A 20-YEAR INDUSTRY PLAN FOR WINDOW TECHNOLOGY

EXECUTIVE SUMMARY

WINDOW INDUSTRY TECHNOLOGY ROADMAP

OFFICE OF BUILDING TECHNOLOGY, STATE AND COMMUNITY PROGRAMS
ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY
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EXECUTIVE SUMMARY

In addition to over 400 window fabricators, the window industry includes glass manufacturers, vinyl and aluminum extruders, wood suppliers, distributors, retailers, and contractors. Serving primarily residential and commercial markets, window sales exceeded 1,200 million square feet and $7 billion in 1997. Owing to their increasing versatility, windows make up a striking portion of wall area in new construction — 13 percent in new residences to 50 percent in large office buildings.

MEETING TOMORROW'S CHALLENGES

A variety of economic, social, and technology trends helped to shape the window industry vision. Economic trends — such as the rise in disposable income and the growth of the replacement market through renovation and upgrading — reveal opportunities for windows to provide additional value to consumers.

Social trends, including heightened environmental awareness, an aging population, and an increase in home ownership, hint at changes in consumer perceptions and values. At the same time, the window industry is in the midst of rapid technological change. Recent developments in glazing, framing, and assembly have dramatically improved the energy conservation potential and quality of new windows. This pace of technological development is expected to continue.

In a second workshop, a larger group of participants identified the market, policy, and technology barriers to achieving the vision. Participants voted to select the most critical barriers in each category, and then developed specific strategies to overcome these barriers.

Key market barriers:

- Lack of educated demand for innovative new window products
- High first cost of innovative new products

Key policy barrier:

- Dissimilar, poorly enforced, and inconsistent building codes

Key technology barriers:

- Lack of integration tools and forms needed to achieve true system integration
- Ambiguous definition of "durability" and its implications for warranty

The specific actions developed to overcome these barriers are detailed in the chart on the following page.

MAPPING RESEARCH NEEDS AND STRATEGIES

In the next phase of the vision and roadmap process, participants identified 65 specific research activities that would support the industry vision. These research priorities are listed in the second chart (far right), grouped by research area.

The *Window Industry Technology Roadmap* is designed to provide clear guidance to both the government and the private sector in planning future investments and initiatives. It serves as a resource for government to appropriately align its activities with industry needs, and as a framework for greater collaboration across the industry.

SELECTED HIGH-PRIORITY ACTIONS FOR THE WINDOWS INDUSTRY

Market Actions	Policy Actions	Technology Actions
Near-term (0–3 years)		
• Establish partnerships through collaborative work among multiple stakeholders and resource groups. • Conduct a value-based market analysis. • Support, specify, and identify applications for improved technology, including breakthrough materials and manufacturing processes. • Provide incentives such as financing programs and low interest loans, perhaps as an expanded ENERGY STAR component.	• Combine the three existing codes by supporting the International Code Council (ICC), professional lobbying, or creating a core industry group. • Educate local building inspectors. • Develop communication channels among building industry groups to address integration issues in areas of education, research, and collaboration.	• Define standards and protocols for integrating different building components. • Develop strategies and hardware necessary to optimize integrated building systems. • Define performance metrics for comfort, system integration, energy, cost, and environmental impacts. • Develop methods for measuring the value of integrated systems. • Establish a system for rating products on the basis of durability. • Define appropriate durability and warranty periods for different window components.
Mid-term (3–10 years)		
	• Establish a regionally sensitive national building code.	• Develop analytical tools to assist manufacturers in designing and marketing efficient windows. • Develop methods to measure and prove durability of fenestration products. • Support, specify, and identify applications for improved technology, including breakthrough materials and manufacturing processes. • Develop products that encourage consumers to upgrade as features advance (replaceable, portable, modular, high value).
Long-term (10–20 years)		
		• Develop long-term photovoltaic products that can be integrated in fenestration products. • Develop superior insulating materials and components for fenestration products. • Develop integrated electronics in fenestration products.
Crosscutting (ongoing)		
• Educate stakeholders and end users on true long-term cost benefits of high-performance products.		• Develop products that encourage consumers to upgrade as features advance (replaceable, portable, modular, high value). • Understand current technology and potential applications and specify technology needs as identified by user expectations.

RESEARCH PRIORITIES

Research Area	Continuing Research	Future Research
Imaging	• Projected display • Interior display	• Electrochromic display • Advanced holograms • Exterior display • Monochromic display • Multichromic display
Energy Production and Supply	• Larger PV panels • PV vision glass • PV thin film	• Environmentally benign PV materials • PV coatings • PV panel colors • Integral wind power
Light Transmission	• Electrochromics scale-up • Photochromics scale-up • Thermochromics scale-up • Holograms • Low-e coatings • UV research by medical researchers • Interior lighting source	• Smart photochromics • Color photochromics • Daylighting rating
Insulation	• Insulating components • Aerogels • Monolithic transparent insulating materials • Vacuum glass • Gas retention	• Insulating coatings • Alternative glazing materials
Analytical Tools	• Thermal modeling • Building energy software • Solar heat gain • Slope U-factor • Holographic modeling • EC failure modes • Life-cycle software/analysis • Window selection software	• Tools to quantify performance • EC service-life prediction
Manufacturing	• Billet stock from recycle • Energy-efficient extrusion • Laser imprinting • Low cost of efficient IG	• Recyclability • Coating equipment • Markets for process waste
Design	• Altitude adaptive IG • Stronger sealant • High-security windows • Glass/frame ratio • Blast-resistant windows • Fenestration durability • Fire-rated windows • Sunscreening • Interior passive lighting • Building integration demonstration	• Modular windows • Ventilation
Electronics	• Power supply miniaturization • Integral wiring • Power system balancing	• Integral smart system • Protocol for communication

A NEW INITIATIVE

The U.S. Department of Energy's Office of Building Technology, State and Community Programs (BTS) is facilitating a new industry-led initiative to develop a series of technology roadmaps. The roadmaps identify key goals and strategies for different areas of the building and equipment industry. The *Window Industry Technology Roadmap* is one of the first sponsored by BTS.

This roadmapping initiative is a fundamental component of the BTS strategic plan and will help to align government resources with the high-priority needs identified by industry. The roadmap will guide cooperation among public and private researchers, window companies, and other State and Federal offices to help the window industry achieve its long-term vision.

A WINDOW TO THE FUTURE

The American window industry has taken an important step in defining its future in response to changing market and business conditions. The industry faces exciting new opportunities but also serious challenges. New technology is expected to play a pivotal role in addressing these conditions, as well as assisting window manufacturers in competing in the marketplace. The pace of technological development should continue to respond to trends in new construction and retrofit that place a premium on energy conservation, enhanced quality, fast delivery, and low installed cost.

The *Window Industry Technology Roadmap* represents the collaborative efforts of window industry professionals, government, environmental organizations, and research groups. These individuals contributed to a dynamic process that ultimately produced general consensus on a vision for the future and the pathways for achieving it.

DEVELOPING A SHARED VISION

Initially, the roadmap process engaged industry leaders to examine the current industry environment and develop a shared vision of the future.

In the next 20 years, the U.S. window industry will offer its customers imaginative new products that challenge traditional perceptions. Windows will become active, integral parts of building systems, including climate, energy, information, and structural systems. Responsible manufacturing practices, material selection, and energy efficiency characteristics will combine to also make windows a solution to environmental concerns.

To help customers understand the added value that windows offer them over competing building products, the window industry will become premier educators. All these efforts will increase demand for windows as an alternative to competing building components and appliances, thereby enhancing the industry's growth and contributing to its strength.

Together, the executive group condensed this vision into the vision statement on this page.

VISION STATEMENT

In 2020, consumers recognize windows[1] as affordable "appliances in the wall" that are active and interactive parts of a true building system. Windows offer added value by providing energy, entertainment, and information with enhanced comfort, lighting, security, and aesthetics, in harmony with the natural environment.

[1] The term "window" in the vision statement, as well as in the document, refers to fenestration products, including windows, doors, and skylights.

For more information, contact:

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Or visit the BTS Web site at: www.eren.doe.gov/buildings

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