

# SOLID-STATE LIGHTING WORKSHOP

Cosponsored by the Illuminating Engineering Society

## MONDAY JANUARY 31

11:00 a.m.–11:30 a.m. ET	<b>Welcome</b> <i>Brian Walker, U.S. Department of Energy</i> <i>Ramachandran Narayananamurthy, U.S. Department of Energy</i> <i>Brian Liebel, Illuminating Engineering Society</i>
11:30 a.m.–12:00 p.m. ET	<b>Keynote: Trevor Palmer, President, Acuity Brands</b> Acuity Brands, headquartered in Atlanta, GA, is the North American market leader and one of the world's leading providers of lighting and building management solutions. Trevor Palmer will share insights on technology trends, what resonates in the lighting market today, and what's coming next.
12:00 p.m.–12:30 p.m. ET	<b>Keynote: Oleg Shchekin, Chief Technology Officer, Lumileds</b> Lumileds is a LED technology leader based in San Jose, CA, supplying billions of LEDs to millions of energy-saving lighting products. Research at Lumileds has been instrumental in driving LED technology and performance advancements for more than two decades. CTO Oleg Shchekin will share insights on technology trends and his vision for incubating new technologies and product concepts.
12:30–1:30 p.m. ET	<b>Break</b>
1:30–3:00 p.m. ET	<b>Energy Savings from Lighting Application Efficiency</b> Lighting energy savings don't just come from source efficiency improvements. More effective optical delivery, spectral content, and intensity control can have enormous energy impacts and improve the functions of lighting. This panel will cover efforts to understand the LAE energy opportunity, the modeling tools necessary for LAE, and real-world implementations that demonstrate the impacts of LAE improvements. <i>Moderator: Morgan Pattison, SSLS, Inc.</i> <i>Raj Bhagavathula, Virginia Tech Transportation Institute</i> <i>Christoph Reinhart, Solemma</i>
3:00–3:30 p.m. ET	<b>Break</b>

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## MONDAY JANUARY 31, CONTINUED

3:30–5:00 p.m. ET	<p><b>Non-Visual Physiological Responses to Light</b></p> <p>Appreciation and understanding for non-visual physiological effects of light have come in parallel with the transition to LED lighting technology. This is good timing because LED technology has the capability to engage healthy, physiological responses to light with minimal energy impacts. This session will cover recent research in human non-visual physiological responses to light and recent results from R&amp;D on physiological impacts of light on humans in realistic settings.</p> <p><i>Moderator: George Brainard, Thomas Jefferson University</i></p> <p>Melissa St. Hilaire, Harvard Medical School Samer Hattar, National Institute of Mental Health John Hanifin, Thomas Jefferson University</p>
5:00–6:00 p.m. ET	<p><b>R&amp;D Project Highlights</b></p> <p>Interactive discussion sessions provide an opportunity to learn more about DOE-funded research projects and engage with today's leading lighting scientists. Select a collaborative session below to discuss specific research topics in more detail.</p>
5:00–5:30 p.m. ET	<ol style="list-style-type: none"><li>1. Lighting Application Efficiency</li><li>2. Advanced Lighting @PNNL</li></ol>
5:30–6:00 p.m. ET	<ol style="list-style-type: none"><li>1. LED Manufacturing</li><li>2. OLED Materials</li></ol>

# SOLID-STATE LIGHTING WORKSHOP

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## TUESDAY FEBRUARY 1

11:00 a.m.–1:00 p.m. ET	<p><b>Next-Generation Lighting Professionals</b></p> <p><b><i>Student Poster Competition Winners</i></b></p> <p>Shruti Hariyani, University of Houston Hannah Moon, University of Hawai'i at Mānoa</p> <p>The lighting industry relies on a broad range of experienced working professionals as well as young professionals with new perspectives. This panel will discuss activities and ideas to promote effective lighting education, technical training, and diversity in the workforce.</p> <p><i>Moderators: Brienne Musselman, Illuminating Engineering Society Lisa Pattison, SSLS, Inc.</i></p> <p>Bernadette Boudreaux, DesignLights Consortium Kenneth Connor, Inclusive Engineering Consortium/Rensselaer Polytechnic Institute Bob Davis, Pacific Northwest National Laboratory Yulia Tyukhova, Independent Researcher &amp; Past Chair, IES Emerging Professionals Committee</p>
1:00–1:30 p.m. ET	<b>Break</b>
1:30–3:00 p.m. ET	<p><b>Advances in LED Materials and Devices</b></p> <p>Advancements in LED materials and devices provide a range of new technical innovations that can enable new features, form factors, or performance levels in lighting systems with improved energy savings, quality, and functionality. This expert panel will discuss some of the latest innovations and new directions in LED device architectures and downconverter materials.</p> <p><i>Moderator: Monica Hansen, LED Lighting Advisors</i></p> <p>Wouter Soer, Lumileds Ling Zhou, BOLB Ilan Jen-LaPlante, Nanosys Jakoah Brgoch, University of Houston</p>
	<p><b>Advances in OLED Materials</b></p> <p>Advancements in OLED materials are being made to improve their performance and manufacturability. Emitters, hosts, and transport layers each play a role in the device, and these materials must work synergistically to achieve peak performance. This panel will discuss advancements and recent innovations in stable, efficient stack materials for white OLEDs.</p> <p><i>Moderator: Lisa Pattison, SSLS, Inc.</i></p> <p>Maria Vasilopoulou, Institute of Nanoscience and Nanotechnology, National Center for Scientific Research Demokritos Michele Ricks, EMD Performance Materials Tommie Royster, R-Display and Lighting Chihaya Adachi, Kyushu University</p>

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## TUESDAY FEBRUARY 1, CONTINUED

3:00–3:30 p.m. ET	<b>Break</b>
3:30–5:00 p.m. ET	<b>Breaking Through to Next-Level Lighting Performance</b> <p>LED lighting technology still has considerable room to improve both in lighting performance and energy savings. Phosphor-converted LED-based products can still be made much more efficient, and LED technology has the potential for greater efficiency gains by transitioning to color-mixed LED architectures, with the added benefit of new functionality from color tuning. LED lighting products can also be made to work better within lighting systems through clearly defined and consistent communication and controls interfaces and through improved integration with sensor technology. This panel will explore the latest innovations to meld improved source efficiency and functionality with improved control and communication.</p> <p><i>Moderator: Mark Lien, Illuminating Engineering Society</i></p> <p>Jim Gaines, Signify Steve Paolini, Telelumen Carol Jones, Axis Lighting Nate Mitten, Kimco Realty Corporation</p>
5:00–6:00 p.m. ET	<b>R&amp;D Project Highlights</b> <p>Interactive discussion sessions provide an opportunity to learn more about DOE-funded research projects and engage with today's leading lighting scientists. Select a collaborative session below to discuss specific research topics in more detail.</p>
5:00–5:30 p.m. ET	1. LED Materials and Down-Converters 2. OLED Light Extraction
5:30–6:00 p.m. ET	1. GUV Measurements and Reliability 2. OLED Manufacturing

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## WEDNESDAY FEBRUARY 2

11:00 a.m.– 1:00 p.m. ET	<p><b>Lighting and Sustainability: A Cradle-to-Cradle Discussion</b></p> <p>Solid-state lighting has been a tremendous environmental success for its significant reduction in energy use, yet the environmental impact extends beyond energy use—from the materials used to create the product, to how a product is manufactured and transported, to disposal or reuse at the end of life. This session will explore challenges and opportunities to reduce the environmental impact of LED lighting across its life cycle and beyond the operational stage, from raw material supply and manufacturing, to end of life including potential for reuse, remanufacture, and recycle.</p> <p><b>Opening Speaker:</b> Lindsay Baker, International Living Future Institute</p> <p><i>Moderator: Kate Hickcox, Pacific Northwest National Laboratory</i></p> <p>Roger Sexton, Stoane Lighting James Salazar, Athena Sustainable Materials Institute Mike Johnson, Sustainability and Net Positive Design Professional</p>
1:00–1:30 p.m. ET	<p><b>Break</b></p>
1:30–3:00 p.m. ET	<p><b>Advanced Manufacturing Technologies</b></p> <p>The advancement of SSL technology provides an opportunity to rethink how lighting products and components are manufactured across the value chain. The ability to embed sustainable manufacturing processes and materials into the supply chain will advance the circular economy. Advanced manufacturing technologies can help eliminate pain points in conventional product designs and can lead to improved lighting product quality and reduced cost, and enable a wider variety of form factors and features. Additionally, new manufacturing technologies can also influence where, when, and how products are manufactured, potentially enabling more localized production. This panel will explore various manufacturing process and tool innovations in the LED lighting ecosystem.</p> <p><i>Moderator: Monica Hansen, LED Lighting Advisors</i></p> <p>Aaron Smith, Finelite Lars Waumans, Signify Drew Hanser, Veeco Instruments Eugene Chow, PARC</p>

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## WEDNESDAY FEBRUARY 2, CONTINUED

1:30–3:00 p.m. ET	<p><b>Diffuse Lighting Panels</b></p> <p>The design and manufacture of thin, lightweight luminaires avoids many of the problems of glare caused by compact LEDs and opens opportunities for new form factors. The structures and manufacturing techniques that are needed to embody diffuse light sources into efficient and affordable lighting panels will be discussed.</p> <p><i>Moderator: Norman Bardsley, Bardsley Consulting</i></p> <p>Jeff Spindler, OLEDWorks Claire Arneson, University of Michigan Sergey Vasylyev, Lucent Optics Homer Antoniadis, Nanosys</p>
3:00–3:30 p.m. ET	<p><b>Break</b></p>
3:30–5:00 p.m. ET	<p><b>Disinfection: What Have We Learned About GUV and Other Methods?</b></p> <p>Germicidal ultraviolet (GUV) is a rapidly expanding market with products to deactivate pathogens in healthcare, farming, manufacturing, congregate care, and many other settings. Some applications have the potential to be permanent additions to the indoor environment, reducing the risk of infection and improving indoor air quality. Moreover, GUV may have potential to mitigate spread of pathogens at substantially lower energy and operational costs relative to alternative methods such as increased HVAC ventilation, with even greater energy savings possible if innovations in solid-state UV-C technology are realized. Research is ongoing, and standards are finally beginning to take shape as solid-state solutions emerge. This panel will discuss the state of the art in GUV, established and emerging applications, current research efforts, and identify opportunities and needs going forward.</p> <p><i>Moderator: Alex Baker, Illuminating Engineering Society</i></p> <p>Dianne Poster, National Institute of Standards and Technology Gabe Arnold, Pacific Northwest National Laboratory Cameron Miller, National Institute of Standards and Technology Ed Nardell, Harvard Medical School Mike Krames, Arkesso</p>

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## WEDNESDAY FEBRUARY 2, CONTINUED

3:30–5:00 p.m. ET	<p><b>Innovations in Display Architecture for Improved Energy Efficiency and Performance</b></p> <p>Displays are pervasive in our everyday lives and their use continues to rise with the implementation of more screens in homes and offices. At the heart of these displays is a solid-state light source. This panel will consider the energy savings opportunities leveraging solid-state technologies to create emissive display architectures with improved efficiencies and performance features. Display fusion with lighting will also be considered.</p> <p><i>Moderator: Wyatt Merrill, U.S. Department of Energy</i></p> <p>Bryan Urban, Fraunhofer USA Stefan Peana, Dell David Chen, Power Integrations Bob Karlicek, Rensselaer Polytechnic Institute</p>
5:00–6:00 p.m. ET	<p><b>Topic Tables</b></p> <p>This is your opportunity to provide input to DOE and IES! Registered attendees will select a single topic from the provided list for small-group discussion. Each group will examine why this topic is important and what the technical challenges are. Some “questions to consider” will be provided for each topic to help spur the discussion. The inputs from each group will be used to guide planning for future DOE and IES research activities.</p>
5:00–5:30 p.m. ET	<ol style="list-style-type: none"><li>1. Lighting Workforce Opportunities</li><li>2. New Lighting Metrics</li><li>3. GUV</li><li>4. LED Materials and Devices</li><li>5. Advanced Luminaires and Systems</li></ol>
5:30–6:00 p.m. ET	<ol style="list-style-type: none"><li>1. Manufacturing and Sustainability</li><li>2. Lighting Application Efficiency</li><li>3. Physiological Responses to Light</li><li>4. OLED and Diffuse Light Sources</li><li>5. Lighting System Data and Grid Interactive Lighting</li></ol>

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## THURSDAY FEBRUARY 3

11:00 a.m.–11:15 a.m. ET	<b>DOE L-Prize Concept Phase Winner Announcement</b> <i>Jennifer M. Granholm, U.S. Secretary of Energy</i>
11:15 a.m.–1:00 p.m. ET	<b>Taming Advanced Lighting System Complexity: A Call to Action</b> <p>Improved lighting control remains a large, untapped opportunity for lighting energy savings and better indoor and outdoor environments. Solid-state lighting can enable data-driven, adaptive lighting control, but currently many lighting system installations experience significant challenges with configuration, commissioning, and maintaining control settings over time. This panel taps experts from various parts of the lighting industry to talk not just problems but key actions that can be taken now to pave the way for future high-performance lighting control systems.</p> <p><b>Opening Speaker:</b> Mike Skurla, Radix IoT  <i>Moderator: Ruth Taylor, Pacific Northwest National Laboratory</i>  Charles Knuffke, Wattstopper/Legrand  David Ghatan, C.M. Kling &amp; Associates  Brian Coddington, Chicago Lightworks</p>
1:00–1:30 p.m. ET	<b>Break</b>
1:30–3:00 p.m. ET	<b>Building Scale Systems Interoperability and Integration</b> <p>This session will examine the interoperability and integration of lighting systems with other building systems at the whole building scale, and will address fundamental questions such as whether integration is possible, and worth the time, cost, and effort? Electric lighting systems in today's typical buildings are commonly disassociated from other building systems and controls. This separation from the inputs and outputs of other building systems precludes acquiring and utilizing data about occupancy, systems status, and interior and exterior environmental conditions that could lead to improved performance of individual building systems (including lighting), and also the holistic network of building systems—essential in the effort to achieve net zero-energy buildings. This session will probe recent work, whose goals are to facilitate realizing the potential for creating interoperable and integrated lighting systems within the framework of a fully integrated network of building systems.</p> <p><i>Moderator: Greg Thomson, PlanArchology</i>  Sarah Safranek, Pacific Northwest National Laboratory  Michael Myer, Pacific Northwest National Laboratory  Kenny Seeton, California State University, Dominguez Hills  Alexi Miller, New Buildings Institute</p>

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## THURSDAY FEBRUARY 3, CONTINUED

3:00–3:30 p.m. ET	<b>Break</b>
3:30–5:00 p.m. ET	<p><b>New Frontiers of Lighting</b></p> <p>The future of lighting will undergo a transformation from today's conventional luminaire form factors integrated with SSL sources to new and innovative approaches that can reshape lighting technology. This panel will explore the convergence of exponential technologies and their impact on lighting, consider strategies for mass customization of lighting products, and envision ways to spur groundbreaking innovations in sustainability. Panelists will discuss their visions for the future of lighting technology and application.</p> <p><i>Moderators: Mark Lien, Illuminating Engineering Society Monica Hansen, LED Lighting Advisors</i></p> <p>Mark Lien, Illuminating Engineering Society Monica Hansen, LED Lighting Advisors Eric Corey Freed, CannonDesign</p>