



U.S. Department of Energy
Lighting R&D Workshop
Co-sponsored by the Illuminating Engineering Society

AGENDA

U.S. DEPARTMENT OF
ENERGY | Office of ENERGY EFFICIENCY
& RENEWABLE ENERGY



Illuminating
ENGINEERING SOCIETY

TUESDAY JANUARY 28

7:00– 8:00 am	Breakfast ► ROOM TBA
8:00– 8:30 am	Welcome <i>Brian Walker, U.S. Department of Energy</i> <i>Brian Liebel, Illuminating Engineering Society</i> ► ROOM TBA
8:30– 9:15 am	Keynote: Disruption Is Coming to the Building Industry Opening remarks from a true visionary will offer a thought-provoking view of the building industry—the technological disruption it is experiencing, what is driving the change, and what it means for Construction 2.0. <i>Steve Burrows, Cameron MacAllister Group</i> ► ROOM TBA
9:15– 10:00 am	Setting the Stage For over a decade, the U.S. Department of Energy and the Illuminating Engineering Society have partnered to advance the quality and efficiency of lighting through science and engineering. This session will set the stage for three days of thought-provoking discussions, with an overview of current DOE lighting R&D directions, lighting science research conducted by Pacific Northwest National Laboratory, and IES directions in research and standards development. What research is needed to drive the next wave of innovation? What aspects of lighting science need to be better understood? What challenges must be overcome, to translate R&D to application? How can new frontiers in lighting leverage advances in synergistic technologies for even more energy savings? <i>Kelly Gordon, Pacific Northwest National Laboratory</i> <i>Brian Liebel, Illuminating Engineering Society</i> <i>Morgan Pattison, SSLs, Inc.</i> <i>Brian Walker, U.S. Department of Energy</i> ► ROOM TBA
10:00– 10:30 am	Break ► ROOM TBA

<p>10:30 am– 12:00 pm</p>	<p>Lighting Application Efficiency Lighting application efficiency is the next frontier in lighting energy savings. The energy savings of a lighting system is defined by the source efficiency and also how effectively the light is delivered into a space for a certain task. There are trade-offs between the source efficiency and color quality, optical control, and intensity control. This panel will explore these trade-offs in detail, and also examine how predictive computational modeling of lighting application efficiency might be used as a tool to guide lighting product design, lighting layouts, and architectural design. <i>Moderator: Morgan Pattison, SSLS, Inc.</i> <i>Michael Herf, f.lux</i> <i>Sarah Safranek, Pacific Northwest National Laboratory</i> <i>Wouter Soer, Lumileds</i></p> <p>► ROOM TBA</p>		
<p>12:00– 1:00 pm</p>	<p>Lunch ► ROOM TBA</p>		
<p>1:00– 2:30 pm</p> <p><i>See page 9 for more details</i></p>	<p>Materials Research & Product Innovation</p> <p>Advances in LED Devices and Materials ► ROOM TBA</p> <p>Advances in OLED Devices and Materials ► ROOM TBA</p>	<p>Lighting Science</p> <p>Latest Understanding on Physiological Impacts of Lighting ► ROOM TBA</p>	<p>Lighting Systems & Building Integration</p> <p>Building Integration Challenges ► ROOM TBA</p>
<p>2:30– 3:00 pm</p>	<p>Break ► ROOM TBA</p>		
<p>3:00– 3:30 pm</p>	<p>Opportunities for Collaboration R&D partnerships are catalysts for innovation, as evidenced in the upcoming poster session. This panel will offer a preview of the myriad opportunities for collaboration with DOE and IES, and ask the question: What other models and methods for collaboration should be considered to support advances and translate R&D to practice? <i>Alex Baker, Illuminating Engineering Society</i> <i>Joel Chaddock, National Energy Technology Laboratory</i> <i>Roy Harvey, Next Generation Lighting Industry Alliance</i></p> <p>► ROOM TBA</p>		
<p>3:30– 6:00 pm</p>	<p>Poster Session Project posters will be presented by research team representatives, providing an opportunity for one-on-one discussions with SSL's leading scientists.</p>		

WEDNESDAY

JANUARY 29

<p>7:00– 8:00 am</p>	<p>Breakfast ▶ ROOM TBA</p>
<p>8:00– 9:00 am</p>	<p>LEDs for Photons, Physiology, and Food LED lighting technology development and advancements in understanding physiological responses to light for plants, animals, and people have created the unique opportunity to save energy for all lighting, improve the health of everyone who uses lighting, increase the productivity of plant growth under electric lighting, and reduce the ecological impact (beyond the energy savings) of outdoor lighting. These benefits can be achieved without any fundamental, negative side effects. This panel of diverse experts will explore what new scientific understanding is needed—in plant, animal, and human physiological responses to light—to guide the development and application of fully optimized lighting solutions. There is also the larger opportunity to connect and relate physiological responses to light across all life forms by exploring molecular responses to light and by comparing responses among species. <i>Moderator/Speaker: Morgan Pattison, SSLS, Inc. George Brainard, Thomas Jefferson University Bruce Bugbee, University of Utah Jeff Tsao, Sandia National Laboratories</i> ▶ ROOM TBA</p>
<p>9:00– 10:00 am</p>	<p>The Business of Lighting Some groups don't play well together, often from a lack of understanding of what each group values. When lighting projects involve various skill sets, conflicts can arise. This panel will explore how lighting gets designed from both a lighting design and a design and build perspective. We will hear how products are distributed from a manufacturer's representative perspective, with a lighting distributor explaining their part of the process. These lighting professionals will explain what motivates them, and how a better understanding of their roles can help us avoid conflicts. <i>Moderator: Mark Lien, Illuminating Engineering Society Megan Carroll, New York Digital Erik Ennen, NALMCO Bob Preston, Capital Electric/Sonepar</i> ▶ ROOM TBA</p>
<p>10:00– 10:30 am</p>	<p>Break ▶ ROOM TBA</p>

<p>10:30 am– 12:00 pm</p> <p><i>See page 10 for more details</i></p>	<p>Materials Research & Product Innovation</p> <p>LED/OLED Device Level Light Extraction and Control</p> <p>▶ ROOM TBA</p>	<p>Lighting Science</p> <p>Great Promise, Few Options: Can Advances in Color Science Shift the Market?</p> <p>▶ ROOM TBA</p>	<p>Lighting Systems & Building Integration</p> <p>How Do Connected Lighting Systems Get Specified?</p> <p>▶ ROOM TBA</p>
<p>12:00– 1:00 pm</p> <p>Lunch</p> <p>▶ ROOM TBA</p>			
<p>1:00– 2:30 pm</p> <p><i>See page 11–12 for more details</i></p>	<p>Materials Research & Product Innovation</p> <p>Directions in Optical Control</p> <p>▶ ROOM TBA</p>	<p>Lighting Science</p> <p>Searching for Holy Grails</p> <ul style="list-style-type: none"> • In Search of a New Illumination Measurement • A Glaring Lack of Definition • Scavenger Hunt, or Create an SPD Database? <p>▶ ROOM TBA</p>	<p>Lighting Systems & Building Integration</p> <p>How Do Connected Lighting Systems Get Installed and Configured?</p> <p>▶ ROOM TBA</p>
<p>2:30– 3:00 pm</p> <p>Break</p> <p>▶ ROOM TBA</p>			
<p>3:00– 4:30 pm</p> <p><i>See page 12 for more details</i></p>	<p>Materials Research & Product Innovation</p> <p>Lighting Product Innovation</p> <p>▶ ROOM TBA</p>	<p>Lighting Science</p> <p>Considerations for Non-Human Physiological Responses to Light</p> <p>▶ ROOM TBA</p>	<p>Lighting Systems & Building Integration</p> <p>Lighting System Data: What Are We Learning?</p> <p>▶ ROOM TBA</p>
<p>4:30– 6:00 pm</p> <p><i>See page 13 for more details</i></p>	<p>Open Discussion Forum: New Frontiers in Lighting</p> <p>▶ ROOM TBA</p> <hr/> <p>Open Discussion Forum: Translating Physiological Research into Practice</p> <p>▶ ROOM TBA</p> <hr/> <p>Open Discussion Forum: Clarifying the Value Proposition for Connected Lighting Systems</p> <p>▶ ROOM TBA</p>		

THURSDAY JANUARY 30

7:00– 8:00 am	Breakfast ▶ ROOM TBA		
8:00– 8:30 am	Lighting Market Trends DOE studies reveal a wealth of insights into LED adoption trends and their impact on energy usage. This talk will provide an overview of major trends and changes, examining which applications are taking off and what technology limitations might be holding others back. <i>Clay Elliott, Navigant</i> ▶ ROOM TBA		
8:30– 10:00 am	New Considerations for SSL 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 integration of connectivity and tunability in SSL products combined with the use of OLEDs have resulted in new considerations for SSL reliability. This panel will explore the reliability of tunable lighting and integrated of sensors and controls. The key failures and barriers that must be overcome to certify 10-year fixture warranties will be examined. <i>Moderator/Speaker: Monica Hansen, LED Lighting Advisors</i> <i>Lynn Davis, RTI International</i> <i>Speaker TBA</i> ▶ ROOM TBA		
10:00– 10:30 am	Break ▶ ROOM TBA		
10:30 am– 12:00 pm	Materials Research & Product Innovation LED Integration and Manufacturing Challenges ▶ ROOM TBA	Lighting Science Exploring Effects of Product Valuation on Energy Use ▶ ROOM TBA	Lighting Systems & Building Integration Connected Lighting System Value ▶ ROOM TBA
12:00– 1:00 pm	Lunch ▶ ROOM TBA		

See page 13–14 for more details

<p>1:00– 2:30 pm</p> <p><i>See page 14 for more details</i></p>	<p>Materials Research & Product Innovation</p> <p>OLED Integration and Manufacturing Challenges</p> <p>▶ ROOM TBA</p>	<p>Lighting Science</p> <p>Translational Research in Physiological Responses to Light</p> <p>▶ ROOM TBA</p>	<p>Lighting Systems & Building Integration</p> <p>Lighting for Grid-Interactive Efficient Buildings</p> <p>▶ ROOM TBA</p>
<p>2:30– 3:00 pm</p>	<p>Break</p> <p>▶ ROOM TBA</p>		
<p>3:00– 4:30 pm</p>	<p>Final Thoughts</p> <p>This last session of the workshop will provide attendees with an opportunity to share final thoughts and observations, connecting the dots between opening remarks, panel discussions, poster session conversations, and hallway chats. Have we answered the core questions we set out to discuss? Join us for this final session, and share your thoughts.</p> <p>▶ ROOM TBA</p>		

SESSION DETAILS

TUESDAY | 1:00–2:30 pm

■ **Advances in LED Devices and Materials**

Materials and devices are the foundational “enablers” of solid-state lighting, and innovation in these would expand possibilities for the efficiency, cost, and performance of solid-state lighting engines and applications. This expert panel will discuss some of the latest innovations and new directions in light-emitting and wavelength-converting materials and devices.

Moderator: Jeff Tsao, Sandia National Laboratories

John Epler, Lumileds

Harald Koenig, OSRAM Opto Semiconductors

Jonathan Owen, Columbia University

Jianli Zhang, Nanchang University

■ **Advances in OLED Devices and Materials**

A key challenge for OLED lighting is the development of efficient, stable devices. This expert panel will review recent advancements in long-lived blue materials and explore novel device structures and materials that aim to improve charge balance or light outcoupling, extending device lifetime.

Moderator: Lisa Pattison, SSSL, Inc.

Michele Ricks, EMD Performance Materials

Speakers TBA

■ **Latest Understanding on Physiological Impacts of Lighting**

The SSL revolution has challenged our fundamental understanding of the physiological impacts of light. This panel will review the latest scientific findings related to lighting for health and well-being and examine what is generally agreed-upon and what research is necessary to fill gaps in understanding. The discussion will explore how the existing knowledge can be deployed into products and design standards to provide the “best” light for occupants.

Moderator: Monica Hansen, LED Lighting Advisors

Timothy Brown, University of Manchester

Speaker TBA

■ **Building Integration Challenges**

What role will lighting play in future buildings? This session will explore where the lighting industry should continue investing its resources as it seeks to integrate effectively with other buildings systems.

Moderator: Michael Poplawski, Pacific Northwest National Laboratory

Speakers TBA

WEDNESDAY | 10:30 am–12:00 pm

■ LED/OLED Device Level Light Extraction and Control

The next generation of SSL devices will require high light extraction efficiency as well as highly engineered device level optical control to maximize the amount of light hitting the target and minimize the requirement for luminaire-level, secondary optics. This panel will explore state-of-the-art light extraction and control for both LED and OLED devices and cover possible paths forward, along with some fundamental understanding including cavity effects, the Purcell effect, and plasmonic effects.

Moderator: Morgan Pattison, SSSL, Inc.

Claude Weisbuch, University of California, Santa Barbara

Speakers TBA

■ Great Promise, Few Options: Can Advances in Color Science Shift the Market?

SSL technology introduced greater potential for spectral engineering, but when optimized for the same old metrics, the delivered performance has been remarkably similar to older light sources. With new metrics recently introduced and more research ongoing, the equation may be changing. A broader range of lighting color objectives facilitates optimized lighting for specific needs, from aesthetically pleasing to aiding medical diagnoses to enhancing wellbeing, which also entails maximizing the benefits delivered per watt. This panel will explore discuss the range of tools available for characterizing a light source's spectral power distribution, including those from the past (e.g., CRI), the present (e.g., TM-30), and future (e.g., Rt, CCT10, etc.). These tools will be related to changes (or lack thereof) in the performance of architectural lighting products, and each presenter will provide their vision for how advances in color science could, or should, change our collective thinking about lighting quality.

Moderator/Speaker: Michael Royer, Pacific Northwest National Laboratory

Tony Esposito, Lighting Research Solutions

Lorne Whitehead, University of British Columbia

■ How Do Connected Lighting Systems Get Specified?

Specifying, installing, and configuring today's connected lighting systems is not getting any easier. This two-part open discussion will start with a look at the specification process, asking who designs the controls, how are they specified, and who verifies the compatibility of specified luminaires with the controls system? Perspectives from a lighting designer, manufacturer, manufacturer representative, electrical contractor, and utility program manager will be shared as we examine their experiences in dividing up the additional responsibilities of connected lighting systems, and where help is needed. Part two (1:00-2:30 today) will focus on installation and configuration challenges.

Moderator: Naomi Miller, Pacific Northwest National Laboratory

Dan Blitzer, Practical Lighting Workshop

Teal Brogden, Horton Lees Brogden Lighting Design

Megan Carroll, New York Digital

Anthony Mulcahy, E.S.B. Electric Corp

Chris Wolgamott, Northwest Energy Efficiency Alliance

WEDNESDAY | 1:00–2:30 pm

■ Directions in Optical Control

Light whose intensity distributions could be engineered in space and time would potentially reduce the over-illumination and under-illumination of spaces—a situation that is inevitable given the current limitations of lighting technologies that are largely fixed in space and time. This expert panel discusses new approaches to such spatially engineered light—both novel sources for producing, and potential applications for using, such light.

Moderator: Jeff Tsao, Sandia National Laboratories

Wendy Davis, University of Sydney

Oleg Shchekin, Lumileds

Billy Tubb, Theatre Consultant

Sergey Vasylyev, Lucent Optics

■ Searching for Holy Grails

In Search of a New Illumination Measurement

The traditional measurement for illumination based on the 2-degree photopic luminous efficiency function has been questioned as an accurate indicator of visual response for many years. Work supported by the DOE over the last 30 years determined that, under the normal condition of a full field of view, relatively higher amounts of blue light content improved visual acuity and increased brightness perception, which would have an effect on visual efficiency, and thereby impact energy efficiency. More recent work has tied this effect directly to the ipRGC photoreceptor. This session brings the latest work to the forefront and asks the question: Should we modify the way we evaluate light source efficacy?

A Glaring Lack of Definition

How do we quantify “glare,” beyond our sensation that it is painful, makes us squint or look away, and can sometimes disable our vision? SSL lighting has been attributed as being too harsh or causing too much glare, but a definition for glare has eluded us for far too long, and is necessary to understand how to design better luminaires and optical systems. This session will explore the most recent work being done in attempt to define metrics beyond knowing glare when we see it.

Scavenger Hunt, or Create an SPD Database?

SSL systems have the unique ability to finesse and refine spectral power distributions, which affect visual and non-visual responses to light, and these refinements cannot be captured in the simplistic metrics of CCT and CRI (or Rf). Understanding the effect of light on visual or physiological outcomes of requires a detailed description of the SPD of the light, and this is becoming more important in the realms of light and health, and horticultural lighting. This panel discusses the value proposition of creating an SPD databank, whereby light source SPDs can be collected and referred to by researchers and laboratories to better understand the correlations between spectral composition and research results.

Moderator: Brian Liebel, Illuminating Engineering Society

Brad Schlesselman, Musco Lighting

Speakers TBA

■ How Do Connected Lighting Systems Get Installed and Configured?

This session continues the morning discussion on connected lighting. In part two, we'll hear multiple perspectives on installation and configuration challenges. Who interprets the specification? Who is responsible for proper installation, configuration, and commissioning? How do you know if it is working properly, and what happens if it doesn't? Once again, this session will draw on the experiences of a designer, manufacturer, manufacturer representative, electrical contractor, and utility program manager to learn how they are working together to address these configuration challenges, and where help is needed.

Moderator: Ruth Taylor, Pacific Northwest National Laboratory

Dan Blitzer, Practical Lighting Workshop

Teal Brogden, Horton Lees Brogden Lighting Design

Megan Carroll, New York Digital

Anthony Mulcahy, E.S.B. Electric Corp

Chris Wolgamott, Northwest Energy Efficiency Alliance

WEDNESDAY | 3:00–4:30 pm

■ Lighting Product Innovation

Solid-state lighting offers new levels of control over light that continue to broaden the impact of SSL beyond just energy savings to providing a visually dynamic lighting environment for the desired application. This panel will explore how R&D advances are impacting luminaire and system designs while discussing the challenges that remain in the path of continued development.

Moderator: Monica Hansen, LED Lighting Advisors

Mark Hand, Acuity Brands

Paul Pickard, Ecosense Lighting

■ Considerations for Non-Human Physiological Responses to Light

LED lighting is enabling improved productivity of plants and animals for food. This panel will cover lighting considerations and recent research for horticultural lighting and lighting for animal production, including latest best practices. The discussion will also cover lighting considerations and recent understanding for minimizing the impact of lighting on wildlife and the environment. Panelists will cover the status of specific plant, animal, and ecological lighting applications.

Moderator: Morgan Pattison, SSLs, Inc.

Bruce Bugbee, University of Utah

Jeremy White, National Park Service

■ Lighting System Data: What Are We Learning?

What can be learned today from the data provided by lighting systems? This session reviews what is happening in the field and how it can be used to provide feedback to lighting designers, optimize system performance for building occupants, and improve manufacturers' understanding of their lighting systems in realistic environments.

Moderator: Andrea Wilkerson, Pacific Northwest National Laboratory

Alex Cooper, Smithsonian National Portrait Gallery

Sarah Dreger, Stantec

Vladi Shunturov, Acuity Brands

OPEN DISCUSSION FORUMS | 4:30–6:00 pm

New Frontiers in Lighting

Join us for a freeform discussion of SSL-synergistic technologies with significant potential for energy savings, including displays, agricultural lighting, germicidal irradiation, Li-Fi, high-power photonics, and power electronics. What are the energy savings opportunities? What are the key technology challenges associated with improving their energy efficiencies? How might overcoming these challenges benefit from synergies with solid-state lighting?

Translating Physiological Research into Practice

While some lighting practitioners are attempting to apply scientific laboratory findings on physiological impact of light to field applications, the evidence base documenting physiological responses in realistic settings has been limited. This freeform discussion will examine the challenges in designing, installing, and evaluating lighting systems for health and well-being. The overall objective is to identify the best practices to employ today and the future research needs to ensure lighting is optimized for both energy efficiency and human response.

Clarifying the Value Proposition for Connected Lighting Systems

For five years now the lighting community has been talking about the promise of connected lighting to finally make lighting control seamless and provide a variety of other new benefits and features. But so far, market success has been elusive and system configuration, operation, and maintenance remain frustratingly complicated, and new value propositions hard to quantify and justify. What will it take for the true value-add of new connected lighting features to be realized? Where do you find yourself on the connected lighting enthusiasm spectrum? Join the freeform discussion and bring your questions and experience—good and not-so-good—with connected lighting systems.

THURSDAY | 10:30 am–12:00 pm

■ LED Integration and Manufacturing Challenges

The LED lighting platform offers new opportunities for on-demand, semi-custom manufacturing which can enable reduced inventory, reduced part count, and new lighting features and capabilities.

Moderator: Morgan Pattison, SSLS, Inc.

Michael Bremser, Tempo Lighting

Eugene Chow, PARC

Chikara Inamura, Designer/Engineer

John Trublowski, Eaton

■ Exploring Effects of Product Valuation on Energy Use

How much do potential buyers value new lighting features enabled by DOE research? How much might this value affect future energy use? This session will review the results and analysis of a recent study—which included a survey of potential lighting product buyers—to assess how improving quality and expanding product functionality affects product purchase decisions and energy use.

Moderator/Speaker: Marc Ledbetter, Pacific Northwest National Laboratory

Valerie Nubbe, Navigant

Lisa Skumatz, Skumatz Economic Research Associates

■ **Connected Lighting System Value**

Connected lighting systems have many purported benefits. This session will take a deep dive into a few benefits and their associated risks, along with a look at what's next, based on what researchers and early adopters are currently exploring in the laboratory and in the field.

Moderator: Michael Poplawski, Pacific Northwest National Laboratory

Farukh Aslam, Sinclair Holdings

Speakers TBA

THURSDAY | 1:00–2:30 pm

■ **OLED Integration and Manufacturing Challenges**

Cost is still the major barrier to wide adoption of OLEDs in general lighting. Significant challenges lie in both the manufacturing of OLED panels and in the integration of the panels into lighting systems in a manner that preserves the attractive form factor of OLEDs and allows full control of multiple panels.

Moderator: Norman Bardsley, Bardsley Consulting

Speakers TBA

■ **Translational Research in Physiological Responses to Light**

Translational lighting research is increasingly sought, as it incorporates the findings indicated by basic research in laboratories with explorations with human participants in complex, realistic settings. Translational research documents the holistic effects of light on people and demonstrates the potential magnitude of the effects when the complex mix of variables that affect realistic settings are considered. This session takes a look at the latest in translational lighting research.

Moderator/Speaker: Bob Davis, Pacific Northwest National Laboratory

Mariana Figueiro, Rensselaer Polytechnic Institute

Ron Gibbons, Virginia Tech Transportation Institute

■ **Lighting for Grid-Interactive Efficient Buildings**

Lighting and grid experts are collaborating at PNNL to explore the potential for connected lighting to provide grid services and contribute to grid-interactive efficient buildings (GEBs). This session will present the characteristics of connected lighting that can support specific grid services in various building types, and the initial results of simulations designed to quantify this potential. We will also hear from market players who are exploring lighting-based grid services.

Moderator: Kelly Gordon, Pacific Northwest National Laboratory

Debyani Ghosh, Navigant

Monica Neukomm, U.S. Department of Energy

Michael Poplawski, Pacific Northwest National Laboratory