

2016 DOE Solid-State Lighting R&D Workshop Agenda

February 2–4, 2016 • Raleigh, NC

TUESDAY, FEBRUARY 2, 2016

7:00 a.m. *Registration Opens and Continental Breakfast*

PLENARY SESSIONS

8:00 a.m. **WELCOME AND INTRODUCTION**

There is widespread agreement today that we are in the midst of a sea change in lighting, one that will reshape the lighting industry as we know it. Rapid advances in SSL technology make it easy to forget that this technology is still at a relatively early stage of development, and much of its potential remains untapped. So what will it take to unlock the full potential of SSL? This workshop will share the latest on SSL R&D advances, examine market forces that are shaping SSL technology, and explore how the technology is defining new market opportunities.

JAMES BRODRICK, U.S. DEPARTMENT OF ENERGY

8:30 a.m. **A NEW LIGHTING PARADIGM**

The lighting industry looks vastly different today compared to a decade ago, as new companies emerge and familiar companies reinvent themselves. This talk will share Acuity's vision for SSL technology, future connected lighting systems, the lighting market, and R&D directions needed to achieve this vision of the future.

JEFF QUINLAN, ACUITY BRANDS

9:15 a.m. **BRINGING OLED LIGHTING TO MARKET**

Learn how an innovative OLED startup in Rochester, NY, is leveraging technologies from research labs at Kodak and Philips to establish OLED panel manufacturing in the U.S. and Europe, applying new approaches to scale up production capacity using limited capital resources. What remaining challenges stand in the way of bringing OLED lighting panels and products to market? How can the OLED industry collaborate on the path forward and contribute to U.S. competitiveness in a global lighting market?

DAVID DEJOY, OLEDWORKS

10:00 a.m. *Refreshment Break*

10:30 a.m. **THE INFLUENCE OF SSL ON LIGHTING DESIGN CONCEPTS FOR RESTAURANTS**

Jack in the Box's early installations of LED lighting systems for their restaurant properties helped to lay the groundwork for the brand's current strategy for implementing energy-efficient lighting solutions in restaurants system-wide. The unique properties of LED lighting have changed how they approach exterior lighting design. Learn more about Jack in the Box's vision for transforming restaurant lighting, and how that impacts energy use, the environment, and the bottom line.

BROCK BOYETT, JACK IN THE BOX
KEVIN REILLY, PEAK LIGHTING & ENERGY

11:15 a.m. **THE IMPACT OF CHINA'S RISING LED INDUSTRY ON GLOBAL LED MANUFACTURING AND SSL ADOPTION**

Insights from Sanan Optoelectronics about the trends and development of the SSL industry in China and the impact of competitive Asian manufacturers on the global SSL industry, including a perspective on how Luminus Devices fits within Sanan's global reach.

DECAI SUN, LUMINUS DEVICES, A SUBSIDIARY OF SANAN OPTOELECTRONICS CORPORATION

Noon Lunch

1:00 p.m. **PANEL | DIRECTIONS IN CONNECTED LIGHTING**

The convergence of lighting controls and the IoT provides a connected lighting platform that will change the way we interact and think about light. Connectivity is harnessing various technologies such as sensors and data analytics with SSL to create a platform that creates new performance capabilities and benefits. The connected lighting vision will be presented from various viewpoints from smart luminaires to connected buildings and smart cities, and the panel discussion will center on R&D needs to achieve that vision.

MODERATOR: MONICA HANSEN, LED LIGHTING ADVISORS
SANDHI BHIDE, INTEL
PETER DUINE, PHILIPS LIGHTING
EVAN PETRIDIS, ENLIGHTED
HIMAMSHU PRASAD, GE LIGHTING

2:30 p.m. Refreshment Break

3:00 p.m. **PANEL | THE RIGHT LIGHT FOR THE APPLICATION**

Different lighting applications require different performance, cost, and features, and SSL technology can be engineered to provide these specific attributes. This panel will review SSL products that were designed for some specific, challenging lighting applications.

MODERATOR: MORGAN PATTISON, SSLS, INC.
JOE CASPER, EPHEBUS LIGHTING
MATTHEW LEGLER, U.S. NAVY
THILO REUSCH, OSRAM OLED
JERRY RYU, OSRAM SYLVANIA

4:30 p.m. **WORKSHOP MISSION**

The DOE SSL R&D Workshop provides an opportunity for stakeholders to provide input to the DOE program. This talk will recap the DOE R&D planning process, share highlights from a series of roundtables and meetings held in Fall 2015, and set the stage for in-depth discussions in the track sessions to come.

MORGAN PATTISON, SSLS, INC.

5:00 p.m. Adjourn

5:30 p.m. **OPTIONAL BUS TOUR OF SSL LIGHTING INSTALLATIONS (Registration Required)**

Guided tour of LED installations at an auto dealership complex and on the corporate campus of Cree, Inc.

WEDNESDAY, FEBRUARY 3, 2016

7:00 a.m. *Continental Breakfast*

PLENARY SESSIONS

8:00 a.m. **DOE SSL R&D PROGRAM DIRECTION**

An overview of the DOE SSL R&D program direction and areas of focus, including recognition of the contributions of visionary Roland Haitz over the last 15 years, and a look ahead to what's coming in the next decade.

JAMES BRODRICK, U.S. DEPARTMENT OF ENERGY

JEFF TSAO, SANDIA NATIONAL LABORATORIES

8:30 a.m. **PANEL | LIGHTING AND HUMAN FACTORS**

The spectral content in light has physiological and biological impacts, which can be both beneficial and detrimental to human health and productivity. LED lighting can provide tailored spectral content that has the potential to improve our health and productivity, but more research is needed to quantify and verify these claims. This panel will discuss the impact of SSL on human color perception, physiological responses, and the impact of blue light on health.

MODERATOR: JEFF TSAO, SANDIA NATIONAL LABORATORIES

JOHN HANIFIN, THOMAS JEFFERSON UNIVERSITY

YOSHI OHNO, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

JENNIFER VEITCH, NATIONAL RESEARCH COUNCIL OF CANADA

10:00 a.m. *Refreshment Break*

TRACK SESSIONS

10:30 a.m. **LED TRACK I: DROOP**

Droop is the single biggest factor than can change the cost structure of LED lighting. Several pathways for eliminating the impact of current density droop will be discussed, as well as how the green gap is tied to droop.

MODERATOR: MONICA HANSEN,
LED LIGHTING ADVISORS

ERIK NELSON, LUMILEDS

BERTHOLD HAHN, OSRAM OPTO

SIDDARTH RAJAN, THE OHIO STATE
UNIVERSITY

JAMES RARING, SORAA LASER DIODE

**OLED TRACK I: MANUFACTURING
CHALLENGES**

This panel will identify remaining challenges regarding the fabrication of OLED lighting panels, with the focus upon cost reduction and the production of flexible devices.

MODERATOR: NORMAN BARDSLEY,
BARDSLEY CONSULTING

JOHN HAMER, OLEWORKS

CHRISTIAN MAY, FRAUNHOFER INSTITUTE

MIKE HACK, UNIVERSAL DISPLAY
CORPORATION

SEAN ARMSTRONG, KURT J. LESKER

Noon

Lunch

1:00 p.m.

LED TRACK II: LED PACKAGE AND POWER SUPPLY

Beyond the LED chip itself there are important areas for improvement in the package and system. This panel will explore R&D in down converters, encapsulants, and novel, more robust power supply components.

MODERATOR: MORGAN PATTISON, SSLS, INC.
RALPH TUTTLE, CREE
MICHAEL BOCKSTALLER, CARNEGIE MELLON UNIVERSITY
JONATHAN OWEN, COLUMBIA UNIVERSITY
TOMAS PALACIOS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

OLED TRACK II: OLED MATERIALS

A look at open science questions related to improving the stability and efficiency of blue emitters, simplifying devices with single emitters, and the status of solution-processable materials for OLED lighting.

MODERATOR: LISA PATTISON, SSLS, INC.
MARK THOMPSON, UNIVERSITY OF SOUTHERN CALIFORNIA
JIAN LI, ARIZONA STATE UNIVERSITY
THOMAS BAUMANN, CYNORA

2:30 p.m.

Refreshment Break

3:00 p.m.

PANEL | QUANTIFYING SYSTEM RELIABILITY

Quantifying SSL system reliability is a challenge for luminaire manufacturers due to the various components that can fail in a variety of fixture designs targeting application specific performance and cost thresholds. The lack of accurate reliability models for LED color shift or SSL drivers creates a critical uncertainty in the true lifetime of luminaires. OLED reliability is critical for market adoption in general lighting, and early reliability results toward a more robust model will be shared. This panel will discuss the key failures and what barriers must be overcome to certify 10-year fixture warranties with less risk to the manufacturer and impact to the end user.

MODERATOR: MONICA HANSEN, LED LIGHTING ADVISORS
ROBERT TALLEY, NORTH CAROLINA STATE CONSTRUCTION OFFICE
WOUTER SOER, LUMILEDS
WARREN WEEKS, HUBBELL LIGHTING
LYNN DAVIS, RTI INTERNATIONAL

4:30 p.m.

LEVERAGING DOE SSL R&D

The DOE SSL program supports the development of energy-saving SSL products directly through Core, Product Development, and Manufacturing R&D projects, funded via the FOA process. But where a broader approach is needed, the program supports other R&D efforts designed to accelerate technology and product advances in ways that benefit the lighting industry as a whole. The speakers in this session will review the typical FOA process as well as new R&D efforts within the DOE SSL program related to OLED testing, connected lighting systems, and more.

JOEL CHADDOCK, NATIONAL ENERGY TECHNOLOGY LABORATORY
MARC LEDBETTER, PACIFIC NORTHWEST NATIONAL LABORATORY

5:00–7:30 **RECEPTION/POSTER SESSION**

p.m. Project posters will be presented by research team representatives, providing an opportunity for one-on-one discussions with SSL’s leading scientists.

POSTER PRESENTERS AND EXHIBITS

Active Layer Parametrics	Navigant Consulting
Acuity Brands	OLEDWorks (+ exhibit)
Arizona State University	Philips Research North America
Carnegie Mellon University	PhosphorTech
Cree	Pixelligent
Eaton	PPG
EIE Materials/Luminari	Princeton University
Fluency Lighting Technologies	RPI Smart Lighting Research Center (exhibit only)
iBeam Materials (+ exhibit)	RTI International (+ exhibit)
Los Alamos National Laboratory	Sinovia (+ exhibit)
Lumileds	SixPoint Materials
Lumisyn	Triton Systems
MicroContinuum	University of California, Los Angeles
MoJo Labs (+ exhibit)	University of California, Santa Barbara
Momentive	University of Michigan
National Energy Technology Laboratory	VoltServer (+ exhibit)
National Renewable Energy Laboratory	

STUDENT POSTER CONTEST WINNERS

Ignas Gaska, Rensselaer Polytechnic Institute
Joseph Gleason, University of New Mexico
Stacy Kowsz, University of California, Santa Barbara
Changmin Lee, University of California, Santa Barbara
Jessica Morrison, Boston University
Chee-Keong Tan, Lehigh University
Benjamin Yonkee, University of California, Santa Barbara

THURSDAY, FEBRUARY 4, 2016

7:00 a.m. *Continental Breakfast*

PLENARY SESSION

8:00 a.m. **MARKET ADOPTION OF SSL INNOVATIONS**

This talk will provide an update on the global market for packaged LEDs, modules, and light engines, plus the most recent research on the general illumination market for lamps and luminaires, with a focus on the smart or connected lighting market. Of particular focus will be the size of the overall market, broken out by region, application, and communication protocol.

PHILIP SMALLWOOD, STRATEGIES UNLIMITED

TRACK SESSIONS

8:30 a.m. **LED TRACK III: NEW MANUFACTURING METHODS AND TOOLS**

Improvements to manufacturing approaches and product design have enabled ongoing cost reductions while maintaining and even improving performance. This session will examine some new concepts in luminaire and component manufacturing.

MODERATOR: MONICA HANSEN,
LED LIGHTING ADVISORS
SHATIL HAQUE, LUMILEDS
CHRIS BOHLER, EATON LIGHTING

OLED TRACK III: LIGHT EXTRACTION AND INTEGRATED SUBSTRATES

This panel will explore progress and challenges in light extraction substrates, looking at manufacturable integrated substrate solutions along with newly conceived light extraction approaches.

MODERATOR: LISA PATTISON, SSLS, INC.
MARK TAYLOR, CORNING
QIBING PEI, UNIVERSITY OF CALIFORNIA,
LOS ANGELES
BARRY RAND, PRINCETON UNIVERSITY
STEVE FORREST, UNIVERSITY OF MICHIGAN

10:00 a.m. *Refreshment Break*

10:30 a.m. **LED TRACK IV: NEW LIGHTING CONCEPTS**

LED lighting products have been coming out with new features, form factors, and functionality. This panel will explore the status of some new products and concepts, and discuss future directions for product development.

MODERATOR: MORGAN PATTISON, SSLS, INC.
RON GIBBONS, VIRGINIA TECH
TRANSPORTATION INSTITUTE
ERIC HAUGAARD, CREE
STEVE PAOLINI, TEDELUMEN
FRED MAXIK, LIGHTING SCIENCE

OLED TRACK IV: DEVELOPING OLED LIGHTING PRODUCTS

The elements needed to convert OLED panels into attractive, affordable luminaires will be surveyed, including OLED-specific drivers, adaptable connectors, industry standards, and form factors appropriate to each application.

MODERATOR: NORMAN BARDSLEY,
BARDSLEY CONSULTING
MIKE LU, ACUITY BRANDS
JACKY QIU, OTI LUMIONICS
DARREN HULSEY, WORKRITE ERGONOMICS
LARRY SADWICK, INNOSYS

12:00 p.m. *Lunch*

1:00 p.m.

LED TOPIC TABLES

LED attendees will break into small groups to discuss a variety of topics considered key to furthering SSL technology advances. Each table will focus on a specific R&D topic, allowing for more detailed exploration of the topic and related issues. Each group will share a brief report of key points related to their topic, with an opportunity for further discussion with the larger group.

OLED PRIORITIES AND MILESTONES

OLED attendees will have an opportunity to review R&D priorities considered key to furthering OLED technology advances. Input will guide the choice of priority R&D topics and other updates to metrics and milestones in the DOE R&D Plan.

3:00 p.m.

Refreshment Break

PLENARY SESSION

3:30 p.m.

PANEL | GLOBAL LIGHTING VISIONS

Speakers from leading global companies will present their visions of the future of SSL technology, sharing perspectives from China, India, Europe, and the U.S. on what is needed to enable these visions to be realized. Topics will include trends in price, value, and performance; government policies; R&D directions; access to SSL for all; deeper energy savings; connectivity; and industry consolidation.

MODERATOR: NORMAN BARDSLEY, BARDSLEY CONSULTING
KLAUS VAMBERSZKY, ZUMTOBEL
GARY TROTT, CREE
LAWRENCE LIN, MLS
VENKATA ATLURI, MIC ELECTRONICS

5:00 p.m.

Adjourn