

# ***Solid State Lighting: Present and Future***

***Next Generation Lighting Industry Alliance***

**June 18, 2012**



# Briefing Topics

- **Next Generation Lighting Industry Alliance**
- **Solid State Lighting (SSL) and Applications**
- **Lighting and Energy Efficiency**
- **DOE's SSL Program and Progress To Date**
- **Broader SSL Benefits**
- **Further Research Needed**



# Speaker Panel

Keith Cook

Philips Lighting

Tom Simpson

3M

Mike McSherry

Cree, Inc.

Cheryl English

Acuity Brands Lighting

Chips Chipalkatti

OSRAM SYLVANIA



# What is NGLIA?

- Alliance of for-profit U.S. corporations formed to accelerate U.S. Solid State Lighting (SSL) development and commercialization through government-industry partnership
- Membership open to any private, for-profit firm substantially active in solid state lighting research, development, infrastructure, and manufacturing in the U.S.



## Why NGLIA?

- Support of Inorganic and Organic-based SSL
- Promotion/support of U.S. DOE ongoing assessment of SSL potential, state of SSL technology, and DOE's SSL R&D Program
- Facilitation of communication between NGLIA members and others



# **NGLIA Members**

**3M**

**Acuity Brands Lighting**

**Applied Materials**

**Bayer MaterialScience**

**CAO Group**

**Corning, Inc.**

**Cree Inc.**

**Eastman Kodak**

**GE-Lumination**

**Light Prescriptions**

**Innovators (LPI)**

**LSI Industries**

**Luminus Devices**

**OSRAM SYLVANIA**

**Philips Solid-State Lighting  
Solutions**

**QuNano**

**Ruud Lighting**

**Universal Display Corp.**

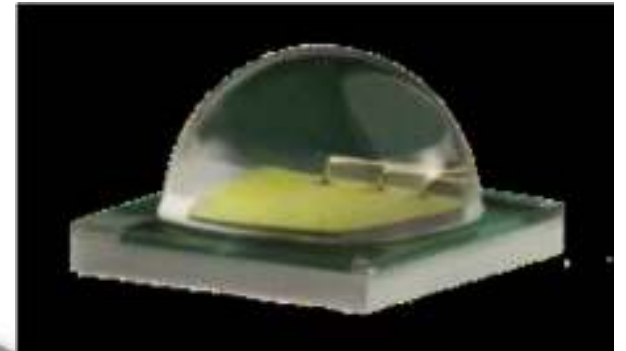
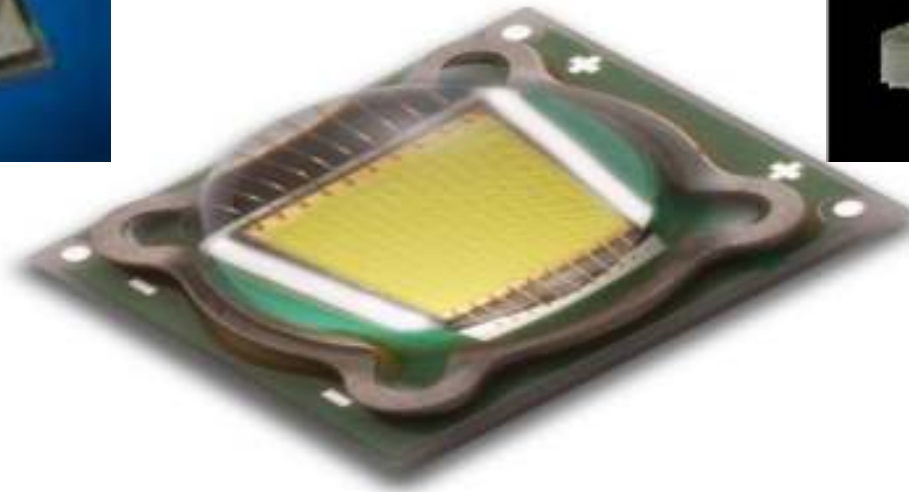
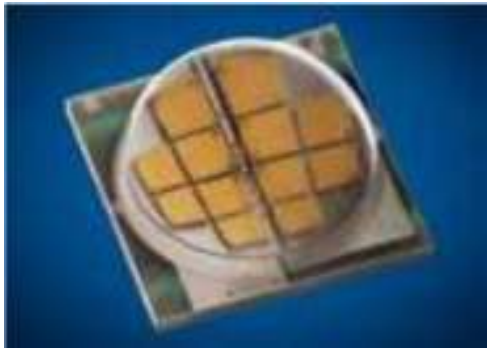


# What Is Solid State Lighting?

- **Fundamentally different from conventional technologies**
  - **Directional**
  - **Compact size**
  - **Long operating life**
  - **Controllability**
- **Light-Emitting Diodes (LEDs)**
- **Organic Light Emitting Diodes (OLEDs)**



# LEDs



Solid-state semiconductor light sources long used for electronics and displays and now for general lighting



# LED "Bulbs" = Lamps



**NGLIA**  
NEXT GENERATION LIGHTING INDUSTRY ALLIANCE

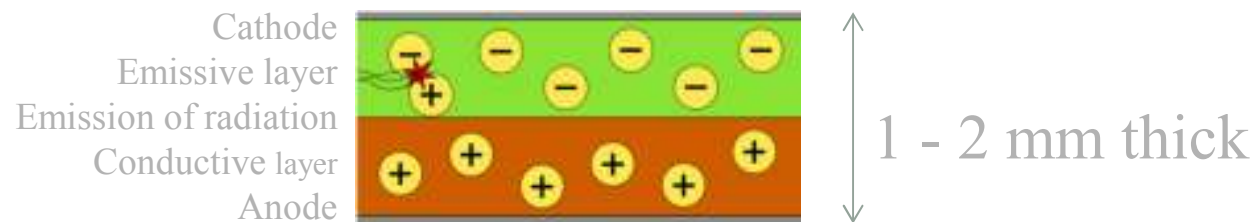
# LED "Fixtures" = Luminaires





# How is OLED different from LED?

- OLEDs are solid-state devices composed of thin films of organic materials that create light with the application of electricity.
- OLEDs are being used for electronic displays and are now emerging as a solution for architectural lighting in buildings.



# OLEDs' Many Unique Characteristics

**Flexible OLEDs**

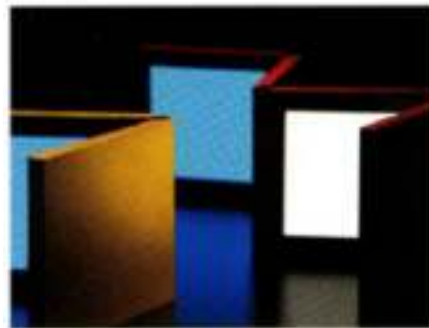


**Arbitrary Shapes**

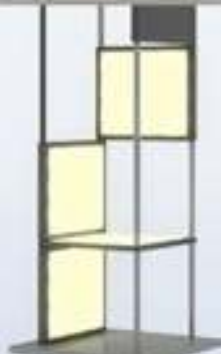


**Architectural**

**Full Color Tuning**



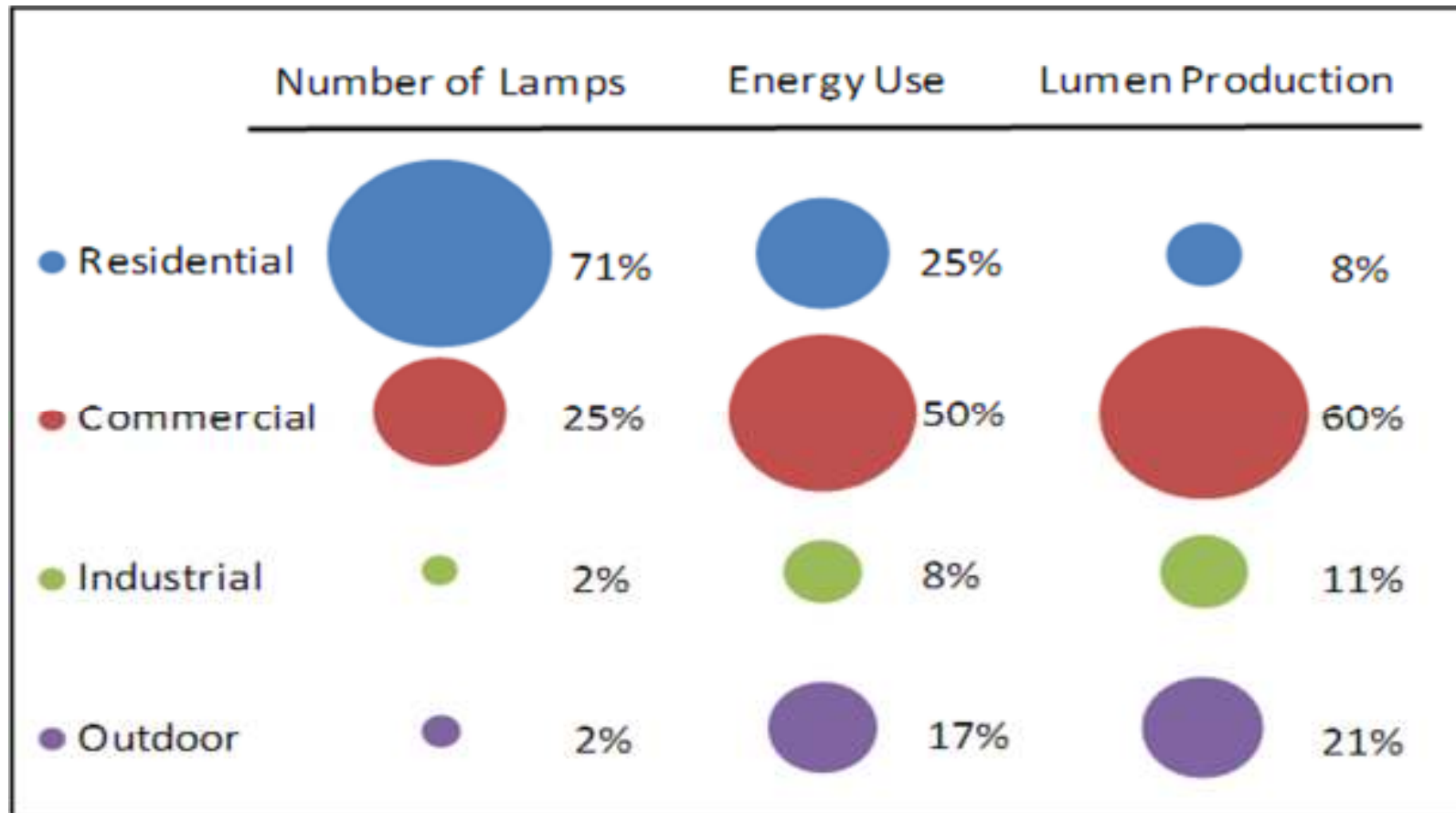
# OLED Apps. for Large Area, Diffuse Light Sources



# OLED Apps. for Large Area, Diffuse Light Sources



# U.S. Lighting and Electricity Use



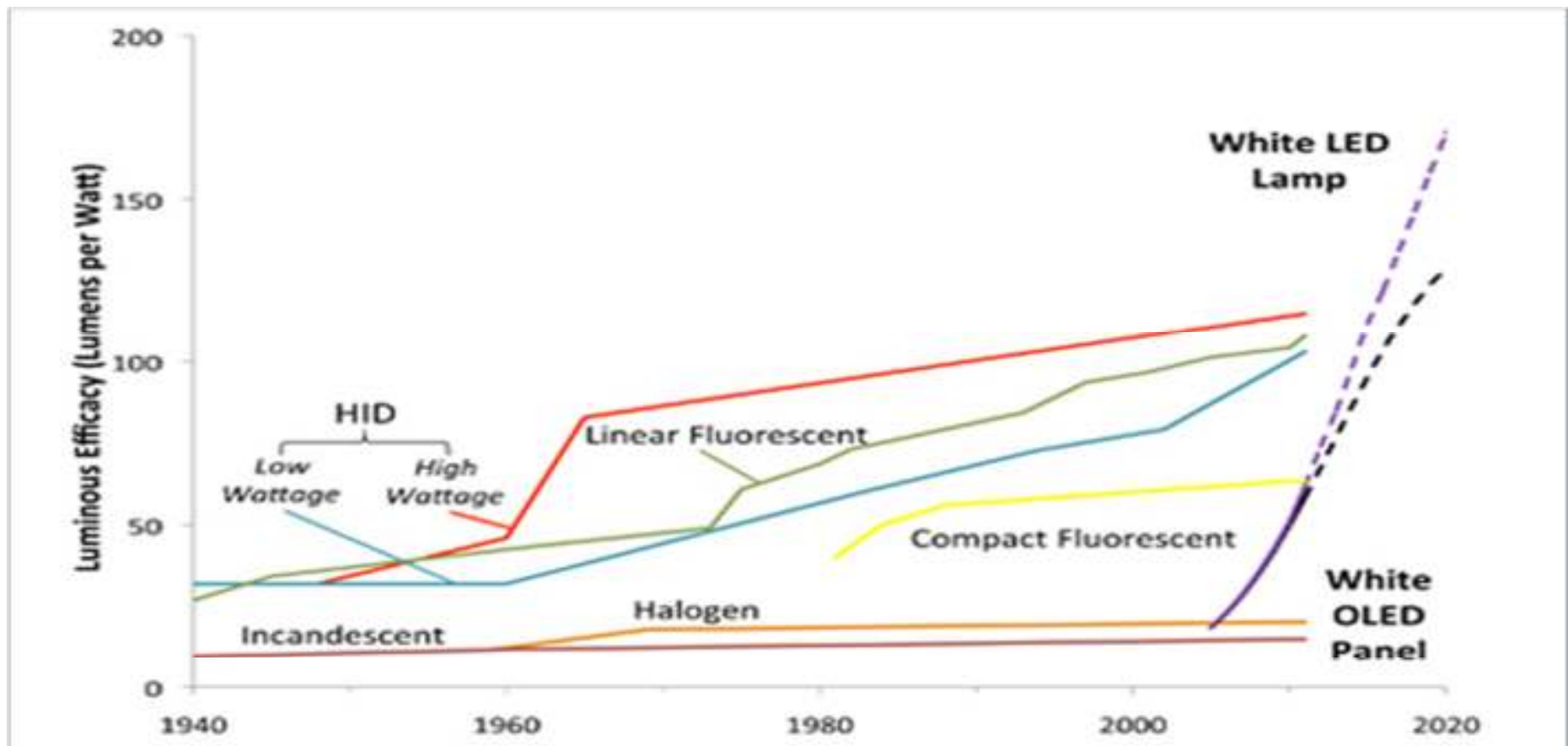


# Energy Efficiency of Lighting Today

Technology	Lumens per Watt
60-watt Incandescent Bulb	13-15
Halogen	15-20
Compact Fluorescent	53-63
Solid State Lighting	70-100



# Historical and Predicted Efficiency



While traditional lighting technologies are relatively mature and offer less potential for improvement, SSL is still at a comparatively early stage and continues to achieve dramatic advances in efficacy.

# Next Generation Lighting Initiative

- **Sec. 912 of Energy Policy Act of 2005 directed**
  - **DOE launch NGLI to support R&D, demonstration and commercial applications, and select an industry partner organization**
  - **National Academy of Sciences periodic review of DOE program**



# DOE SSL Program

- **Research & Development**
  - Core technology
  - Product development
  - Manufacturing
- **Standards Development**
  - Coordination with industry organizations



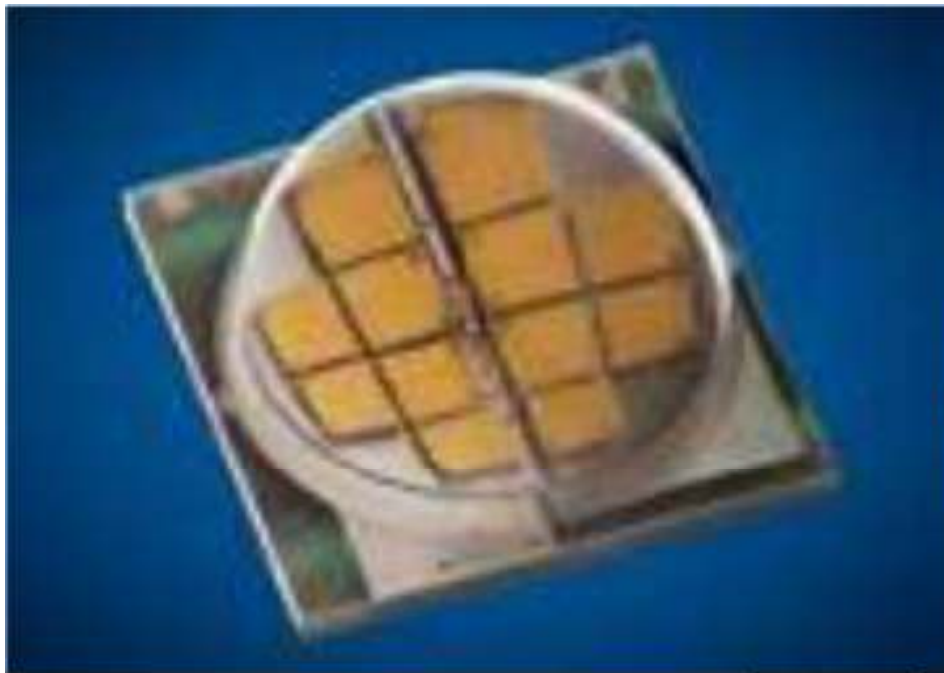
# Recent U.S. R&D Highlights

Bright white LED package: 600 lm @ 149 lm/W



# Recent U.S. R&D Highlights

9 mm x 9mm LED for MR-16-type: 1,525 lm



# Recent U.S. R&D Highlights

**Undercabinet OLED System: 420 lm @ 55 lm/W,  
10,000k hr life**



## R&D “To-Dos”

- Half-way there...but this is the hard part
- Efficacy using today’s techniques leveling off
- “Status quo” falls short, leaving massive energy savings on the table
- Significant technology headroom remains
- Need for breakthroughs vs. incremental improvements



# DOE SSL Program

- **Market Development Support**
  - **Demonstration projects: GATEWAY**
  - **Testing and quality reporting: CALiPER**
  - **Competitions: L-Prize, Next Gen. Luminaires**
  - **Buyer Support: LightingFacts label**



# GATEWAY

- **Demonstration projects**
  - **Real-world data on performance and cost effectiveness**
  - **I-35 bridge in Minneapolis, MN**
  - **Dept. of Labor parking garage**
- **Municipal Solid State Street Lighting Consortium**



## CALiPER

- **Commercially Available LED Product Evaluation and Reporting**
  - Takes products on the market, tests them, and compares actual performance to manufacturer's claims and to conventional products
  - Provides lighting buyers w/objective assessments
  - Points manufacturers to make improvements
  - Helps guide DOE support for R&D



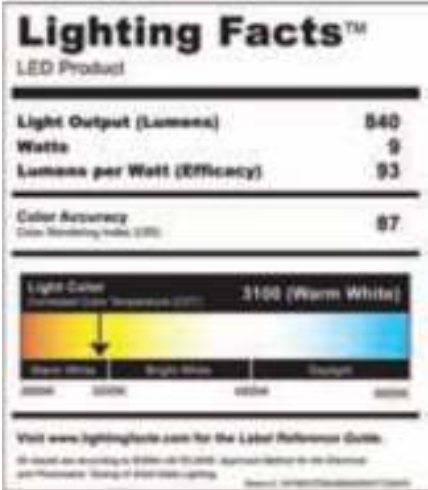
# Design Competitions

- **Bright Tomorrow Lighting Prize (“L-Prize”)**
  - Aims to accelerate development, adoption of SSL products
  - Challenges industry to develop replacements for 2 of most widely used inefficient products
    - “60-watt replacement” bulb
    - “PAR-38 replacement” bulb
    - “Light of the Future”
- **Next Generation Luminaires**
  - Recognizes excellence in design of energy-efficient LED commercial luminaires
  - Separate categories for indoor and outdoor fixtures



# Buyer Support

- SSL Quality Advocates and LightingFacts
- Participating manufacturers test to prescribed standards and use “nutrition”-type label
  - Light output (lumens)
  - Energy usage (watts)
  - Efficiency (lumens/watt)
  - Color (warm-to-cool spectrum)



**Lighting Facts™**  
LED Product


Light Output (Lumens)	840
Watts	9
Lumens per Watt (Efficiency)	93

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Color Accuracy  
Color Rendering Index (CRI) 97

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Light Color  
Color Temperature (K) 3100 (Warm White)



Visit [www.lightingfacts.com](http://www.lightingfacts.com) for the Label Reference Guide.  
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## Status Report

- Rapid technical progress being made, supported by industry-DOE partnership
- R&D global, but U.S. leadership
- U.S. manufacturing with support of international supply chains
- SSL products on the U.S. market
- But.....
- DOE decision to reallocate R&D support for FY2012 jeopardizes U.S. SSL leadership



# International Competition

- **China**
  - Central govt. spending \$1 billion annually on SSL R&D alone (provinces provide additional incentives)
- **Japan, Taiwan, Germany, European Union**
  - Each govt. spending at least \$100 million annually



# SSL Deployments...So Far

- Outdoor lighting
  - Parking lots, roadways, walkways
- Area lighting
  - Parking garages
- General and residential lighting
- Commercial lighting
  - Hotels, restaurants
  - Offices





# Where Can You See SSL Nearby?

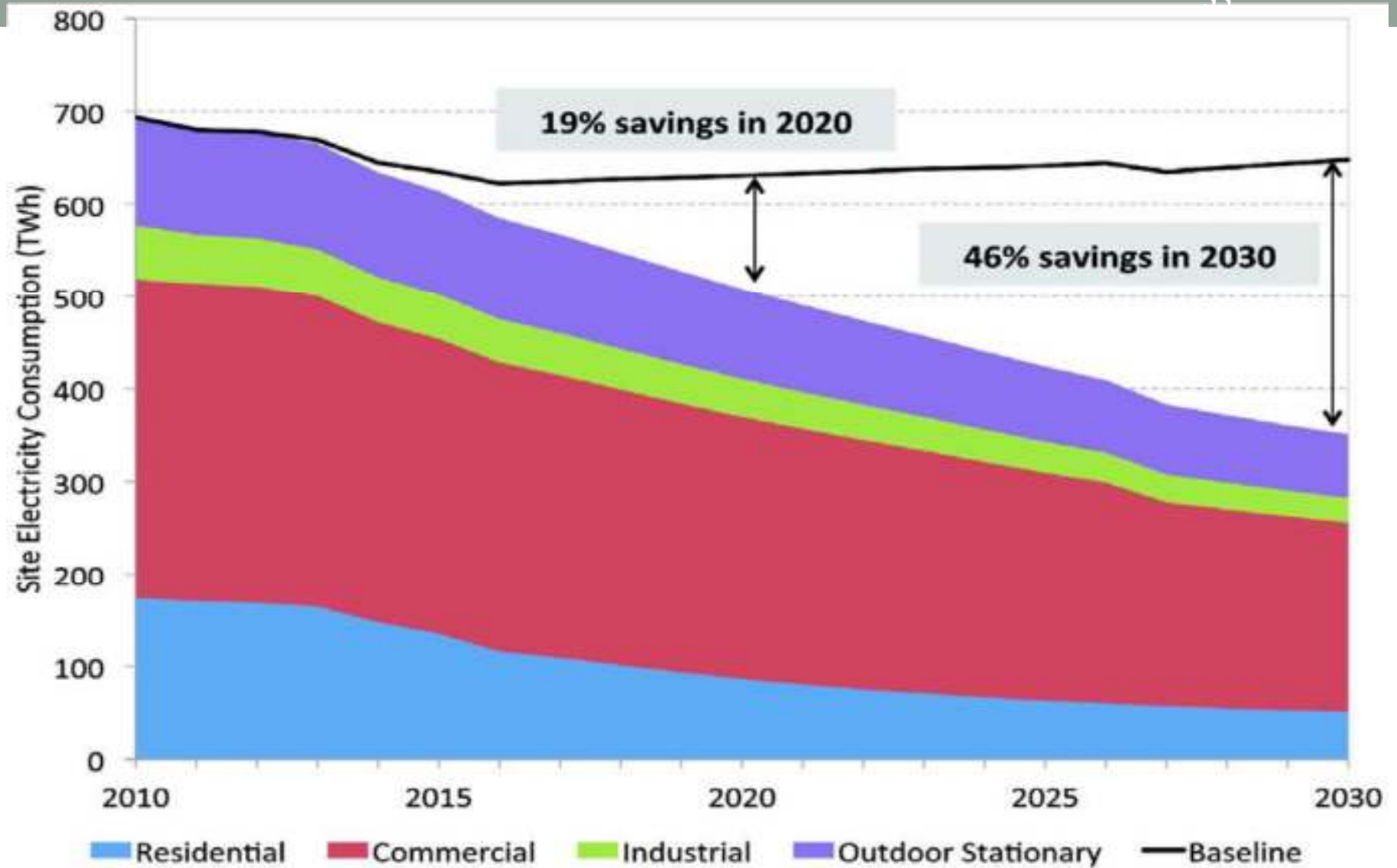
- **On Capitol Hill**
  - **Rayburn Cafeteria, “Senate Chef”**
  - **Senators’ Offices**
- **On the National Mall**
  - **Walkway post-top fixtures**
  - **Jefferson Memorial**
  - **Depts. of Labor and Defense**



## Energy Savings in U.S.

- **SSL potential to reduce all U.S. lighting electricity use by approx. 50 percent by 2030 (from 2010 base)**
- **Return on Investment**
  - **DOE SSL spending: \$250 million since 2005**
  - **4 GigaWatts of energy conserved (savings equal to energy generated by \$13 billion solar program)**





Source: *Energy Savings Potential of SSL in General Illumination Applications*, DOE, 2012

# SSL Lighting Systems

- **Directional: Puts Light Where Needed**
- **Low Profile and Compact**
- **Instant-On**
- **Durable and Long Life**
- **Color Tunable**
- **Controllable and Dimmable**
- **Energy Efficient**



# Human Aspects of Lighting

- **Attitude and mood**
- **Controllable**
- **Integrated with architecture**
- **More responsive to the human environment**



# SSL Manufacturing “To-Dos”

- **Bring down cost to manufacture**
  - **Materials, processes**
  - **Capital investments: plant, equipment**
- **Bring down first-cost to the consumer**



# DOE OLED Panel Cost Projection

**Table 9. Cost Targets for OLED Panel Fabrication**

*Source: Based on recommendations from the 2011 Manufacturing Workshop and Roundtable Attendees*

	Units	2012	2015	2020
Materials	\$/m <sup>2</sup>	180	91	42
Depreciation	\$/m <sup>2</sup>	1000	80	24
Labor	\$/m <sup>2</sup>	400	40	10
Operations	\$/m <sup>2</sup>	120	24	8
Overhead	\$/m <sup>2</sup>	100	15	6
<b>Total</b>	<b>\$/m<sup>2</sup></b>	<b>1800</b>	<b>250</b>	<b>90</b>
<b>Total</b>	<b>\$/klm</b>	<b>180</b>	<b>25</b>	<b>9</b>

**2012-2020: 20x  
reduction**

## Benefits to the U.S.

- **Federal government**
  - Energy savings
  - Reduced maintenance costs
- **Private sector**
  - Energy and cost savings
  - Innovation & transition to high technology
  - High-tech R&D and manufacturing jobs
  - Economic growth, economic security





# Challenges Facing U.S. SSL

- **Technical**
  - Core technology
  - Product development, commercialization
  - Manufacturing
- **Economic**
  - Manufacturing
  - Market
- **Consumer education**



# What Can Congress Do?

- Evaluate means to fund DOE SSL Program more in line with globally competitive level
- Deployment incentives
  - Federal facilities
  - Rebates
  - Tax treatment



# Special Thanks

## House Committee on Science, Space and Technology

*Content and images provided by*

3M

Acuity Brands Lighting

Cree, Inc.

GE

KonicaMinolta

Mitsubishi Chemical

OSRAM SYLVANIA

Philips Lighting

Universal Display Corporation

U.S. Department of Energy



**THANK YOU FOR YOUR ATTENTION.**

**QUESTIONS AND DISCUSSION  
PLEASE!**

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