

# ANNUAL REPORT

## 2003



ACCELERATING INNOVATION  
AND TECHNOLOGY DEVELOPMENT



VISION

WORKSHOPS

ROADMAPS

COLLABORATIVE R&D

TECHNOLOGY

COMMERCIAL USE

# Report Card 2003

Through the **Chemical Industry Vision2020 Technology Partnership**, chemical companies, government, and academia have worked together to achieve the following results in 2003:

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- ✓ **Established chemical industry consensus on pre-competitive R&D needs:**  
R&D priorities agreed upon by chemical companies at Vision2020 forums gained recognition and influence among universities, the federal research community, federal funding agencies, and chemical companies alike. By building consensus, Vision2020 is the voice of the industry.
- ✓ **Jointly analyzed R&D opportunities to create leading-edge research agendas:**  
From the consensus list of priorities, chemical companies identified topics for scoping studies to further elucidate opportunities for technology innovation. Chemical companies then worked with experts from National Laboratories and other organizations to complete those studies. The results are already influencing the market and helping to shape future initiatives that could benefit the entire chemical industry and society.
- ✓ **Gained knowledge and built strategic partnerships through networking:**  
Vision2020 provided expert forums that helped chemical companies advance their understanding of technical challenges and identify collaborative partnerships for problem-solving.
- ✓ **Leveraged government funding for R&D priorities—\$96 million in 2003:**  
Federal programs look to Vision2020 to help them leverage research investments in a manner that will expand economic growth, create new products, improve processes, increase energy efficiency, and enhance environmental performance. Citations of Vision2020 roadmaps and reports in government solicitations indicate the importance of these documents in helping to set the government's research agenda.

For more detailed information, see our website at [www.ChemicalVision2020.org](http://www.ChemicalVision2020.org)

| Priority Research Area                                              | Key Results in 2003                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Importance to the Chemical Industry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Nanomaterials and nanotechnology</b>                             | <ul style="list-style-type: none"> <li>✓ Published the <i>Chemical Industry R&amp;D Roadmap for Nanomaterials By Design: From Fundamentals to Function</i>, which recommends a research strategy to Federal agencies (see page 7).</li> <li>✓ Initiated study to estimate the economic and societal impacts of nanomaterials by design.</li> </ul>                                                                                                                                                                                        | Nanomaterials present a tremendous opportunity for the U.S. chemical industry to introduce a host of new products that could energize the economy, solve major societal problems, revitalize existing industries, and create entirely new businesses.                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Biomass-to-energy from forestry and/or farming</b>               | <ul style="list-style-type: none"> <li>✓ Published the <i>Highlights of Biopower Technical Assessment: State of the Industry and Technology</i> (see page 6).</li> <li>✓ Green Power Market Development Group signed renewable energy certificates for 265,000 MWh/year, most fueled by biomass residues.</li> </ul>                                                                                                                                                                                                                      | A sustainable, stable supply of biomass energy derived from environmentally sound forestry and/or farming transformed by efficient technology could provide a significant source of cost-effective renewable energy to chemical plants.                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Bio-separations</b>                                              | <ul style="list-style-type: none"> <li>✓ Report on <i>Separations—Direct Capture of Products from Biotransformations</i> led to DOE and SBIR solicitations targeting efficient separation technology and collaborative R&amp;D projects among small materials technology companies and National Laboratories (see page 6).</li> <li>✓ Initiated study of advances in separations science, engineering, and technology that offer novel solutions—such as new membrane and adsorption materials to drive equilibrium reactions.</li> </ul> | New bio-chemical separations technology is vital to improved productivity, energy efficiency, and environmental performance in chemical production.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Ionic liquids</b>                                                | <ul style="list-style-type: none"> <li>✓ Published a literature search on existing and potential industrial applications of ionic liquids.</li> <li>✓ 40 experts from around the world identified R&amp;D needs and barriers to commercialization at a workshop held in collaboration with the American Chemical Society [ACS] on September 11 and 12, 2003. A report will be available in early 2004.</li> </ul>                                                                                                                         | Ionic liquids (room-temperature liquid organic salts) offer the potential for ground-breaking changes to catalytic reactions, separations, electrochemistry, and combined reaction/separation unit operations. The thermodynamics and reaction kinetics of processes carried out in ionic liquids differ from those in conventional media. These differences, plus their non-detectable vapor pressures (no VOCs) and unique solvent properties, provide the possibility for new “green chemistry” processing.                                                                                                                          |
| <b>Utility energy mapping and benchmarking</b>                      | <ul style="list-style-type: none"> <li>✓ Software tool under development, the Plant Energy Profiler Tool, will enable plant engineers to quantify the amounts and costs of energy consumed by individual utility services and to identify resources for saving energy.</li> <li>✓ DuPont, Millennium, BASF, Rohm and Haas, and Reilly Industrial are beta testing the Profiler software. The tool, which was developed collaboratively by Vision2020, AIChE, and DOE/EERE, will be available in late 2004.</li> </ul>                     | Only 47% of the energy delivered to U.S. chemical plants is used productively for heat and power. Inefficiencies in on-site and off-site energy generation, transmission, conversion, and distribution account for energy losses of more than 2.7 quadrillion Btu (quads) annually, which is nearly enough energy to meet the needs of every house and commercial building in California for one year. More efficient energy systems—and more efficient system operation and maintenance—represent significant opportunities for improving productivity, reducing costs, and increasing energy efficiency in chemical plants worldwide. |
| <b>Innovative energy systems integrated into chemical processes</b> | <ul style="list-style-type: none"> <li>✓ Published <i>Opportunities for Innovative Energy Systems in the U.S. Chemical Industry</i>, which targets an often overlooked area of R&amp;D: integration of energy systems with chemical processing within plant boundaries.</li> <li>✓ Helped shape a DOE R&amp;D solicitation (expected in 2004).</li> </ul>                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Materials of construction</b>                                    | <ul style="list-style-type: none"> <li>✓ Published the <i>Roadmap for Process Equipment Materials Technology</i> to identify technology R&amp;D pathways and priorities.</li> <li>✓ Fostered the development of collaborative projects on high-temperature corrosion of metals and metal dusting with industrial partners, national laboratories, and academia.</li> </ul>                                                                                                                                                                | R&D to create new solutions and materials is essential to reducing equipment failure, lengthening the time between equipment shutdowns, extending operating life, and consequently reducing the use of energy and other raw materials.                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Computational methods for chemical and physical properties</b>   | <ul style="list-style-type: none"> <li>✓ Assessed improved computational methods for materials properties in terms of impacts on science and technology, the environment, and U.S. economy. The report (due for release in June 2004) will foster support for additional research in computational methods.</li> </ul>                                                                                                                                                                                                                    | The design of new, high-performance materials and efficient processes depends on leading-edge empirical research into why materials behave the way they do, as well as on computational methods and models of thermodynamics, quantum mechanics, and solid-state physics.                                                                                                                                                                                                                                                                                                                                                               |

# Leveraging Federal Resources

## Investing in the Chemical Industry

**Vision2020 successfully increased investments in R&D projects that should bring broad benefits to the chemical industry. By communicating the industry's priorities to government funding agencies, the partnership achieved results:**

- Chemical companies joined the DOE Office of Energy Efficiency and Renewable Energy (EERE) Industrial Technologies Program in co-funding over 53 R&D projects in separations, catalysis, computations, controls, process heating/cooling, and materials. (See [www.eere.energy.gov/industry/program\\_areas/](http://www.eere.energy.gov/industry/program_areas/).) Examples of projects and partners include the following:
  - *Distillation Column Modeling Tools*—Dow Chemical Company, Praxair, Sulzer Chemtech, Fluent Inc., Koch-Glitsch, University of Texas, Oak Ridge National Laboratory
  - *Mesoporous Membranes for Olefin Separations*—BP Chemicals, MEDAL Air Liquide
  - *Alloys for Ethylene Production*—Exxon Chemical Company, BP Chemicals, Shell Chemical Company, Air Products and Chemicals, Oak Ridge National Laboratory, and 6 other industry partners
- DOE's Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) programs provided a total of \$14.3 million in FY2003 for priority R&D topics identified by Vision2020. The projects addressed biobased products and bioenergy; catalysis R&D for chemical manufacturing and refinery operations; nanotechnology applications in industrial chemistry; nanomaterials for energy efficiency; and catalysts for petroleum refining and chemical synthesis (see [www.er.doe.gov/sbir/](http://www.er.doe.gov/sbir/)). 2004 funding is expected to increase in the following topic areas deemed priority by Vision2020:
  - Nanotechnology applications in industrial chemistry
  - Reactive separations
  - Energy-efficient membranes
  - Materials for industrial energy systems
  - Sensors and controls
  - Innovative waste-heat recovery
- The 16 Federal agencies participating in the National Nanotechnology Initiative co-sponsored the Vision2020 roadmap *Chemical Industry R&D Roadmap for Nanomaterials By Design: From Fundamentals to Function*.

**Vision2020 leveraged over \$96 million for chemical industry R&D in 2003**

**Vision2020 initiatives succeeded in obtaining \$50 million in Federal funds for priority research projects in 2003. Chemical companies provided \$46 million matching funds and also contributed time and expenses for Vision2020 planning and collaborative activities. These commitments are a clear indication of the strong public and private support for Vision2020 initiatives.**



## An Innovative Energy Systems Challenge

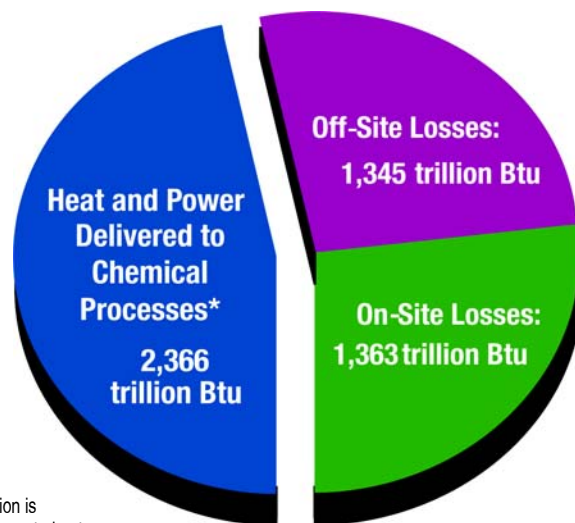
**Chemical companies will help select R&D projects to integrate innovative energy systems with chemical processing—an opportunity that could realize significant cost and energy savings**

The chemical industry loses over 53 percent of its total energy each year—more than 2.7 quadrillion Btu (quads)—to inefficient on- and off-site energy generation, transmission, conversion, and distribution.

To accelerate the development of more efficient energy systems, Vision2020 has embarked on a three-year effort with the DOE/EERE Industrial Technologies and Distributed Energy programs. *The Innovative Energy Systems Challenge* will support research, development, and demonstration of projects that enhance the productivity of energy systems integrated with chemical processing and energy supply within plant boundaries—an area currently overlooked by technology developers. Chemical companies purchase and use energy systems but typically do not invest in energy system R&D, which they do not consider a part of their core business. The goal of the Challenge is to commercialize one or more innovative energy systems that will have widespread application and yield significant energy savings for the chemical industry. Towards that end, Vision2020 has already completed a report titled *Opportunities for Innovative Energy Systems in the U.S. Chemical Industry*, which is available on the website. In 2004, Vision2020 will define specific technology performance criteria used in R&D proposal solicitations, advertise the opportunity to equipment and technology developers, and help select projects for investment. Vision2020 welcomes additional companies to participate in the Challenge.

For more information see [www.chemicalvision2020.org/utility.html](http://www.chemicalvision2020.org/utility.html).

**Total Energy Supply to the Industry:  
5,074 Trillion Btu**



\* A portion is lost as waste heat, flared gases, and by-products.



### Scoping Studies Identify Opportunities for Partnerships

DOE/EERE Industrial Technologies Program's Chemicals Plus provides Vision2020 access to experts in the DOE National Laboratories and other facilities to conduct scoping studies and other research projects. The goal is to identify research areas for pre-competitive collaboration and, ultimately, to develop innovative technology with broad benefits for the U.S. chemical industry.

For example, a Chemicals Plus project is estimating the impact of improved computational methods for materials properties on diverse industry sectors. Improved computational methods—quantitative descriptions of physical and chemical phenomena that are used to predict and manage material behavior—could realize enormous potential for energy savings, waste reduction, creation of U.S. jobs, and U.S. capital investment.

For more information see [www.chemicalvision2020.org/chemicalsplus.html](http://www.chemicalvision2020.org/chemicalsplus.html)

# Results: Targeting Technology Opportunities

## Advances in separations will be boon to bioprocessing

The Vision2020 report *Separations—Direct Capture of Products from Biotransformations* identified separations technology as a critical economic driver for large-scale bioprocessing of chemical products. Reducing the cost of separations could significantly expand the market for biobased products and processes. R&D investment and collaborations to advance the technology for the direct capture of valuable products from biotransformations could produce significant energy, environmental, security, and economic benefits for the U.S. chemical, petrochemical, and pharmaceutical industries. The most suitable topic areas for collaborations among industry, universities, and national laboratories include pre-competitive R&D in the design of new materials; removal of impurities; modification of genetic materials; and enhanced screening, modeling, and database development for separation materials, processes, and biocatalysis. The key to competitive bioprocessing will likely be to optimize biocatalysis and separations in an integrated process and simultaneously enhance both selectivity and flux while reducing impurities and fouling. This will require integrated R&D both in biocatalysts and in separations processes, such as membranes, ion exchange, extractants, and selective adsorbents. As a result of this initiative, several collaborations have been established to begin addressing these issues.

*Project participants include: Air Products and Chemicals, Cargill, The Dow Chemical Company, Dow Corning, DuPont, Eastman Chemical Company, ExxonMobil, Fairfield Resources, GlaxoSmithKline, Practical Sustainability, Praxair, Tate & Lyle, Argonne National Laboratory, and Oak Ridge National Laboratory.*

For more information see [www.chemicalvision2020.org/separations.html](http://www.chemicalvision2020.org/separations.html)

## Biopower options explored for chemical industry

Conclusions presented in Vision2020's new report *Highlights of Biopower Technical Assessment: State of the Industry and Technology* are of interest to those considering applications for chemical processing:

- Capital costs for bio-fed facilities are only 30% above those for coal-fired plants.
- Co-firing biomass waste with coal is the most economical option due to lower capital costs.
- Co-firing with readily available biomass fuels is currently the only option that is cost competitive with fossil-fueled facilities.
- Near-term projects to produce power from woody-type biomass would aid in the design of biorefinery waste treatment facilities.
- Of the available bio-based energy generation processes, gasification is the least technically developed.

The Green Power Market Development Group ([www.thegreenpowergroup.org](http://www.thegreenpowergroup.org)) is using the results of this report to explore three areas of opportunity: on-site biomass-to-energy (power and/or heat power); purchase agreements with biomass-to-electricity project developers; and options for purchasing the renewable energy certificates (RECs) from projects generating electricity using biomass residues.

*Project participants include: DuPont, Cargill Dow, General Electric, Interface, DOE/EERE, Department of Agriculture, National Bioenergy Center, Oak Ridge National Laboratory, World Resource Institute, Tate & Lyle, Green Power Market Development Group, and Ciba.*

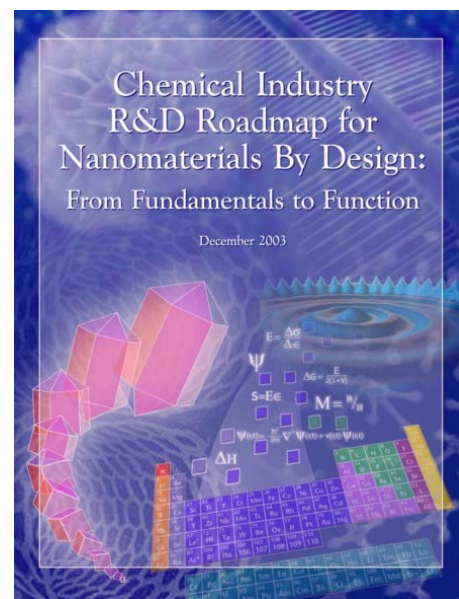
For more information see [www.chemicalvision2020.org/biomass.html](http://www.chemicalvision2020.org/biomass.html)

## Chemical companies reach consensus on strategy to achieve nanomaterials by design

Vision2020 published the *Chemical Industry R&D Roadmap for Nanomaterials By Design: From Fundamentals to Function* in December 2003. The roadmap was designed to stimulate public and private investment, help guide chemical industry R&D, and inform policy development. To accelerate widespread market entry of beneficial nanomaterials, the roadmap strategy suggests major innovations in the approach to nanomaterials R&D.

Nanomaterials on the market today have evolved largely through the discovery of new phenomena and subsequent application development. While individual researchers will continue that approach, the novel strategy proposes a broader, collaborative effort to systematically build fundamental knowledge of nanostructures and properties in tandem with the necessary tools, modeling, and manufacturing capabilities. The long-term goal is to develop the capability to design nanomaterials tailored to specific end-use functions, moving the United States to the forefront of this emerging science. Potential applications promise revolutionary advances in energy, computing, medicine, and other fields. Success will require closely integrated, multidisciplinary R&D from fundamentals to function, necessitating a cultural change in the way science and technology are pursued.

The roadmap identifies R&D priorities in four core areas (fundamental knowledge, tools, modeling, and manufacturing capabilities) and additional needs in key enabling areas, including effective protocols to assure health and safety in nanomaterials R&D, production, transport, use, and disposal; standards and informatics; technology transfer; education; and infrastructure.



**Smart investment in nanoscience will accelerate commercialization of safe, reliable, and cost-effective products that will benefit society and the economy.**

The interagency Nanoscale Science, Engineering, and Technology (NSET) Subcommittee that guides the U.S. Nanotechnology Initiative (NNI) asked Vision2020 to spearhead the development of a technology roadmap representing the chemical industry perspective on the NNI Grand Challenge for Nanostructured Materials by Design.

A twelve-member Vision2020 committee developed the roadmap based on in-depth analysis of preliminary results from the "Nanomaterials and the Chemical Industry R&D Roadmap Workshop" in September 2002, and extensive deliberation and review to reach consensus. Sponsors included Vision2020, NNI, and DOE/EERE.

*Project participants include: Air Products and Chemicals, DuPont, The Dow Chemical Company, General Electric, Praxair, Rohm and Haas Company, Oak Ridge National Laboratory, U.S. Naval Research Laboratory, and DOE/EERE.*

For more information see [www.chemicalvision2020.org/nanomaterialsroadmap.html](http://www.chemicalvision2020.org/nanomaterialsroadmap.html)

# Looking Forward: Activities Planned in 2004

## Aggressively foster federal funding in high-priority areas

Vision2020 will pursue priority, pre-competitive R&D to benefit the U.S. chemical industry. Initial activities for 2004 will expand and build new partnerships with federal programs to focus on R&D in the following six areas (examples provided in italics).

### Technology for Alternative Energy Production, Storage, & Transmission

*Solar alternatives*  
*Biomass power*  
*Hydrogen production & storage*  
*Robust stationary fuel cells*  
*Microturbines*  
*CO<sub>2</sub> sequestration*  
*Cost and net energy assessments for energy alternatives*

### Separations

*Low-energy separation with reduced capital costs; membranes*  
*Hybrid separation systems*  
*Aqueous separation*

### New Materials

*Bio-based materials*  
*Nanomaterials*  
*Coatings & films*

### Alternative Fossil-Based Feedstocks & Chemistries

*Gasification; Synthesis gas*  
*Remote methane; Methane activation & coupling*  
*Control of selective oxidation*  
*Paraffins; Selective conversion of paraffins*

### Energy-Efficient Process Alternatives

*Process intensification*  
*Heat integration*  
*Low-temperature heat recovery systems*  
*Homogeneous catalyst recovery and reuse*  
*Biocatalysts*

### Cross Cutting Capabilities For Research and Design

*High-throughput experimental approaches for design*  
*Modeling methods and tools for properties of materials*  
*Databases and protocols*  
*Interfacial science*  
*Tool for quick assessment of energy efficiency potentials*

## Help to implement the *Chemical Industry R&D Roadmap for Nanomaterials By Design: From Fundamentals to Function*

Vision2020 Technical Subcommittees will pursue diverse nanotechnology activities:

- Work with NSET to develop an effective way for NSET and the U.S. chemical industry to work together in promoting adoption of the roadmap as a core strategy for NNI's Grand Challenge in Nanostructured Materials by Design, and in fostering effective roadmap implementation.
- Lead an effort to analyze the potential impacts of Nanomaterials By Design on energy efficiency, waste reduction, productivity, and economic competitiveness in the chemical and allied industries.

## Communicate chemical industry research priorities to Federal agencies

The Vision2020 Steering Committee will hold tactical discussions on the pre-competitive research needs of the chemical industry. After reaching consensus, Vision2020 will provide the results to Federal funding agencies.

## Work with ACC to reduce greenhouse gas emissions

Vision2020 will work with the American Chemistry Council (ACC) to help fulfill the chemical industry's commitment to the President's Global Climate Business Challenge (also called Climate VISION). Specifically, ACC has asked Vision2020 for input on technology options to reduce greenhouse gas emissions. ACC is working with the DOE/EERE Industrial Technologies Program to reduce the industry's overall greenhouse gas intensity 18% by 2012 (from 1990 levels).



## **Encourage participation in the Innovative Energy Systems Challenge**

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Vision2020 will publicize the R&D challenge solicitation and encourage technology developers and others to submit proposals for enhancing the productivity of energy systems used throughout the chemical industry. Vision2020 will be involved in selecting R&D projects to ensure that the resulting target technologies deliver real benefits to the chemical industry.

## **Foster research on material properties**

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Vision2020 is a co-sponsor of the Tenth International Conference on Properties and Phase Equilibria for Product and Process Design, a premier gathering of scientists and engineers from around the world. Held in the United States for the first time in nine years, this conference in May 2004 represents a unique opportunity to organize industry-university research collaborations (see [www.engconfintl.org/4aa.html](http://www.engconfintl.org/4aa.html)).

## **Represent the chemical industry**

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Vision2020 is invited to represent the interests of the chemical industry at diverse events sponsored by government, industry, and other organizations throughout the year. For example, Vision2020 plans to participate in the following activities:

- Grand Challenges Workshop on Sustainability, organized by the National Research Council of the National Academies in collaboration with NIST, NSF, AIChE, and others in the Fall of 2004.
- 2nd International Conference on Green and Sustainable Chemistry in June 2005.
- Council on Competitiveness's Initiative on High Productivity Computing Systems and Competitiveness.

## **Pursue R&D results through Technical Subcommittees**

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Vision2020 Technical Subcommittees will continue to pursue projects already underway in bio-separations, energy from biomass, utility energy use mapping, nanotechnology, process equipment materials technology, and computations, as well as new projects in areas to be identified. New subcommittee activities in 2004 include the following:

- In collaboration with the agriculture industry, explore opportunities for using chemical building blocks derived from the oil fraction of plant/crop-based feedstocks.
- Investigate opportunities and approaches to achieve by-product synergies among companies by tracking achievements of the U.S. Business Council for Sustainable Development and case studies from member companies.

## **Network to build strategic partnerships**

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Knowledge gained through participation in Vision2020 helps companies better understand technical challenges and identify collaborative partnerships for problem-solving. Vision2020's strength is the diverse companies participating on its Steering Committee, technical subcommittees, and other activities. The number and diversity of chemical companies participating in Vision2020 activities will expand further in 2004.

# About Vision2020

## Vision2020 brings chemical companies, academia, and government together

Investing in innovative technology is one of the most effective means to ensure long-term competitiveness in the chemical industry. In today's competitive environment, however, short-term financial expectations and the complexity of research limit a company's ability to independently develop needed technologies. As a result, chemical companies have begun to share the risks and costs of research through collaboration, marking a major milestone for this fiercely competitive industry.

### Participating Companies Reap Benefits

- Reducing risks and costs of complex, multidisciplinary R&D
- Leveraging and guiding government R&D investments
- Understanding long-term technology needs and trends
- Gaining access to top scientific expertise and facilities
- Forming collaborative technology relationships and teams to respond to government solicitations

The **Chemical Industry Vision2020 Technology Partnership (Vision2020)** accelerates innovation and technology development in the chemical industry. By bringing together industry, academia, and government on collaborative research and development (R&D) projects, we reduce the risks and enhance the probability of success. Vision 2020 leverages financial and technical resources to establish R&D collaborations in areas of promising or emerging technologies that offer broad benefits for the industry. Participating companies work together toward common goals to protect the economic interests of shareholders and to foster a sustainable, internationally competitive chemical industry characterized by continued economic growth, new products, improved processes, and environmental responsibility.

Through collaborative efforts, Vision2020 fosters revolutionary technology innovation. Stakeholders identify common problems and leverage resources to develop the critical enabling technologies of the future. To help maintain U.S. leadership as the world's largest chemical producer, Vision2020 performs the following functions:

- Organizes forums to reach consensus on priority pre-competitive R&D needs
- Provides guidance for government R&D investments
- Fosters development of research collaborations

### Technology Advances Propel the Growth of the U.S. Chemical Industry and the U.S. Economy

A robust U.S. chemical industry is critically important to the U.S. economy. Chemicals are essential to millions of consumer goods and enable hi-tech advances in our aerospace, computing, and telecommunications industries. Growth of the chemical industry is sustained by technology advances, including the development of basic enabling technology. Partnership among government, industry, and academia is essential to technology advancement and maintaining our competitive edge in a rapidly expanding global market. Federally cost-shared research builds the foundation for future innovation, boosting competitiveness and improving energy and environmental performance throughout the entire economy.

#### Chemical Industry Snapshot

|                        |                 |
|------------------------|-----------------|
| Percent of Annual GDP  | 2.0%            |
| Value of Shipments     | \$458 billion   |
| Employment             | 1.04 million    |
| Capital Expenditures   | \$27.1 billion  |
| Net Trade Balance      | - \$5.0 billion |
| Net Energy Consumption | 6.5 quads       |

Vision 2020 develops and maintains technology roadmaps that establish consensus on R&D priorities. These roadmaps are powerful tools for guiding academic and government R&D investments that can benefit the entire industry. Vision2020 also publishes reports on diverse topics of broad interest to the chemical industry.

Publications on the following topics are available at [www.ChemicalVision2020.org](http://www.ChemicalVision2020.org):

- Agile Manufacturing
- Biocatalysis
- Biopower
- Catalysis
- Combinatorial Chemistry
- Computational Chemistry
- Computational Fluid Dynamics
- Energy Systems
- Ionic Liquids
- Materials of Construction
- Materials Technology
- Nanomaterials
- New Process Chemistry
- Process Measurement and Control
- Process Equipment Materials Technology
- Reaction Engineering
- Separations

## The Steering Committee guides the program

The Vision2020 Steering Committee meets quarterly to plan, coordinate, prioritize, and initiate activities for the benefit of all stakeholders—industry, academia, and the public. Member companies have pledged their time and resources to guide the partnership, and also contribute \$5,000 annually to cover organization operation costs.

### Steering Committee Members:

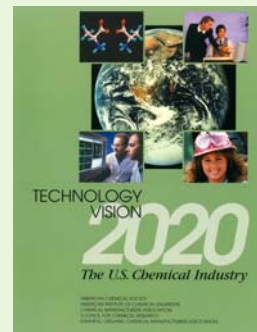
- Air Products and Chemicals Inc.
- BP
- Cargill
- Ciba Speciality Chemicals
- The Dow Chemical Company
- Eastman Chemical Company
- Honeywell International Inc.
- E.I. du Pont de Nemours and Company
- General Electric Company
- Praxair, Inc.
- Rohm and Haas Company
- American Chemical Society
- American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

The Vision2020 Steering Committee will implement the planned activities in 2004 and respond to opportunities that arise during the year.

Your chemical company can become a member and/or participate on Technical Subcommittees.

### For more information, contact:

Jack Solomon,  
Chair of the Vision2020 Steering Committee  
and Director of Technology Planning at Praxair, Inc.  
(203) 837-2164  
[Jack.Solomon@praxair.com](mailto:Jack.Solomon@praxair.com)



## How Vision2020 Came to Be

In 1994, the White House Office of Science and Technology Policy requested an industrial perspective on how the U.S. government could better allocate R&D funding to advance the manufacturing base of the U.S. economy. In response, chemical industry leaders created the report, *Technology Vision 2020: The U.S. Chemical Industry*, which spawned the creation of Vision2020.

# Vision2020 Participation in 2003

3D-ID  
3M  
Adapco Group  
AEA Technology  
Air Products and Chemicals, Inc.  
Akzo Nobel Chemicals  
Allegheny Ludlum  
Amoco  
Archer Daniels Midland  
Armour Associates, Ltd.  
AspenTech  
Avesta Sheffield  
BASF Corp.  
Bayer Corporation  
BP Chemicals  
Cargill-Dow  
Caterpillar  
Celanese  
Chem Tech Research Organization  
ChevronTexaco  
Ciba Geigy  
Ciba Specialty Chemicals  
Colgate-Palmolive  
Creusot-Loire  
Cytec Industries, Inc.  
DACA Instruments  
DASF  
Degussa Corp.  
The Dow Chemical Company  
DSM NV, International  
Duraloy Specialty Metals  
E.I. du Pont de Nemours and Co.  
Eastman Chemical Co.  
Ecole Polytech de Montreal  
Eli Lilly  
Energy Concepts Co.  
Equistar  
ExxonMobil  
Fairfield  
Fluent, Inc.  
Fluor Daniel  
FMC Corporation  
Ford Motor Company

|                                                |           |
|------------------------------------------------|-----------|
| <b>Companies</b>                               | <b>98</b> |
| <b>Universities</b>                            | <b>22</b> |
| <b>Government Offices<br/>and Laboratories</b> | <b>11</b> |
| <b>Organizations</b>                           | <b>11</b> |

Foster Wheeler  
Gaussian, Inc.  
General Electric Corp.  
GlaxoSmithKline  
Haynes  
Haynes International  
Honeywell International Inc.  
HumbersideSolutions  
Inco Alloys  
Integrated Genomics  
Interface  
Johnson Mathey  
KCC Process Equipment  
KEMA  
Koch-Glitsch  
Krupp VDM Technologies  
Lorentzian  
Materials Methods  
MC Research  
Medal Air Liquide  
Millennium  
Nanomaterials Research  
National Starch  
Nippon  
Neville Chemical Corp.  
Nooter Fabricators  
Nova Corporation  
OLI Systems  
Particulate Solids Research  
PhotoSense LLC  
Praxair, Inc.

Prime Separations  
Reaction Design  
Reilly Industries Inc.  
Rohm and Haas Company  
Rolled Alloys  
Sachem, Inc.  
Sandvik Steel  
Shell  
Siemens Westinghouse  
Special Metals Corp.  
SRI  
Sulzer  
Sulzer Chemtech  
Tate & Lyle  
TDA Research  
Texaco, Inc.  
United Technologies  
UOP LLC  
Velocys, Inc.  
W. R. Grace Co.  
Westvaco  
Whittaker Materials Engineering  
Colorado School of Mines  
Ecole Polytechnique de Montreal  
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Texas State University  
University of Notre Dame  
University of Colorado  
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University of Minnesota  
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Washington University  
Wesleyan University  
Yokohama National University  
Argonne National Laboratory  
Los Alamos National Laboratory  
National Energy Technology Laboratory  
National Institute of Standards  
and Technology  
National Nanotechnology Initiative  
National Renewable Energy Laboratory  
Naval Research Laboratory  
Oak Ridge National Laboratory  
Department of Energy/ Office of Energy  
Efficiency and Renewable Energy  
Pacific Northwest National Laboratory  
Sandia National Laboratory  
American Institute of  
Chemical Engineers  
American Chemical Society  
Center for Waste Reduction  
Technologies  
CoMSE  
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