U.S. Department of Energy

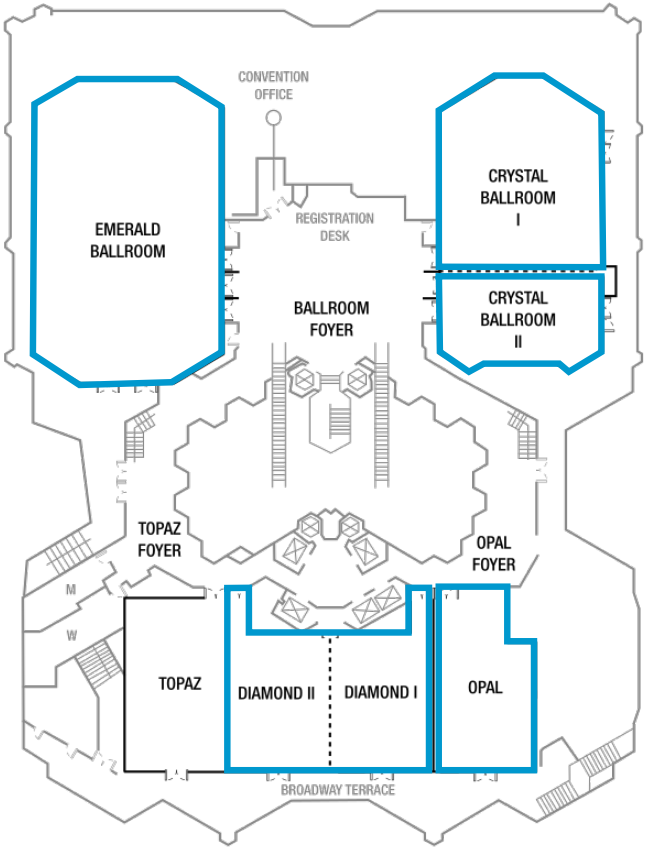
Lighting R&D Workshop

Co-sponsored by the Illuminating Engineering Society

AGENDA

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

Illuminating ENGINEERING SOCIETY



Hotel floor plan
Level 2

TUESDAY JANUARY 28

7:00– 8:00 am	Breakfast ►**Diamond Room**
8:00– 8:30 am	**Welcome** *David Nemtzow, U.S. Department of Energy* *Brian Liebel, Illuminating Engineering Society* ►**Emerald Ballroom**
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. *Steve Burrows, Cameron MacAllister Group* ►**Emerald Ballroom**
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? *Morgan Pattison, SSLS, Inc.* *Andrea Wilkerson, Pacific Northwest National Laboratory* *Brian Liebel, Illuminating Engineering Society* *Brian Walker, U.S. Department of Energy* ►**Emerald Ballroom**
10:00– 10:30 am	Break ►**Ballroom Foyer**

10:30 am– 12:00 pm	**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. *Moderator: Morgan Pattison, SSLS, Inc.* *Michael Herf, f.lux* *Wouter Soer, Lumileds* *Sarah Safranek, Pacific Northwest National Laboratory* **▶Emerald Ballroom**		
12:00– 1:00 pm	Lunch **▶Diamond Room**		
1:00– 2:30 pm *See page 9 for more details*	**Materials Research & Product Innovation**	**Lighting Science**	**Lighting Systems & Building Integration**
	Advances in LED Devices and Materials **▶Crystal Ballroom I**	**Latest Understanding on Physiological Impacts of Lighting** **▶Emerald Ballroom**	**Building Integration Challenges** **▶Crystal Ballroom II**
	Advances in OLED Devices and Materials **▶Opal Room**		
2:30– 3:00 pm	Break **▶Ballroom Foyer**		
3:00– 3:30 pm	**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? *Alex Baker, Illuminating Engineering Society* *Roy Harvey, Next Generation Lighting Industry Alliance* *Michele Ricks, OLED Coalition* *Joel Chaddock, National Energy Technology Laboratory* **▶Emerald Ballroom**		
3:30– 6:00 pm *See pages 15–19 for more details*	**Poster Session** Project posters will be presented by research team representatives, providing an opportunity for one-on-one discussions with SSL's leading scientists. **▶Diamond Room**		

WEDNESDAY JANUARY 29

7:00– 8:00 am	Breakfast ▶**Diamond Room**
8:00– 9:00 am	**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. *Moderator/Speaker: Jeff Tsao, Sandia National Laboratories* *Morgan Pattison, SSLS, Inc.* *Bruce Bugbee, Utah State University* *George Brainard, Thomas Jefferson University* ▶**Emerald Ballroom**
9:00– 10:00 am	**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. *Moderator: Mark Lien, Illuminating Engineering Society* *Diane Borys, Noctiluca Lighting Design / H+W Engineering* *Megan Carroll, New York Digital* *Erik Ennen, NALMCO* *Bob Preston, Capital Electric/Sonepar* ▶**Emerald Ballroom**
10:00– 10:30 am	Break ▶**Ballroom Foyer**

10:30 am–12:00 pm *See page 10 for more details*	**Materials Research & Product Innovation** **LED/OLED Device Level Light Extraction and Control** ▶Crystal Ballroom I	**Lighting Science** **Great Promise, Few Options: Can Advances in Color Science Shift the Market?** ▶Emerald Ballroom	**Lighting Systems & Building Integration** **Connected Lighting System Complexity: Identifying the Challenges** ▶Crystal Ballroom II
12:00–1:00 pm	Lunch ▶Diamond Room		
1:00–2:30 pm *See pages 11–12 for more details*	**Materials Research & Product Innovation** **Directions in Optical Control** ▶Crystal Ballroom I	**Lighting Science** **Searching for Holy Grails** • In Search of a New Illumination Measurement • A Glaring Lack of Definition • Scavenger Hunt, or Create an SPD Database? ▶Emerald Ballroom	**Lighting Systems & Building Integration** **Connected Lighting System Complexity: Finding Solutions** ▶Crystal Ballroom II
2:30–3:00 pm	Break ▶Ballroom Foyer		
3:00–4:30 pm *See page 12 for more details*	**Materials Research & Product Innovation** **Lighting Product Innovation** ▶Crystal Ballroom I	**Lighting Science** **Considerations for Non-Human Physiological Responses to Light** ▶Emerald Ballroom	**Lighting Systems & Building Integration** **Lighting System Data: What Are We Learning?** ▶Crystal Ballroom II
4:30–6:00 pm *See page 13 for more details*	**Open Discussion Forum: New Frontiers in Lighting** ▶Crystal Ballroom I		
	Open Discussion Forum: Translating Physiological Research into Practice ▶Emerald Ballroom		
	Open Discussion Forum: Clarifying the Value Proposition for Connected Lighting Systems ▶Crystal Ballroom II		

THURSDAY JANUARY 30

7:00– 8:00 am	Breakfast ▶**Diamond Room**		
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. *Clay Elliott, Guidehouse* ▶**Emerald Ballroom**		
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 OLED lighting and tunable LED lighting systems. The key failures and barriers that must be overcome to certify 10-year fixture warranties will be examined. *Moderator/Speaker: Monica Hansen, LED Lighting Advisors* *Lynn Davis, RTI International* *Bob Davis, Pacific Northwest National Laboratory* *Ben Sweet-Block, Signify* ▶**Emerald Ballroom**		
10:00– 10:30 am	Break ▶**Ballroom Foyer**		
10:30 am– 12:00 pm *See pages 13–14 for more details*	**Materials Research & Product Innovation**	**Lighting Science**	**Lighting Systems & Building Integration**
	LED Integration and Manufacturing Challenges ▶**Crystal Ballroom I**	**Exploring Effects of Product Valuation on Energy Use** ▶**Emerald Ballroom**	**Lighting for Grid-Interactive Efficient Buildings** ▶**Crystal Ballroom II**
12:00– 1:00 pm	Lunch ▶**Diamond Room**		

1:00– 2:30 pm *See page 14 for more details*	**Materials Research & Product Innovation** **OLED Integration and Manufacturing Challenges** ▶ **Crystal Ballroom I**	**Lighting Science** **Translational Research in Physiological Responses to Light** ▶ **Emerald Ballroom**	**Lighting Systems & Building Integration** **Connected Lighting System Value** ▶ **Crystal Ballroom II**
2:30– 3:00 pm	Break ▶ **Ballroom Foyer**		
3:00– 4:30 pm	**Looking Ahead** This last session of the workshop will provide an opportunity for speakers, moderators, and attendees to share insights and observations, connecting the dots between opening remarks, panel discussions, poster session conversations, and hallway chats. What were the major discussion themes? Are there clear R&D inputs for the DOE? Join us for this final session, share your thoughts, and learn more about next steps and the path forward. ▶ **Emerald Ballroom**		

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
Jim Speck, University of California, Santa Barbara
John Epler, Lumileds
Jonathan Owen, Columbia University
Harald Koenig, OSRAM Opto Semiconductors

■ 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, SSLS, Inc.
Jian Li, Arizona State University
Chris Giebink, Penn State University
Michele Ricks, EMD Performance Materials
Jason Hartlove, Nanosys

■ Latest Understanding on Physiological Impacts of Lighting

New levels of control offered by SSL technology have enabled a pathway to tailor spectral power distributions and optimum light levels for building occupants. 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 lighting products and design standards to provide the "best" light for occupants.

Moderator: Monica Hansen, LED Lighting Advisors
Luc Schlangen, Eindhoven University of Technology
Timothy Brown, University of Manchester
Jamie Zeitzer, Stanford University

■ 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/Speaker: Michael Poplawski, Pacific Northwest National Laboratory
Joel Timmins, Markon Solutions

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, SSLS, Inc.
Claude Weisbuch, University of California, Santa Barbara
Andrew Kim, Glint Photonics
Michael Boroson, OLEDWorks
Jongchan Kim, University of Michigan

■ 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 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., R_t, 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
Lorne Whitehead, University of British Columbia
Tony Esposito, Lighting Research Solutions

■ Connected Lighting System Complexity: Identifying the Challenges

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 challenges involved, drawing on perspectives from a lighting designer, manufacturer, manufacturer representative, electrical contractor, and utility program manager as they share their experiences. Who specifies the controls, and who interprets the specification? Who verifies the compatibility of the specified luminaires with the controls system? 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? Part two (1:00-2:30 today) will focus on brainstorming solutions to overcome barriers, reduce complexity, and deliver successful connected lighting solutions.

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
Billy Tubb, Theatre Consultant
Sergey Vasylyev, Lucent Optics
Oleg Shchekin, Lumileds

■ Searching for Holy Grails

Moderator: Brian Liebel, Illuminating Engineering Society

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?

Brad Schlesselman, Musco Lighting
Sam Berman, Berman Consultants

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 an attempt to define metrics beyond knowing glare when we see it.

Bob Davis, Pacific Northwest National Laboratory

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 R_f). 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.

Michael Herf, f.lux

Connected Lighting System Complexity: Finding Solutions

This session continues the morning discussion on connected lighting. In part two, we'll hear multiple perspectives on what we can do to reduce complexity and deliver successful connected lighting solutions. Once again, this session will draw on the experiences of a designer, manufacturer, manufacturer representative, electrical contractor, and utility program manager to lead a group discussion on how we can work together to address the complex 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
Heinz Willebrand, Signify
Dan Schwade, Acuity Brands

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.
Kale Harbick, USDA Agricultural Research Service
Bruce Bugbee, Utah State University
Jeremy White, National Park Service
Curtis Leyk, Signify

Lighting System Data: What Are We Learning?

What can be learned today from the data provided by lighting systems? There is plenty of talk about the potential of lighting data, but is the data actually delivering value or is it sitting in the cloud? This session looks at examples of how lighting data is delivering value, from optimizing building performance to improving occupant experience.

Moderator: Andrea Wilkerson, Pacific Northwest National Laboratory
Vladi Shunturov, Acuity Brands
Alex Cooper, Smithsonian National Portrait Gallery
Sarah Dreger, Stantec

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 very 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
John Trublowski, Eaton
Chikara Inamura, Designer/Engineer
Eugene Chow, PARC

■ 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
Lisa Skumatz, Skumatz Economic Research Associates
Valerie Nubbe, Guidehouse

■ Lighting for Grid-Interactive Efficient Buildings

Connected lighting systems (CLS) have the potential to provide grid services, along with improved lighting control and energy efficiency. This session will provide a view into utility demand response programs, and the challenges and potential for CLS to play a role in this market. We will also look at connected lighting in the context of grid-interactive efficient buildings (GEBs), a framework being applied by DOE to build on existing energy efficiency efforts and develop technological capabilities to optimize the interplay between building loads and the electric grid. Finally, we will present current research on the ability of CLS to deliver grid services while simultaneously delivering sufficient lighting service and occupant satisfaction.

Moderator/Speaker: Michael Poplawski, Pacific Northwest National Laboratory
Debyani Ghosh, Guidehouse
David Nemtzow, U.S. Department of Energy

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
Max Shtein, University of Michigan
Jeff Spindler, OLEDWorks
Bill Reisenauer, LED Specialists

■ 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
Ron Gibbons, Virginia Tech Transportation Institute
Mariana Figueiro, Rensselaer Polytechnic Institute

■ 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
Peter Brown, Lighting Transitions

POSTER SESSION PRESENTERS

No.	Title/Presenter	Type
1	**Lighting Research Center Overview and Graduate Programs** *Nadarajah Narendran, Lighting Research Center, Rensselaer Polytechnic Institute*	Research Center
2	**California Lighting Technology Center** *Cori Jackson, California Lighting Technology Center*	Research Center
3	**Materials Data Science for Reliability Center** *Paul W. Leu, University of Pittsburgh*	Research Center
4	**High Performance Substrate Embedded Microgrids for High Efficiency, Flexible Organic Light Emitting Diodes** *Ziyu Zhou, Electroninks, Inc.*	DOE STTR
5	**Enhanced Light Outcoupling from OLEDs Fabricated on Novel Low-Cost Patterned Plastic Substrates of Varying Periodicity** *Ruth Shinar, Iowa State University*	DOE BTO FOA
6	**Scalable Ultrahigh Conductive Transparent Single-Walled Carbon Nanotube Films for High-Efficiency OLED Lighting** *Huaping Li, Atom Inc*	DOE SBIR
7	**Manufacturable Corrugated Substrates for High Efficiency OLEDs** *Franky So, North Carolina State University*	DOE BTO FOA
8	**Low Refractive Index OLEDs for Practical High Efficiency Outcoupling** *Chris Giebink, Pennsylvania State University*	DOE BTO FOA
9	**From Deposition to Encapsulation: Roll-to-Roll Manufacturing of Organic Light Emitting Devices for Lighting** *Jongchan Kim, University of Michigan*	DOE BTO FOA
10	**Lighting Market Trends** *Clay Elliott, Guidehouse*	DOE Validation R&D
11	**High Performance Green LEDs for Solid State Lighting** *James Speck, University of California, Santa Barbara*	DOE BTO FOA
12	**High-Luminance LED Platform for Improved Efficacy in Directional Lighting** *Wouter Soer, Lumileds, LLC*	DOE BTO FOA
13	**Improved Radiative Recombination in AlGaInP LEDs** *Wouter Soer, Lumileds, LLC*	DOE BTO FOA
14	**AlInP-based LEDs for Efficient Red and Amber Emission** *Kirstin Alberi, National Renewable Energy Laboratory*	DOE Lab Call

No.	Title/Presenter	Type
15	**Closing the Green Gap in GaN-Based LEDs Using Ternary Nitride Semiconductors** *Adele Tamboli, National Renewable Energy Laboratory*	DOE Lab Call
16	**Solid-State Lighting Lifetime and Reliability** *Lynn Davis, RTI International, Inc.*	DOE Validation R&D
17	**Dim-to-Warm LED Lighting: Initial Benchmarks** *Monica Hansen, LED Systems Reliability Consortium*	Industry Association
18	**Reserved**	
19	**Novel Materials for Flexible Solid-State Lighting** *Larry Sadwick, InnoSys Inc.*	DOE SBIR
20	**Ultra-Thin Flexible LED Lighting Panels** *Sergey Vasylyev, Lucent Optics, Inc.*	DOE SBIR
21	**Overview of GLASE Horticultural Lighting Research** *Robert Karlicek, Greenhouse Lighting and Systems Engineering (GLASE)*	Research Center
22	**From Physics to Fixtures to Food: Potential Efficacy of LEDs** *Bruce Bugbee, Utah State University*	Speaker
23	**Unlocking Potential with Vision Science Research** *Michael Royer, Pacific Northwest National Laboratory*	DOE Core Lab R&D
24	**Next Generation Lighting Systems (NGLS) Evaluations** *Ruth Taylor, Pacific Northwest National Laboratory*	DOE Core Lab R&D
25	**Improved Light Extraction for a 130 lm/W OLED Lighting Panel** *Selina Monickam, Pixelligent Technologies LLC*	DOE SBIR
26	**Mask-Free OLED Fabrication Process for Non-Tunable and Tunable White OLED Panels** *Jeff Spindler, OLEDWorks, LLC*	DOE BTO FOA
27	**Printed Anodes and Internal Extraction Layers on Flexible Glass to Create Cost Effective High Efficacy Bendable OLED Lighting Panels** *Jeff Spindler, OLEDWorks, LLC*	DOE SBIR
28	**Commercialization of an Ultra-Thin, Bendable, High Efficacy OLED Light Engine** *Michael Boroson, OLEDWorks, LLC*	DOE SBIR
29	**High Efficiency OLED Light Engine** *Bill Reisenauer, LED Specialists Inc.*	DOE BTO FOA
30	**A New Tool for Meta-Analysis of Lighting Data and Projections** *Wyatt Merrill, AAAS Science & Technology Policy Fellow*	DOE BTO

No.	Title/Presenter	Type
31	**Non-Equilibrium Synthesis of Semiconductor Alloys for Energy Applications** *Phil Ahrenkiel, South Dakota School of Mines and Technology*	EPSCoR
32	**Controlled Growth of Self-assembled InGaN Quantum Dots Using Size-controlled Quantum Dot Templates** *Syed Ahmed Al Muyeed, Lehigh University*	Student Winner
33	**Tunneling-Enabled High-Efficiency High-Power Multi Junction LEDs** *Paul Sharps, Sandia National Laboratories*	DOE Lab Call
34	**High Efficiency InGaN LEDs Emitting in Green, Amber, and Beyond** *Hongping Zhao, Ohio State University*	DOE BTO FOA
35	**Micro-LEDs and Superluminescent Diodes: Optical Properties and Carrier Dynamics** *Dan Feezell, University of New Mexico*	EPSCoR
36	**Hybrid Down-Converting Structures for Solid State Lighting** *Hisham Menkara, PhosphorTech Corporation*	DOE SBIR
37	**Environmentally Robust Quantum Dot Downconverters for Highly Efficiency Solid State Lighting** *Jonathan Owen, Columbia University*	DOE BTO FOA
38	**Tunable Nanocrystal-based Phosphors with Reduced Spectral Widths** *Keith Kahen, Lumisyn, LLC*	DOE SBIR
39	**The Impact of Output Capacitor Aging Under Constant and Cycled Temperature Conditions on LED Driver Lifetime** *Sachintha G. De Vas Gunawardena, Rensselaer Polytechnic Institute*	Student Winner
40	**Additively Manufactured Solid-State Luminaire** *John Trublowski, Eaton Corporation*	DOE BTO FOA
41	**Adaptive Lighting for Streets and Residential Areas** *Ron Gibbons, Virginia Polytechnic Institute and State University*	DOE BTO FOA
42	**Investigating the Health Impacts of Outdoor Lighting** *Ron Gibbons, Virginia Polytechnic Institute and State University*	DOE BTO FOA
43	**Understanding Lighting Systems in Realistic Settings: Evolving Analysis of System Performance and Occupant Feedback** *Andrea Wilkerson, Pacific Northwest National Laboratory*	DOE Core Lab R&D
44	**Connected Lighting Systems Investigations** *Michael Poplawski, Pacific Northwest National Laboratory*	DOE Core Lab R&D
45	**Lighting for Grid-Interactive Efficient Buildings** *Michael Poplawski, Pacific Northwest National Laboratory*	DOE Lab Call

No.	Title/Presenter	Type
46	**Reserved**	
47	**Improved Light Extraction by Engineering Molecular Properties of Square Planar Phosphorescent Emissive Materials** *Jian Li, Arizona State University*	DOE BTO FOA
48	**Combining Fluorescence and Phosphorescence to Achieve Efficient White OLEDs** *Mark Thompson, University of Southern California*	DOE BTO FOA
49	**Stable White Organic Light-Emitting Diodes Enabled by New Materials with Reduced Excited-State Lifetimes** *Bernard Kippelen, Georgia Institute of Technology*	DOE BTO FOA
50	**Analysis of Measurement Assurance Program Data—Second Round** *Cameron Miller, National Institute of Standards and Technology*	DOE Validation R&D
51	**Improvements in Optical Metrology for Solid-State Lighting** *Cameron Miller, National Institute of Standards and Technology*	DOE Validation R&D
52	**Outdoor Lighting—Emphasis on Data** *Naomi Miller, Pacific Northwest National Laboratory*	DOE Core Lab R&D
53	**Part 1–Using Multiple Methods for Valuing Hard-to-Measure "Next Generation Features" of Energy Efficient LED Lighting** *Lisa Skumatz, Skumatz Economic Research Associates* **Part 2–Quantifying Potential Energy Savings of Next Generation LED Lighting** *Valerie Nubbe, Guidehouse*	DOE Core Lab R&D
54	**Spectral Database for New Lighting Applications** *Lily Donaldson, American University*	Student
55	**Commercial Building Initiatives in the Lighting Space** *Cedar Blazek, Department of Energy, Building Technologies*	DOE BTO
56	**Getting Beyond Widgets: Integrated Systems for Commercial Buildings** *Jordan Shackelford, Lawrence Berkeley National Laboratory*	DOE BTO
57	**Lighting Technology Energy Solutions (LiTES) Program Findings** *Nathalie Osborn, LiTES*	DOE BTO
58	**Lighting and Daylighting Integration R&D** *Luis Fernandes, Lawrence Berkeley National Laboratory*	DOE BTO
59	**Reserved**	
60	**Chip Assembly Printer for LEDs and Beyond** *Eugene Chow, PARC*	Speaker

Table Presenter	Type
Effective Education for Networked Lighting Controls Adoption *Shaun Darragh, Lighting Design Lab*	Research Center
Lighting Enabled Systems & Applications *Robert Karlicek, LESA , Rensselaer Polytechnic Institute*	Research Center
SSL and Energy Electronics Center *Tal Margalith, SSLEEC*	Research Center
Illuminating Engineering Society *Zoe Milgram, Illuminating Engineering Society*	Industry Association
Next Generation Lighting Industry Alliance *Roy Harvey, Next Generation Lighting Industry Alliance*	Industry Association
Opportunities for Collaboration with DOE *Joel Chaddock, National Energy Technology Laboratory*	DOE BTO

BTO—Building Technologies Office
FOA—Funding Opportunity Announcement
SBIR—Small Business Innovation Research
STTR—Small Business Technology Transfer
EPSCoR—Established Program to Stimulate Competitive Research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