We’ll be starting in just a few minutes….

Tell us…

What topics are you interested in for future webinars?

Please send your response to the webinar organizers via the question box.
Bright Idea: Lighting Toolkit for K-12 School Districts

November 6, 2018
3:00 – 4:00 PM EST
K-12 School District Facilities in the U.S.

CHALLENGE
- > 50 million students
- ~ 130,000 school buildings
- 1,000 hours and 200 school days
- Utility expenditures ~ $10 billion

OPPORTUNITY
- Manage energy costs and maintain healthy learning environments
- Leverage STEM academic requirements, learning labs
- Redirect utility expenditures back into the classrooms
## Today’s Presenters

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
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<tbody>
<tr>
<td>Tracy Beeson</td>
<td>Pacific Northwest National Laboratory</td>
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<tr>
<td>Robert Davis</td>
<td>Pacific Northwest National Laboratory</td>
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</table>
Webinar outline

- Overview of new K-12 Lighting Toolkit
- What is tunable LED lighting (and why should I care)?
- Pilot studies with tunable LED lighting in K-12 Classrooms
Solutions Center

- An abundance of resources
  - Search by technology
  - Help to overcome barriers
  - Find Promising Solutions
    - Buildings by size
    - By location
    - By sector
  - Financial options and planning
  - Successful project showcase
  - Analysis tools
  - Accelerators
  - Toolkits

https://betterbuildingssolutioncenter.energy.gov
Identifying Resources

- Needs specific for schools
  - Dynamic use of spaces
  - Maintenance
  - Scheduling of upgrades
  - Time of use

- Challenges specific to schools
  - Dimming and controls
  - New science on light and healthy environments
  - Financing options
K-12 Lighting Toolkit

- Case Studies
- Design Guides
- Fact Sheets
- Reports
- Specifications
- Videos
- Webinar
Case Studies

- Highlight actual projects
- How other schools approached challenges
- Specific Solutions

INSTITUTIONAL-LEVEL ADAPTIVE CONTROL SYSTEM FOR EXTERIOR LIGHTING
(University of California, Davis)

The Institutional-level Adaptive Control System incorporates exterior light points—pathways, building perimeters, parking lots, and roadways—into a smart, wireless system. Originally launched as a pilot study, this system has since been installed for over 1,000 luminaries at the University of California, Davis.

The System, designed by the California Lighting Technology Center (CLTC), is a unique, comprehensive solution that leverages existing infrastructure to create a more efficient and sustainable lighting system. It allows for dynamic adjustment of light output based on occupancy and environmental conditions, reducing energy consumption without compromising safety or aesthetics.

FEATURES:
- Easy to integrate
- Smart lighting control
- Occupancy sensors
- Adaptive control
- Energy efficient
- Cost-effective

CLTC well-spaces, Inc. designed the Institutional-level Adaptive Control System for Exterior Lighting, an easy-to-integrate adaptive control system that leverages a building’s existing exterior lighting to improve energy efficiency and occupant comfort. The system is designed to adapt to varying conditions, ensuring that lighting is optimally adjusted to meet the needs of users and the environment.

11

SOLID-STATE LIGHTING

Nothing to Mock At
In the spring of 2018, LUMENS’ Surface Mounting Technologies was selected by the California Lighting Technology Center (CLTC) to design and build a new, innovative lighting system for the University of California, Davis. The system, known as the "Institutional-level Adaptive Control System for Exterior Lighting," is designed to provide a more efficient and sustainable lighting solution for outdoor spaces.

The system features an adaptive control system that adjusts lighting output based on occupancy and environmental conditions. This allows for reduced energy consumption and improved lighting quality, while maintaining a consistent level of brightness and safety.

The system is expected to reduce energy usage by 50%, while improving overall lighting quality. It is also designed to be easy to install and maintain, with a long lifespan and low maintenance requirements.

CLTC well-spaces, Inc. leveraged its expertise in lighting design and technology to create a system that is both innovative and practical. The University of California, Davis is expected to benefit from the system's energy efficiency and improved lighting quality, making it an ideal solution for outdoor spaces.

For more information or to learn more about the California Lighting Technology Center (CLTC), please visit www.CLTC.org.
Design Guides

- Design considerations
- Guidance for specific applications
- Tailored solutions/approaches
Fact Sheets

- Compilation of potential issues
- Provides multiple paths to solutions
- Application-specific guidance
FACT SHEET: Upgrading troffer luminaires to LED

Upgrading Troffer Luminaires to LED

Lighting accounts for roughly 30% of the electricity use in a typical commercial building, and historically the luminaires in these indoor applications have been the most fluorescent lamps. In 2009, lighting systems using linear fluorescent lamps accounted for 75% of the lighting service in commercial buildings. Troffer luminaires, commonly available at 32 W/ft², are the most common fixture type. The total installed cost of troffers in the United States is estimated to be over $60 billion.

Although the installation of LED troffers has increased significantly in recent years, it is important that LED luminaires only represent 1% of luminaire fixtures. It may be possible to achieve over 70% energy savings in a national LED technology model. A projected market penetration in troffer luminaires of over 70% penetration by 2025. The energy savings on an individual project can be much greater than 50%. The realized economic and environmental benefits are likely to be significant.

Introduction

Three primary LED options exist for upgrading lighting systems from fluorescent troppers, replacing the fluorescent lamps with LED replacement lamps, replacing the fluorescent lamps and other luminaires compatible with an LED retrofit kit, and replacing the fluorescent luminaires with new luminaires designed with LED light sources. Selecting the best option for an individual project depends on several factors, including the condition of the fluorescent troffer luminaires, the desired photometric properties of the upgraded lighting system, the compatibility of the ceiling plane, and the IES and energy savings goals for the upgrade. This fact sheet provides guidance on the various factors to consider when deciding on an LED upgrade for a fluorescent troffer.

System Factors to Consider

As an evaluation of LED upgrade systems include assessing the system costs and the effects on the lighting system performance. Table 1 identifies a number of the key factors, and the accompanying text explores these factors. The column heading covers LED replacement lamps, the lumen output of the LED retrofit kit, and the luminaire luminaire to new LED luminaires. For each of these LED upgrade systems, the system factors to consider include the initial costs, the operating costs, and the replacement costs. Table 1 shows a summary of the LED options for each major factor, with cost and energy savings details.

Initial Costs

Equipment Purchase Costs

LED replacement lamps often provide the lowest cost option in terms of purchasing the LED components. The cost of LED retrofit kits is much more than replacement lamps, and purchasing new LED luminaires is the highest cost.

Table 1. System factors to consider for LED upgrades.

<table>
<thead>
<tr>
<th>SYSTEM FACTORS TO CONSIDER</th>
<th>DESCRIPTION</th>
<th>LAMPS</th>
<th>KITS</th>
<th>LUMINAIRES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial costs</td>
<td>Equipment purchase costs</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
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<tr>
<td>Installation labor costs</td>
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<tr>
<td>Safety certification costs</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>Operating costs</td>
<td>Energy costs for equal light output</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Current light levels</td>
<td>Acceptable; should not be reduced at all</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
</tr>
<tr>
<td>Dimming required</td>
<td>No, dimming is not required</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
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<tr>
<td></td>
<td>Yes, dimming is required</td>
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</table>

Installation Labor Costs

Replacement lamps that simply snap into the existing fluorescent lamp socket provide the lowest labor costs for installation. However, some products marketed as replacement lamps require additional purchase of components and labor costs. The labor cost is in addition to costs for installing new LED luminaires. The labor costs for replacement lamps are usually less expensive than the costs associated with purchasing new LED luminaires and the labor costs. For example, a typical labor cost for replacing a fluorescent luminaire with a LED retro-fit kit is $150, while the cost of a new LED luminaire is $250. This additional cost is due to the labor costs associated with the procurement and labor costs.

Operating costs

Replacement costs over system life

| Current light levels       | Acceptable; should not be reduced at all | ☑ | ☑ | ☑ |
| Dimming required           | No, dimming is not required | ☑ | ☑ | ☑ |
|                           | Yes, dimming is required | ☑ | ☑ | ☑ |
Reports

- Technical
- Vast level of detail
- Research-oriented
- Facts to support why we consider investing in the upgrades and work that is done
Specifications

- Technical documents
- Sets high standards
- Provides guidance on performance characteristics

High Efficiency Troffer Performance Specification

Version: 5.0
17 APRIL 2015

The U.S. Department of Energy’s (DOE) Better Buildings Alliance (BBA) has developed this specification for the performance characteristics of high-efficiency lighting troffers. The purpose of this specification is to provide a description of requirements that will result in energy savings for troffers, reliable performance, and energy cost savings. It also includes options for additional requirements such as emergency lighting, dimming, and controls. The specification was developed through collaboration with Better Buildings Alliance Lighting & Electrical Task members and with input from manufacturers and other interested parties.

Attachments: BBA_High_Efficiency_Troffer_Specification_5.0_vf.pdf
Publication Date: 01/07/2013
Resource Type: Specification
Videos

- Summarizes projects in a more visual way
- Easily shared
- Generally less technical
Webinars

- Summaries from experts
- Dynamic discussions
- Provides additional resources, considerations, and avenues for additional exploration
Robert Davis
PNNL
Energy efficient lighting

Fluorescent lighting saved energy and money . . .

**BUT**

- Mediocre color quality
- Difficult to dim
- Flicker, buzz
- Warm up time
- Static color
- Mercury
LED lighting saves energy and money . . .

- Good color quality
- Easy to dim
- Instant on
- Tunable color
- No mercury
- Better for learning??
What is tunable LED lighting?

Fluorescent – 3800 K
What is tunable LED lighting?

Tunable LED System

Ability to vary the spectrum and intensity of light
Why use tunable LED systems?

Circadian
Why use tunable LED systems?

Behavioral cues

Circadian

Alertness
Why use tunable LED systems?

- Biophilic
- Control
- Circadian
- Matching
- Behavioral cues
- Preferences
- Atmosphere
- Alertness
DOE GATEWAY Pilot Studies:
Carrolton TX & Folsom CA

Evaluating Tunable Lighting in Classrooms
Trial LED lighting systems in three classrooms in the Folsom Cordova Unified School District

September 2016

Tuning the Light in Classrooms:
Evaluating Trial LED Lighting Systems in Three Classrooms at the Carrollton-Farmers Branch Independent School District in Carrollton, TX

Prepared by the U.S. Department of Energy
Solid State Lighting Program
September 2016
Prepared by Pacific Northwest National Laboratory
1: FULL – All 100%
2: AV – Front Off, Room 40%
3: PRESENT – Front 100%, Room 60%
4: ALL Dim 10%
UP / DOWN – Change all by 5% each click
Tunable spectrum LED lighting
SCENE CONTROLS

- General
- AV Mode
- Screens
- Energize
- Calm
- Sensor Override
Folsom-Cordova Unified School District

**SCENE CONTROLS**
- General
- AV Mode
- Screens
- Energize
- Calm
- Sensor Override

**SLIDE CONTROLS**
- General room intensity
- Whiteboard intensity
- Color tuning of all fixtures
Folsom-Cordova Unified School District

Tunable LED System

- 6500 K
- 4300 K
- 2700 K

Wavelength

34
Energy use for lighting during a typical day
Energy use for lighting during a typical day
Classroom Outcomes in GATEWAY Pilot Studies

- 45-60% energy savings based on power reduction
  - Deeper savings due to controls / dimming (>70%)
Classroom Outcomes in GATEWAY Pilot Studies

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- Color consistency between fixtures & over dimming range was very good
Classroom Outcomes in GATEWAY Pilot Studies

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- Lighting used by teachers to provide behavioral cues
  - Increased student engagement; improved the learning environment
  - FCUSD included two classrooms with ASD students
Classroom Outcomes in GATEWAY Pilot Studies

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- Color consistency between fixtures & over dimming range was very good

- Lighting used by teachers to provide behavioral cues
  - Increased student engagement; improved the learning environment
  - FCUSD included two classrooms with ASD students

- One teacher credited the lighting with “keeping me from retiring”
Summary

- LED lighting systems can offer significant energy and economic benefits to schools
- Dimming & scene control of LED lighting can produce even deeper savings

- Tuning the spectrum of LED lighting may offer further benefits
  - *Not* more energy savings (non-energy benefits or NEB)
  - Gives teachers more control of classroom environment
  - Provides visual cues for desired student behaviors
  - Allows for “future proofing” to adapt to emerging science on alertness and focus

robert.davis@pnnl.gov
Additional Resources

To access the new K-12 Lighting Toolkit (coming soon!):
- [https://betterbuildingssolutioncenter.energy.gov](https://betterbuildingssolutioncenter.energy.gov)

FACT SHEET: Upgrading troffer luminaires to LED:
- [https://www.energy.gov/eere/ssl/technology-fact-sheets](https://www.energy.gov/eere/ssl/technology-fact-sheets)

GATEWAY Evaluation Reports
- [https://www.energy.gov/eere/ssl/gateway-evaluations](https://www.energy.gov/eere/ssl/gateway-evaluations)

LED Color-Tunable Products
- [https://www.energy.gov/eere/ssl/led-color-tunable-products](https://www.energy.gov/eere/ssl/led-color-tunable-products)
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Tuesday, January 8, 2019 | 3:00 - 4:00 PM ET
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BENCHMARKING WATER:
NEW APPROACHES AND OPPORTUNITIES FOR BUILDINGS
Tuesday, October 16, 2018 | 3:00 - 4:00 PM ET
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REAL WORLD APPLICATIONS THAT INFORM R&D
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LIGHTING TOOLKIT FOR K-12 SCHOOL DISTRICTS
Tuesday, November 6, 2018 | 3:00 - 4:00 PM ET
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STRATEGIES FOR HEALTH & WELLNESS
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Tuesday, December 4, 2018 | 3:00 - 4:00 PM ET
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HOW EFFICIENCY-AS-A-SERVICE UNLOCKS NEW POTENTIAL FOR BUSINESS
Tuesday, April 2, 2019 | 3:00 - 4:00 PM ET
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Hear from leaders at the National Laboratories working to advance technologies related to space conditioning, lighting, plug loads, building envelope, and energy management information systems.
How can you take advantage of Better Buildings?

- Access publically available resources
  - Technology specifications, guides, case studies
  - Energy efficiency financing options
  - Archived and live webinars

- Join as a partner or participant
  - Access expertise at the National Labs
  - Share ideas with peers via Better Buildings events
  - Earn recognition for your host organization
  - Elevates energy efficiency to senior leadership
  - Third party validation of energy savings
  - Leave a legacy of energy efficiency support
More than 1,000 solutions are available publicly in the Better Buildings Solution Center

Showcase Projects:
- Large and small buildings
- All sectors
- Specific building types such as schools, hospitals, hotels, grocery stores, universities, civic centers, libraries, offices and labs

Implementation Models (Playbooks):
- Overcome barriers: finance, data, energy management, staff training, community and customer outreach, partnering with utilities, and more
- Multi-faceted and applicable across sectors

Other Resources, Case Studies, Guidance
### Today’s Presenters

<table>
<thead>
<tr>
<th></th>
<th>Email</th>
</tr>
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<tbody>
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### DOE Program Leads

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<tbody>
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<td>DOE, Better Buildings Challenge</td>
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### Program Support

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Additional Questions? Please Contact Us

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