FEMP Exterior Solid-State Lighting Initiative:
High Performance Parking Structure Lighting

FEMP Webinar
January 25, 2012

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Solid-State Lighting is an umbrella term that encompasses both organic light emitting diodes (OLEDs) and inorganic light emitting diodes (LEDs). Present applications focus on LEDs, but OLEDs may find their way into the marketplace as technology improves.
With support from FEMP, the U.S. Army Corps of Engineers (USACE) is developing a policy and implementation plan (including guidance materials, training, qualified product lists, and performance specifications) in support of the widespread adoption of exterior SSL in the Federal sector.
Status Update

• Technical Assistance to Exterior SSL Policy Development
  – Provide technical guidance to the USACE (and others) on a policy to standardize SSL technology in exterior areas
  – Construction Standard Specifications
• FEMP-Designated Exterior SSL Performance Levels and Product List
  • Utilize DesignLights™ Consortium Qualified Products List
• SSL Exterior Lighting Outreach/Education
  – Guides, Training Materials, Field Guides, Fact Sheets, Etc.
• Federal Market Assessment for Exterior SSL
• FEMP Exterior SSL Initiative Website:
  – www.femp.energy.gov/technologies/solid_state_lighting.html
## Technical Requirements Table v1.6

**DesignLights™ Consortium Qualified Products List - Non-Residential Applications**

Submit any or all of the following product information and Testing Results to DesignLights for qualification. Please note that it is ONE per submission.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Outdoor Pole/Arm-Mounted Area and Roadway Luminaires</td>
<td>1,000 lm</td>
<td>=100% 0-90°, &lt;10% 80-90°</td>
<td>60 lm/W</td>
<td>≤5700K</td>
<td>50</td>
<td>50,000 hrs</td>
<td>5 years</td>
</tr>
<tr>
<td>2) Outdoor Pole/Arm-Mounted Decorative Luminaires</td>
<td>1,000 lm</td>
<td>≥65%: 0-90°</td>
<td>40 lm/W</td>
<td>≤5700K</td>
<td>50</td>
<td>50,000 hrs</td>
<td>5 years</td>
</tr>
<tr>
<td>3) Outdoor Wall-Mounted Area Luminaires</td>
<td>300 lm</td>
<td>=100% 0-90°, &lt;10% 80-90°</td>
<td>60 lm/W</td>
<td>≤5700K</td>
<td>50</td>
<td>50,000 hrs</td>
<td>5 years</td>
</tr>
<tr>
<td>4) Bollards</td>
<td>500 lm</td>
<td>&lt;15%: 90-110° 0%; &gt;110°</td>
<td>35 lm/W</td>
<td>≤6500K</td>
<td>50</td>
<td>50,000 hrs</td>
<td>5 years</td>
</tr>
<tr>
<td>5) Wall-wash Luminaires</td>
<td>575 lm</td>
<td>≥50%: 20-40°</td>
<td>40 lm/W</td>
<td>≤5000K</td>
<td>50</td>
<td>50,000 hrs</td>
<td>5 years</td>
</tr>
<tr>
<td>6) Parking Garage Luminaires</td>
<td>2,000 lm</td>
<td>≥30% 60-80°, ≤25% 70-80°</td>
<td>60 lm/W</td>
<td>≤5700K</td>
<td>50</td>
<td>50,000 hrs</td>
<td>5 years</td>
</tr>
</tbody>
</table>
Street/Roadway Lighting

- Municipal SSL Consortium
  - Performance Specification
- U.S. Department of Energy (DOE) SSL Gateway Demos
- CALiPER Test Results

Parking Lot/Structure Lighting

- DOE SSL Gateway Demos
- Commercial Building Energy Alliances (CBEA) Performance Specs
  - Lot and Structure Lighting

General Resources

- DOE SSL Program
- DesignLights™ Consortium
- Qualifying Products Lists
What is the L Prize?

- Technology competition to spur innovation and exceptional performance
- Created under Section 655 of the Energy Independence and Security Act (EISA) of 2007
- Two key lamp replacements:
  - 60W Incandescent
  - PAR 38 Halogen
- Future focus: 21st century lamp
- Cash prizes, federal purchasing, utility programs
L Prize Competition Requirements

- Exceptional efficacy
- Long life
- Form factor identical to lamps they replace
- Additional details specified for
  - Quality
  - Performance
  - Mass manufacturing
Winning Lamp Coming to Market Soon
Focus on Promotion of Winning Lamp

• Philips planning for commercial rollout February 2012
• Consumer rollout in April 2012
• Coordinating plans and promotions with partners
• Partner feedback on production lamp has been very good, noting:
  – Improved dimming
  – Streamlined/improved appearance
  – Excellent light output
  – Excellent color
Philips LED L Prize Audit Tool

- Calculate energy savings for the 10 Watt A-shape retrofit LED
- [www.usa.lighting.philips.com/lightcommunity/trends/l-prize/](http://www.usa.lighting.philips.com/lightcommunity/trends/l-prize/)
- Additional resources available
Topics

• Introduction

• Estimates about parking structures
  – Energy usage of parking structures
  – Typical fixtures
  – Design issues
  – Potential for lighting controls

• Review of CBEA specification

• Review of financial incentives
  – 179D tax deduction
  – Database of State Incentives for Renewable Energy (DSIRE)
  – Example utility/Electric Efficiency Program (EEP) incentives

• Examples in action – Cleveland Clinic
Overview
U.S. Energy Use

2008 Buildings Share of U.S. Primary Energy Consumption End-Uses

Source: Building Energy Data Book http://buildings databook.energy. doe.gov/
Note: The “Adjust to SEDS” percentage for the residential and commercial end-use splits were distributed among the other categories.
Agenda

• Introduction
• **Estimates about parking structures**
  – Energy usage of parking structures
  – Typical fixtures
  – Design issues
  – Potential for lighting controls
• Review of CBEA specification
• Review of financial incentives
  – 179D tax deduction
  – DSIRE
  – Example utility/EEP incentives
• Examples in action – Cleveland Clinic
Parking Structure Information
Quick Facts

Approximately 110 Million Spaces
• **NOT** Structures
Low/Medium Fixture Wattage
• Typically 50W–200W
Long Daily Operation
• 18 hours/day = 6,570 hours/year
High Energy Use
• 28.1 terawatt-hour (TWh)/year
Infrequent Occupancy at Times
Low Occupancy at Times
Daylight and Controls Potential
## Parking Structure Information
### Energy Usage

<table>
<thead>
<tr>
<th>Light Source</th>
<th>Portion of Installed Equipment</th>
<th>Number of Lights (000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incandescent</td>
<td>1.6%</td>
<td>600</td>
</tr>
<tr>
<td>Halogen</td>
<td>2.2%</td>
<td>800</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>45.9%</td>
<td>16,600</td>
</tr>
<tr>
<td>Induction</td>
<td>7.4%</td>
<td>2,700</td>
</tr>
<tr>
<td>Mercury Vapor</td>
<td>0.1%</td>
<td>44</td>
</tr>
<tr>
<td>High Pressure Sodium</td>
<td>23.2%</td>
<td>8,500</td>
</tr>
<tr>
<td>Metal Halide</td>
<td>15.3%</td>
<td>5,600</td>
</tr>
<tr>
<td>LED</td>
<td>4.1%</td>
<td>1,500</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>36,400</td>
</tr>
</tbody>
</table>

**DOE Energy Savings Estimates of LEDs in Niche Lighting Applications (January 2011)**
Parking Structure Information Costs

<table>
<thead>
<tr>
<th>Cost Type</th>
<th>Median Annual Cost per Space</th>
<th>Part of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cashiering Salaries &amp; Benefits</td>
<td>$184.57</td>
<td>33%</td>
</tr>
<tr>
<td>Management Costs</td>
<td>$57.69</td>
<td>10%</td>
</tr>
<tr>
<td>Security Costs</td>
<td>$90.65</td>
<td>16%</td>
</tr>
<tr>
<td>Utilities</td>
<td>$50.00</td>
<td>9%</td>
</tr>
<tr>
<td>Insurance</td>
<td>$13.76</td>
<td>2%</td>
</tr>
<tr>
<td>Supplies</td>
<td>$6.61</td>
<td>1%</td>
</tr>
<tr>
<td>Routine Maintenance</td>
<td>$37.02</td>
<td>7%</td>
</tr>
<tr>
<td>Structural Maintenance</td>
<td>$38.07</td>
<td>7%</td>
</tr>
<tr>
<td>Snow Removal</td>
<td>$4.07</td>
<td>1%</td>
</tr>
<tr>
<td>Equipment Maintenance</td>
<td>$6.07</td>
<td>1%</td>
</tr>
<tr>
<td>Other Expenses</td>
<td>$75.43</td>
<td>13%</td>
</tr>
<tr>
<td>Total</td>
<td>$564.03</td>
<td>100%</td>
</tr>
</tbody>
</table>

Parking Structure Information Materials

Unpainted concrete
*Embassy Suites, Portland, OR*

Ceiling and columns painted white
*Arizona State University, Tempe, AZ*
Department of Labor Headquarters Site Overview

- Subterranean parking deck
- Directional flow traffic
- Parking for office building
- T12 → High pressure sodium (HPS) → LED
- LED demo
- LED fixtures use occupancy sensors
- LED fixtures Next Generation Luminaires (NGL) winners

Department of Labor Headquarters, Washington, D.C.
Results

• 55% savings
  – HPS draws 137 W
  – LED draws 62 W (high state)

• Illuminance
  – Average down from HPS to LED
  – Minimum up from HPS to LED
More than Just LEDs – Use Controls!

Highlights
Bi-level LED lighting uses motion sensors to reduce lighting levels when the parking area is not in use.

Application
Bi-level LED lighting is appropriate for garage, parking lot, and pedestrian areas. It can also be applied to pathway lighting where appropriate.

Key Factors for Deployment
Evaluate specific lighting and environmental requirements before deployment.

Ranking Criteria
0 (low) – 5 (high) and Weighted Score: 0 (low) – 100 (high)

<table>
<thead>
<tr>
<th>Metric</th>
<th>Federal Energy Savings</th>
<th>Cost Effectiveness</th>
<th>Probability of Success</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighting</td>
<td>50%</td>
<td>30%</td>
<td>20%</td>
<td>100%</td>
</tr>
<tr>
<td>Interior LED Value</td>
<td>2.5</td>
<td>3.0</td>
<td>4.5</td>
<td>61</td>
</tr>
<tr>
<td>Bi Level Garage/Parking Lot/Pedestrian Lighting Value</td>
<td>0.9</td>
<td>4.0</td>
<td>5.0</td>
<td>53</td>
</tr>
</tbody>
</table>
Controls Sample Usage Data
Saturday, January 29

Preliminary Data – Department of Labor

Daily Fixture Amperage

Hour of Day

Preliminary Data – Department of Labor
Results

• Operating profile
  – Operating in high state ≈ 30% of time
  – Operating in low state ≈ 70% of time

• Time out of sensor affects savings

• One way traffic affects usage
Parking Structure Information
Possible Use of Controls

Challenges

• Pipes and signs affect coverage
• Air handler caused “false positive”* for at least one luminaire
• Columns affect coverage

*Suggested movement from person/car when no actual movement occurred
Agenda

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• Estimates about parking structures
  – Energy usage of parking structures
  – Typical fixtures
  – Design issues
  – Potential for lighting controls
• Review of CBEA specification
• Review of financial incentives
  – 179D tax deduction
  – DSIRE
  – Example utility/EEP incentives
• Examples in action – Cleveland Clinic
What is a specification?

Performance Specification:
- Adopted by end user/site
  - E.g., Walmart, Walgreens, Westfield
- Product must deliver X (e.g., lumens, footcandles, uniformity) for Y energy units (e.g., W/sf, W, kWh)

Technology (Product/Widget) Specification:
- Can be done via RFP/mass procurement
- Can be incentivized by utility or energy efficiency program
- Example of lighting, product X delivers Y lumens for Z watts
- Examples: ENERGY STAR®, CEE Premium T8s, Etc.
Energy Conservation

1. 0.18 W/sf

Background

1. EPAct 40% Parking Structure Lighting Power Density (LPD): 0.18
2. Parking Structures are covered by EPAct deduction

Internal Revenue Bulletin: 2008-14 Section 6. APPLICATION OF THE INTERIM LIGHTING RULE TO UNCONDITIONED GARAGE SPACE

### Specification Overview

**Lighting Requirements**

<table>
<thead>
<tr>
<th>Area of Structure</th>
<th>Horizontal(^1) Illuminance Requirement</th>
<th>Vertical(^2) Illuminance Requirement</th>
<th>Uniformity Max:Min</th>
<th>Uniformity CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covered Parking Areas</td>
<td>1.25 (Min)</td>
<td>0.5</td>
<td>7:1</td>
<td>0.38</td>
</tr>
<tr>
<td>Ramps (Day)</td>
<td>2.00 (Min)</td>
<td>1.0</td>
<td>10:1</td>
<td>0.41</td>
</tr>
<tr>
<td>Ramps (Night)</td>
<td>1.00 (Min)</td>
<td>0.5</td>
<td>10:1</td>
<td>0.41</td>
</tr>
<tr>
<td>Vehicle Entry (Day)(^3)</td>
<td>50.00 (Min)</td>
<td>25.0</td>
<td>10:1</td>
<td>0.41</td>
</tr>
<tr>
<td>Vehicle Entry (Night)</td>
<td>1.25 (Min)</td>
<td>0.5</td>
<td>10:1</td>
<td>0.41</td>
</tr>
<tr>
<td>Uncovered (Top Deck)</td>
<td>0.75 (Min)</td>
<td>0.4</td>
<td>10:1</td>
<td>0.41</td>
</tr>
</tbody>
</table>

1. Measured on parking surface
2. Vertical measurements at 5’ Above Finish Grade (AFG)
3. Contributions from the sun should be factored in

*Illuminance requirements might change*
Specification Overview
Technologies

Fluorescent

LED

Induction
Specification Overview
Lighting Controls

A. Daylighting Controls

1. Luminaires within 20’ of perimeter and if wall is 40% open must be controlled with daylight harvesting

2. Luminaires in vehicle exit/entry area turn off additional lighting at night

3. Photocell requirements
   a. 15–30 second time delay
   b. 10 fc set point for sensor
   c. Mounted in an unobscured location
   d. Use relays that are UL 773 or UL 773A
B. Occupancy Sensor Controls

1. 1 occupancy sensor per luminaire, maximum coverage
2. Sensors comply with WD 7-2000
3. Sensor Type: Infrared or microwave
4. Sensors not affected by ambient temperature
5. Failsafe feature to fail “on” in event of sensor failure
6. Site owner to specify if sensors are on/off or high/low

Control requirements might change
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Financial Incentives for LPDs

- Sliding scale reductions for taxes
- $0.30/square foot (sf) when lighting is 0.225 W/sf
- $0.60/sf when lighting is 0.18 W/sf
- Applicable to covered floors
  - Open-to-sky top floors not applicable
- Extended to December 31, 2013
- IRS Notice 2008-40 issued March 7, 2008
- Government structures $$ → design team

Parking Structures → Low-Hanging Fruit

- Large footprint, but low equipment density
  - High tax incentive with low-capital outlay
Financial Incentives
179D Tax Incentive

Sample Parking Structure
• ≈ 41,400 sf
Federal money from tax deduction
• Final amount per tax bracket

<table>
<thead>
<tr>
<th>Tax Bracket</th>
<th>0.18 W/sf</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>$2,484.00</td>
</tr>
<tr>
<td>15%</td>
<td>$3,726.00</td>
</tr>
<tr>
<td>25%</td>
<td>$6,210.00</td>
</tr>
<tr>
<td>28%</td>
<td>$6,955.20</td>
</tr>
<tr>
<td>33%</td>
<td>$8,197.20</td>
</tr>
<tr>
<td>35%</td>
<td>$8,694.00</td>
</tr>
</tbody>
</table>
Financial Incentives
179D Tax Incentive

Contains:

- Information
- Draft letters
- IRS Bulletins
- FAQs
- Resources

www.lightingtaxdeduction.org
Financial Incentives
179D Tax Incentive

www.geconsumerandindustrial.com/environmentalinfo/tools_calculators/eligibility_estimator.htm/
Sample Text:

- In addition to the pricing above, this project anticipates meeting the requirement for federal tax deduction for Energy Efficient Lighting Property. As a public agency, the U.S. General Services Administration (GSA) will designate the Contractor as the designer to qualify for this deduction in accordance with Internal Revenue Service Notices 2006-52 and 2008-40. The anticipated value of the deduction is $0.60 per conditioned square foot. The Contractor is authorized to retain 15% ($0.09 per square foot of this) and will credit GSA the balance (an estimated amount of $0.51 per square foot).
Specification in Practice: Cleveland, OH

Highlights:

- Hospital
- ≈ 1,000,000 sf
- 1,500 spaces
- Converted from HPS (top) to LED (bottom)
- 840 fixtures
  - 620 with occupancy sensors
  - 218 with daylight sensors
- Projected 82% energy savings
- Payback: 4.2 years simple payback

Cleveland Clinic
Specification in Practice: Washington Metro

Highlights:

- 13,000 HPS luminaires
- 24-hour operation
- 24 parking structures
  - 303,000 – 1,130,000 sf
- Constructed between 1980 - 2011
- Offerors are requested to submit a design-build-maintain solution for replacing all HPS fixtures in accordance with the CBEA High Performance Lighting Parking Structure Specification except where noted below.

Federal Demonstrations

US Department of Labor Building, Washington, DC

- Integral occupancy sensor dims fixture to 10% power
- Initial minimum horizontal illuminance increased 21%; average decreased 53%
- 55% installed wattage reduction in high state; 95% reduction in low
- ~ 80% kWh energy savings expected, includes dimming
- 1:1 replacement
- ~ 8 year simple payback (for retrofit), ~ 5 year for new
Questions

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Pacific Northwest National Laboratory
jeff.mccullough@pnnl.gov
DOE Resources

• FEMP Exterior SSL Initiative
  – www.femp.energy.gov/technologies/solid_state_lighting.html

• Commercial Building Energy Alliance
  – www.buildings.energy.gov/alliances/parking_structure_spec.html
  – www.buildings.energy.gov/alliances/parking_lot_lighting.html

• Municipal Solid-State Street Lighting Consortium

• U.S. Department of Energy Solid-State Lighting
  – www.ssl.energy.gov
Non-DOE Resources

- **DesignLights™ Consortium**
  - [www.designlights.org/](http://www.designlights.org/)

- **Illuminating Engineering Society (IES)**
  - [www.iesna.org](http://www.iesna.org)
  - **TM-21**:

- **Philips L Prize Tool**
  - [www.usa.lighting.philips.com/lightcommunity/trends/l-prize](http://www.usa.lighting.philips.com/lightcommunity/trends/l-prize)
Non-DOE Resources

• GE EPAct Tax Calculator
  – www.geconsumerandindustrial.com/environmentalinfo/tools_calculators/eligibility_estimator.htm/

• National Electrical Manufacturers Association (NEMA)/Tax Incentive Site
  – www.lightingtaxdeduction.org

• IRS Tax Bulletin

• Washington Metropolitan Area Transit Authority (WMATA)