BPA Emerging Technologies for Energy Efficiency Technology Focus Area:

Solid State Lighting (SSL) and Controls

Technology Background

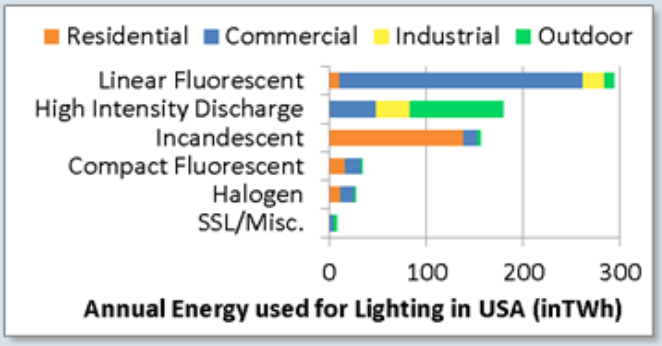
The US Department of Energy (US DOE) expects SSL (also called LED lighting) to comprise over 80 percent of lighting sales by 2030, saving 40 percent of lighting energy, even without support from energy efficiency programs[1] . We want to ensure that this technology revolution maximizes energy savings, exceeding US DOE predictions. Concerns about this technology include: low product quality can cause early failure or inferior lighting quality; not all LED lights save energy; and unfamiliar products require new expertise for proper selection and installation. BPA sponsors research projects to address these concerns and promote the adoption of energy-saving SSL in the Pacific Northwest.

Current Research

Quality Guidelines for Mogul Base LED Lamps
Timeline: 2014 – 2015
Collaborators: Lighting Research Center (LRC) at Rensselaer Polytechnic Institute, Washington State University Extension Energy Program (WSUEE)

High Intensity Discharge (HID) light bulbs use 26 percent of the lighting energy in the US, but only comprise two percent of all light bulbs. When an HID light source is replaced by SSL, this often reduces energy use by 70 percent or more. LED light bulbs (or "lamps") for mogul base sockets can convert old HID fixtures to efficient SSL, without the expense of a new fixture. In order to incentivize high quality products that save energy in commercial SSL applications, BPA relies primarily on the DesignLights Consortium Qualified Products List (DLC QPL).In 2014, this list does not yet include mogul base LED lamps. BPA is supporting research to develop quality guidelines, in order to include these products in the DLC QPL. This project began in January 2014,anda Phase 1 progress report is online.

The following chart shows energy used annually for lighting in the USA[2] :



Significant energy (30 percent to 95 percent for each project) can be saved by replacing existing lights with efficient SSL and controls.

Development of Test Methods for LED Reliability
Timeline: 2014 – 2016
Collaborators: LRCASSIST (Alliance for Solid State Illumination Systems and Technologies), WSUEE

The SSL industry lacks a standardized test method to determine the life of a complete SSL system, such as an LED light bulb or fixture. Over the past three years, an accelerated test method has been developed (funded by other sponsors), to accurately predict SSL whole system life at any environment temperature and system use pattern. BPA's funds will expand this work to a wider range of SSL product types, further validate the test method, and move the method forward toward broad industry adoption and standardization. This study will propose a timely, cost-effective industry standard test for life and color shift, to reliably determine the expected life of an SSL product based on three months of testing. This project began in 2014 as a project of BPA's Technology Innovation Office.

[1]Percent of lumen-hour sales, "Energy Savings Forecast of Solid-State Lighting in General Illumination Applications", DOE/Navigant, Aug. 2014, p.8

[2]Adapted from "2010 U.S. Lighting Market Characterization", DOE/Navigant, Jan. 2012 p.xiii

Demonstration of Outdoor Lighting for Maximizing Perceptions of Safety and Security
Timeline: 2014 – 2015
Collaborators: LRC, Seattle Lighting Design Laboratory

Many visual responses relevant to outdoor lighting are not well-characterized by the specifications currently used for lighting in parking lots, streets and roadways. Thus, outdoor lighting often uses more energy than necessary. If the perceptual benefits of lighting are properly characterized, outdoor lighting energy can be reduced by 40 percent to 50 percent, with light sources that are better tuned to human visual responses. This project will demonstrate practical outdoor lighting design best practices, with a guideline for lighting specifiers describing how brightness, safety and security perceptions can be integrated into outdoor lighting practice. The project began in 2014 as a project of BPA's Technology Innovation Office.

Easy Lighting Controls Product Review
Timeline: 2014 – 2015
Collaborators: LRC, WSUEE

Lighting controls can save electricity by providing appropriate light levels at appropriate times & places, without wasting energy on light when and where it is not needed. However some systems are difficult or expensive to install, commission, maintain & predict energy savings. This project began in 2014, to investigate new products claiming to address these concerns.

SSL Case Studies
Timeline: 2011 – 2015
Collaborators: LRC, WSUEE

An online library of regional case studies illustrates SSL installations in various types of commercial space. Most sites are publicly accessible, so that interested parties can visit to see the light for themselves. This project is ongoing 2011-2015.

Recent Research

Western Exterior Occupancy Survey
Timeline: 2012 – 2014
Collaborators: California Lighting Technology Center at University of California at Davis, Southern California Edison, Pacific Gas & Electric

Occupancy controls for exterior lights can save energy by dimming the lights when spaces are unoccupied. However, little research has been published to quantify energy savings. For this pilot survey, occupancy levels were measured in parking lots and walkways around several commercial buildings. A final report is online. Lessons learned include:

- Energy savings potential is probably high in K-12 and office, and lower in retail.
- Energy savings depend heavily on the delay setting and on the number of sub-zones.
- For a statistically significant Phase 3 survey, methods for site recruitment and data collection will need to be streamlined

Development of an Image-processing Occupancy Sensor
Timeline: 2011 – 2013
Collaborators: National Renewable Energy Laboratory

Current occupancy sensors use security-based motion sensors with limited effectiveness for lighting control in an office, because there is little motion to detect. Occupant dissatisfaction with poor performance often results in the restriction of occupancy-based controls, minimizing the potential energy savings. This project developed a cost-effective occupancy sensor based on cell phone camera technology and image processing techniques to identify and classify occupancy, even in the absence of motion. This project was conducted from 2011 to 2013, and won a 2013 R&D 100 award.

Integrated Daylighting and Energy Analysis Toolkit
Timeline: 2011 – 2013
Collaborators: National Renewable Energy Laboratory

The OpenStudio Platform supports integrated design for deep energy savings by providing a free, open source, user-friendly tool to create EnergyPlus building energy models early in the design process. The IDEAKit project added Radiance daylight modeling to OpenStudio. This project was conducted in 2011-2013.

For more information on this technology, reports, and collaboration opportunities, please visit our website.
www.bpa.gov/goto/E3T