



DOE's 5-Year SSL Commercialization Support Plan

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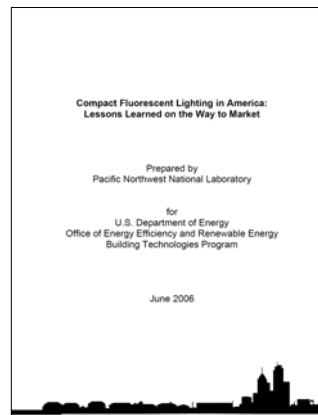


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SSL Lessons from CFL Market Introduction?

- Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market
 - Prepared for U.S. DOE by PNNL
 - LJ Sandahl, et al.
 - June 2006
 - <http://www.netl.doe.gov/ssl/publications.html>



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Early Fluorescent Lamp Days (Pre-CFL)

- Green tint due to use of halophosphors
- Harsh, unattractive
- Reputation persists
- Carried over to CFLs



“Harsh fluorescent lighting, linoleum floors and regular plaster walls are not ideal surroundings for neonatal intensive care units.” – Google Search.

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Early CFLs

- Too big
- Too heavy
- Buzz and flicker
- Poor cold weather performance
- Poor color quality (high CCT, low CRI)
- High prices (\$25 - \$35 in 1980s)



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Key Take Away from CFL Experience

- Early consumer experience with fluorescent lamps and CFLs still defines attitudes towards CFLs, even though the technology has greatly improved since its introduction



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5-Year SSL Plan Purpose

1. *Affect the types* of products adopted by the market
2. *Accelerate commercial adoption* of products
3. Support applications that *maximize energy savings*

Plan Scope

FY08 to FY12 ♦ general Illumination SSL luminaires

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Goals: By FY12

1. Products Brought to Market:

Warm White Products

1. 68 lm/W luminaire efficacy
2. 85 CRI (or similar for revised metric)
3. 3500 CCT or less

Cool White Products

1. 88 lm/W luminaire efficacy
2. 70 CRI (or similar for revised metric)
3. 6500 CCT or less

2. Market Adoption: 1 million units/year (ENERGY STAR)

3. Energy Savings: 230 GWh per year

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Primary Market Barriers

- High costs
- Lack of industry standards and test procedures
- Lack of information

Note: *Barriers do not address technical barriers, which are being addressed in R&D program.*

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Market Needs (to address Barriers)

- Effective product purchasing and architectural design guidance
- State of the art products and lighting designs
- Highly visible examples of model SSL general illumination applications
- Independent performance test results on commercial products
- Objective technical information from a credible source
- Industry standards and test procedures for SSL general illumination products
- Coordination of local, regional, and federal SSL commercialization activities

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DOE SSL Commercialization Support Strategy Elements

1. Buyer Guidance
 - ENERGY STAR
 - Design Guidance
2. Design Competitions
 - Lighting for Tomorrow (Residential Fixtures)
 - Commercial Fixture Design Competition
 - Architectural Lighting Design Competition
3. Technology Demonstrations/Procurements
 - Demonstrations of Market Readiness
 - Demonstrations to Test Field Performance

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DOE SSL Commercialization Support Strategy Elements (cont.)

4. Commercial Product Testing Program
5. Technical Information
 - Technical Information Development & Dissemination
 - Technical Information Network
6. Standards and Test Procedures Support
7. Coordination and Leadership
 - Facilitating & Coordinating Local and Regional Efforts
 - Federal Government Leadership

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1) Buyer Guidance

- Developed draft ENERGY STAR criteria for SSL luminaires
- General illumination only
- Residential and commercial products
- Intended to provide early market presence
- 1st draft issued in December 06
- Stakeholder workshop on February 8, 2007 in DC
- 2nd draft issued in April 07; final by June 07



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Why ENERGY STAR SSL? Why Now?

- Many new products entering market
- Many appear to have greatly exaggerated performance
- DOE SSL commercial product testing is showing actual performance is much less than claimed



Example: Downlight claimed 40 lm/W; measured luminaire efficacy of 13 lm/W and 193 lumens; less than 1/2 the efficacy of typical CFL downlight, and ~1/3 the lumens.

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Why ENERGY STAR SSL? Why Now?

- Meanwhile, LED technology is rapidly improving
- Manufacturers are announcing new performance records almost every month
 - Nichia announced 150 lm/W @ 20 mA in December (lab)
 - Seoul Semiconductor announced 100 lm/W @ 350 mA in December (commercial)
 - Lumileds announced 115 lm/W @ 350 mA in January (commercial)

Note: the above performance levels are typically done at 25°C for 25 ms with non-standard test; they are not meant to represent actual performance in a luminaire

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Design Guidance

- Develop SSL design guidance in cooperation with IESNA
- Purpose: provide lighting designers with key information on SSL technology & characteristics to be considered in designs
- Project in development



2) Design Competitions

- Lighting for Tomorrow
 - Partnership with ALA and CEE approved through 2008
 - Niche applications
 - Cutting edge design
 - Residential products only
 - Recently expanded to include SSL
 - Expert judges
 - Publicity, visibility for winners





Design Competitions (cont.)

- New commercial luminaires design competition being considered
- Also considering SSL architectural design competition in future
- New competitions being discussed with IES

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3) Technology Demonstrations/ Procurements

- **Purpose:** Demonstrate advanced technology in general illumination applications for visibility & improved understanding
- Leverage demos with closely linked promotional/procurement effort
- Two types of demos:
 - Market readiness
 - Field test

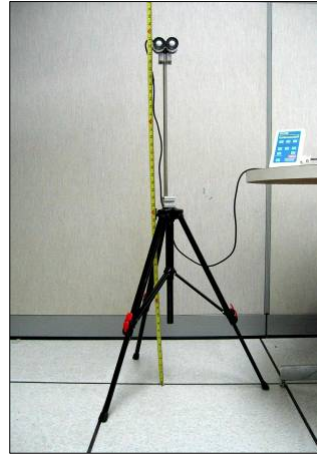


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Technology Demonstrations

- 1st Round started
- Invitation issued to manufacturers in March
- DOE finds partners & host sites, conducts testing, publicizes results and helps promote follow-up sales
- Evaluations to focus on light quality, occupant responses
- Next round likely before FY end

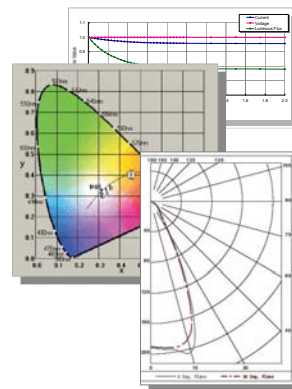


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4) Commercial Product Testing Program

- Commercially-available SSL products for the general illumination market
 - Luminaires (white light)
 - Indoor and outdoor
 - Residential and commercial
- Testing for
 - Luminaire light output, efficacy
 - Power, thermal characteristics
 - Beam and intensity
 - Lumen depreciation
 - Spectral power distribution, CCT, CRI
 - Benchmarking (other light sources)



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Thermal Management of White LEDs

LEDs emit heat just like any other light source. In fact, thermal management is arguably the most important aspect of successful LED lighting design. This heat must be removed for the LEDs to perform and last for 50,000 hours.

All LED systems consist of three parts: the LED chip, the LED package, and the LED system. The LED chip is the smallest part of the LED system. The LED package is the largest part of the LED system. The LED system is the combination of the LED chip and the LED package.

Power Dissipation (W)	Thermal Resistance (K/W)	Temperature Rise (K)
1	10	10
10	10	100
100	10	1000

Energy Efficiency of White LEDs

Energy efficiency of LEDs is a complex combination of factors such as the LED chip, the LED package, the LED system, and the LED application. The LED chip is the most important part of the LED system. The LED package is the largest part of the LED system. The LED system is the combination of the LED chip and the LED package.

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Lifetime of White LEDs

One of the main "selling points" of LEDs is their potentially long life. The life expectancy of LEDs is typically 50,000 hours. This is significantly longer than the life expectancy of incandescent lamps, which typically last 1,000 hours.

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Color Quality of White LEDs

Color quality is one of the key attributes of LED lighting systems. It is defined as the ability of a lighting system to reproduce colors accurately. The color quality of a lighting system is determined by its color rendering index (CRI) and its color temperature (CT).

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Technical Information Network

- Cooperative agreements to be awarded to selected partners: (CEE and NEEP)
- Outreach to efficiency orgs, utilities, and their contractors
- Leverage existing programs & contacts
- Quarterly meetings
- Disseminate information to:
 - Retailers, builders
 - Consumers, others

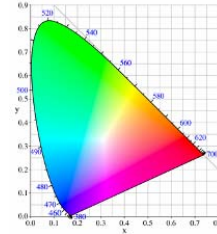




6) Standards & Test Procedures Support

Key Measurement Issues:

- Measurement of luminous flux
 - Luminous efficacy
 - Luminaire efficacy
- Chromaticity and color rendering
- Electrical characteristics
- Drivers
- Life rating (lumen maintenance)
- Definitions and nomenclature



Standards and Test Procedures Support



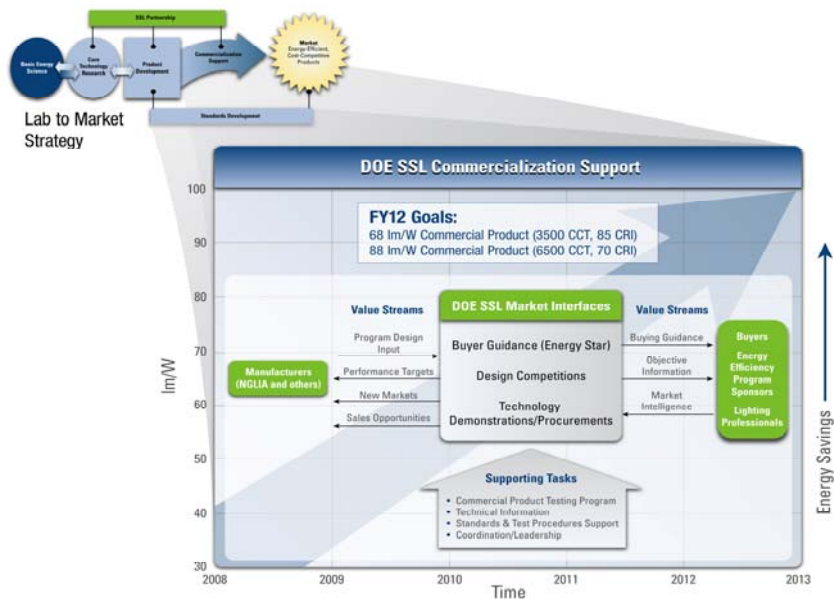
- DOE workshops in Mar & Oct 2006
- In process:
 - Photometric Measurement (LM-79)
 - Lumen Depreciation (LM-80)
 - Chromaticity (ANSI C78.377A)
 - Electrical performance (ANSI C78.XX3)
 - SSL-LED power supply (ANSI C82.XX1)
 - Definitions/nomenclature (IESNA RP-16)
- New standards before end of 2007



7) Coordination & Leadership

- Federal government is largest U.S. energy consumer
 - Working with FEMP to identify opportunities for early SSL applications
- Organize workshops, joint projects for key partners, including
 - Efficiency organizations, utilities
 - Lighting industry professionals
 - Fixture manufacturers

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DOE Solid-State Lighting Website

- Current information on SSL program, progress, and events
- SSL publications: roadmaps, reports, technical fact sheets
- Solicitations
- Register for ongoing SSL UPDATES at: www.netl.doe.gov/ssl

