

THE LIGHTING INDUSTRY'S 20-YEAR PLAN

EXECUTIVE SUMMARY

Vision 2020



THE LIGHTING 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

Lighting accounts for nearly one-sixth (approximately \$40 billion) of the total annual electricity use in the United States.¹ Advances in lighting, particularly the use of high-efficiency lighting sources, have the potential to reduce U.S. electricity bills by billions of dollars annually. In addition to these bottom-line savings, energy-efficient lighting reduces emissions of carbon dioxide and air pollutants into our environment.

MEETING TOMORROW'S CHALLENGES

Tomorrow's lighting will respond to the significant changes now under way in the nature of work and, in turn, in commercial building design and management. Lighting of the future will enable more effective use of space for multi-tasking, so businesses can adapt workplaces currently designed for individualized, manual, and paper-based operations into an environment that promotes teamwork, shared resources, and electronic processes. High-quality lighting systems increasingly will be valued for their ability to improve employee productivity, employee retention, and quality control, particularly as work becomes ever-more dependent on information access and interconnectivity.

Advances in lighting also will help answer the needs of building owners and managers for the highest possible return on capital investments. Efficient, intelligent lighting systems will enable managers to minimize operations, maintenance, and energy costs, and to provide the high-performance, aesthetically pleasing environments that increasingly will be demanded by tenants.

In addition, advanced lighting will help fulfill consumers' appetites for comfort, convenience, and connectivity. Sensors and controls will provide us with new levels of information about our environment, and will allow us to shape that environment to enhance our creativity and productivity.

ADDRESSING BARRIERS

Vision 2020: The Lighting Technology Roadmap describes an exciting future for lighting in the coming decades. It represents nearly two years of work by a broad cross-section of lighting manufacturers and professionals, as well as members of the academic, government, and research communities. A total of 201 lighting stakeholders from 175 organizations cast their votes to select the high-priority activities identified in the Technology Roadmap.

Eight lighting industry associations (see back cover) have sponsored the vision and roadmap process and have expressed their commitment to the ongoing effort to implement the Technology Roadmap priorities.



¹ Energy Information Administration, Annual Energy Outlook 2000

Achieving the Lighting Vision will require strategies to encourage more purchasers to consider life-cycle benefits as well as low first-cost. Such a change in purchasing decisions will, in turn, create demand for innovative lighting solutions and drive higher levels of investment in lighting research and development.

The Technology Roadmap describes seven strategies for moving forward. Four strategies address the challenges of **market transformation**, with activities targeted for implementation in the short (less than three years) to medium (three to 10 years) term. The remaining three strategies relate to lighting **technology development**. These strategies target attributes that are likely to be valued in tomorrow's lighting systems. Virtually all the desired attributes are judged to be technically achievable in the short (less than three years) to medium (three to 10 years) term.

Today, there is negligible demand for innovation in commercial lighting. Lighting systems are often purchased on a low-first-cost basis by a general or electrical contractor on behalf of the building owner or manager. The end user typically has little or no voice in lighting selection and often lacks awareness of the options available.

The overriding market-related barrier to the Lighting Vision is the **lack of a strong business case for advanced lighting that** can drive end-user demand. Many case studies point to the advantages of high-quality lighting in improving productivity, employee retention, error-reduction, and workplace safety; in attracting retail customers and improving retail sales; and in reducing energy consumption and other operating and maintenance costs. The challenge is to adequately document, measure, and communicate these benefits to make a compelling case to tenants and building owners.

MARKET TRANSFORMATION

High-Priority Activities (Top Vote-Getters)

STRATEGY 1—Develop clear definitions and standards for lighting quality

Develop a uniform set of performance specifications for lighting systems.

Create industry-standard formats for energy and economics data for use across the many available software packages.

STRATEGY 2—Increase demand for high-quality lighting solutions by quantifying, demonstrating, and promoting life-cycle benefits to broad audiences

Increase scientific knowledge of how lighting parameters impact human psychology, health, and productivity.

Maintain nonpartisan lighting centers and laboratories around the country where innovative lighting technologies can be demonstrated.

Conduct educational forums for end users about the effects of lighting on people and their activities.

STRATEGY 3—Strengthen industry education and credential lighting professionals

Create educational programs on the design, installation, and use of lighting controls.

Improved education on daylighting, including simple rules of thumb for architects.

STRATEGY 4—Accelerate the market penetration of advanced lighting technologies and systems, by providing incentives for R&D and reducing barriers inherent in today's specification and distribution methods

Continue to develop rebate programs, coupled with public information programs, to transform the market for energy-efficient technologies.

TECHNOLOGY DEVELOPMENT

High-Priority Attributes/Capabilities (Top Vote-Getters)

STRATEGY 5—Develop advanced source and ballast technologies that enhance quality, efficiency, and cost effectiveness

Achieve dimmability that still maintains energy efficiency, color, and lamp life.

Extend lamp life (less turnover).

Develop low-cost electronic ballasts for compact fluorescent lamps (CFLs).

Develop point source for optical fibers and pipes (high efficiency).

Create advanced solid-state structures such as LEDs, LEPs, and ceramics.

STRATEGY 6—Develop lighting controls with high levels of intelligence, interface capabilities, multiple levels of control, and ease of configuration

Enable easy installation (e.g., self-configuring and friendly to non-experts).

Develop controls that are self-teaching, intuitive, easy to use.

Develop universal control and communication protocols for component interconnection (such as BACnet or Echelon).

STRATEGY 7—Develop luminaires and systems that enhance the quality and flexibility of light delivery

Develop and utilize compatibility protocol to support "plug and play" (software and hardware).

Utilize positioning and control to allow more effective task lighting.

Develop combined light source/reflector panel.

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 *Lighting Technology Roadmap*, focusing on opportunities in commercial lighting, 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, lighting companies, and other State and Federal offices to help the lighting industry achieve its long-term vision.

SHAPING OUR BUILT ENVIRONMENTS

From the cave dwellers right through much of the 19th century, humans had to rely on fire to extend the light of the day. Thomas Edison's 1879 invention of the carbon-filament lamp and its electric supply system changed everything. Steady advances in lamps, ballasts, fixture, controls, and other lighting technologies made electric lighting progressively more affordable, available, and convenient throughout the 20th century.

Today, we are on the verge of another wave of innovation, one that may well dwarf the accomplishments of the past century. Emerging technologies can spell great improvements in our ability to harness light efficiently and effectively, to extend the reach and power of human vision, and to dynamically monitor and shape our built environments to suit specific purposes and preferences. Technology advances promise to drive down the costs and multiply

the capabilities of microchips, lasers, and photovoltaics, opening the way to entirely new levels of performance in sensors and controls.

Also on the horizon are innovative materials, high-efficiency light sources, breakthroughs in biotechnologies and chemical sciences, and ever more powerful methods of system modeling and integration. New technologies will, in turn, enable advanced design and engineering approaches. Starting in the commercial building sector, but later moving into the residential sector as well, we will see growing sophistication in the design of lighting and other building systems within an integrated, "whole buildings" framework. The "whole buildings" approach will optimally use both human-made and natural systems to provide efficient, high-quality lighting, heating, cooling, ventilation, and information exchange.

The result? Tomorrow's buildings will provide unprecedented levels of comfort, productivity, flexibility, and well-being for occupants, while reducing energy use and other impacts on the natural environment.

VISION STATEMENT

In 2020, lighting systems in buildings and other applications will:

- Enhance the performance and well-being of people
- Adapt easily to the changing needs of any user
- Use all sources of light efficiently and effectively
- Function as true systems, fully integrated with other systems (rather than as collections of independent components)
- Create minimal impacts on the environment during their manufacturing, installation, maintenance, operations, and disposal

As a result, people will understand, value, and utilize the tangible, personal benefits provided by these lighting systems.



For more information, contact:

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**For a full version of the Lighting Technology
Roadmap, call the Energy Efficiency and
Renewable Energy Clearinghouse at:
1-800-DOE-3732**

**Or visit the Lighting Technology
Roadmap Web site at:
www.eren.doe.gov/buildings/vision2020**

CO-SPONSORS

The following associations have taken a lead role in developing the Lighting Technology Roadmap and are committed to its implementation.

Illuminating Engineering Society of
North America (IESNA)

International Association of Lighting
Designers (IALD)

InterNational Association of Lighting
Management Companies (NALMCO)

National Association of Electrical
Distributors (NAED)

National Electrical Manufacturers
Association (NEMA)

National Electrical Manufacturers
Representatives Association (NEMRA)

National Electrical Contractors
Association (NECA)

National Association of Independent
Lighting Distributors (NAILD)