

5-YEAR SSL COMMERCIALIZATION SUPPORT PLAN

**July 2007
DRAFT**

**U.S. Department of Energy
Solid-State Lighting Program**

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Plan Summary

This plan sets out a strategic, five year framework for guiding DOE's commercialization support activities for *high-performance solid-state lighting (SSL) products for the U.S. general illumination market*. The commercialization support activities described in this plan, which span federal fiscal years 2008 to 2012, are intended to affect the types of SSL general illumination products adopted by the market, to accelerate commercial adoption of those products, and to support appropriate application of those products to maximize energy savings.

DOE has established aggressive FY12 goals for these activities, including goals for the types of products brought to market, the market adoption of those products, and the energy savings achieved through use of SSL products. These goals are for the combined effect of DOE's SSL commercialization support and R&D investment, as well as the leveraged activities of its partners. Among the goals are inducing the market introduction of SSL luminaires achieving 68 lumens per Watt (lm/W) luminaire efficacy (for warm white products), and 88 lm/W (for cool white products). Other FY12 goals include sales of 1 million high-performance SSL luminaires per year, and achieving annual energy savings of 230 gigawatt hours (GWh).

The plan identifies seven key SSL market needs for DOE commercialization assistance. They are:

- 1) Effective product purchasing and architectural design guidance (to guide buyers to products that perform well, and to provide lighting designers with critical new technology application information)
- 2) State of the art products and lighting designs (to convincingly illustrate the energy saving potential of the technology)
- 3) Highly visible examples of model SSL general illumination applications (to illustrate the practicality and cost effectiveness of SSL)
- 4) Independent performance test results on commercially available products (to overcome widespread confusion on actual product performance)
- 5) Objective, widely available technical information from a credible, respected source (to help fill information gaps and clear up widespread misunderstanding of the technology, its attributes, and its limitations)
- 6) Industry standards and test procedures for SSL general illumination products (to enable basic market infrastructure)
- 7) Coordination of local, regional, and federal SSL commercialization activities (to maximize effect of invested public and ratepayer money)

If met, the above market needs can collectively help drive down the costs of SSL by creating near-term market opportunities for SSL, which in turn generates revenue for SSL manufacturers to invest in R&D and lower-cost production. The market needs were used for deciding which types of programs and projects DOE should create, and what general form they should take. Those projects and programs are identified in this plan as the plan's *key strategic elements*. They are:

- 1) Buyer Guidance**
 - a) ENERGY STAR
 - b) Design Guidance
- 2) Design Competitions**
 - a) Lighting for Tomorrow (Residential Fixtures)
 - b) New Commercial Fixture Design Competition
 - c) Architectural Lighting Design Competition
- 3) Technology Demonstrations/Procurements**
 - a) Demonstrations of Market Readiness
 - b) Demonstrations to Test Field Performance
- 4) Commercial Product Testing Program**
- 5) Technical Information**
 - a) Technical Information Development and Dissemination
 - b) Technical Information Network
- 6) Standards and Test Procedures Support**
- 7) Coordination/Leadership**
 - a) Facilitating and Coordinating Local and Regional Efforts
 - b) Federal Government Leadership

The above seven strategy elements represent DOE's comprehensive approach to SSL commercialization support. They depend on active and extensive involvement from program partners, ranging from energy efficiency program sponsors, to industry associations, to standards setting bodies. The resources, expertise, and networks these program partners bring to the efforts represented by this plan greatly multiply any market development DOE can achieve on its own, and thus are a critical element to the success of this plan.

Progress toward achieving plan goals with the above strategic elements will be closely monitored and reported annually. Those annual reports will track new commercial product performance, product sales, and estimated annual energy savings.

Introduction

Purpose

The purpose of this plan is to set out a strategic, five-year framework for guiding DOE's commercialization support activities for *high-performance SSL products for the U.S. general illumination market*. The purpose of the commercialization support activities described in the plan is threefold. DOE plans to create the conditions, specifications, standards, opportunities, and incentives that:

- (1) *affect the types of SSL general illumination products adopted by the market, emphasizing high-performance products likely to reduce energy use and satisfy users;*
- (2) *accelerate commercial adoption of these products;*
- (3) *support appropriate application of these products to maximize energy savings.*

DOE intends the sum of its efforts to shift the commercial adoption curve for high-performance SSL products ahead by five years, yielding large energy and economic savings. DOE estimates that annual energy savings from full implementation of this plan (in combination with its SSL R&D plan) are 230 GWh (site electricity use), or 2.5 terrabtus (primary energy use) by FY12.

DOE Role in SSL Commercialization

The primary responsibility for commercializing advanced SSL technologies rests with the private sector. SSL system and component manufacturers are best positioned to decide how and when products are brought to market. However, DOE has a commercialization role for SSL, derived from explicit authority given DOE in Sec. 912 of EPLAW 2005:

The Secretary [of Energy] shall carry out a Next Generation Lighting Initiative in accordance with this section to support research, development, demonstration, and commercial application activities related to advanced solid-state lighting technologies based on white light emitting diodes.

In addition, SSL commercialization activities are consistent with the 2006 DOE Strategic Plan, which states DOE will,

Work collaboratively with other Federal agencies, private industry, and other countries to accelerate the adoption of technologies capable of substantially reducing global emissions of greenhouse gases and other emissions.

DOE is uniquely positioned to carry out these activities. First, DOE has a large and growing SSL R&D program that provides a strong technical basis from which to develop and implement an SSL commercialization support program (DOE 2006b). SSL technology is fundamentally different from conventional lighting technologies. It requires different standards, methods of measurement, product integration, thermal design, optical design, and a range of different approaches for successful lighting application. All this makes a thorough understanding of SSL technology necessary for development and implementation of an appropriate and well-considered commercialization assistance program.

In addition, DOE's extensive experience with a wide range of commercialization methods and programs, especially when coupled with its SSL technical understanding, make DOE the right agency to carry out this program. And last, DOE entered into a memorandum of understanding with the Next Generation Lighting Industry Alliance (NGLIA) on February 2, 2005, which, among other things, stated NGLIA's intent to cooperate with DOE on developing and implement commercialization support activities such as ENERGY STAR.

DOE can offer significant value to SSL commercialization efforts, as evidenced by the Next Generation Lighting Industry Alliance's (NGLIA) decision to enter into an agreement with DOE calling for commercialization cooperation. That value derives from far more than provision of additional financial resources. It also derives from:

- DOE and the federal government are valued by the public as being providers of unbiased, technically sound information. With the buying public holding a healthy skepticism about vendor product claims, SSL manufacturers value the credibility DOE can bring to this new market.
- DOE's can influence federal purchasing. Many federal agencies look to DOE for assistance and advice on which new energy saving products to investigate and buy. Through FEMP, federal regulations, and a wide range of conferences and technical materials, DOE exerts important influence on what SSL products should be considered for purchase by other federal agencies.
- DOE can provide leadership to the industry, and serve as a focal point to catalyze private activity that competing companies may otherwise be reluctant to engage in. For example, SSL manufacturers now widely credit DOE with having successfully organized the industry into developing a wide ranging set of industry standards and test procedures for SSL application to the general illumination market.
- DOE can facilitate partnerships with a wide range of organizations that can influence the rate at which SSL products are accepted by the market. By working with electric utilities, non-profit organizations, state energy offices, trade associations and others, DOE can rally the assistance of organizations motivated to engage in activities that lead to efficiency improvements and energy savings.
- DOE can use the highly valued and widely recognized ENERGY STAR program to leverage a wide range of activities in support of SSL product commercialization.

DOE's role and value in SSL commercialization was also recognized by the Illuminating Engineering Society of North America (IESNA), with which DOE entered into a Memorandum of Agreement on July 17, 2006 to enhance, among other things, DOE's SSL commercialization support efforts. The MOA expresses the organizations' plans to work closely together, including an agreement to:

Develop and maintain guides and procedures to assist the lighting community in the photometric measurement of SSL devices and other technologies to support DOE programs (including the development of ENERGY STAR® criteria for solid-state lighting), and to provide consistency and uniformity in photometric reports.

Time Frame

This plan addresses the period FY08 – FY12.

Goals

The goals of DOE's SSL commercialization support efforts for the five years covered by this plan are directly related to the purposes of these activities, as described in the above Purpose Section. They are to create and catalyze market conditions, specifications, standards, and market opportunities that, influence products brought to market, accelerate market adoption of SSL products, and achieve energy savings through use of SSL products. Specifically, they are:

- (1) **Products Brought to Market:** induce the manufacture and purchase of highly efficient LED luminaires, leading to U.S. market introduction by 2012 of *warm white* LED general illumination luminaires achieving at least:

- a. 105 lm/W luminous efficacy¹;
- b. 68 lm/W luminaire efficacy;
- c. 85 CRI (or similar revised color quality metric), and;
- d. at most, 3500 K CCT.

For *cool white* LED general illumination luminaires, at least:

- a. 135 lm/W luminous efficacy;
- b. 88 lm/W luminaire efficacy;
- c. 70 CRI (or similar revised color quality metric), and;
- d. at most, 6500 K CCT.

- (2) **Market Adoption of Products:** accelerate the development of the SSL general illumination market such that high-performance (ENERGY STAR compliant) luminaires achieve sales of 1 million units per year by 2012.

¹ To date, there is no ANSI/IESNA published test procedure for measuring luminous efficacy of LED devices or arrays. Until such test procedures are standardized, DOE will use manufacturer reported values of "typical luminous flux" which are typically measured with device temperature at 25° C while power is applied to the device in a brief (milliseconds) pulse. For the LED luminous efficacy calculation, wattage of the device is assumed to be the product of typical forward voltage (V_F) and typical drive current (I_F).

- (3) **Energy Savings:** influence application of SSL luminaires such that electricity savings of at least 230 GWh per year are achieved by FY12.

Desired End State

DOE can be confident that further market support is unnecessary and can justify conclusion of its SSL commercialization support efforts when the U.S. market for high-performance SSL products achieves a state DOE believes will be self sustaining, as defined by the following characteristics:

- (1) **Products Brought to Market:** at least ten 100+ lm/W (luminaire efficacy) *warm white* general illumination luminaires, and at least ten 120+ lm/W *cool white* general illumination luminaires, are offered for sale by major fixture manufacturers (and are available in most major markets through normal lighting equipment sales channels) in each of the following product categories:
Warm White Products: residential recessed downlights, commercial recessed downlights, and commercial office ambient lighting
Cool White Products: pole-mounted roadway luminaires and high-bay luminaires
- (2) **Market Adoption of Products:** high-performance luminaires (ENERGY STAR compliant) comprise 10% of annual sales in the above product categories
- (3) **Energy Savings:** annual U.S. electricity savings of 5 TWh per year²

Market Barriers and Needs Addressed by Plan

Owing to its technical potential for greatly improved performance and greatly reduced costs, the longer-term barriers to market acceptance faced by SSL technology appear modest. Its nearer-term barriers are primarily a consequence of the technology being in its early stages of technical maturation, and its nascent introduction to the market as a general illumination product. As large private and public R&D investments steadily yield large improvements in the technology, SSL is expected by most observers to make its way deeply into the general illumination market. But still at question are how long this market penetration will take, and the extent of resulting energy savings. Accordingly, this plan is focused on near-term market barriers and needs.

The primary near-term market barriers faced by SSL general illumination products are:

- High costs relative to competing technologies
- Lack of industry standards and test procedures for SSL general illumination products
- Lack of information (for buyers, designers, and lighting fixture manufacturers)

² DOE estimates it is technically achievable and economically feasible for SSL to produce U.S. electricity savings of 50 TWh per year by approximately 2015 (DOE 2006).

To help overcome these barriers, DOE has identified the following high-priority market needs. If met, they can collectively help drive down the costs of SSL by creating near-term market opportunities for SSL, which in turn generates revenue for SSL manufacturers to invest in R&D and lower-cost production. Market need 6) addresses the lack of standards and test procedures, and the remaining market needs address the lack of information market barrier.

Market Needs:

- 1) Effective product purchasing and architectural design guidance (to guide buyers to products that perform well, and to provide lighting designers with critical new technology application information)
- 2) State of the art products and lighting designs (to convincingly illustrate the energy saving potential of the technology)
- 3) Highly visible examples of model SSL general illumination applications (to illustrate the practicality and cost effectiveness of SSL)
- 4) Independent performance test results on commercially available products (to overcome widespread confusion on actual product performance)
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- 7) Coordination of local, regional, and federal SSL commercialization activities (to maximize effect of invested public and ratepayer money)

Each of the above market needs is used to generate strategy elements for SSL commercialization support, which are discussed in the following section.

Key Strategy Elements

The following key elements collectively are the DOE strategy for SSL commercialization support. They were selected on the basis of:

- Consistency with appropriate federal role
- Expected impact on market development
- Expected impact on potential energy savings
- Expected program costs not exceeding available resources

SSL Commercialization Support 5 Year Plan

Goals: By 2012, induce market introduction of general illumination SSL warm white luminaires that achieve 68 lm/W and cool white luminaires that achieve 88 lm/W (luminaire efficacy), facilitate 1 million annual sales of high performance SSL luminaires, and achieve 230 GWh annual energy savings.

Strategy Elements

1) Buyer Guidance

- a) ENERGY STAR
- b) Design Guidance

2) Design Competitions

- a) Lighting for Tomorrow (Residential Fixtures)
- b) New Commercial Fixture Design Competition
- c) Architectural Lighting Design Competition

3) Technology Demonstrations/Procurements

- a) Demonstrations of Market Readiness
- b) Demonstrations to Test Field Performance

4) Commercial Product Testing Program

5) Technical Information

- a) Technical Information Development and Dissemination
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6) Standards and Test Procedures Support

7) Coordination/Leadership

- a) Facilitating and Coordinating Local and Regional Efforts
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1) Buyer Guidance

***Market Need:** Effective product purchasing and architectural design guidance (to guide buyers to products that perform well, and to provide lighting designers with critical new technology application information)*

a. ENERGY STAR®

DOE observed a large number of new SSL general illumination products entering the market in recent years. Based on its knowledge of SSL technology and its own product testing, DOE became concerned that a large number of these products would likely disappoint their buyers due to low energy performance, low color quality, short lives, and other problems. DOE feared a repeat of the early market introduction mistakes that plagued the compact fluorescent lamp market for many years – thus greatly delaying

their widespread market acceptance. In addition, DOE recognized that rapid technological progress being made with white, high-power LEDs meant the market could be supplied in the near-term with high performance LEDs capable of providing substantial energy savings, and providing good customer satisfaction. As one of the federal agencies responsible for the ENERGY STAR program, DOE developed ENERGY STAR criteria for SSL general illumination products, with the intent to help steer businesses and consumers to high performance, good quality SSL products. DOE issued the first public draft of its proposed ENERGY STAR SSL criteria in December, 2006, and after modifications in response to public comment, plans to finalize those criteria in late Summer, 2007.

The proposed ENERGY STAR SSL criteria are presently narrow in scope, allowing ENERGY STAR qualification for only a small number of general illumination applications, such as under-cabinet lighting, task lamps, and recessed downlights. In part, this reflects the limited number of general illumination applications currently appropriate for SSL technology, and in part, reflecting DOE's "go slow" approach to applying ENERGY STAR criteria to general illumination – given the entire lighting industry is in the early stages of learning how best to use this technology for the general illumination market. However, due to the technology's rapid rate of improvement, DOE anticipates quick growth in the number of general illumination applications appropriate for SSL. Accordingly, DOE plans to regularly and frequently expand the number of lighting applications covered by the criteria, based on findings of on-going analysis of the technology.

At some point in the future, approximately three years after finalization of the initial ENERGY STAR SSL criteria, SSL technology will have matured to the point that it will no longer be feasible to base the criteria on individual lighting applications. At that point the technology will be robust enough that specific, application by application criteria are no longer necessary. More general criteria, applying to much broader categories of general illumination products will be substituted to make the criteria more easily managed.

DOE also anticipates the lighting industry will learn about a wide range of SSL application issues as experience is gained with SSL in the general illumination market. Some of these issues may need to be addressed through future changes in the ENERGY STAR criteria. For example, early users of commercial ambient lighting systems may find that a large number of products suffer from significant glare problems due to the very high luminous intensity of high-power LEDs. Such a problem many need to be addressed through glare mitigation requirements in ENERGY STAR criteria. Consistent with its planned go-slow approach, DOE will add to and expand the scope of its criteria as DOE and the lighting industry become more familiar with the particular challenges of using SSL for general illumination.

As described in Section 5 below (Technical Information), DOE plans to develop and disseminate a wide range of information addressing SSL technology and its appropriate application to general illumination. This informational effort will be closely coordinated

with ENERGY STAR, providing timely and useful information to ENERGY STAR partners involved in selling or promoting ENERGY STAR SSL products.

b. Design/Purchasing Guidance

Most lighting designers are unfamiliar with SSL technology. Its unique characteristics, flexibility, and appropriate application will take time for lighting design professionals to learn. From DOE's perspective, a very important element of this learning process will be how to apply this technology in a manner that meets lighting quality needs yet maximizes potential energy savings.

As the technology evolves, the range of applications to which it can be appropriately applied will grow, though use of conventional lighting technologies will continue to be more efficient for a number of lighting applications for some time. Helping lighting designers and their customers sort through this complicated terrain will increase the likelihood that the U.S. can attain the early energy savings potential of the new technology.

An attractive starting point for DOE efforts to provide purchasing and design guidance is the Federal sector, where DOE has a lead role in providing technical support to federal agency efforts to reduce energy consumption. A new Executive Order announced January 24, 2007 directs federal facilities to reduce energy use by 30 percent by end of FY2015, relative to 2003 levels.³ SSL will potentially play an important role in reaching this goal. Initial outreach by DOE to federal agencies has elicited a high level of interest in demonstrating and evaluating SSL technologies. Early federal sector experience in terms of specific product performance, energy savings in specific applications, product costs and procurement issues, and impact on maintenance and lighting service will be captured, synthesized into guidance documents, and shared with the federal sector through the Federal Energy Management Program, the Inter-Agency Energy Task Force, and the Federal Utility Partnership Working Group.

The guidance documents will be organized by application, for example, task lighting for modular offices, recessed downlighting, or parking area lighting. To be useful to those responsible for selecting lighting technologies for federal facilities (i.e., facility managers, consulting lighting designers, lighting contractors, etc.), the following information is necessary: 1) product performance data based on traceable test procedures and in standard IES photometric file format; 2) cost information, including purchase, installation and service costs; 3) information on in-situ performance, such as results of field testing.

As DOE builds a database of performance information on a variety of luminaire types (through the Commercial Product Testing Program), and implements demonstrations in various federal and non-federal facilities, DOE will produce a series of LED design and purchasing guidance documents. This information will be of use and interest not only in the federal sector, but also in the wider lighting design community. Professional lighting

³ <http://www.whitehouse.gov/news/releases/2007/01/print/20070124-2.html>

designers look to IESNA Design Guides and Recommended Practice documents as key references. Information developed for the federal sector will be fed into the IESNA committee process for incorporation into these types of references.

DOE's Building Technology program will work closely with the IESNA and the Federal Energy Management Program to develop appropriate design and purchasing guidance for the federal and private sectors.

2) Design Competitions

Market Need: *State of the art products and lighting designs (to convincingly illustrate the energy saving potential of the technology)*

a. Lighting for Tomorrow (Residential Fixtures)

DOE co-developed a residential lighting fixture design competition in 2002 in cooperation with the Consortium for Energy Efficiency and the American Lighting Association. In its fourth year of operation (2006), Lighting for Tomorrow (LFT) added for the first time a category requesting proposals for high-performance, residential SSL luminaires. The competition attracts a substantial amount of attention in the lighting industry, primarily through the lighting trade press. Judging by the volume and quality of press covering the LFT in recent years, the program has very successfully raised the profile and awareness of attractive, well-designed energy-efficient residential lighting fixtures.

DOE plans to continue to cooperate in LFT with its partners, focusing its resources on the SSL component of the competition. Planned strategic changes for DOE's role in LFT include:

- expanding the scope and profile of the SSL component of LFT as more high-performance SSL luminaires are introduced into the market;
- highlighting luminaire efficacy and potential energy savings, and;
- emphasizing leading edge technology by getting NGLIA manufacturers more involved in the program, and cooperating in joint proposals with fixture manufacturers.

b. Commercial Fixture Design Competition (Commercial Fixtures)

In addition to LFT, which is a residential fixtures-only program, DOE plans to explore the development of a similar commercial fixtures-only program, perhaps in collaboration with the Illuminating Engineering Society of North America (IESNA). (A commercial fixtures program needs to be separate from LFT because the American Lighting Association's primary focus is the residential lighting industry.) Its operation and purpose would be very similar to LFT, but oriented toward commercial lighting fixtures, and the media channels serving this industry.

c. Architectural Lighting Design Competition

DOE will also explore the development of an architectural lighting design competition, focusing on lighting designs for interior and exterior spaces, as opposed to the fixtures that are the focus of the above design competitions. As with the commercial fixtures design competition, DOE plans first to consult with the IES about potential collaboration in development of this design competition. Its purpose would be to draw attention to the highest quality lighting designs using SSL technology, with special emphasis on designs that take advantage of the unique characteristics of LEDs, and result in significant energy savings relative to conventional lighting technology.

To the extent possible, DOE will attempt to link winners of the residential and commercial fixture design competitions with other projects, especially within the DOE portfolio. One example of this would be to explore the potential for using winners from the fixture design competitions in the demonstration/procurement projects discussed below.

d. State-of-the-Art LED Luminaire Showcase

To draw attention to the significant technical progress being made with LED luminaires, DOE will organize a state-of-the-art LED luminaire showcase, in which luminaire manufacturers and their LED manufacturer partners will be periodically invited to submit proposals to DOE for products they would like highlighted. The showcase would consist of a traveling display illustrating state-of-the-art products, which would be shown at various high visibility lighting industry events, as well as in related descriptive printed and electronic materials. DOE will make a significant effort to seek publicity for products in the showcase, aimed primarily at lighting industry trade media. By prominently featuring state of the art products for the lighting industry, DOE hopes to encourage the lighting fixture industry to aggressively develop new generations of LED luminaires.

3) Technology Demonstrations/Procurements

Market Need: *Highly visible examples of model SSL general illumination applications (to illustrate the practicality and cost effectiveness of SSL)*

DOE proposes to conduct two general types of technology demonstrations: those that demonstrate market readiness, and those that evaluate field performance.

a. Demonstrations of Market Readiness

These demonstrations will seek to work with products whose technical risks of use are low and whose performance is high, yet face market resistance simply because they are new to the market and use an unfamiliar technology. DOE intends to couple these demonstrations to follow-up activities aimed at achieving significant sales of successfully demonstrated products.

DOE will minimize technical risks and unsuccessful demonstrations through careful selection of candidate products, limiting participation to only those exhibiting high potential of performing well in the field. Prior to field installation, DOE will subject candidate products to a range of rigorous laboratory tests and technical reviews. Only after receiving acceptable results from these evaluations and tests will DOE proceed with field installations. Long-term laboratory testing for lumen depreciation will continue in parallel with field tests. Given the long hours required for this type of testing, lumen depreciation test results will not be available before completion of field testing (but will be so soon after).

In general for these projects, DOE will:

- identify target product categories for demonstrations;
- issue a solicitation for proposals to candidate manufacturers;
- evaluate proposed products to assess their quality and performance, including verification through laboratory testing;
- conduct laboratory lumen maintenance testing that will run concurrently with field testing;
- identify candidate project hosts who would be highly motivated to follow up a successful demonstration project with significant direct purchases or product promotion;
- install products in host facilities;
- measure and evaluate field performance;
- prepare and issue project report, and finally;
- use the demonstration to leverage significant follow-up sales and product promotion.

Via the strong linkage with follow-up promotion and sales activity and careful selection of projects with potential for high visibility and impact, DOE intends to achieve more direct market impacts with this type of demonstration project than is typically achieved with technology demonstrations.

DOE's first project utilizing the above approach is in its early development phase. It is targeting LED products that represent a step-improvement in performance above current LED products, and that offer potential to significantly out-perform conventional products.

b. Demonstrations to Test Field Performance

The second type of demonstration planned by DOE is more traditional, in that its purpose is to observe and measure field performance of advanced LED lighting prototypes. For example, products investigated under this activity may be integrated into automatic lighting control systems, or may use LEDs placed in nontraditional light source locations that lower the need for ambient lighting. These technologies will have inherently higher technical risks than those addressed in the *Part a.* demonstrations described above. These demonstrations will be used to help SSL product manufacturers and lighting

professionals to learn about use of advanced SSL products, and to explore the boundaries of how small, low-voltage, high intensity light sources can be used to significantly reduce lighting energy needs. Manufacturers can learn how field conditions and operation affect the performance of their products, and lighting professionals can gain a better understanding of issues encountered in lighting designs using advanced SSL technologies.

In general for these projects, DOE will:

- identify target product categories for demonstrations;
- issue a solicitation for proposals to candidate manufacturers;
- evaluate proposed products to assess their quality and performance, including verification through laboratory testing;
- install products in host facilities;
- measure and evaluate field performance, and;
- prepare and issue project report whose focus will be identification and evaluation of issues that advance the understanding of using LED systems in general illumination applications.

4) Commercial Product Testing Program

Market Need: *Independent performance test results on commercially available products (to overcome widespread confusion on actual product performance)*

DOE intends to conduct a SSL commercial product testing program to serve three purposes: (1) to provide market feedback data to its SSL R&D program, (2) to collect information useful for developing, evaluating and improving standardized test procedures for SSL equipment, and (3) to provide accurate, objective product performance information to SSL buyers.

DOE launched the SSL commercial product testing program in the first quarter of FY07. The program broadly monitors SSL general illumination products available in the market, and identifies products that are high priority targets for testing, weighing a number of factors intended to serve the three purposes of the program described above. Products are purchased and then tested by one of several contractors arranged to assist this program. Tests include a number of electrical, photometric, and colorimetric measurements. Manufacturers of tested products are given an opportunity to comment on test results prior to their finalization. Testing results, summaries, and interpretations are distributed in both hard copy and via the DOE SSL website.

The testing conducted to date has already revealed important technical issues, including power consumption by LED luminaires in the off state, and the need for better definition and standardized procedures for rating the performance of individual LED packages. Issues identified through the testing program will feed into the standards development process and the ENERGY STAR program.

This program will be continued and expanded in the following ways:

- The number of products tested per quarter will increase from 5-10 to 10-20, subject to budget constraints, product availability, and program needs.
- Once a substantial collection of test results are available, the profile of the program will be ramped up through promotional efforts, wider distribution of program materials, and linkages with related lighting and energy efficiency programs.
- Reports based on analysis of accumulated test results will be periodically prepared to identify important trends and issues needing consideration by DOE and other entities interested in monitoring the performance of commercial SSL products.

DOE anticipates the program will operate for 3-5 years, during which time DOE will seek both management and financial involvement from partners valuing products from the program, such as energy efficiency program sponsors. During that time, DOE will investigate with its partners various options for longer term operation of the program, should those partners agree there is value in it. Options to be considered include incorporation of the program into a self-financing element of the ENERGY STAR program, similar to the approach DOE has taken with incorporating the testing responsibilities of PEARL within the ENERGY STAR CFL program.

5) Technical Information

***Market Need:** Objective, widely available technical information from a credible, respected source (to help fill information gaps and clear up widespread misunderstanding of the technology, its attributes, and its limitations)*

a. Technical Information Development and Dissemination

DOE will implement a multi-faceted technical information effort whose purpose is to inject high-quality, objective, impactful information into the emerging SSL market such that buyers can make better SSL purchasing decisions. Information materials developed for this effort will primarily be oriented toward potential buyers of SSL systems and to the organizations that develop technical information and purchasing guidance for those buyers, such as electric utilities. These materials will not be aimed at general consumers. Instead, they will be aimed at facility managers, energy managers, lighting professionals, and organizations that develop technical materials for residential and commercial buyers, such as electric utilities.

Included among the technical information to be developed and distributed by DOE will be:

- Fact sheets on key technical issues
- Explanations of SSL technology (technology primers)
- Lighting applications issues unique to SSL systems
- Buying guidance
- Lighting application/design guidance
- Technology demonstration reports

- Selected experience/knowledge base for SSL installations
- Peer-reviewed journal articles
- Trade press articles
- Conference papers and presentations

DOE's technical information will be posted on the commercialization support section of DOE's SSL website <http://www.netl.doe.gov/ssl/>. These materials will help serve participants in the technical information network and others. Materials posted on the website will be regularly updated and expanded, creating a rich, highly useful collection of technical information.

In addition to the website, DOE will produce a range of printed technical materials, focusing on two-page fact sheets and other short printed formats useful for distribution at conferences and meetings.

b. Technical Information Network for Solid-State Lighting

To maximize the effectiveness of this effort, DOE will rely heavily upon a voluntary Technical Information Network of organizations with established, effective outreach programs in key lighting markets. Creation of the network is based upon the idea that is far more cost-effective and impactful to leverage existing, well-established information channels than to create new ones. Organizations and companies DOE expects to participate in this network include electric utilities, regional market transformation organizations, state energy offices, and other operators of energy efficiency programs.

The network will be structured to educate participants about SSL technology and key issues in its effective application. This is a critical step in development of the market in a way that maximizes energy efficiency and quality. The network's members will go through a core curriculum to attain a firm grasp of the technical issues and challenges unique to SSL.

DOE issued a solicitation for proposals to participate in this network in late FY06. Awardees (who will enter into cooperative agreements with DOE) will be expected to help build the network, help develop appropriate information materials for selected target markets based on technical material provided by DOE, and help distribute this information to those selected target markets. The Network will meet at least quarterly.

Depending upon experience in operating the SSL Technical Information Network and the receptivity of its members, DOE will consider expanding the role of the network to include joint development of projects, such as technology demonstration projects.

6) Standards and Test Procedures Support

Market Need: Industry standards and test procedures for SSL general illumination products (to enable basic market infrastructure)

When DOE initiated its SSL commercialization support efforts in FY06, there were no industry standards or test procedures for SSL general illumination products. Knowing the importance of standards and test procedures for the successful commercialization of the technology, an intensive effort was initiated to organize and support the organizations with responsibilities for developing these standards and test procedures. Much progress has been made since the March 1, 2006 launch of these efforts, but to date, a small set of high priority standards and test procedures are not yet final, and additional, next-tier standards and test procedures need to be developed.

The primary responsibility for developing these standards and test procedures rests with the industry standards organizations, such as NEMA, IESNA, and UL, but DOE will offer support for the purpose of speeding standards development, and will focus on those standards and test procedures needed to achieve SSL's energy saving potential. DOE plans to continue to support these efforts with national meetings, coordination assistance, technical assistance, and laboratory testing.

7) Coordination/Leadership

Market Need: *Coordination of local, regional, and federal SSL commercialization activities (to maximize effect of invested public and ratepayer money)*

a. Facilitating and Coordinating Local and Regional Efforts

A large number of electric utilities, state energy offices, state RD&D organizations, and regional energy efficiency programs operate programs to promote the deployment of emerging energy-efficient technologies. The cumulative program resources available to these organizations greatly exceed those of DOE. However, most of these organizations have not yet developed programs that address SSL. DOE could help catalyze activity among these organizations, first by providing much needed technical information on the technology (which is proposed as part of the SSL Technical Information Network), but also by proposing joint projects, providing opportunities for collaboration, and by convening meetings and conferences.

DOE's expertise with SSL technology, its national mission, and its reputation for technical excellence position it well to provide the national leadership to leverage additional SSL commercialization support activity.

b. Federal Government Leadership

A key means by which DOE can provide leadership and catalyze activity in other government funded programs is to stimulate SSL adoption within the federal sector. The Buildings Technology (BT) Program needs to work closely with the Federal Energy Management Program for this element. Joint BT/FEMP activities could include collaboration on demonstration projects, educational seminars, presentations at FEMP meetings and conferences, development and distribution of technical materials designed specifically for the federal sector, technical assistance for model projects, and others.

Task Areas and Their Interrelationships

Each of the strategic elements of the plan described above comprises a task area. Those task areas and their relationships to each other are described here. The task areas are organized to exploit three primary market interfaces, each providing a distinct approach for working with manufacturers, interacting with buyers, and ultimately accelerating movement of high-efficiency products into the market place. These three pathways – Buyer Guidance (e.g., ENERGY STAR), Design Competitions (e.g., Lighting for Tomorrow), and Technology Demonstrations/Procurements – are complementary, and collectively provide a comprehensive approach to commercialization support. They are supported by a set of crosscutting task areas that provide a range of important services to the pathways.

Figure 1 illustrates the relationship of the proposed task areas to the SSL program, SSL MYPP goals, market, and each other. As seen, the three market interfaces are the central elements of the commercialization effort. They are positioned at the critical juncture between manufacturers and buyers, leveraging DOE's unique identity, reputation for objectivity, and resources to accelerate the rate at which the market demands high performance SSL devices and the rate at which manufacturers commercialize these products. Positioning DOE's efforts in this manner allows DOE to offer valuable assistance to both manufacturers and buyers, as indicated in the value streams. Likewise, it allows DOE to obtain valuable information and collaboration from buyers and manufacturers. Supported by the crosscutting task areas at the bottom of the figure, the three market interfaces are the primary channels through which the SSL program seeks to influence what manufacturers produce, and what buyers purchase. The distinguishing characteristics of these three market channels are:

Buyer Guidance (e.g., ENERGY STAR) – mass market oriented; unique brand; used to guide buyers to higher performing, energy-efficient products; strong emphasis placed on working with retailers, distributors and energy efficiency program sponsors

Design Competitions (e.g., Lighting for Tomorrow) – industry oriented; unique brands; primarily used to support new product introductions; strong emphasis on aesthetic design to make products attractive to buyers; strong emphasis on collaborating with lighting retailers, fixture manufacturers and lighting professionals

Technology Demonstrations/Procurements – target market oriented; no branding; supports new product introductions; strong emphasis on collaborating with high volume buyers and energy efficiency program sponsors

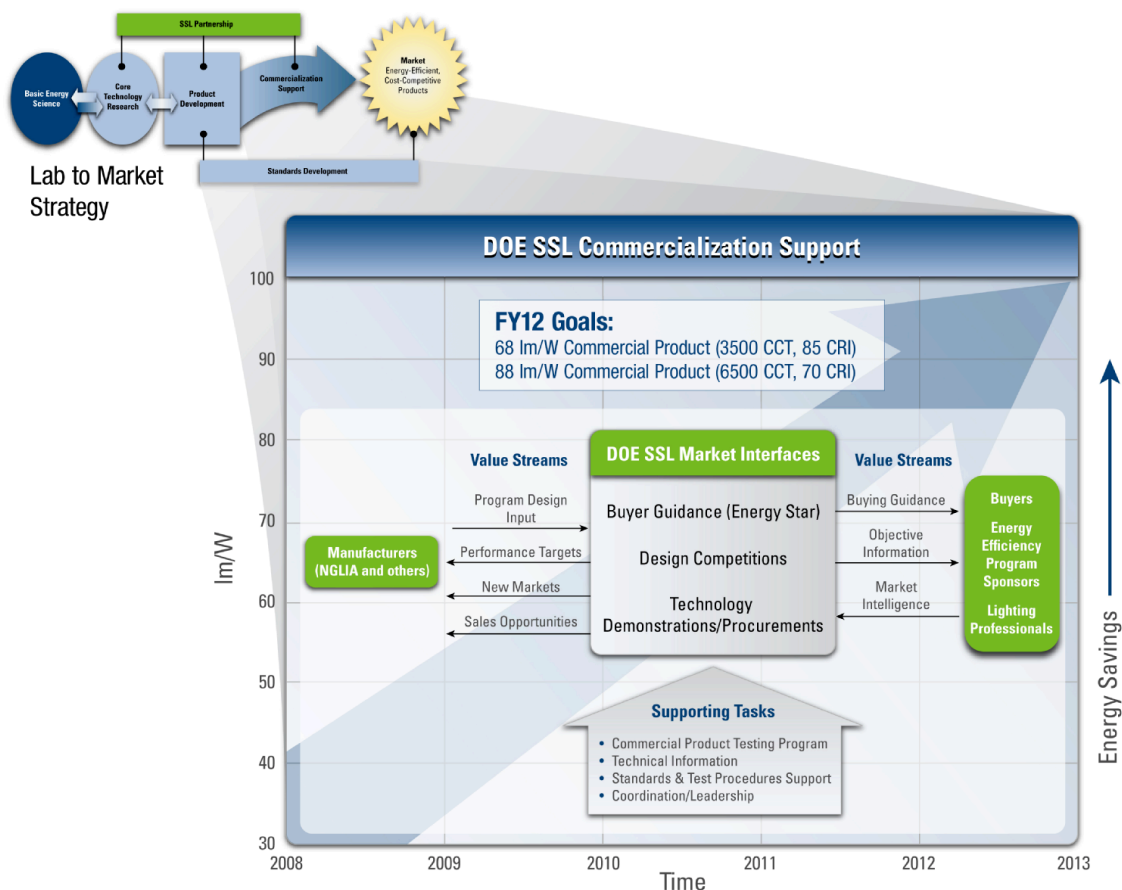


Figure 1. Relationship of task areas to SSL Program, SSL MYPP goals, market, and each other.

The supporting task areas provide valuable services to the above market interfaces, in multiple and interrelated ways:

Commercial Product Testing Program – needed to verify product performance claims, provide consumers with reliable third-party product information, and inform test procedures and standards; supports:

- Buyer Guidance by providing performance information directly to buyers and those who work with buyers
- Design Competitions by helping judges evaluate products submitted in competitions
- Technology Demonstrations by providing useful laboratory performance information on products to be tested in field demonstrations

Technical Information – delivers important information into the hands of buyers – and those who influence them – to help them make better purchase decision; supports:

- Buyer Guidance by providing a range of technical information primarily of use to energy efficiency program sponsors (who use them to develop program designs and materials for their customers) and large facility managers

- Technology Demonstrations/Procurements by helping large volume buyers in those projects better understand SSL technology

Standards and Test Procedures Support – accelerates development of standards and test procedures that support application of SSL to the general illumination market; supports:

- Buyer Guidance by helping develop the test procedures and standards that are necessary for ENERGY STAR specifications and design/purchasing guidelines
- Design Competitions and Technology Demonstrations/Procurements by making possible the standards and test procedures needed to properly evaluate product performance

Coordination/Leadership – helps organize and leverage the substantial resources of the federal government and energy efficiency program sponsors; supports:

- Buyer Guidance by improving the effectiveness with which energy efficiency program sponsors can use ENERGY STAR
- Design Competitions by expanding involvement in and awareness of design competition results
- Technology Demonstrations/Procurements by helping identify potential partners for projects and by expanding involvement in and awareness of projects

Key Issues to be Addressed in Project Development

The preceding section described the key elements of DOE's SSL commercialization support strategy. These elements will be used to guide development of projects that flow from the plan, some of which will be short-term, others may last the entire five year life of this plan. This section identifies a number of high priority issues DOE plans to consider when developing these projects.

1. *Early, low- performing SSL products are likely to cause substantial and lasting market damage. (First impressions are important.)*

As occurred with compact fluorescent lamps and described in the report, *Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market*, early generation, new technology lighting products can cause long-term market damage (DOE, 2006c). Disappointed buyers of those early products are reluctant to try the new technology again, even if it has been improved, and share their disappointment with other potential buyers, both of which can lead to long-term market damage.

2. *High costs*

High quality, high brightness LEDs currently sell for roughly 40 times more than fluorescent lighting when measured on a per kilolumen basis. DOE projects this difference will continue to decline rapidly, but will remain higher than conventional cost lighting for many years to come. Lighting equipment buyers, however, don't purchase light sources by comparing per kilolumen costs. They use such measures as simple

payback and lifecycle costing. Careful analysis of the economics of using SSL for individual general illumination applications will be necessary to help guide program planning and project designs.

3. Low color quality/high color correlated color temperature (CCT)

An oft heard complaint of early generation CFLs was they didn't produce warm light and they made skin color look unnatural. This widely held view didn't die out when warm color, high color quality CFLs became available. Reporters and consumers continue to refer to "harsh, cold fluorescent lighting" as if the technology hasn't changed and by definition, fluorescent means poor quality lighting. A recent Wall Street Journal article on CFLs described the persistence of this view, and how it continues to hinder sales of CFLs long after CFLs with good color quality became available in the market.⁴

Similarly, most early versions of LEDs being introduced as general illumination products use high-CCT, low-CRI LEDs because they are more efficacious than their warm white counterparts. These products may be defining LED products to the market for a whole generation of potential users, creating the possibility that like fluorescent lamps, LEDs will mean cold, unattractive light for a significant number of potential buyers.

4. Incomplete standards, test procedures

One of DOE's first efforts in helping commercialize SSL products was offering its assistance to the SSL industry for developing a number of industry standards and test procedures. As of December, 2006, four key standards and test procedures were under development. The specific procedures selected were identified by DOE and the SSL industry as having the highest priority for early completion. However, a number of other standards and test procedures are still needed, and until they are complete, the industry will continue to encounter problems that limit growth of the SSL industry. Among those still needed are those addressing interconnections between system components, LED device and LED array efficacy, and perhaps test procedures for low-cost methods to measure luminous flux from residential SSL luminaires.

5. Will SSL lead to profligate use of lighting?

LEDs' small form factor, low-voltage circuits, and high durability, as well as high potential to become much less expensive and much more efficient combine to create the possibility of a future in which new applications for lighting become so numerous, and LED lighting so ubiquitous, that SSL technology could in the long run lead to more lighting energy use rather than less.

6. Quick obsolescence

⁴ "Philips Pushes Energy Saving Bulbs: Why this Bright Idea is a Hard Sell," Wall Street Journal, Dec. 5, 2006.

The speed of technology improvement for LEDs creates special challenges for their market introduction. Similar to computer hardware during the 1990s, technological improvements for LEDs are being introduced so quickly that systems become obsolete long before the end of their physical lives. So how important is it for LED systems to have physical lives in the tens of thousands of hours when products being introduced to the market one year or 18 months later may be twice as efficient? Should LED systems have easily replaceable parts knowing that in most cases, users will be better off replacing the entire LED system upon component failure? Should product specifications and standards require physical lives longer than economic lives?

7. Retrofit products

Many of the early LED general illumination products introduced to the market were designed to imitate the function of incandescent lamps, and thus could be retrofit into lighting fixtures designed for incandescent lamp use. These products were generally poorly designed, from both a thermal management and optical perspective. They didn't (and couldn't) use light fixtures into which they were installed as part of their heat sink, and they cast light in all directions, causing significant light loss within the fixture and forfeiting one of the inherent efficiency advantages of LEDs. In short, the limitations of current technology present very substantial challenges for designing LED products to be retrofit into existing fixtures.

But that is likely to change as technology improves. Manufacturers steadily introduce products with much higher maximum operating temperatures than previous LED generations. Products designed with these LEDs face far less challenging thermal management design difficulties, potentially enabling future LED retrofit products that won't need to use the fixture as part of the thermal management system. In addition, the unrelenting pace of efficacy improvement means that LED retrofit products will eventually be so efficient that significant light losses within the fixture may still leave an LED-retrofitted fixture a more efficient option than a fluorescent-retrofitted fixture.

In addition, a lesson learned from the many years of utilities promoting CFL fixtures is also applicable here: While a fixture specifically designed for using CFLs is typically more efficient than an incandescent fixture retrofit with a CFL, consumers have overwhelmingly chosen to retrofit CFLs into existing fixtures rather than buy CFL-dedicated fixtures. Among the reasons consumers choose screw in CFLs over CFL fixtures is they cost less, they like their existing fixtures, and they like the flexibility of being able to revert back to another light source if they don't like the CFL. Many existing fixtures are an important aesthetic part of a living space, and consequently, consumers don't easily part with them. We can expect a similar reaction to new LED fixtures. When faced with the choice of buying a dedicated-LED fixture of high efficiency or retrofitting an LED system into an existing fixture of modest efficiency, we can expect a large fraction of consumers to choose the latter.

9. Commercial vs. residential luminaire emphasis

As indicated in the Purpose, Goals, and End State sections above, DOE plans to strongly emphasize those SSL applications likely to produce significant energy savings. This raises the question of whether to focus efforts on the residential or commercial sector. While commercial lighting dominates U.S. lighting energy use, and thereby represents a much larger potential energy savings target, residential lighting nonetheless represents a significant energy saving opportunity for SSL because:

- incandescent lighting is the dominant light source in the sector, a very inefficient source relative to fluorescent and SSL technology;
- required levels of luminous flux from fixtures is modest due to generally lower ceilings and smaller spaces (which is consistent with the lower flux capabilities of SSL's near-term state of technical development), and;
- SSL's dimming capabilities compete well with fluorescent lighting, the primary energy-efficient alternative to SSL. (Compact fluorescent dimming products tend to be difficult to find in retail stores, are significantly more expensive than non-dimming products, and often don't perform well enough to meet consumer expectations.)

However, the commercial market remains the leading candidate for SSL products because:

- electricity costs are generally higher than in the residential sector, and lighting hours of operation are much longer, making the economics of SSL more compelling;
- commercial customers tend to be more sophisticated lighting buyers, and pay more attention to cost-effective lighting investments;
- labor costs for replacement and maintenance are often monetized, making LED durability and long life more attractive, and;
- commercial customers are generally more receptive to lighting products with higher first costs than other alternatives.

DOE will closely monitor changing economics for both commercial and residential applications, as well as changes in the technology affecting SSL's suitability for various applications. Resources will be focused on lighting applications and projects most likely to maximize potential U.S. energy savings.

10. Likely near-term target lighting applications

Near-term general illumination applications that are both technically appropriate and economically feasible for SSL technology will likely exhibit the following characteristics:

- total lighting flux requirements are low to moderate;
- the application can take full advantage of SSL's directional light, thereby minimizing optical losses in fixtures;
- higher color temperatures acceptable or advantageous;
- fixtures are operated a large number of hours per year;

- high value can be derived from SSL's potential for long life, and therefore low maintenance costs;
- dimming or ability to withstand frequent switching is important;
- fixtures are subjected to constant or frequent low ambient temperatures;
- low or no emissions in the infrared and ultraviolet range are important;
- small form factors are valuable, and;
- the incumbent light source technology for the application has significant shortcomings, such as inefficiency or poor color quality.

DOE will develop and maintain a list of applications consistent with the above characteristics (and other characteristics identified after adoption of this plan), and include those under the economic analysis described in Point 9 above.

Performance Measurement

Progress towards the goals of this plan will be assessed using a set of quantitative and qualitative metrics. Measurements will be made at least annually, and more frequently should conditions require it. Results from these measurements will be used to update and modify the plan, improving the quality and effectiveness of its activities. These measures will also be used to facilitate early identification of problems so that timely corrections can be made while any issues are still minor.

DOE will seek commitments from its SSL Commercialization Support partners and contractors to work toward the goals of this plan and take responsibility for ensuring satisfactory progress. At a minimum, DOE will pursue commitments from:

- Next Generation Lighting Industry Alliance
- Pacific Northwest National Laboratory
- Akoya, Inc.
- Organizations that have signed cooperative agreements under the SSL Technical Information Network

The performance metrics and underlying information for each include:

1) Identification and documentation of top-performing general illumination commercialized SSL products

- Device efficacy (luminous efficacy), luminaire efficacy, CCT and CRI if available from manufacturer; verify with independent laboratory testing
- Description of intended lighting applications
- Description of market availability (e.g., where offered for sale, through what channels, evidence of installations, references in lighting media, etc.)
- Data collected via active monitoring of trade media, manufacturers communications, conference proceedings, laboratory testing, and survey instruments

- 2) Annual sales of ENERGY STAR compliant SSL products
 - ENERGY STAR compliance representing the baseline of high-performance products
 - Voluntary sales reporting from ENERGY STAR manufacturer partners
 - Identification of intended lighting application by sales category; these numbers will be compared to sales of conventional light sources for these lighting applications to estimate fraction of sales due to SSL products.
 - In addition, DOE has entered into an agreement with the National Electrical Manufacturers Association (NEMA) to collect and analyze SSL sales data. DOE will have NEMA track and document ENERGY STAR sales as part of this contract.
- 3) Annual energy savings achieved
 - Annual energy savings calculated as the difference between energy savings due to a “natural rate” of SSL market adoption and energy savings due to an accelerated rate of market adoption.⁵

Annual measurements for all three of the above metrics will be completed by March 1 for each year covered by this plan.

Schedule

A schedule of key outcomes, by task, by fiscal year is attached as Attachment A.

Partnerships

DOE has identified the following key partners whose cooperation will be important to successful implementation of this plan. The resources, expertise, and networks these program partners bring to the efforts represented by this plan greatly multiply any market development DOE can achieve on its own.

⁵ The “natural rate” of SSL market adoption would occur in the absence of a DOE SSL program. It is not directly measurable, or easily estimated because DOE has already made five years of substantial investments in SSL technology, thus already affecting the rate at which SSL general illumination products are being developed and sold.

Based on findings from a National Research Council evaluation of DOE energy research, DOE is estimating its investment in SSL is accelerating the market adoption of the technology by five years. The natural and accelerated market adoption curves are parallel, but offset by five years. The accelerated rate market adoption curve is deemed to be that curve estimated in a recent DOE energy savings estimate (DOE, 2006). The natural rate adoption curve is deemed to be the accelerated curve, plus five years. DOE will collect market data to support annual updates of its SSL energy savings estimate, using the same methodology used for its 2006 energy savings estimate.

This plan will be shared with them, and to the extent possible, DOE will seek agreements solidifying their cooperation in helping implement elements of this plan. In addition to many special purpose meetings that will be held with these partners, DOE plans to hold an annual SSL Commercialization Support Workshop whose primary purpose will be to solicit involvement and guidance on projects carried out under this plan, as well as the plan itself. The first of such workshops is already planned for April 23 and 24, 2007 in Southern California.

Key Partners (not listed in order of priority)

- 1) Federal Energy Management Program
- 2) Energy Efficiency Program Sponsors, especially those which have partnered with the ENERGY STAR program (utilities, energy efficiency organizations, and state agencies)
- 3) Building America
- 4) U.S. Green Building Council
- 5) Next Generation Lighting Industry Alliance
- 6) Illuminating Engineering Society of North America
- 7) American Lighting Association
- 8) International Association of Lighting Designers
- 9) National Association of Lighting Distributors
- 10) National Electric Manufacturers Association
- 11) American National Standards Institute
- 12) Underwriters, Inc. Laboratories (U.L.)

Attachment A

KEY OUTCOMES BY FY							
		Pre-Plan Year					
		07	08	09	10	11	12
1.0	<u>Market Interfaces</u>						
	<u>Buying Guidance</u>						
1.1	Energy Star Criteria	Final Criteria	Vers 1.1, 1.2	Vers 1.3, 1.4	Ver 2.0	Ver 2.1	Ver 2.2
1.2	Federal Design/Purchasing Guidance	-	New Guidance	Update	Update	Update	Update
2.0	<u>Design Competitions</u>						
2.1	Lighting for Tomorrow	07 Comp	08 Comp	09 Comp	10 Comp	11 Comp	12 Comp
2.2	Commercial Fixtures	Project Design	08 Comp	09 Comp	10 Comp	11 Comp	12 Comp
2.3	Lighting Design	Project Design	08 Comp	09 Comp	10 Comp	11 Comp	12 Comp
2.4	State-of-the-Art Showcase	Project Design	08 Comp	09 Comp	10 Comp	11 Comp	12 Comp
3.0	<u>Demonstration/Procurements</u>						
3.1	Market Readiness Demonstrations	2-3 Demos	3-4 Demos	3-4 Demos	3-4 Demos	3-4 Demos	3-4 Demos
3.2	Field Test Demonstrations	-	1-2 Demos	1-2 Demos	1-2 Demos	1-2 Demos	1-2 Demos
	<u>Supporting Task Areas</u>						
4.0	<u>Commercial Product Testing Program</u>						
4.1	Commercial Product Testing	20-30 Tests	40-50 Tests	40-50 Tests	Self-suppt spin-off	-	-
5.0	<u>Technical Information</u>						
5.1	Technical Information Dev. & Dissemination	new website	Dev/Dissm 4 Prod	Dev/Dissm 4 Prod	Dev/Dissm 4 Prod	Dev/Dissm 4 Prod	Dev/Dissm 4 Prod
5.2	Technical Information Network Mtgs/Coord	launch network	4 Qrt. Meetings	4 Qrt. Meetings	4 Qrt. Meetings	4 Qrt. Meetings	4 Qrt. Meetings
6.0	<u>Standards and Test Procedures Support</u>						
6.1	Standards and Test Procedures Support	6 new std	2 new std/2 update	1 new std/2 update	1 new std/2 update	1 new std/1 update	-
7.0	<u>Coordination/Leadership</u>						
7.1	Local and Regional	-	2 joint projects	2 joint projects	2 joint projects	2 joint projects	2 joint projects
7.2	Federal Government	-	1 major fed action	1 major fed action	1 major fed action	1 major fed action	1 major fed action
	<u>Project Management</u>						
	Management	-	meet proj goals	meet proj goals	meet proj goals	meet proj goals	meet proj goals
	Project Analysis and Planning	as assigned	as assigned	as assigned	as assigned	as assigned	as assigned
	Progress Measurements	-	annual report	annual report	annual report	annual report	annual report
	Annual Comm. Support Workshop	-	annual workshop	annual workshop	annual workshop	annual workshop	annual workshop

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