,000) Participants include: Oak Ridge National Laboratory, Sandia National Laboratory, Argonne National Laboratory, Weyerhaeuser, PPG Industries, Dow Chemical, Amoco, and other industry partners in CRADAs and other cooperative agreements.
	Combustion Systems: No activities. ($0)	**Combustion Systems**: Complete whirl burner scoping with transfer of technology to industry. Continue pre-competitive fuel injection recirculation research to determine why this procedure is more effective than flue gas recirculation. In conjunction with glass, steel, and metal casting activities, demonstrate oscillating combustion in additional equipment	**Combustion Systems**: The combustion program will continue and initiate projects to meet combustion vision and roadmap targets. These include goals of environmental quality (2 parts per million NOx is a long term goal for boilers), fuel flexibility (maximize the use of multiple fuels, including waste and renewable fuels), energy efficiency (or 20 to

Activity	FY 1998	FY 1999	FY 2000
		types and continue development of efficient low cost heat exchanger system for power generation. For FY99, the combustion program will solicit projects in industrial boilers, process heaters, and furnaces in the seven industries for cross-cutting impacts. ($990)	50% specific fuel consumption reduction is a long term goal for furnaces), cost effectiveness (lower life cycle costs), and improved system reliability (double the time between scheduled boiler outages). Specific projects for boilers may include an increased reliability air-fuel ratio control system which could cut boiler energy use by more than 5% or 200 billion Btu/year. In the furnace area, an improved furnace design could lower specific fuel consumption by 20% or over one quad in extensive use. ($2,000) Participants include: industrial boiler manufacturers, burner manufacturers, process heater and furnace manufacturers.
	Sensors and Control Technologies: No activities. ($0)	**Sensors and Control Technologies**: Emphasis is on low emissions, high efficiency, and remote sensing for high temperature, corrosive systems. Synergies between the vision industries are utilized through a competitive solicitation to increase leveraging of projects. ($991)	**Sensors and Control Technologies**: The Sensors and Controls Program will continue to develop and deploy integrated measurement systems for operator-independent control of manufacturing processes with broad applicability across multiple industry sectors. In collaboration with major industrial associations and

Activity	FY 1998	FY 1999	FY 2000
			instrumentation manufacturer societies, the Sensors and Controls Program will implement a comprehensive technology development strategy to meet the needs identified in the individual industry technology roadmaps. Particularly needed is improved technology both in sensors including embedded, high temperature, and harsh environment applications and in information processing from different sensory modalities to detect and remedy malfunctions. ($2,000) Participants include: Institute of Gas Technology/U. Of Illinois/Combustion Tec/Owens Brockway Glass Containers/Acme; GE Research & Development Center/Krupp Werner-Pfleiderer; Visteon Automotive Systems/Sandia National Laboratory/U. of Utah; Energy Research Company/Mississsippi State University/Oak Ridge National Laboratory; Tennessee Technological University/Utah State U./Idaho National Engineering Laboratory/Albany Research

III. Performance Summary: INDUSTRIES OF THE FUTURE (CROSSCUTTING) (Cont=d)

Activity	FY 1998	FY 1999	FY 2000
			Center/American Foundrymen=s Society/General Motors.
	$14,182	$19,218	$22,000
Distributed GenerationDistributed Generation (Cont=d) Distributed Generation (Cont=d)	**Industrial Power Generation**: Continued the industrial and utility Advanced Turbine Systems (ATS) program activities including design, manufacture, and field testing of full-scale components and integrated subsystems. Completed engine detail designs. Continued turbine and compressor rig testing. Commenced first engine builds. Evaluated the market of ATS for distributed generation applications.	**Industrial Power Generation**: Continue the industrial ATS program activities including manufacture and field testing of full-scale components. Commence first industrial scale engine builds and initiate full-scale testing. Continue ceramic insertion program for industrial turbines, including microturbines.	**Industrial Power Generation**: Complete the industrial ATS program activities including manufacture, demonstration, and deployment of full-scale engines. Complete first industrial scale engine build and ATS deliver to customer site for full-scale demonstration of technology. Begin to validate program goals of increased engine efficiency (15%) with less than 10 parts per million NOx and less than 20 parts per million carbon monoxide emissions, and reduction in the cost of electricity by 10%.
	Completed 2000 hour Gas Turbine Ceramic Retrofitted field test at the cogeneration site in Bakersfield, CA. Continued pre-and post-testing component evaluation and characterization. Continued	Complete post-testing component evaluation and characterization. Continue enabling materials support program including scale-up of single crystal turbine casting and improved Thermal Barrier Coatings. Initiate	Continue enabling materials and manufacturing support program including demonstration of the durability of next generation thermal barrier coating systems in an industrial gas turbine engine.

Activity	FY 1998	FY 1999	FY 2000
	enabling materials support program, including scale-up of single crystal turbine casting and improved Thermal Barrier Coatings. Completed melt desulfurization technology development for turbine castings. Completed Phase III for Thermal Barrier Coatings projects. Continued development of catalytic combustion technologies for reduced emissions in industrial gas turbines. ($33,921)	Phase IV of thermal barriers coatings. Continue to identify defect tolerance limits and alternative casting technologies. Continue to support the development of catalytic combustion systems and initiate pilot demonstrations for catalyst stability, fuel poisoning, and long-term durability. ($50,516)	Continue industrial engine program activities such as demonstrating a 40% efficient microturbine system for distributed generation. Distributed generation in the form of microturbines and advanced gas engines (less than 1,000 KW) have the potential to alleviate high-peak load demands. Complete Phase I feasibility studies for microturbines and identify key barriers and enabling technologies required for development. ($28,300) Participants include: Solar Turbines Inc., Allison Engines, Oak Ridge National Laboratory, Argonne National Laboratory, Battelle Columbus Laboratories, Pratt & Whitney, Westinghouse, Southwest Research Institute, University consortium, Allied Signal Ceramics Inc., Kyocera, Catalytica, PCI, microturbine and engine suppliers.
	Industrial Distributed Generation: No activities planned. ($0)	**Industrial Distributed Generation**: Assess the potential for ATS technology for industrial combined heat and power applications including refrigeration,	**Industrial Distributed Generation**: Complete industrial visioning activities for power and industrial process applications. Continue the development of technology roadmaps and R&D

Activity	FY 1998	FY 1999	FY 2000
		cooling, and industrial process systems. Initiate visioning efforts in the industrial power community for distributed power generation focusing on grid reliability and stability such as grid control of flickering in the steel industry. Initiate technology roadmaps and R&D priority activities for combined heat and power technologies having a system efficiency of greater than 65%. ($500)	priorities. Support industrial power technologies R&D through the industrial visions and roadmaps on power quality, power reliability and stability such as grid control of flickering in the steel industry; combustion and power in the glass industry; gasification in the paper industry; alternative fuels combined heat and power for the mining/agricultural industries; and cooling/refrigeration needs that crosscut all industries. ($3,000) Participants include: steel companies, utilities, Edison Technology Solutions, Oak Ridge National Laboratory, universities.
	$33,921	$51,016	$31,300
Financial AssistanceFinancial Assistance (Cont'd) Financial Assistance (Cont'd)	No activities.	No activities.	**Financial Assistance:** OIT will introduce an integrated delivery system of financial assistance services in the form of grants. The Program will address industry requests for a simpler, more flexible package of services that is easier for industry to access.

Activity	FY 1998	FY 1999	FY 2000
			By reducing overhead activities, additional worthy projects can be supported. The programs work with regional centers to more effectively leverage local resources and to better tailor assistance to specific needs and situations. The NICE^3 and Inventions Programs will issue a total of 45 to 50 new grants.
Financial Assistance (Cont=d)	**NICE^3**: The National Industrial Competitiveness Through Energy, Environment and Economics (NICE^3) Program was in its seventh year in FY 1997. The Program, which is designed to improve competitiveness, foster energy efficiency, and reduce waste, provided funding to State and industry partnerships on a competitive basis. NICE^3 supported projects which demonstrate energy efficient, clean production technologies that are emerging or are ready for commercialization. A Process Action Team review was conducted to look at ways to streamline the solicitation and improve customer satisfaction.	**NICE^3**: NICE^3 is funding 10 to 15 proposals through its competitive solicitation process. The Program is continuing to offer a non-regulatory, competitive approach to improved energy efficiency, reduced emissions and pollution prevention. Increased emphasis continues to be placed in the solicitation on commercialization and deployment of projects to assure replication of successful technologies. ($5,944)	**NICE^3**: NICE^3 will continue to provide a non-regulatory approach to improve competitiveness, foster energy efficiency, and reduce waste. The program will work closely with the I&I program to support an integrated delivery of OIT=s financial assistance services. Competitive solicitations for both programs will continue to be issued on concurrent schedules. Administrative streamlining, and the use of regional centers will continue to allow for more effective leveraging of local resources and enhance the ability of both programs to better meet specific regional industry needs. See the Financial Assistance description above. ($7,000)

Activity	FY 1998	FY 1999	FY 2000
	The NICE^3 and the I&I programs were conducted using competitive solicitations, issued on different schedules. NICE^3 funded 10 to 15 proposals through its competitive solicitation process. ($5,887)		Participants: The OIT focus industries, the dominant energy users and waste generators in the U.S. manufacturing and industrial sectors, are the primary recipients of the 10-15 grants awarded each year.
	Inventions and Innovations: The Inventions and Innovations program (I&I) continued to assist in the development of new technology by private sector individuals, particularly independent inventors, and start-up businesses. The recommendations from the strategic program review conducted in FY 1997 began to be implemented. I&I continued to provide evaluations and support of energy-related inventions. ($4,870)	**Inventions and Innovations:** Inventions and Innovations continue to assist in the development of new technology by private sector individuals, particularly independent inventors and start-up businesses. The recommendations from the strategic program review conducted in FY 1997 are fully implemented. For the first time, the programs issue funding by using a competitive solicitation. ($4,755)	**Inventions and Innovations**: The I&I Program will continue to provide financial assistance to support the development of new energy efficient technologies. The program will work closely with the NICE^3 Program to support an integrated delivery of OIT's financial assistance services to IOF partners. The I&I Program reaches typically underserved population of independent inventors and small start-up businesses. The program has received over 34,000 applications for financial assistance since its inception in 1974. Nearly 25% of the technologies funded have reached commercial success. The successful technologies

Activity	FY 1998	FY 1999	FY 2000
			supported by this program have saved enough energy to light 6 million homes for one year. ($5,000) Participants: Each year the I&I program awards 25-30 new grants to independent inventors and small technology-based businesses through competitive processes. These recipients change from year to year.
	$10,757	$10,699	$12,000
Technical Assistance Technical Assistance (Cont=d) Technical Assistance (Cont=d) Technical Assistance (Cont=d)	**Technical Assistance Activities**: In order to respond to requests from OIT=s industry partners for a simpler, integrated package of technical assistance services that is both flexible and easy to access, OIT began to experiment with a new integrated delivery process. In this process OIT worked with industrial firms to host a showcase, at the plant level, of as many OIT, and other DOE technologies as possible, to demonstrate to other	**Technical Assistance Activities**: Initial evaluation of Burns Harbor Pilot is completed. Work with American Foundrymen=s Society and metal casting plants continued to showcase lost-foam and other clean energy efficient technologies. Groundwork and plans are being developed to select other IOF showcase plant sites. ($0)	**Technical Assistance Activities**: In order to respond to its industry partners, OIT introduces an integrated system for delivery of technologies, tools, and technical assistance to thousands of plants. At the core of the integrated delivery strategy is the development of one-on-one ongoing partnerships between OIT and its IOF industry partners at the plant level. OIT=s efforts will model the success

Activity	FY 1998	FY 1999	FY 2000
Technical Assistance (Cont=d) Technical Assistance (Cont=d) Technical Assistance (Cont=d)	companies how successful the technologies are, and to increase awareness of and confidence in these technologies. ($0)		achieved since 1998 at Bethlehem Steel=s Burns Harbor plant and other showcase plant sites. By 2000, each of the IOF industries will have at least one major showcase initiative in partnership with OIT. ($2,000) Participants will be selected from the 9 IOF target industries.
	Industrial Assessment Centers (IACs): Support for IACs operating at 30 participating universities continued. Approximately 750 combined energy, waste, and productivity assessments were conducted. Engineering students received hands-on training in energy and waste management. A strategic review of the program was begun. ($8,292)	**Industrial Assessment Centers**: Support for IACs continues. Approximately 750 combined energy, waste, and productivity assessments are being conducted. Top performing schools are given incentives to look at and evaluate innovative program approaches. Collaborative work with State agencies continues. Work that strengthens university and local industry cooperation continues. Continue collaboration with the NIST Manufacturing Extension Program centers. ($8,222)	**Industrial Assessment Centers**: OIT will support IACs efforts to provide hands-on training in energy and waste management to an additional 240 engineering students and to conduct approximately 750 new combined energy, waste, and productivity assessments. The program will work closely with the other OIT Technical Assistance programs to fully support an integrated delivery of services and will provide industrial assessment expertise to identify and capitalize on technology applications at participating showcase plants. The IAC database, with data on over 8,000 industrial assessments, will help these plants target specific opportunities for efficiency.

Activity	FY 1998	FY 1999	FY 2000
			Engineering students who have worked with the 30 IAC's nationwide graduate with the experience and skills necessary to implement energy efficiency, waste reduction, and productivity improvements. The students transfer best practices learned through the program to U.S. manufacturers all across the nation. To date, 2,300 students have been trained by the IAC program. Work at national level to share results of successful IACs/NIST Manufacturing Extension Program Centers collaboration. ($8,300)
			Funding recipients are Rutgers University, the University City Science Center, University of Dayton, University of Florida, Georgia Institute of Technology, Hofstra University, University of Louisville, University of Maine, University of Massachusetts, University of Michigan, Mississippi State University, North Carolina State University, University of Notre Dame, Old Dominion University, University of Tennessee, West Virginia University, University

Activity	FY 1998	FY 1999	FY 2000
			of Wisconsin, Arizona State University, University of Arkansas-Little Rock, Bradley University, Colorado State University, Iowa State University, University of Kansas, University of Missouri-Rolla, University of Nevada-Reno, Oklahoma State University, Oregon State University, Prairie View A&M University, San Diego State University, San Francisco State University, South Dakota State University, Texas A&M University
	Technology Transfer: The Technology Transfer Program continued to work closely with industry to develop outreach products to convey the benefits of advanced energy efficient, pollution prevention technology. ($800)	**Technology Transfer**: The Technology Transfer Program continues to work closely with industry to develop outreach products to convey the benefits of advanced energy efficient, pollution prevention technology. ($396)	**Technology Transfer**: No activities. (See Evaluation and Planning in the next section below.) ($0)
	Combined Heat and Power (CHP) Challenge: No activities. ($0)	**Combined Heat and Power (CHP) Challenge**: Initiate CHP challenge program for improved deployment of CHP systems. Benchmark combined heat and power activities in the U. S. and abroad. Hold four workshops at the Federal and State level to address	**Combined Heat and Power (CHP)**: CHP technical assistance activities will focus on addressing the barriers and providing the technical tools and expertise necessary to demonstrate to industry how successful CHP technologies are and to increase awareness of and confidence in

Activity	FY 1998	FY 1999	FY 2000
		combined heat and power technology barriers and successes. ($991)	these technologies. The program will continue to work with the other OIT Technical Assistance programs to fully support an integrated delivery of services making CHP an important technology option for IOF industries. ($1,000) Participants include: State Energy Offices, Onsite Energy, Washington State University, Oak Ridge National Laboratory, Allison Engines.
	Motor Challenge: More than 49 million electric motors convert electricity into useful work in U.S. manufacturing operations. The cost to industry is over $30 billion annually. In addition, motor-driven system energy usage is 70% of the total industrial electricity market. Industry has traditionally looked at its equipment with a component focus, e.g., one motor, one pump, one drive system, etc., at a time. Accordingly, significant systems-oriented efficiency gains are	**Motors and Compressed Air**: All Vision industries are being targeted and supported by Motor Challenge. These industries comprise over half of the U.S. manufacturing sectors motor system electricity consumption. Motor Challenge products are being tailored to each industry=s application-specific needs and are being delivered to plant sites in partnership with the industry end-user trade associations and Motor Challenge end-user Partner corporate offices. Activities will	**Motors and Compressed Air:** Motors and compressed air are both motor driven systems. Technical assistance support and expertise in these areas will be provided as critical components of OIT=s integrated delivery of technical assistance services. The programs will continue to work with manufacturers to identify and target new energy efficiency and productivity opportunities and to help them develop and refine the credible, unbiased tools that assist industry in making the most informed energy decisions. ($9,000)

Activity	FY 1998	FY 1999	FY 2000
	often overlooked. The strategy of DOE=s Motor Challenge Program is to create industry/government partnerships designed to assist and encourage industrial end-users to adopt the systems approach in managing, specifying, purchasing, and maintaining their electric motors, drives, and motor-driven equipment (e.g., pumps, fans, and compressors). ($6,103)	continue to catalyze the efforts of suppliers, distributors, utilities, states and trade associations to develop and deliver the tools and technical assistance manufacturers need to make informed decisions about motors and motor-driven systems. Starting in FY 1999, and building on the success of Motor Challenge as a model, work is started that will provide enhanced technical assistance on steam and compressed air systems. ($8,010) **Steam:** The Steam Challenge was launched under the Motor Challenge budget to provide tools, information, and technical assistance to help industry improve the energy efficiency of its steam systems. ($1,500)	Participants include: Oak Ridge National Laboratory, National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Macro International, Washington State University Extension Office. **Steam:** The Steam Challenge, which was run under the Motor Challenge budget in FY99, will be a full fledged initiative jointly partnered by DOE and the Alliance to Save Energy. Technical assistance, information and tools will be provided to plants interested in improving the energy efficiency of their steam systems and industrial heating equipment. This program provides valuable unbiased information on system design, equipment, purchase, and operation from experts with practical experience addressing steam system challenges. As with motors and compressed air, this program aims to increase U.S. industrial energy efficiency by helping industry adopt the systems approach with boilers, steam distribution systems, steam applications, furnaces and other

Activity	FY 1998	FY 1999	FY 2000
			equipment. The Steam program will work with suppliers, equipment manufacturers and end-users to garner the greatest impact. At the same time integrated delivery of technical assistance will provide the right level of assistance to each plant. ($2,000) Participants include: Oak Ridge National Laboratory, National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Macro International, Washington State University Extension Office, Alliance to Save Energy.
	$15,195	$19,119	$22,300
Industries of the Future (Crosscutting) Total	**$74,055**	**$100,052**	**$87,600**

INDUSTRIAL TECHNOLOGIES
INDUSTRY SECTOR
(dollars in thousands)

MANAGEMENT AND PLANNING

I. Mission Supporting Goals and Objectives:

The request supports 69 full-time equivalent (FTE) positions to maintain adequate program management and support for the Industrial Sector Program (Interior and Related Agencies). This program also includes Technical Evaluation, Analysis and Planning.

II. A. Funding Table: MANAGEMENT AND PLANNING

Program Activity	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request	$ Change	% Change
Evaluation and Planning	$ 800	$ 792	$ 1,590	$+798	+100.8%
Program Direction	6,900	7,559	7,810	+251	+3.3%
Total, Management and Planning	$ 7,700	$ 8,351	$ 9,400	$+1,049	+12.6%

II. B. Laboratory and Facility Funding Table: MANAGEMENT AND PLANNING

All Other	$ 7,700	$ 8,351	$ 9,400	$+1,049	+12.6%
Total, Management and Planning	$ 7,700	$ 8,351	$ 9,400	$+1,049	+12.6%

III. Performance Summary: (New BA in thousands of dollars)

Activity	FY 1998	FY 1999	FY 2000
Management and Planning			
Evaluation and Planning	Provide increased technical evaluation, analysis, and planning with emphasis on development of quality metrics for the energy intensive industries.	Provide increased technical evaluation, analysis, and planning, including development of quality metrics for the energy intensive industries.	Provide increased technical evaluation, analysis, and planning, including development of quality metrics for the energy intensive industries. Continue some technology transfer activities transferred from Industries of the Future (Crosscutting).
	$800	$792	$1,590
Program Direction	The following is a breakdown of the funding by Object Class: 11.9 Personnel compensation $ 4,901 12.1 Civilian personnel benefits $ 1,037 21.0 Travel and transportation of persons $ 662 25.2 Other services $ 300 Funds support the salaries, benefits, and travel (including normal increases in both salaries and benefits) for 68 FTEs needed to conduct and monitor research, development of the various Industry technologies, at Headquarters and in	The following is a breakdown of the funding by Object Class: 11.9 Personnel compensation $ 5,260 12.1 Civilian personnel benefits $ 1,340 21.0 Travel and transportation of persons $ 670 25.2 Other services $ 289 Funds are requested to support the salaries, benefits, and travel (including normal increases in both salaries and benefits) for 72 FTEs needed to	The following is a breakdown of the funding by Object Class: 11.9 Personnel compensation $ 5,400 12.1 Civilian personnel benefits $ 1,435 21.0 Travel and transportation of persons $ 675 25.2 Other services $ 300 Funds are requested to support the salaries, benefits, and travel (including normal increases in both salaries and benefits) for 69 FTEs needed to conduct and monitor research, development of the various Industry technologies, at Headquarters and in

Activity	FY 1998	FY 1999	FY 2000
Program Direction (Cont=d)	the field and to support implementation of the Industry sector requirements of the Energy Policy Act of 1992.	conduct and monitor research, development of the various Industry technologies, at Headquarters and in the field. The request for other services supports such activities as training, permanent change of station moves, and a small contingency.	the field. The FY 2000 Congressional Request for program direction provides for staffing adjustments resulting from Workforce 21 plans. The request for other services supports such activities as training, permanent change of station moves, and a small contingency.
	$6,900	$7,559	$7,81
Management and Planning Total	**$7,700**	**$8,351**	**$9,40**