Chemicals
Industry of the Future

Fiscal Year 2004 Annual Report

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

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

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

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

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

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

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

ITP uses a leveraging strategy that maximizes the energy and environmental benefits of its process-specific technology investments by coordinating and cooperating with energy-intensive industries. By working closely with the private sector, the ITP is able to effectively plan and implement comprehensive R&D agendas and help disseminate and share best energy management practices throughout the United States. The ITP public-private partnerships also facilitate voluntary efforts, such as the President's Climate VISION initiative, to encourage industry and government to reduce greenhouse gas emissions. ITP also conducts R&D projects on enabling technologies that are common to many industrial processes such as industrial energy systems, combustion, materials, and sensors and process control systems. In addition, ITP funds technical assistance activities to stimulate near-term adoption of best energy-saving technologies and practices within industry. These activities include plant assessments, tool development and training, information dissemination, and showcase demonstrations.

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

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Today the chemical industry faces significant challenges in maintaining its leadership position in global markets. Competition from developing countries where energy and labor are cheaper is putting increasing pressure on U.S. producers, and is exacerbated by the increasing volatility of energy prices. Growing societal demands for environmental stewardship and demand for shorter-term returns on investment continue to impact the availability of R&D funds, especially for basic and applied research. The skilled workforce conducting chemical R&D has dropped by at least 10 percent. These challenges have led to a major change in this highly competitive industry. Companies are now more willing to collaborate in strategic, pre-competitive areas to reduce costs, environmental impacts, and energy use.

The U.S. chemical industry is the second largest consumer of energy in manufacturing, using almost 6.1 quads of energy in 1998 (the largest industrial user of energy is the petroleum refining industry). The magnitude of energy consumed by the industry makes it a prime target for energy efficiency R&D. Increasingly stringent environmental regulations associated with the combustion of fuels and the growing volatility of energy markets are making investments in energy efficiency R&D more attractive. Record high prices for natural gas over the last two years and growing dependence on imported oil threaten national energy security and make a strong case for reducing the use of energy.

Transformational R&D, such as that funded by the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Industrial Technologies Program (ITP), is critical to maintaining the global competitive position of the U.S. chemical industry. Permanent technology changes, rather than short-term fixes, are needed to revolutionize the way energy is used in chemical manufacturing. New catalysts, for example, can dramatically increase product yield (the amount of product obtained from every barrel of oil) and reduce feedstock requirements. More efficient process heating technology can reduce the use of fuels and electricity. DOE's goal for the Chemicals portfolio will help the chemical industry achieve a 30 percent reduction in energy, water use, and toxic and pollutant dispersion per unit of output by 2020.

A Successful Strategy with Industry

The DOE/EERE leads the federal role in developing advanced energy-efficient and environmentally-friendly industrial technologies. Chemical industry R&D is a component of the overall EERE strategy and contributes to the goals outlined in the National Energy Policy. Improving energy efficiency in chemical manufacturing could directly reduce the amount of petroleum imported into the United States and will reduce the energy intensity of industry, two of EERE's top priorities.

EERE/ITP is working to build the Industries of the Future through a strategy that is based on multi-year planning, industry involvement and input during the decision making process, and careful analysis and data based decision-making. This strategy not only takes into consideration the interests of the industry as described in their R&D Technology Roadmaps, but also consists of an agenda including analytical studies that provide the basis for decision-making. For instance, the *Vision 2020: Reaction Engineering Roadmap*, published in 2001, has provided the basis for focusing the R&D by identifying industry research interests. The *Chemicals Energy and Environmental Profile*, Bandwidth study and Footprint study were developed using both government and industry data, information and expertise to provide the next level of prioritization for the portfolio. By using these studies, the portfolio is able to design a multi-year R&D plan based on the focus area, barrier, and pathway approach. In this approach, a limited number of critical technology focus areas are identified along with the technical barriers preventing their successful implementation. A multi-year plan (called a "Pathway") is then developed that will guide the R&D activities leading to a successful development of the focus area technology. The "Pathways" are then the basis for solicitations of pre-competitive R&D that addresses both energy efficiency goals outlined in the National Energy Policy and chemical industry research priorities. This successful strategy has now evolved to a point where it provided focus on potentially high-impact research to make revolutionary improvements in chemicals manufacturing.

The ITP Chemicals portfolio will help the chemical industry achieve a 30 percent reduction in energy, water use, and toxic and pollutant dispersion per unit of output by 2020.

EERE/ITP directs the Chemicals portfolio, which seeks to boost efficiency and productivity of the energy- and resource-intensive chemical industry by investing in a balanced R&D portfolio with broad applicability in chemical processing. ITP works in partnership with the Chemical Industry Vision2020 Technology Partnership (Vision2020, see http://www.ChemicalVision2020.org), a group of executives from major U.S. chemical companies. This group works with government, academia, and national laboratories to promote technology development of more energy-efficient and environmentally-sound chemical technologies. By partnering with Vision2020 and fostering collaboration with chemical industry trade organizations, ITP leverages public and private resources and ensures the application of research results.

Achieving Energy Savings: Portfolio Strategy

The ITP Chemicals portfolio of pre-competitive research addresses technological needs that have broad applicability throughout the chemical industry. The program strategy fosters both revolutionary technologies and incremental improvement to existing processes, thereby addressing long-term goals without neglecting short-term opportunities to improve energy efficiency. ITP also strives to expand the industry's fundamental base of knowledge to optimize key processes and resource efficiency.

As the ITP Chemicals portfolio continues to shift toward supporting a smaller number of high-impact projects, research activities are organized into the following categories: reactions, separations, enabling technology (materials, process heating, computations, and sensors and controls), and technology deployment. The FY 2004 ITP Chemicals portfolio included 37 active and 32 SBIR projects. Many other projects funded by EERE are applicable to the chemical industry. More information about the Chemicals portfolio is available online at http://www.eere.energy.gov/industry/chemicals.

FY 2004 Highlights

- **Solicitations Conducted for Innovative Chemical Processing Technologies –** ITP conducted two competitive solicitations in FY 2004 addressing the Chemicals portfolio, one for industry and one for National Laboratories. Both solicitations primarily focused on catalytic oxidation and distillation technologies, and nine award winners have been announced.

- **Twelve Projects Received Final Funding, Several Technologies Appear Promising –** During FY 2004, twelve RD&D projects were funded to completion. Final results from these projects will be posted on the Chemicals Web site.
  - Membranes for Corrosive Oxidations, Argonne National Laboratory
  - Mesoporous Membranes for Olefin Separation, Los Alamos National Laboratory
  - Membranes for P-xylene Separations, Sandia National Laboratories
  - Autothermal Reformer Kellogg Brown & Root
  - Ethylene Process Design Optimization, BP
  - High Throughput Catalyst Screening, TDA Research
  - Short Contact Time Residence Reactors, Sandia National Laboratories
  - Molecular Simulation for Chemical Industry, Sandia National Laboratories
  - Research Consortium for Multiphase Fluid Dynamics, Sandia National Laboratories
  - Solution Crystallization Modeling Tools, OLI Systems
  - Alloys for Ethylene Production, Oak Ridge National Laboratory
  - Distillation Column Flooding Predictor, 2nd Point Industries

- **Energy Bandwidth Study Continued** – This study was initiated to gain knowledge of inefficiencies for a number of the highest energy-consuming processes employed in the chemical industry. The "bandwidth" provides a snapshot of the energy losses that can potentially be recovered through improvements in technology. The bandwidth analysis is based on calculation of the energy and exergy losses associated with individual chemical processes. In FY 2004, the study looked at 25 different manufacturing processes for high volume chemicals.

- **Advanced Analytic Tools Developed –** To better select and manage R&D projects, two tools were significantly upgraded during FY 2004. The Chemicals Project Assessment Tool (CPAT) measures energy

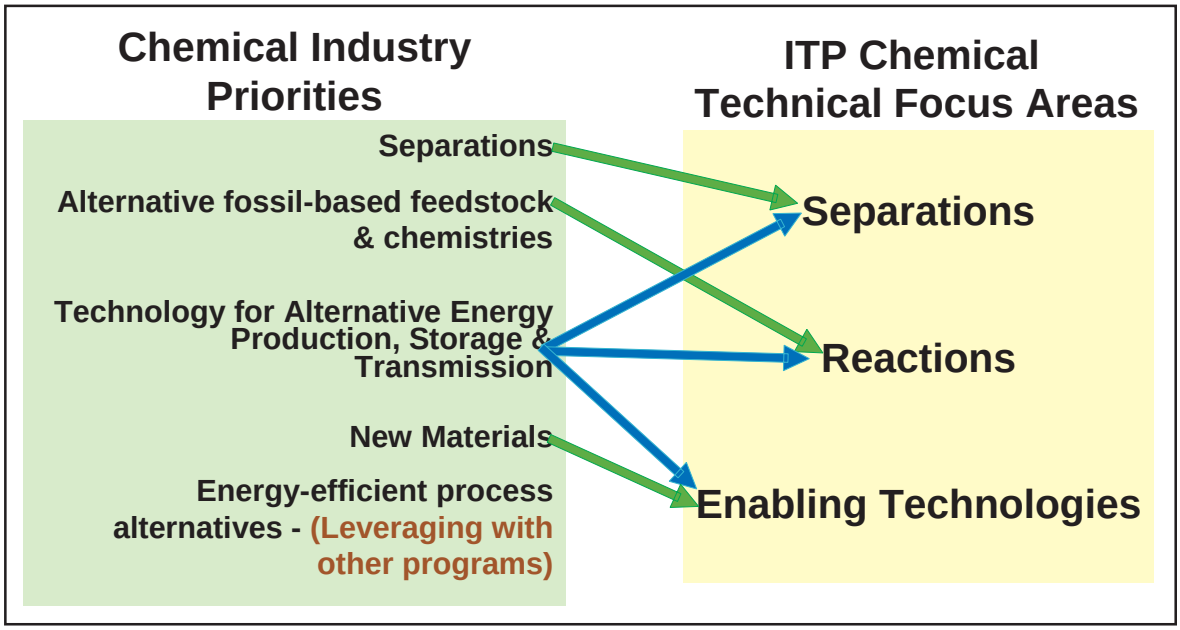
and environmental impacts, as well as the cost/benefit of projects. The Chemicals Portfolio Management Tool (CPMT) addresses risk and performance for each project. Significant efforts are being made to integrate and customize these tools for the proposal selection and portfolio review processes.

- **Continued Refocusing Efforts to Better Meet Industry Needs** – ITP strives to continually improve performance. As part of these efforts, a crosswalk of industry priorities with Chemicals portfolio focus areas was prepared and is depicted on page iii. In addition, feedback was received from several peer reviews, which will allow the Chemicals portfolio to be more productive.

Climate VISION

- Industrial Technologies Program (ITP) continues to work in partnership with the DOE Office of Policy and the U.S. chemical industry through the American Chemistry Council (ACC) to implement activities in support of ACC achieving its ClimateVISION commitment. A ClimateVISION workplan is being developed where ACC will be collaborating with the federal government on near-term energy efficiency activities, cross-sector projects, and R&D to develop and commercialize advanced technology (see ClimateVISION Web site at http://www.climatevision.gov).

Focus Areas Meet Chemical Industry's Priorities



INDUSTRY OVERVIEW

The chemical industry is a vital part of the U.S. economy, transforming raw materials into more than 70,000 diverse products that are integral to today's quality of life. Nearly every product in use today, from transportation to plastics to paper, requires some input from the chemical industry.

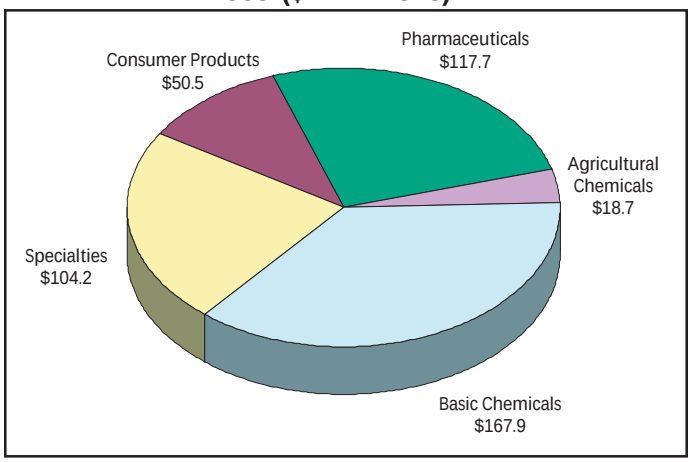
Products Requiring Chemical Inputs

Plastics	Antifreeze
Paints	Printing Links
Detergents	Textiles
Adhesives	Food Packaging
Solvents	Carpets
Pharmaceuticals	Insulation
Toys	Auto Interior Parts
Film	Paper
Plastic Bags	Cell Phones
Medical Supplies	Microwaves
Cosmetics	Refrigerators

The chemical industry is a global enterprise worth $1.9 trillion, and the United States holds the largest market share (24 percent). In the U.S. alone there are over 13,000 chemical establishments employing more than 900,000 people.[2] In 2003, the domestic chemical industry provided 2 percent of the U.S total GDP and invested almost $22 billion on R&D. Chemicals manufacture is the second largest industrial consumer of energy, and the industry spends almost $11 billion on environmental programs annually.[1,2]

Globalization and innovation are major influential forces in the chemical industry. Dynamic global demand and rapid technological change have led to accelerated restructuring, joint ventures, mergers, and acquisition activities throughout the industry. Chemical companies today are highly diversified and knowledge-based, relying on technology, science and innovation to create value-added products and gain ground in new markets. For example, leading companies are increasingly utilizing biotechnology to produce value-added products, which also provides opportunities for more efficient use of energy and environmental benefits.

Exhibit 1
Value of Industry Shipments by Sub-Sector, 2003 ($ in Billions) (1)



In 2003, U.S. chemical industry shipments totaled over $459 billion.[1] Exhibit 1 shows the value of shipments for the major sub-sectors. Over the last decade the industry has grown at an average real rate of almost 2 percent per year, with some sectors experiencing flat or negative growth, while others are growing rapidly. The composition of the industry has been steadily changing, with an increasing emphasis on high technology and niche markets such as the life sciences and specialty chemicals. While commodity chemicals continue to form the core of the industry, it is these specialty markets where the highest future growth is predicted.

The U.S. chemical industry has traditionally maintained a trade surplus over the years. In 2003, however, the U.S. chemical industry reported a $9.6 billion trade deficit, continuing a trend that began in 2002. The U.S. still remains the largest exporter of chemicals in the world, with over $91 billion in products shipped to foreign trading partners in 2003, in large part due to the research-intensive pharmaceutical sector. Canada, Mexico, Western Europe, and the Asia-Pacific region account for over 88 percent of U.S. export markets.[1]

In 2003, production of petrochemicals and organic chemicals was estimated at 273 billion pounds. That same year, production of inorganic chemicals totaled 329 billion pounds. Plastics account for about 109 billion pounds per year of organic chemical production.[1]

1 *Guide to the Business of Chemistry 2004*, American Chemistry Council.
2 *2001 Census of Manufacturers*, U.S. Department of Commerce.

Energy Use in the Chemical Industry

In 1998, energy consumption in the chemical industry was an estimated 7.3 quads (with electricity losses), which represents about 7 percent of all domestic energy use and over one-quarter of total U.S. manufacturing energy use.[1] Energy use in the chemical industry is split almost evenly between heat and power and feedstock energy for the production of petrochemicals, plastics, and other products. During the last few decades, significant improvements have been made in energy efficiency, reducing energy use per unit of output by nearly 40 percent since 1974.[4] Technologies such as cogeneration, advanced catalysts, and improved separations have played a major role in efficiency improvements. Today one third of the electricity used by the industry is produced onsite more efficiently, mostly through cogeneration, which provides both power and process heat.

Exhibit 2 shows the chemical industry's energy inputs by source. The industry is the second largest consumer of natural gas, accounting for over one-third of total U.S. manufacturing use, and the largest consumer of liquefied petroleum gas (LPG), at 95 percent of total manufacturing use.[5] Natural gas provides the largest share of energy for heat and power. The industry is fuel-intensive; electricity only provides about 16 percent of heat and power requirements. Feedstock energy is a mix of LPG, natural gas liquids (NGL), heavy petroleum liquids, and natural gas.

Energy consumption varies widely among the industry sectors. Petrochemicals and other organics account for the largest share of energy use (35 percent), followed by plastics and resins (19 percent), and fertilizers (9 percent), as shown in Exhibit 2. Energy costs on average account for about 7 percent of the value of chemical industry shipments. In 2001, the industry spent $31.4 billion in energy purchases for fuel, power, and feedstocks, a 65 percent increase over energy costs in 1999. The dramatic increases in natural gas prices since 2000 have had a substantial impact on certain sectors of the industry. For example, about 50 percent of methanol capacity and 40 percent of ammonia capacity, both of which depend on natural gas for feedstock, were idled during the early part of the decade.[6]

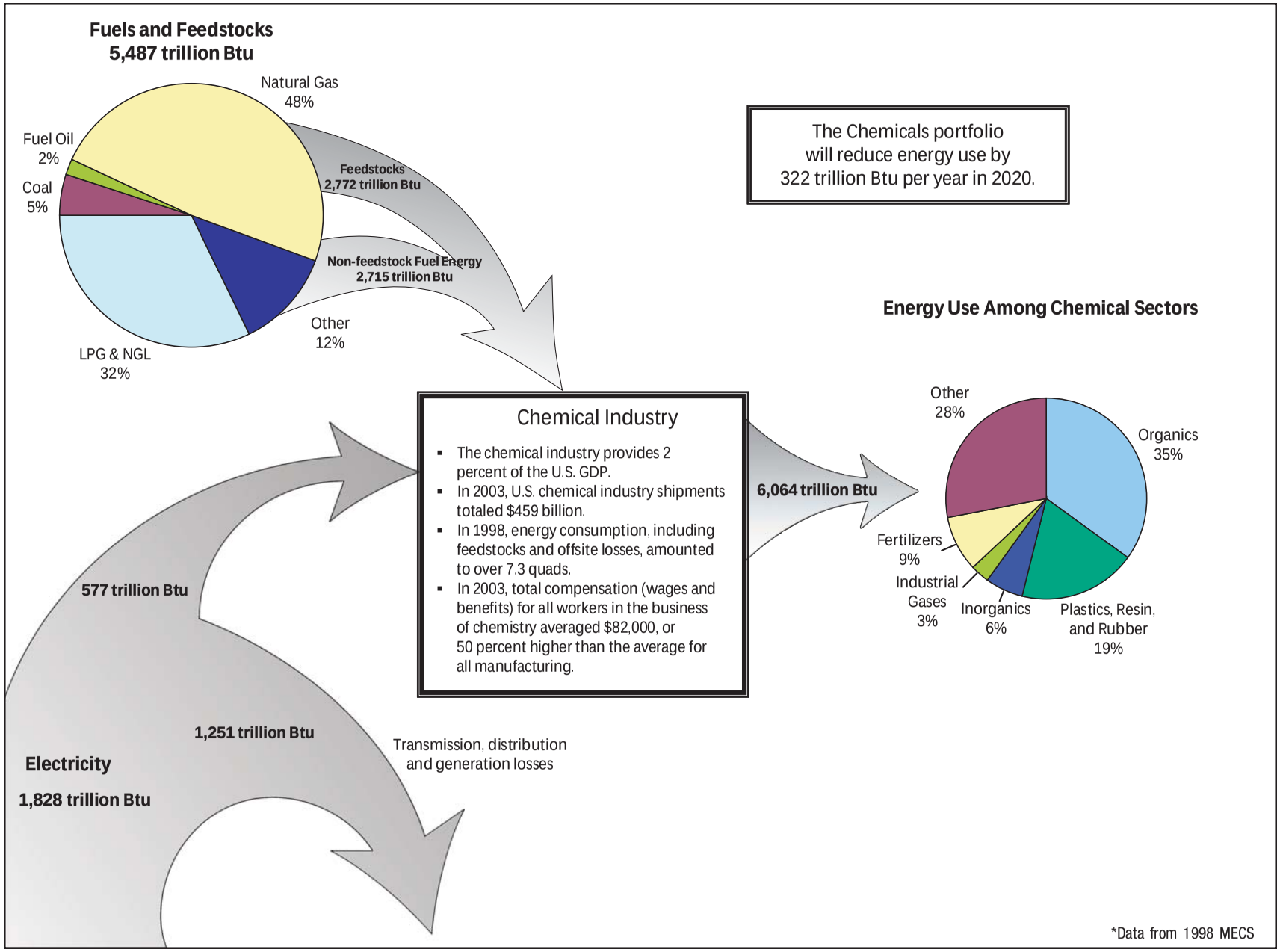
Within the plant boundary, about 37 percent of energy delivered to the plant is lost prior to being used in specific processes. For example, steam is used extensively in the chemical industry for fluid heating and to produce power. In the steam system, which includes boilers, steam distribution lines (pipes, valves, traps), and energy conversion systems (heat exchangers, preheaters, etc.), about 45 percent of delivered energy is lost. Process heating (both steam and fired heaters) represents the largest use of fuels in the chemical industry (77 percent), followed by motor systems (12 percent). Technologies that improve the efficiency of process heating systems have significant potential to reduce overall industry energy use.

Process operations represent substantial energy sinks where new technology as well as incremental improvements can have an impact. Distillation columns, for example, the mainstay of the industry, often operate with thermal efficiencies as low as 20 percent.

Off-site losses for the industry are considerable, amounting to about 1345 trillion Btu. Over 93 percent of these losses occur in electricity generation off-site. Technologies that produce electricity on-site, such as cogeneration, have the potential to reduce these off-site losses by increasing thermal efficiency.

3 *1998 Manufacturing Energy Consumption Survey (MECS)*, U.S. Department of Energy, Energy Information Administration, 2002.
4 *Guide to the Business of Chemistry 2003*, American Chemistry Council.
5 *1998 Manufacturing Energy Consumption Survey (MECS)*, U.S. Department of Energy, Energy Information Administration, 2002.
6 *Guide to the Business of Chemistry 2002*, American Chemistry Council.

Exhibit 2
Energy Use in the Chemical Industry*



THE CHALLENGE

Chemicals are integral to nearly every sector of the economy. The products of the chemical industry are essential raw materials for U.S. manufacturers, agriculture, construction, health care, communications, transportation, and national security. It is a very complex industry, producing over 70,000 products using thousands of different processes. The industry relies heavily on a highly skilled workforce and continuous technological innovation to maintain competitiveness and economic growth.

Today the chemical industry faces significant challenges in maintaining its leadership position in global markets. Competition from developing countries is putting increasing pressure on U.S. producers, particularly countries where energy and labor are cheaper, and government subsidies help to fuel new industry with less stringent regulations. Growing societal demands for cleaner production and environmental stewardship continue to place increasing pressure on limited R&D funds. Demand for shorter-term returns on investment in recent years has also limited the amount of capital available for research activities, especially basic and applied research. The workforce of scientists and engineers engaged in chemical industry R&D has dropped in recent years by more than 10 percent, from 91,000 to 81,000.

The competitive demands facing chemical companies have led to a major change within this highly competitive industry. Companies are now more willing to collaborate in strategic, pre-competitive areas to reduce costs, environmental impacts, and energy use. In *Technology Vision 2020: The U.S. Chemical Industry*, the industry has emphasized that collaborative partnerships involving government, industry and academia will be critical to meeting the technology challenges of the future and accelerating the pace of technological innovation. Recognizing that R&D consortia could benefit both industry and the nation, the industry has organized Chemical Industry Vision2020 Technology Partnership (Vision2020, see http://www.ChemicalVision2020.org), a group of executives from major U.S. chemical companies. This group works with government and academia to promote the development of more energy-efficient, environmentally sound chemical technology.

An Energy-Intensive Industry

Energy is a major factor in the technology equation for the chemical industry. The U.S. chemical industry is the second largest consumer of energy in manufacturing, using almost 7.3 quads of energy in 1998 and accounting for around one-quarter of all manufacturing energy use. The magnitude of energy consumed by the industry makes it a prime target for energy efficiency R&D, with potentially large energy savings opportunities.

The industry relies primarily on petroleum and natural gas to provide feedstocks for the manufacture of chemicals. Nearly 50 percent of the energy consumed by the industry is for feedstocks – about 2.8 quads, or the equivalent of about 500 million barrels of oil. Transforming fossil energy and other raw materials into saleable products also consumes large amounts of energy in the form of heating, cooling, and electrical power.

While tremendous advances have been made in energy efficiency since the oil crises of the 1970s, the industry still relies on many processes which are inefficient and energy-intensive (e.g., distillation). When energy costs are low relative to the costs of processing and other inputs to production, investments in energy efficiency often take a back-seat to investments in environmental compliance or product development. However, increasingly stringent environmental regulations associated with the combustion of fuels and the growing volatility of energy markets is moving energy efficiency to the forefront. The record high prices for natural gas over the last two years, for example, have forced plants to close and to move new projects out of North America to locations where natural gas is cheap and plentiful. The use of petroleum as a feedstock for commodity chemicals has served to increase our dependence on imported oil and impacts our energy security.

Both government and industry agree that conservation, or improving the efficiency of energy use, is part of the solution for reducing energy consumption of both fuels and feedstocks in the chemical industry[7],

7 M. S. Reisch, "Running Low on Gas," C&E News, July 14, 2003.

especially in the long term. Permanent technology changes, rather than short-term fixes, are needed to revolutionize the way energy is used in chemicals manufacture. New catalysts, for example, can dramatically increase product yield (the amount of product obtained from every barrel of oil) and reduce feedstock requirements. More efficient process heating technology can reduce the use of fuels and electricity. Alternatives to distillation could impact nearly 2 quads of energy use annually.

Chemical industry R&D is a component of the overall EERE strategy to improve energy efficiency worldwide and contributes to the goals outlined in the National Energy Policy. Specifically, improving energy efficiency in chemicals manufacture could directly reduce the amount of petroleum imported into the United States and will reduce the energy intensity of industry, two of EERE's top priorities.

Strategy for Improving Chemical Industry Energy Efficiency

The U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) leads the federal role in developing advanced energy-efficient and environmentally-friendly industrial technologies. The EERE Industrial Technologies Program (ITP) directs the Chemicals portfolio which seeks to boost efficiency and productivity of the energy- and resource-intensive chemical industry.

The ITP Chemicals portfolio responds to the unique challenges in the chemical industry by: 1) supporting collaborative, innovative R&D on chemical process technologies and design tools and methodologies; 2) promoting demonstrations of promising technologies; and 3) promoting the implementation of best practices and emerging technologies that will help the chemical industry achieve a 30 percent reduction in energy, water use, and toxic and pollutant dispersion per unit of output by 2020. The overall goal is to reduce energy use in the chemical industry by 322 trillion Btu per year in 2020.

ITP works in partnership with the Chemical Industry Vision2020 Technology Partnership (Vision2020, see http://www.ChemicalVision2020.org) to identify research priorities with broad applicability in the chemical industry on an ongoing basis. Vision2020 was formally established in 2001 to represent the needs of the entire chemical industry, bridging diverse interests and creating a unified voice. By partnering with Vision2020 and fostering collaboration with chemical industry trade organizations, the ITP leverages public and private resources and ensures the application of research results.

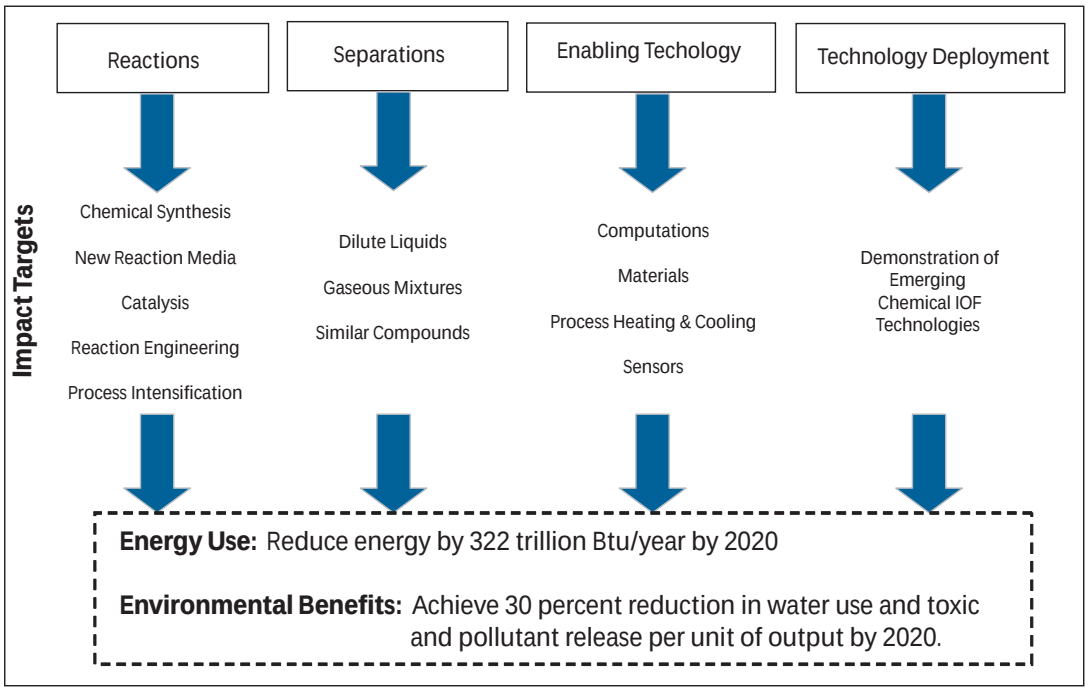
Vision2020 Members

- Air Products and Chemicals Incorporated
- American Chemical Society
- American Institute of Chemical Engineers
- BP
- Cargill
- Ciba Specialty Chemicals
- Council for Chemical Research
- The Dow Chemical Company
- Eastman Chemicals
- E.I. du Pont de Nemours and Company
- General Electric Company
- Honeywell International, Incorporated
- Materials Technology Institute of the Chemical Process Industries
- Praxair Incorporated
- Rohm and Haas Company

The ITP Chemicals portfolio strategy fostered the development of Vision2020 and created the impetus for the industry to develop a long-term vision and numerous roadmaps for diverse research areas (See project listing by topic area on page 7). ITP Chemicals portfolio solicitations reflect the priorities in the vision and roadmaps, as well as ITP's analysis of opportunities for energy savings, national priorities, and the appropriate federal role. To assure broad participation among chemical companies, ITP Chemicals portfolio solicitations are announced to the Chemicals portfolio Contacts database via email, in trade society publications, Web sites, meetings, the *Commerce Business Daily*, *FedBizOpps*, and the Chemicals portfolio Web site. Selection of projects follows merit based sound analysis using CPAT, a standardized Web-based procedure available online at the Chemicals portfolio Web site. This rigorous development and implementation process ensures targeted, competitive solicitations for pre-competitive R&D.

The ITP Chemicals portfolio strategy is designed to have the greatest impact on reducing chemical industry energy intensity. The strategy evolves over time as R&D projects are funded and completed, as new opportunities to have a significant impact on the industry are identified, and as national priorities change. ITP organizes its Chemicals portfolio into four categories: reactions, separations, enabling technologies, and technology deployment. Exhibit 3 shows the target areas of each of these research categories.

Exhibit 3
Process and Technology Improvements Target Energy Efficiency

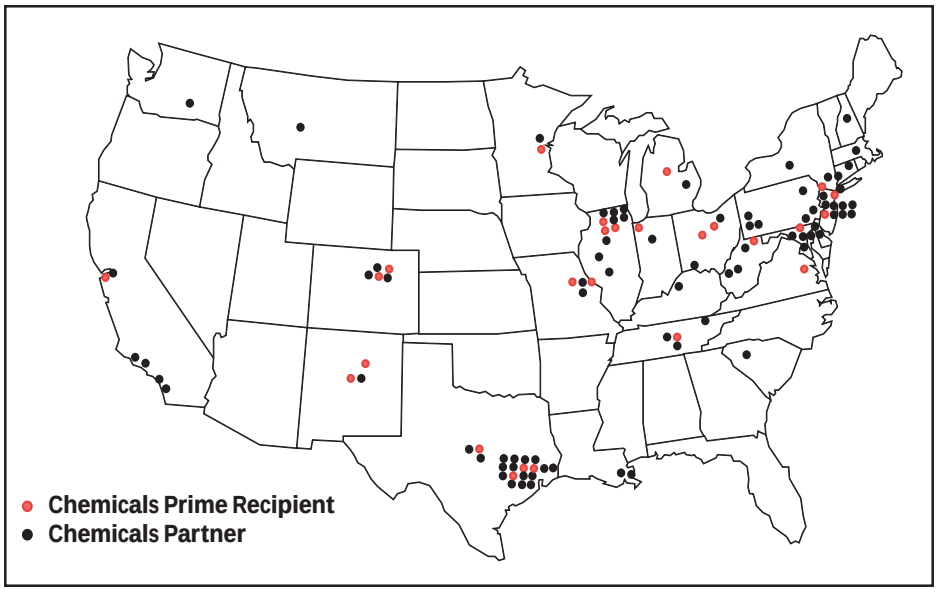


In FY 2004, the ITP Chemicals portfolio continued to transition to higher-risk, higher-impact research projects that have the opportunity to produce revolutionary improvements in chemical processing efficiency. In addition, ITP also submits and manages technical topics for the DOE Small Business and Innovation Research and Small Business Technology Transfer (SBIR/STTR) Program Solicitation each year relevant to the Chemicals portfolio (see http://sbir.er.doe.gov/sbir). Recent topic areas include nanotechnology applications in industrial chemistry, reactive separations, energy efficient membranes, materials for industrial energy systems, sensors and controls, and innovative waste heat recovery. ITP also encourages other EERE programs to fund R&D priorities of the chemical processing industries.

The projects in the portfolio have significant risk. The portfolio includes high-risk, high-return R&D, applied research, applied development, demonstrations, and technology delivery projects. Most projects in the portfolio address R&D needs in multiple chemical industry segments and chemical chains. R&D is conducted by large and small chemical companies, national laboratories, research organizations, and universities. Industry involvement accelerates the dissemination of research results and technology transfer.

Projects are distributed across the United States, with clustering at national laboratories and areas densely populated with chemical industry manufacturing facilities, such as Texas and the northeast. The map shows the distribution of projects throughout the country.

Exhibit 4
Active Chemicals Portfolio Projects Map



FY 2004 HIGHLIGHTS AND ACCOMPLISHMENTS

The ITP Chemicals portfolio supports a diverse portfolio of cost-shared, pre-competitive research that addresses high-risk, high-impact needs that have a broad application throughout the chemical industry. In fiscal year 2004, the Chemicals portfolio included 37 core-active projects – 12 projects were completed (see Exhibit 5) and 7 new projects have been selected to become part of the portfolio in FY 2004. The core projects, organized by research categories, are listed in Exhibit 6. The portfolio also includes 12 SBIR Phase II and STTR projects. In addition to the core portfolio, other EERE programs support projects that address key R&D priorities in the chemical processing industries (see Exhibit 7).

Factsheets describing projects in the Chemical portfolio are located on the Web site at http://www.eere.energy.gov/industry/chemicals.

In addition to sponsoring R&D, the ITP Chemicals portfolio achieved a number of noteworthy accomplishments in FY 2004. These accomplishments are described below:

R&D Highlights

Solicitations Conducted for Innovative Chemical Processing Technologies – ITP conducted two competitive solicitations in FY 2004, one for industry and one for national laboratories. Both solicitations primarily focused on catalytic oxidation and distillation technologies.

Exhibit 5
Chemicals Projects with Completed Government Funding in FY 2004

1. Membranes for Corrosive Oxidations, Argonne National Laboratory (Separations)
2. Mesoporous Membranes for Olefin Separation, Los Alamos National Laboratory (Separations)
3. Membranes for P-Xylene Separations, Sandia National Laboratories (Separations)
4. Autothermal Reformer, Kellogg Brown & Root (Reactions)
5. Ethylene Process Design Optimization, BP Amoco (Reactions)
6. High Throughput Catalyst Screening, TDA Research (Reactions)
7. Short Contact Time Residence Reactors, Sandia National Laboratories (Reactions)
8. Molecular Simulation for Chemical Industry, Sandia National Laboratories (Enabling-Computations)
9. Research Consortium for Multiphase Fluid Dynamics, Sandia National Laboratories (Enabling-Computations)
10. Solution Crystallization Modeling Tools, OLI Systems (Enabling-Computations)
11. Alloys for Ethylene Production, Oak Ridge National Laboratory (Enabling-Materials)
12. Distillation Column Flooding Predictor, 2nd Point Industries (Enabling-Sensors)

Exhibit 6
Core Chemicals Portfolio in FY 2004

Separations

1. Separation of Olefin/Paraffin Mixtures with Carrier Facilitated Membranes, Membrane Technology & Research, Inc.
2. Low-Cost Chemical Feedstocks Using an Improved and Energy-Efficient Natural Gas Liquids Removal Process, Gas Technology Institute
3. Advanced Membranes Technology Platform for Hydrocarbon Separations, Air Products, and Chemicals

Reactions

4. Production and Separation of Fermentation-Derived Acetic Acid, BP Chemical
5. Tackifier Dispersions to Make Pressure-Sensitive Adhesives, West Virginia University
6. Microchannel Reactor System Design, Stevens Institute of Technology
7. New Sustainable Chemistries for Low-VOC Coatings, Rohm & Haas Company
8. Microchannel Reactor System for Catalytic Hydrogenation of Olefins by High-Intensity Oxidation, Stevens Institute of Technology
9. Advances in Process Intensification Through Multifunctional Reactor Engineering, Chemical Research & Licensing Inc
10. Olefins by High-Intensity Oxidation, Velocys, Inc
11. A Novel Highly-Efficient and Economic Purification Process Revolutionizing PTA Production, GTC Technology
12. Enhanced Chemical Processing Using Dense Fluidized Beds, Millennium Chemicals

Enabling Technology

Computations

13. Computational Chemistry and Reaction Engineering Workbench, Colorado School of Mines
14. Distillation Column Modeling Tools, University of Texas and Oak Ridge National Labs

Materials

15. Chemical Industry Corrosion Management, Honeywell, Inc.
16. Alloy Selection System (ASSET), Shell
17. Chemical Industry Corrosion Management – A Comprehensive Information Management System (ASSET 2), Shell Global Technologies
18. Metal Dusting Phenomenon, Argonne National Laboratory

Process Heating and Cooling

19. Enhanced Heat Exchangers for Process Heaters, Gas Technology Institute

Sensors

20. Development of In-Situ Sensors for the Chemical Industry, Dow Chemical Co.
21. Distillation Column Flooding Predictor, 2nd Point Industries
22. Instrumentation for Multiphase Flow Measurement, Washington University at Saint Louis

Technology Deployment

23. Processes for the Production of Paraxylene that Utilize Waste Heat Powered Ammonia Absorption Refrigeration, BP
24. LPG Recovery with Ammonia Absorption Refrigeration, Giant Yorktown
25. Rotary Burner Demonstration, Calcpos
26. Process Heater Ultra Low Excess Air Control, Valero Energy

Exhibit 7
Examples of Other EERE Projects Relevant to the Chemical Industry

Advanced Industrial Materials Projects Relevant to Chemicals
- Advanced Chlor-Alkali Technology
- Advanced Composite Coatings
- Advanced Integration of Multi-Scale Mechanics and Welding Process Simulation in Weld Integrity Assessment
- Advanced Nanoporous Composite Materials for Industrial Heat Applications
- Advanced Thermoelectric Materials for Efficient Waste Heat Recovery in Process Industries
- Advanced Wear- and Corrosion-Resistant Systems through Laser Surface Alloying and Materials Simulation
- Combinatorial Methods for Alloy Design and Optimization
- Development of a New Class of Fe-3Cr-W(V) Ferritic Steels for Industrial Process Applications
- Development of Bulk, Nanocrystalline-Cemented Tungsten Carbide for Industrial Applications
- Development of Cost-Effective Ceramic and Refractory Components for Aluminum Melting and Casting
- Development of Materials Resistant to Metal Dusting Degradation
- Development of Stronger and More Reliable Cast Austenitic Stainless Steels
- Fracture Toughness and Strength in a New Class of Bainitic Chromium-Tungsten Steels
- High-Density Infrared Transient Liquid Coatings for Improved Wear and Corrosion Resistance
- High Performance Oxide-Dispersion Strengthened Tubes for Production of Industrial Chemicals
- Low-Temperature Surface Carburizing of Stainless Steels
- Novel Carbon Film for Next Generation Rotating Equipment Applications
- Novel Modified Zeolites for Energy Efficient Hydrocarbon Separations
- Physical and Numerical Analysis of Extrusion Process for BiMetallic Tubes
- Prediction of Corrosion of Advanced Materials and Fabricated Components
- Stress-Assisted Corrosion in Boiler Tubes
- Thermochemical Models and Databases for High Temperature Materials
- Ultrahigh Magnetic Field Processing of Materials
- Ultrananocrystaline Diamond Coatings for Pump Seals

Combustion Projects Relevant to Chemicals
- Integrated Process Heater System
- Development of an Innovative, Energy-Efficient, High Temperature Natural Gas-Fired Furnace
- Super Boiler: Packed Media/Transport Membrane Boiler Development and Demonstration
- Ultra-Low NOx Burners with FGR and Partial Reformer

Forest Products Projects Relevant to Chemicals
- Bubble Size Control to Improve Oxygen-Based Bleaching
- High Selectivity Oxygen Delignification
- Improved Recovery Boiler Performance Through Control of Combustion, Sulfur and Alkali Chemistry
- Increasing Yield and Quality of Low-Temperature, Low-Alkali Kraft Cooks
- Development of METHANE de-NOx® Reburning Process for Wood Waste, Sludge, and Biomass-Fired Stoker Burners
- Particle Formation and Deposition in Recovery Boilers

Mining Project Relevant to Chemicals
- In-Plant Testing of High-Efficiency Hydraulic Separators
- Reducing Energy Consumption for Water Pumping at Limestone Quarries

Petroleum Projects Relevant to Chemicals
- Energy-Saving Separations Technology for the Petroleum Refining Industry
- Micro-Gas Chromatography Controller
- Biocatalytic Desulfurization of Petroleum

Sensors and Controls Projects Relevant to Chemicals
- Advanced Wireless Sensors for the Industries of the Future
- Diagnostics and Control of Natural Gas-Fired Furnaces via Flame Image Analysis Using Machine Vision and Artificial Intelligence Techniques
- Distributed Wireless Multisensor Technologies – A Novel Approach to Reducing Motor Energy Usage
- Fiber-Optic Sensor for Industrial Process Measurement and Control
- Tunable Diode Lasers Sensors for Monitoring and Control of Harsh Combustion Environments
- Wireless and Sensing Solutions Advancing Industrial Efficiency

Inventions and Innovation Projects Relevant to Chemicals
- Insoluable Titanium-Lead Anode for Sulfate Electrolytes
- Chemically Inert Membranes for Separation of Solvent/Oil Mixtures

EERE/Fossil Energy Science Initiative
- Atomic-Scale Design of Cobalt Fischer-Tropsch Catalysts: A Combined Computational Chemistry Experiment and Microkinetics Modeling Approach
- Design Synthesis and Mechanistic Evaluation of Iron-Based Catalysis for Synthesis Gas Conversion to Fuels and Chemicals
- Separation of Fischer-Tropsch Wax Products from Ultra-Fine Iron Catalysts
- A Novel Polymer-Derived Nano-Ceramic for Ultrahigh Temperature MEMS

Four projects from the industry solicitation were awarded:

- Gold Catalyzed Cyclohexane Oxidation, Solutia, Inc.
- Heat-Integrated Distillation Through Use of Microchannel Technology, Velocys, Inc.
- Millisecond Oxidation of Alkanes, Rohm and Haas Co.
- Using Ionic Liquids in Selective Hydrocarbon Conversion Processes, California Institute of Technology

Three projects from the laboratory solicitation were awarded:

- Development of Highly-Selective Oxidation Catalysts by Atomic Layer Deposition, Argonne National Laboratory
- Ethylene via Ethane Oxidative Dehydrogenation, Oak Ridge National Laboratory

- Microchannel Catalytic Distillation for Efficient Chemical Manufacturing, Pacific Northwest National Laboratory

Successful Conclusion for Multi-Phase Fluid Dynamics Research Consortium – This consortium was established to support learning and fundamental research to better understand and model multi-phase flows. Its members include Chevron Texaco, Dow Chemical, Dow Corning, DuPont, ExxonMobil, Millennium Chemicals, Fluent, AEA Technology, seven universities, and six national laboratories. The team continues to provide improved software and insightful modeling techniques, and continues to educate the scientific community.

Alloy Selection and Corrosion Prediction System Software Entering Beta Testing – Data generation, compilation and thermochemical modeling have been completed, and the final version of the software has been released. Project partners are promoting the software through articles in trade publications and presentations at industry conferences. The system will greatly improve the ability to predict corrosion for high-temperature process equipment used in the petrochemical industries.

Dimpled-Tube Technology for Process Heaters Readied for Field Trial – The Gas Technology Institute has successfully completed bench-scale testing and selected BP's Cherry Point facility for field testing. The field test unit has been designed and will be fabricated and installed in FY 2005. This promising technology provides improved thermal efficiency without a significant increase in pressure drop.

Partnership Highlights

Chemical Industry R&D Roadmap for Nanomaterials by Design: From Fundamentals to Function Published – This roadmap, written for the chemical industry by a Vision2020 team, was published in December 2003 and was sponsored by ITP and the federal agencies participating in the National Nanotechnology Initiative. Nanomaterials present a tremendous energy saving opportunity for the U.S. chemical industry.

Chemical Peer Review Conducted – As part of ensuring stewardship of public funds, the ITP conducted an evaluation of research projects to assess performance, including progress towards technical, economic and market goals. This review was held in April 2004 in conjunction with the AIChE Spring Meeting. Meeting attendees heard presentations detailing ongoing research projects being conducted by industry, university, and national laboratory researchers in order to evaluate each project's progress, significance and relevance to the industry's needs.

Chemicals Portfolio Participated in ITP Corporate and NAS Peer Reviews - The Chemicals portfolio was reviewed as part of the ITP Corporate Peer Review that was held March 9-10, 2004. This Peer Review brought industry stakeholders and government partners together to review the mission, strategies and future direction of the Industrial Technologies Program, including a strategic overview of the Chemicals R&D portfolio. Subsequently, the National Academy of Sciences was briefed with similar presentations about ITP and is preparing a formal report of findings.

Advanced Analytic Tools Developed – To better select and manage R&D projects, two tools were significantly upgraded during FY 2004. The Chemicals Project Assessment Tool (CPAT) estimates future energy and environmental impacts, as well as the cost/benefit of projects. The Chemicals Portfolio Management Tool (CPMT) addresses risk and performance for each project. Significant efforts are being made to integrate and customize these tools into the proposal selection and portfolio review processes

Ionic Liquids Roadmap Published – The roadmap, entitled "Accelerating Ionic Liquid Commercialization: Research Needs to Advance New Technology" was published in June 2004. Ionic liquids offer the potential for ground-breaking changes to synthesis routes and unit operations in the chemical industry.

Bioseparations ChemPlus Project Identifies State-of-the-Art – Bioprocessing means using a living organism such as bacteria or yeast, or an enzyme secreted by the organism, for a chemical process. In some cases bioprocessing can be more efficient than a process normally carried out at a higher temperature. Given the copious amount of water currently required for bioprocessing, separations technology is the critical economic

driver for large-scale bioprocessing of chemical products. This project seeks to identify the state-of-the-art in separations technologies that could be applied in bioprocessing and to identify the R&D needed to make the technology more cost-effective.

The Plant Energy Profiler (PEP) Tool Begins Beta Testing – This tool will enable plant engineers to create a benchmark energy map that defines how much and where energy is used in individual facilities. The tool uses energy data developed through the chemical "energy footprint" as a starting point, and then allows users to input actual utility data and nameplate capacity to create a plant-specific energy map. A scorecard is ultimately created for each utility area and estimates energy losses, as well as potential opportunities for energy and cost savings. Users are then directed to a possible suite of other tools or technologies that could be used to achieve energy savings. During FY 2004, a third version of the beta test software was released and evaluated by three industrial partners.

Five Allied Partnerships Continue, Sixth Initiated – The American Institute of Chemical Engineers (AIChE), FMC Corporation, Millennium Chemicals Inc., Rohm & Haas, and Society of Plastics Industry continued to be Allied Partners in FY 2004, and 3M initiated an Allied Partnership. Allied Partners undertake voluntary activities that promote increased energy efficiency and productivity.

Green Power Market Development Group Exploring Biopower Options – Based on the Biopower Technical Assessment, Green Power is exploring three areas of opportunity: onsite biomass-to-energy, purchase agreements with biomass-to-electricity project developers, and options for purchasing the renewable energy certificates from projects generating electricity using biomass residues.

Improving Energy Efficiency Today

Plant-wide assessments (PWAs) are cost-shared assessments of plant utility and process-related energy efficiency opportunities across a plant. Plants are eligible through a competitive solicitation. In FY 2004, Solutia (Springfield, Massachusetts) was selected to receive funding for assessments, becoming the ninth chemical plant to receive such funding. In addition, Rohm & Haas (Deer Park, Texas) completed their assessment. Based on the experience of other manufacturers, these companies can expect to cut energy costs by anywhere from $1 million to $10 million per year. Success stories from PWAs are available on ITP's Web site at http://www.oit.doe.gov/bestpractices/case_studies_pwa.shtml.

Disseminating Research Results to Industry

ITP conducts numerous outreach activities to disseminate R&D results and encourages companies to reduce energy intensity of chemical processing. In addition, ITP participated in trade shows and annual meetings, and updated its Web site to be more consistent with other EERE Web sites and better highlight activities and opportunities. Emerging technologies of interest are shown in Exhibit 8 (following page). More information about ITP emerging and commercialized technologies of interest to the chemical industry can be found in ITP's "Impacts" document (http://www.pnl.gov/impacts).

Energy Analysis – Targeting Energy Efficiency

The **Energy Bandwidth Study** continued in FY 2004 to gain knowledge of inefficiencies for a number of the highest energy-consuming processes employed in the chemical industry. The "bandwidth" provides a snapshot of the energy losses that can potentially be recovered through improvements in technology. The bandwidth analysis is based on calculation of the energy and exergy losses associated with individual chemical processes. Exergy takes into account both the amount and quality of energy content of a stream (based on conditions and composition). The study looked at 25 different manufacturing processes for high volume chemicals, including ethylene and major derivatives, propylene, styrene, methanol, vinyl chloride, ammonia, p-xylene, nitric acid, terephthalic acid, acrylonitrile, cumene, formaldehyde, and others. The results identify top chemical targets for improvements in energy efficiency, identify key process steps where energy consumption is highest, and provide recommendations for new technology approaches.

The **Energy Footprint Study** of the chemical industry shows the flow of energy for heat and power

Exhibit 8
Emerging Chemical Technologies

(Factsheets describing projects in the Chemical portfolio are located on the Web site at http://www.eere.energy.gov/industry/chemicals)

Emerging Technologies are projects that are no longer receiving ITP funding, but are anticipated to be commercialized within the next three years. The Emerging Technologies include:

Reactions
1. Selective Oxidation of Aromatic Compounds
2. Novel Catalyst for CH4-CO Conversion
3. Membrane Reactor Designs for the Production of Olefins
4. Sonic-Assisted Membrane Processing

Separations
5. Membrane for P-Xylene Separation
6. Economic and Self-Sustaining Production of Saleable Products from Waste Anions Using Phase-Transfer Catalysis
7. Novel Low-Cost Zeolite Ceramic Membrane Module

Enabling Technologies
8. Alloys for Ethylene Production
9. Metal Dusting Phenomena
10. Mixed Solvent Corrosion
11. Computational Chemistry and Reaction Engineering Workbench
12. Molecular Simulation for the Chemical Industry
13. Accelerated Characterization of Polymer Properties

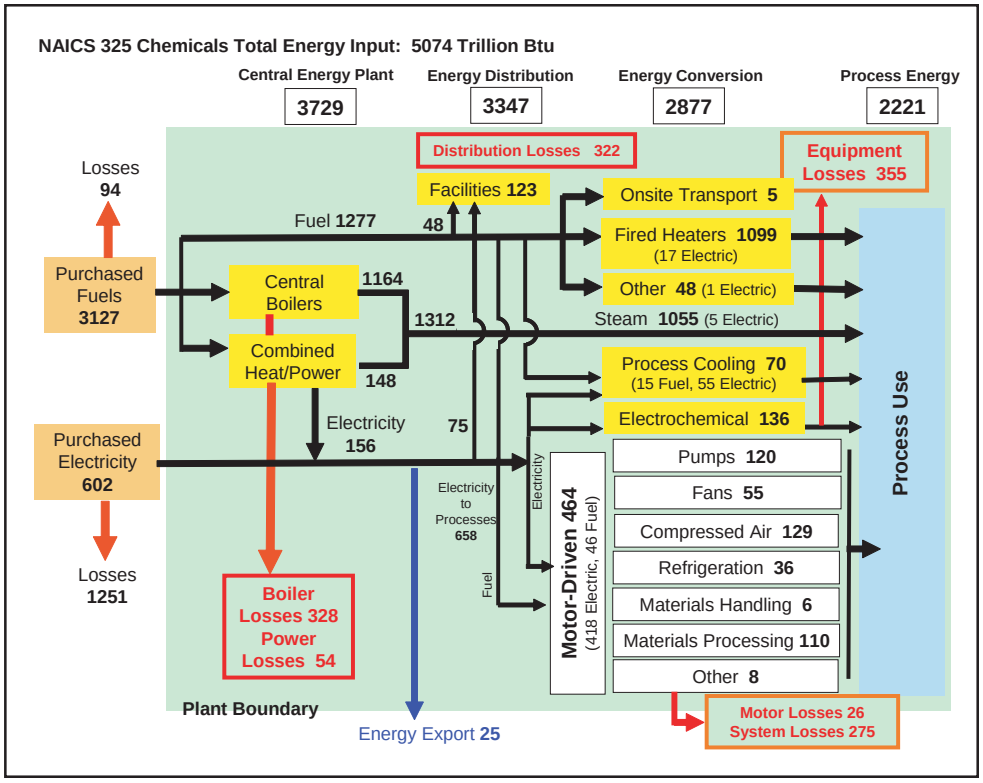
throughout the industry. The energy flow and losses are shown for energy supply, central energy generation/utilities, energy distribution, energy conversion, and process energy (see Exhibit 9).

The **Chemicals Project Assessment Tool (CPAT)** provides a measure of the potential commercial deployment of new processes, technologies, and practices. This tool projects energy, environmental, and economic benefits of for chemical technologies. Applicants to Chemicals portfolio solicitations are required to use CPAT.

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

The **Chemicals Portfolio Management Tool (CPMT)** is an internal tool that allows an assessment of the overall Chemicals portfolio. Risk and performance for each project is evaluated as part of the portfolio review process.

Exhibit 9
Energy Footprint for the U.S. Chemical Industry



TOOLS, PUBLICATIONS, AND RESOURCES AVAILABLE

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

Technology Vision2020: The U.S. Chemical Industry – This landmark document, developed with participation from over 300 companies and released in 1996, outlines a unified vision for the chemical industry in 2020 and identifies industry-wide goals for making more efficient use of energy and raw materials, better managing of the supply chain, and enhancing environmental performance (see http://www.ChemicalVision2020.org).

R&D Roadmaps – Groups of chemical companies have come together to jointly develop R&D agendas, or "roadmaps," that outline priority R&D needs in critical technology areas. To date, the industry has completed the roadmaps listed below.

- Biocatalysis
- Combinatorial Chemistry
- Computation Chemistry
- Computational Fluid Dynamics
- Ionic Liquids
- Materials of Construction
- Materials Technology
- Nanomaterials
- New Process Chemistry
- Reaction Engineering
- Separations

Fact Sheets and Success Stories – Publications describing research, development, and demonstration (RD&D) projects are available at http://eere.energy.gov/industry/chemicals/success.html.

Resources and Tools for Energy Efficiency and Cost Reduction Now CD – The CD provides tips and tools for spotting the biggest energy-saving opportunities in chemical plants today, as well as details on energy efficiency technologies. (contact the EERE Information Center at 877-337-3463 or eereic@ee.doe.gov).

Energy and Environmental Profile of the Chemical Industry – A detailed report benchmarking the energy and environmental characteristics of key technologies used in major processes of the chemical industry (see http://www.eere.energy.gov/industry/chemicals/tools_profile.html).

Beyond the Molecular Frontier – This National Research Council report examines the current state of knowledge across the chemical sciences and outlines the challenges for the 21st century (see http://www.oit.doe.gov/chemicals/pdfs/beyond_molecular_frontier.pdf).

Highlights of Biopower Technical Assessment – This report assesses the current status of the biopower industry for producing electricity and heat from biomass (see http://www.nrel.gov/docs/fy03osti/33502.pdf).

A Pilot Study of Energy Efficiency Performance Levels for the U.S. Chemical Industry: A Methodology for Determining Practical Minimum Energy Metrics – This study discusses preliminary results of a joint study with AIChE to develop and implement tools and methodologies to estimate energy performance levels (see http://www.bridgestos.org/PME_final_report.pdf).

Chemicals Project Assessment Tool (CPAT) – Software is available that can be used to estimate the potential energy, environmental, and economic benefits of a proposed new chemical technology (see http://www.bcstools.net/CPAT).

HOW TO GET INVOLVED AND CONTACT INFORMATION

Partnership Information

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

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

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

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

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

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

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

Access to Resources and Expertise

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

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

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

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

- ITP's qualified industrial energy specialists will work with your plant personnel to identify savings opportunities and train staff in the use of ITP software tools.

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

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

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

Where to Go to Get More Information

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

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

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

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

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

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

The Opportunities

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

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

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

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

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

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

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

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

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

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

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

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

Chemicals Industry of the Future

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

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

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