# LED WATCH

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## BUILDING THE EVIDENCE OUTSIDE THE LAB

### Research in the field is uncovering lighting's impact on human health and performance

LED lighting systems provide new opportunities for controlling the spectrum, intensity and duration of light exposure. These levels of control can be engaged as we come to better understand the effects of lighting on human health and performance. There is already good evidence that lighting can be alerting, affect melatonin secretion and affect sleep. Lab-scale studies have shown these impacts under highly controlled conditions. And these effects can have large-scale health and productivity implications. But right now, there's still a lot we don't know about physiological responses to light. Most research to date has been conducted in laboratories, where the conditions don't always match what happens in the real world, so there's a need for more studies in real-world settings where the light stimulus is realistic and the physiological responses can be collected from a sufficiently large group of participants.

The U.S. Department of Energy (DOE) is working to address these needs. One way is by hosting roundtable discussions and R&D workshops that bring together physiology, lighting and LED experts to discuss these R&D challenges. These experts from different fields don't normally have a chance to converse with each other and trade notes. The most recent roundtable on physiological responses to light took place in Washington, D.C., in September. Steven Lockley of Harvard Medical School noted that we already know a lot about the immediate effects of light on such things as our alertness, neurobehavioral performance, heart rate and body temperature—as well as on the suppression of the hormone melatonin, which plays a key role in circadian response. Shadab Rahman of Harvard Medical School said that although exposure to light before bed disrupts sleep, depleting the "blue" content of that light may facilitate sleep. He noted that we need more studies with large populations, so that we can determine lighting effects on such things as health, productivity and worker safety.

Gena Glickman of the University of California at San Diego (UCSD) explained that when it comes to lighting effects on human physiology, spectral content is not the only parameter that comes into play; the timing, intensity and duration of the light exposure are also important, as are the personal history of light exposure and whether the exposure is continuous or intermittent. And Wouter Soer of Lumileds reminded everyone that nonvisual impacts of light must be balanced with its primary role of illumination.

#### REAL-WORLD STUDIES

So while scientific understanding of the nonvisual physiological effects of light is still at a relatively early stage, there is a lot that we already know on a basic level. What we now need to do is build the evidence in real-world settings, characterizing the light stimulus and the resulting physiological responses. DOE is facilitating this by funding research designed to fill gaps in our understanding.

One such study is being conducted by Glickman at UCSD and involves novel lighting strategies for optimizing circadian health and alertness in nightshift workers. This study is employing two evidence-based lighting interventions to address two different light responses: circadian phase resetting, to maximize input during the day and minimize input close to bedtime; and acute alerting, to contribute to making the person more alert while performing important work.

Another DOE-funded study is being conducted by Ron Gibbons at Virginia Tech Transportation Institute to measure the impact of different types of roadway lighting on levels of melatonin in drivers, pedestrians and nearby sleepers. Five different light sources are being evalu-

ated in terms of their impact on melatonin secretion for the different activities under the lighting. The analysis is expected to provide insights into the health and alerting effects of nighttime light exposure for drivers on the roadway, pedestrians along the roadway and homeowners with bedrooms exposed to street lighting. The R&D topic of physiological responses to light was included in the most recent DOE R&D funding opportunity announcement and continues to be identified as an R&D priority by DOE SSL stakeholders.

Another mechanism for getting real-world feedback on lighting designed to engage physiological responses is the DOE SSL Gateway program. DOE has been conducting Gateway studies of tunable LED lighting systems in various senior-care, classroom and health-care settings, where, in addition to the energy savings, the potential non-energy benefits are of considerable interest. The results from related Gateway projects can be found at *www.energy.gov/eere/ssl/gateway-tunable-lighting-projects*.

It's clear that there is a lot of work to be done on the topic of physiological responses to light. The DOE SSL Program is leading the way by bringing the scientific, technology and application stakeholder groups together for discussion and collaboration; by funding R&D to understand how lab-scale results translate to realistic lighting conditions; and by sponsoring Gateway studies to see how SSL systems can be deployed and measured in different settings for various physiological benefits. SSL technology, coupled with the new understanding in physiological responses to light, offers the potential for lighting to be both optimized for health and highly efficient. But that's only possible if we have a clear understanding of the physiological responses to light in real-world conditions.

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