Glass — Industry of the Future

The glass industry is developing, demonstrating, and deploying advanced technology as a result of active participation in the Industries of the Future partnership.
The U.S. glass industry is a world leader in the production of flat, fiber, container, and specialty glass products. With annual shipments of slightly more than 20 million tons, valued at $27 billion, the industry employs 150,000 people and has significant operations in numerous states. The high temperatures required to melt sand and other materials make the glass industry one of the most energy-intensive industries in the manufacturing sector.

In 1996, leaders in the glass industry joined in a unique partnership with the U.S. Department of Energy’s Office of Industrial Technologies (OIT) to foster the development and use of advanced technologies and processes. The partnership was unique since at the time there was no single organization that represented the entire glass industry. The Industries of the Future partnership has helped effectively position the U.S. glass industry for continuing prosperity while advancing national energy efficiency and environmental goals.

“\textit{The American glass industry can continue to lead the international community in the sustainable development and production of glass products in an ecologically responsible manner.}”

\textit{Glass: A Clear Vision for a Bright Future}

### Energy Sources for Glass

- **Natural Gas**: 80%
- **Electricity**: 17%
- **Other**: 3%

**Total Energy Use = 249 trillion Btu**

The glass industry relies predominantly on natural gas to meet its energy needs.

\textit{Source: EIA, MECS, 1994}
Industry drives the process

The U.S. glass industry is actively implementing the Industries of the Future strategy through the leadership of the Glass Manufacturing Industry Council (GMIC)—which was formed in 1998 as a result of the partnership activities and which represents all sectors of the glass industry. By reaching consensus on common goals and priorities, the industry has created a powerful force for attracting and guiding public and private investment in new technology development. As successes occur, the partnership is taking an active role to ensure advances are made available to the industry—while continuing to pursue other promising technologies.

**Vision**

*Glass: A Clear Vision for a Bright Future*

The 1996 document established long-term goals and broad research priorities based on key business, market, and environmental trends.

**Roadmap**

Industry-led subcommittees working through the GMIC interact regularly to refine research priorities, issue proposal requests, rank recommended proposals for funding, and review ongoing projects.

**Implementation**

To date, OIT has provided cost-shared support for around 25 R&D projects proposed by collaborative partnerships to address industry-defined priorities and meet national goals for energy and the environment.

**Renewed Commitment**

The industry reaffirmed its commitment to the partnership by signing a second compact with DOE in 1999, which emphasized the role that the GMIC would have in implementing the partnership.

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### Glass Industry – Energy Use by Sector

The container glass sector produces the most glass by weight and also uses the most energy.

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**Benefits to local communities and the nation:**

- A cleaner environment
- Improved national energy security
- Reduced emissions of gases implicated in global climate change

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**Source:** EIA, MECS, 1994
Improving industry performance

OIT awards cost-shared support to projects that will improve the glass industry’s energy efficiency and global competitiveness, based on industry-defined priorities and recommendations. Collaborative teams from industry, national laboratories, suppliers, universities, and other organizations share the costs and risks of R&D.

To date, OIT’s Glass Team has supported approximately 25 projects, worth a total of $22 million in OIT funding. The industry cost-share has been about $10 million. A majority of the projects relate to the glass furnace—which easily accounts for the largest share of energy use in glass processing and is used in all sectors of the glass industry.

Demonstrating success

Of the technologies supported by the partnership to date, two have already become commercial successes, and three others are currently in the demonstration phase, attaining promising results. Among commercial successes, Oxygen-Enriched Air Staging is currently in use at several container glass plants and has a measured reduction in NOx emissions while maintaining consistent quality and increasing productivity. Another commercial success, an Advanced Combustion Space Model, has been licensed for distribution and is currently in use in three glass sectors to analyze potential impacts of combustion system adjustments and evaluate furnace designs.

Oxygen-Enriched Air Staging Concept for Endport Furnaces

Oxygen-Enriched Air Staging uses a two-stage process to reduce NOx formation. The amount of air entering the furnace is reduced, which not only reduces NOx formation but also yields incomplete combustion. Therefore, oxygen or oxygen-enriched air is injected into the furnace near the exhaust port to complete combustion and heat release.
Pursuing industry priorities

Through the Glass Team, industry plays a central role in focusing near-term and long-term research investments. Industry-led subcommittees for four technical focus areas—Production Efficiency, Energy Efficiency, Environment, and Innovative Uses—work with DOE to conduct solicitations, merit reviews of all incoming proposals, and technical reviews of all ongoing RD&D projects. OIT makes the final selection for new R&D awards based on ranked lists from these subcommittees.

In addition, the partnership has created an innovative program—known as GPLUS—for glass manufacturers belonging to the GMIC. Through this program, individual companies work directly with the national laboratories on industry-defined projects that tap the unique capabilities offered in the national laboratory system.

Research and Development Projects

- **High-Luminosity, Low-NOx Burner**
  Partners have developed a novel burner that increases luminosity and radiant heat transfer. It will increase thermal efficiency and reduce energy use. The burner has reached the commercial demonstration stage. Partners in the project are Gas Technology Institute, New York State Energy Research and Development Agency, Combustion Tec, and Owens Corning.

- **Batch Preparation and Charging**
  - Integrated Batch and Cullet System Measurement and Control of Glass Feedstocks
  - In-House Recovery and Recycling of Glass from Glass Manufacturing Waste

- **Melting and Refining**
  - Molybdenum Disilicide Composites for Glass Processing Sensors
  - Redox State Sensor Technology in Glass Melts
  - Diagnostics and Modeling of Corrosion of Superstructure Refractories in Cyl-D-Fuel Glass Furnaces
  - Glass Furnace Combustion and Melting Test Facility
  - Development and Validation of a Coupled Combustion Space/Glass Bath Furnace Simulation
  - Improved Refractories for Glass
  - Development of Advanced Combustion Space Models
  - High-Luminosity, Low-NOx Burner
  - Modeling of Glassmaking Processes
  - Monitoring and Control Technologies in Glass Melting Furnaces

- **Forming**
  - Auto Glass Process Control
  - Advanced Process Control for Glass Fabrication

- **Finishing**
  - Enhanced Cutting and Finishing of Handglass
  - Online Sensor System for Monitoring the Cure of Coatings on Glass Optical Fibers and Assemblies
  - Development of Process Optimization Strategies, Models and Chemical Databases for On-Line Coatings of Float Glass
  - Integrated Ion Exchange Systems for High-Strength Glass Products

Visit [www.oit.doe.gov/glass](http://www.oit.doe.gov/glass) to learn more about the projects in OIT’s Glass portfolio.
OIT awards approximately $4 million annually to new and ongoing cost-shared projects that benefit the glass industry. Awards are based on a competitive solicitation process open to collaborative industry teams and the national laboratories as prime contractors. Universities and other organizations can participate on the collaborative teams.

OIT’s Glass Team supplements its own R&D budget by coordinating activities with other OIT programs that can help advanced glass industry goals. OIT’s program in Sensors and Controls, for example, has funded the development of a process control system using sensor fusion. OIT’s Steel Team also funds R&D in high-temperature processing, some of which is adaptable to the glass industry. Emerging technologies gain credibility through demonstrations funded under OIT’s NICE³ (National Industrial Competitiveness through Energy, Environment, and Economics) program.

OIT programs of value to the glass industry include research and development of Enabling Technologies, BestPractices initiatives, and Financial Assistance.

Enabling Technologies

OIT works with industry, the national laboratories, academia, and others to research, develop, and commercialize enabling materials that can benefit a wide range of industries, including glass. In Industrial Materials, the focus is on new and improved materials and coatings. The MPLUS program assists industrial users in accessing national laboratory resources in materials. Efforts in Combustion target clean, cost-effective technologies that will improve energy efficiency, reduce emissions, and enhance fuel flexibility while increasing productivity. 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 glass-making operations in real time.

Plant-wide assessment at Anchor Glass Container Corporation

Anchor Glass Container Corporation was recently selected for a cost-shared, plant-wide assessment as a result of a competitive OIT solicitation. Anchor Glass plans to assess major end uses of steam, motors, cogeneration, and heat recovery at two plants—one in Jacksonville, Florida, and the other in Warner Robbins, Georgia.
**BestPractices**

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

BestPractices also offers **plant-wide assessments**, helping 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. Participants agree to a case study follow-up of results. 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**

Two Financial Assistance programs are offered by OIT to accelerate 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, and initiate commercialization activities. The second program, **NICE³**, provides cost-shared grants of up to $500,000 to industry-state partnerships for demonstrations of clean and energy-efficient technologies.

**State-Level Industries of the Future**

In addition, State-Level Industries of the Future programs are starting up in a number of states to bring the energy, environmental, and economic benefits of industrial partnerships to the local level.

For more information on these and other resources, please contact the OIT Clearinghouse at (800) 862-2086.

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