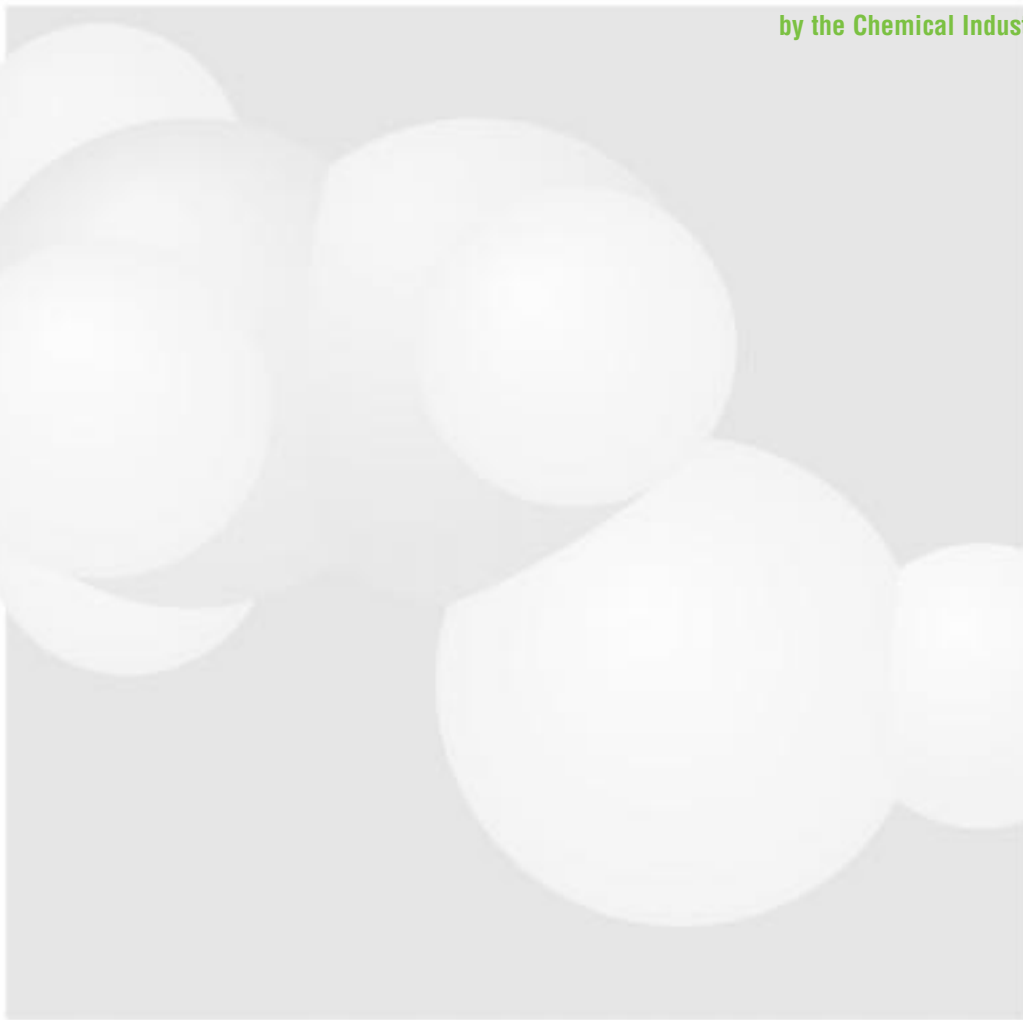


chemicals

Chemicals — Industry of the Future



A diverse portfolio of collaborative R&D efforts is accelerating development of high-priority enabling technologies identified by the Chemical Industry Vision 2020 Partnership.



Office of Industrial Technologies



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

Collaborative efforts stimulate R&D for a sustainable future

Why work together?

By participating in Industries of the Future partnerships, the chemical industry is working together to pursue innovative technology development that ensures future competitiveness and sustainable growth. Industrial partners benefit from:

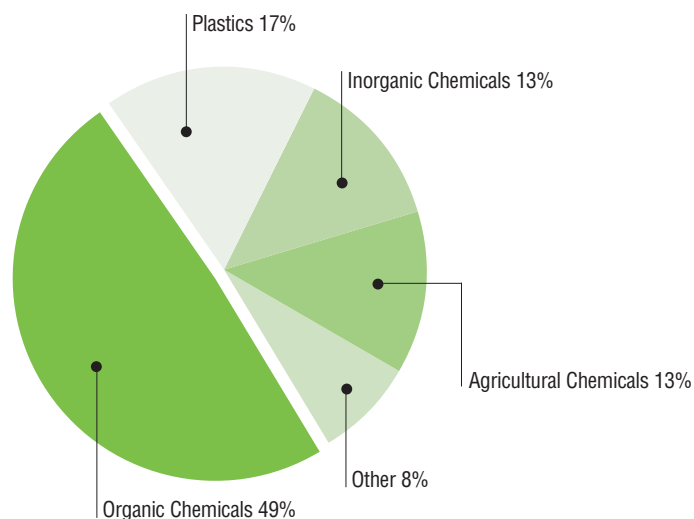
- Clearly defined R&D goals and pathways to their successful attainment
- A powerful common voice to guide government investments
- Expanded resources to accelerate R&D
- Multidisciplinary approaches to industry needs
- Cleaner, more energy-efficient technologies and processes, including use of alternative feedstocks
- Increased plant productivity and profitability now and in the future

Chemicals help serve fundamental societal needs for food, healthcare, and shelter, and many manufacturing sectors rely on chemicals to carry out their processes. With annual shipments valued at over \$347 billion, the U.S. chemical industry leads the world in chemical production. The industry employs more than a million workers and has achieved a trade surplus of over \$8.2 billion.

Energy is essential to the chemical industry both as a source of heat and power for plant operations and as a raw material for production. While the U.S. chemical industry has significantly reduced energy consumption in the past several decades, it still consumes 5.3 quads per year, or close to 25 percent of all manufacturing energy use.

In 1996, chemical industry leaders articulated a long-term vision for the industry, its markets, and its technology in the groundbreaking document *Technology Vision 2020—The U.S. Chemical Industry*. To achieve the vision, the industry joined the U.S. Department of Energy's Office of Industrial Technologies (OIT) in the innovative Industries of the Future partnership.

Energy Use in the Chemical Industry



Total Energy Use = 5.3 quads

Over half of the energy consumed by the chemical industry is used for heat and power; the remaining energy is used as feedstock.



Industry articulates R&D priorities

The U.S. chemical industry and OIT are working together to actively implement the Industries of the Future strategy. Participants in the Chemical Industry Vision 2020 Partnership—representatives from over 300 chemical companies and associations—are steering the direction for future research. Industry-led involvement ensures that R&D activities yield

the greatest benefits for the industry while improving energy efficiency and environmental quality. Through the Partnership, the chemical industry has created a powerful force for attracting and guiding private and public investments in new technology development.

Vision

*Technology Vision 2020—
The U.S. Chemical Industry*

This landmark 1996 document established long-term goals and research priorities based on key market, business, and environmental needs. Priorities were established in New Chemical Science and Engineering Technology, Supply Chain Management, Information Systems, and Manufacturing and Operations.

Focused Roadmap

Technology roadmaps in diverse, critical areas identify the priorities and performance targets for the chemical industry. Completed roadmaps include: *Biocatalysis, Computational Chemistry, Computational Fluid Dynamics, Materials of Construction, Materials Technology, and Separations.*

Implementation

To date, OIT has provided over \$36 million in cost-shared support for R&D projects that meet national goals for energy and the environment and give the U.S. chemical industry an edge in global markets. The current portfolio contains 38 chemical R&D projects conducted by collaborative partnerships.

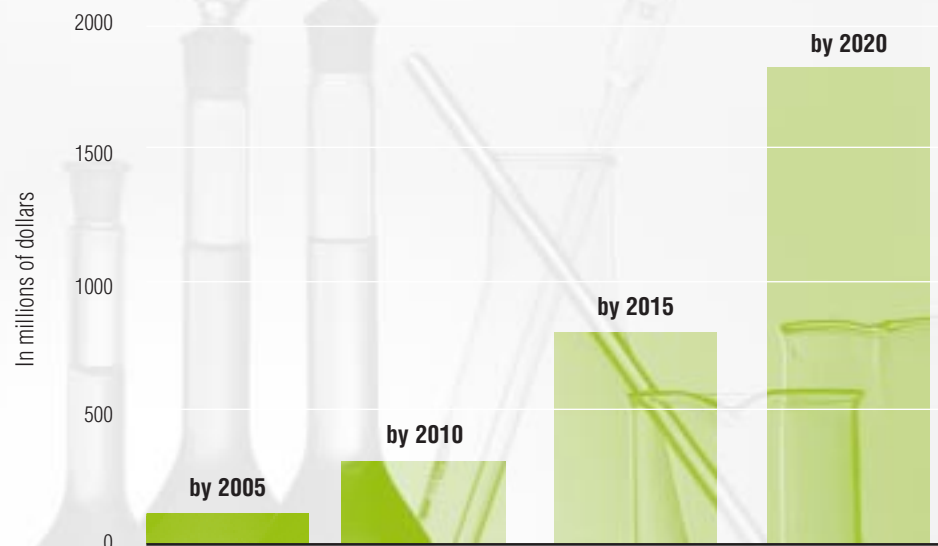
New Technology Strategy

The Chemical Industry Vision 2020 Partnership is strengthening and refocusing priorities, formalizing a steering group, increasing industry participation, and expanding roadmap scope. Such efforts ensure that Vision 2020 priorities meet the changing needs of industry.

Benefits to local communities and the nation:

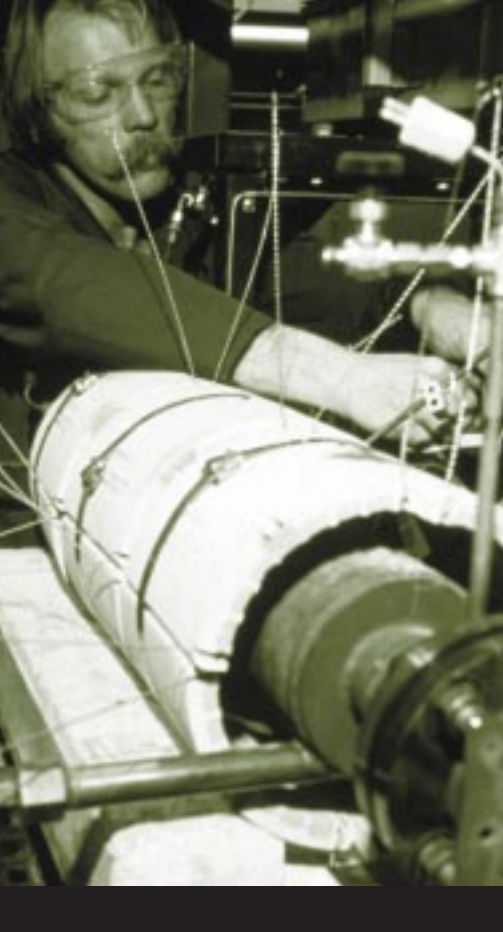
- Cleaner air
- Decreased greenhouse gas emissions
- Enhanced quality of food, health, housing, and transportation
- Improved energy security
- Increased exports

Projected Energy Cost Savings through Industries of the Future Partnerships



The Chemical Industry of the Future portfolio is helping companies cut energy consumption now and in the future.

Source: Based on an energy and economic analysis of the current Chemical Industry of the Future portfolio.



results

Industry-wide innovations through a diverse portfolio

Based on industry-defined priorities and recommendations, OIT awards cost-shared support to projects that will improve the industry's energy efficiency and global competitiveness. Collaborative teams from industry, universities, suppliers, national laboratories, and other organizations share the costs and the risks of R&D. To date, OIT has provided over \$36 million in funding to cost-shared projects.

Collaborative projects have allowed the industry to pursue a wide range of high-priority technology announcements. The current portfolio consists of 38 different collaborative projects.

Collaborative projects yield success

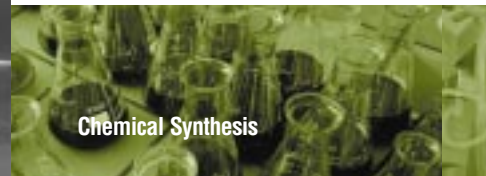
OIT and chemical industry partnerships are giving companies a competitive edge. To date, the Industries of the Future initiative has launched dozens of partnerships with companies to develop valuable new technology.

Commercialized projects are already providing the chemical industry with solutions to environmental and energy challenges.

Visit www.oit.doe.gov/chemicals to learn more about the projects in OIT's Chemical Industry of the Future portfolio.



The Current Chemical Industry



Chemical Synthesis

- Alkane Functionalization Catalysis
- Autothermal Reformer
- C1 Chemistry with Catalytic Partial Oxidation
- Catalytic Hydrogenation Retrofit Reactor
- Direct Production of Silicones from Sand
- Membrane Reactors for Olefin Production
- Nanoscale Catalysts
- Novel Catalyst for CH_4 -CO Conversion
- Oxidative Cracking of Hydrocarbons to Ethylene
- Phase Transfer Catalysis
- Selective Catalytic Oxidative Dehydrogenation of Alkanes to Olefins
- Selective Oxidation of Aromatic Compounds
- Sonic-Assisted Membranes

To date, the Chemical Industry of the Future portfolio consists of 38 R&D projects.

Technology advances through cost-shared R&D

Materials Technology Institute (MTI) is a cooperative research organization that is demonstrating the R&D opportunities made possible through cost-sharing. MTI has brought together an impressive list of partners for each of its five current Materials projects, one of which is described at right.

Multi-phase fluid dynamics research consortium

With OIT support, top industrial companies, national laboratories, and universities have joined forces to develop effective modeling tools for materials handling. Universities and national labs benefit from practical knowledge gained from working directly with companies, and the technology that emerges will help industry prevent problems associated with materials transport, the leading cause of downtime in petrochemical plants.

Partners include:

Industrial companies: Chevron, Dow Chemical, Dow Corning, DuPont, Exxon, Millennium Inorganic Chemicals, Siemens Westinghouse Power Corporation, AEA Technology, and Fluent

National laboratories: Los Alamos National Laboratory, National Energy Technology Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and Sandia National Laboratories

Universities: Clarkson University, Illinois Institute of Technology, Princeton University, Purdue University, University of Colorado, University of Michigan, and Washington University-St. Louis

Advanced Intermetallic Alloys for Ethylene Reactors

Coating the inside of ethylene furnace tubes with intermetallic alloy materials promises to reduce tube maintenance, a leading cause of inefficiency in ethylene production. Research is focusing on using these coatings to prevent two major problems with conventional tubes: carburization, which limits tube life, and coke formation, which requires costly plant shutdowns for steam decoking of the tubes. Fabrication methods and welding techniques are also being developed.

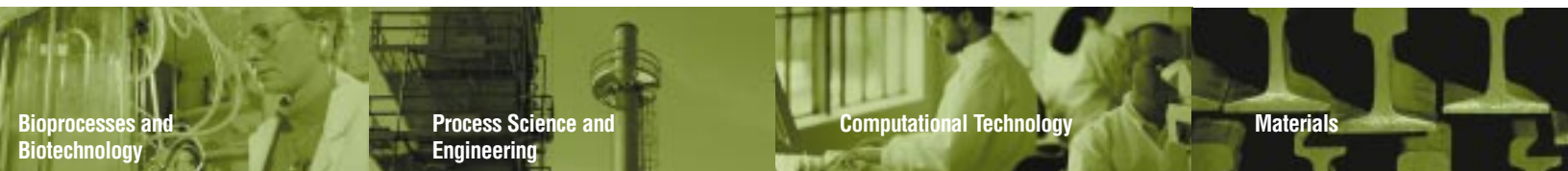
Partners

- Sandvik Steel Company
- Nooter Fabricators, Inc.
- Duraloy Technologies, Inc.
- Inco Alloys International, Inc.
- Oak Ridge National Laboratory

Benefits

- Extends tube service life
- Improves reaction conditions
- Reduces furnace downtime
- Lowers energy use

of the Future R&D Portfolio



Bioprocesses and Biotechnology

Process Science and Engineering

Computational Technology

Materials

Development of Non-Aqueous Enzymes
Plastics from Cellulose
Succinic Acid from Lignocellulose

Electrodeionization for Product Purification
Intelligent Extruder
Membrane for p-Xylene Separations
Membrane Module Tubesheet
Membranes for Oxidative Corrosive Reactions
Mesoporous Membranes for Olefin Separations
Nanofiltration of Solvents
Olefin Recovery from Chemical Waste Streams
Pressure Swing Adsorption for Product Recovery
Separation of Hydrogen/Light Hydrocarbon Gas Mixtures
Sorbents for Gas Separations
Zeolite Membrane

Instrumentation of Multi-Phase Flows
Integrated Workbench for Gas-Phase Thermodynamics
Molecular Simulation for Chemical Industry
Multi-phase Computational Dynamics
Simulating Industrial-Scale Flows

Alloys for Ethylene Production
Alloy Selection System
Corrosion Monitoring System
Mixed Solvent Corrosion
Metal Dusting Phenomena



resources

Expanding assistance to accelerate progress



Each year, OIT awards approximately \$5 million in cost-shared funding to new projects and an additional \$7.5 million to ongoing projects in the chemical portfolio. For its share, industry contributes approximately \$11 million annually to projects in the portfolio. All awards are based on a competitive solicitation process open to national laboratories and collaborative teams with members from industry, academia, and other sectors that hold a stake in the future of the chemical industry.

OIT's Chemical Industry of the Future supplements its own R&D budget by coordinating activities with other OIT programs that can help advance chemical industry goals. For example, OIT's Petroleum and Agriculture Teams have conducted R&D projects with carryover benefits for the chemical industry. The Inventions and Innovation program has provided funding to over 12 inventors of energy-efficient technologies for the chemical industry, and the Industrial Materials program has sponsored a number of projects with applications in the chemical industry.

Enabling Technologies

OIT works with industry, national laboratories, academia, and others to research, develop, and commercialize enabling technologies that can benefit the chemical industry. The **Industrial Materials** program funds projects that fill the need for materials that are light, strong, corrosion-resistant, and capable of withstanding high-temperature environments. Efforts in **Combustion** target clean, cost-effective technologies that will increase productivity, improve energy efficiency, reduce emissions, and enhance fuel flexibility. Research in **Sensors and Controls** addresses such challenges as improving sensor reach and accuracy in harsh environments and providing integrated, on-line measurement systems for operator-independent control of plant processes.

BestPractices

Through the BestPractices program, OIT helps chemical companies apply existing technologies to save money, cut emissions, and reduce waste. OIT alerts companies to opportunities for funding, tools, expertise, and potentially applicable technologies in OIT's extensive portfolio of crosscutting products and services.



OIT BestPractices plant-wide assessment of Rohm and Haas plant

A plant-wide assessment of the Rohm and Haas facility in Deer Park, Texas, revealed over 125 ways to reduce energy consumption. With OIT BestPractices program assistance, Rohm and Haas has saved \$50,000 per year in energy costs by modifying just three cooling tower pumps. To date, the facility has saved a total of \$15 million per year and improved overall energy efficiency by 17%.



BestPractices **plant-wide assessments** help chemical manufacturers develop a comprehensive strategy to increase efficiency, reduce emissions, and boost productivity. Up to \$100,000 in matching funds is awarded for each assessment through a competitive solicitation process. Akzo Nobel, one of the world's largest chemical companies, is currently participating in a plant-wide energy efficiency assessment program to reduce energy consumption by 20 percent. The assessment team is using pinch technology to monitor water systems, and other software is providing data on motors, compressed air, steam, and pump systems. Small to mid-sized manufacturers can take advantage of the **Industrial Assessment Centers** program, which provides no-charge assessments through a network of engineering universities.

Financial Assistance

OIT offers two Financial Assistance programs to boost technology development and application. The **Inventions and Innovation** program awards grants of up to \$200,000 to inventors of energy-efficient technologies. Grants are used to establish technical performance, conduct early development activities, and initiate commercialization activities. The second program, **NICE³** (National Competitiveness through Energy, Environment, and Economics), provides cost-shared grants of up to \$500,000 to industry-state partnerships for demonstrations of clean and energy-efficient technologies. Through NICE³, DuPont-Merck Pharmaceutical Co., the New Jersey Department of Environmental Protection, and Telesonic Ultrasonics have developed ultrasonic technology to clean tank surfaces without harmful solvents. The technology allows DuPont-Merck to reduce cleaning times, conserve petroleum feedstocks, eliminate VOC emissions, reduce energy use by 225 million Btu, and save \$350,000 per year.

State-Level Industries of the Future

State-Level Industries of the Future programs bring the energy, environmental, and economic benefits of industrial partnerships to the local level. The Chemical Industry of the Future is assisting states such as Alabama, Kentucky, Massachusetts, New Jersey, Texas, and West Virginia to implement State-Level Industries of the Future activities.

How to get involved

Through Industries of the Future partnerships, U.S. chemical companies reap the competitive advantages of more efficient and productive technologies, and, in turn, contribute to our nation's energy efficiency and environmental quality.

To participate:

- *Monitor the OIT Chemical Industry of the Future Web site for news and announcements of R&D solicitations, meetings and conferences, and research projects (www.oit.doe.gov/chemicals).*
- *Team with other organizations and respond to solicitations for cost-shared research.*
- *Begin saving energy, reducing costs, and cutting pollution today by participating in any of the BestPractices programs.*
- *Take advantage of OIT's extensive information resources, including fact sheets and case studies, training, software decision tools, technical advice, newsletters, and publications catalogs.*
- *Attend the biennial Industrial Energy Efficiency Symposium and Expo.*

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

www.oit.doe.gov/chemicals



For more information on the Chemical Industry of the Future,
contact the OIT Clearinghouse at (800) 862-2086
or visit www.oit.doe.gov/chemicals

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



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