

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



FEMP Webinar
January 25, 2012

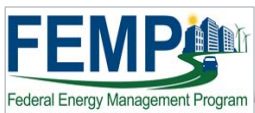
Michael Myer, PNNL
Jeff McCullough, PNNL

- FEMP Exterior Solid-State Lighting (SSL) Initiative
 - Forthcoming Army Policy
 - FEMP-Designated Performance Levels
 - DesignLights™ Consortium (DLC)
 - Resources
- Update on the L Prize™ Competition
- **Featured Topic:** High Performance Parking Structure Lighting
- Questions and Answers

***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.*

FEMP Exterior SSL Technology Deployment

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.



USACE

Collaboration



Army Exterior SSL Policy Announcement

Widespread deployment in Army and other agency facilities



Outreach

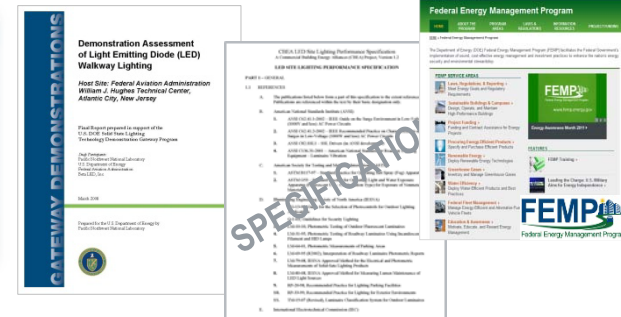
Training



Webinars

Support Resources

FEMP Designated Products



- 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

See a list of our category definitions here


Designlights™ Consortium Qualified Products List- Non-Residential Applications – Submit any or all of the following product Information and Testing Results to Designlights for qualification <i>*please make note that it is ONE per submission*</i> PDF Download							
Application	Minimum Light Output	Zonal Lumen Density	Minimum Luminaire Efficacy	Allowable CCTs (ANSI C78.377-2008)	Minimum CRI	L70 Lumen Maintenance	Minimum Luminaire Warranty
1) Outdoor Pole/Arm-Mounted Area and Roadway Luminaires	1,000 lm	=100% 0-90°, <10% 80-90°	60 lm/W	≤5700K	50	50,000 hrs	5 years
2) Outdoor Pole/Arm-Mounted Decorative Luminaires	1,000 lm	≥65%: 0-90°	40 lm/W	≤5700K	50	50,000 hrs	5 years
3) Outdoor Wall-Mounted Area Luminaires	300 lm	=100% 0-90°, <10% 80-90°	60 lm/W	≤5700K	50	50,000 hrs	5 years
4) Bollards	500 lm	<15%: 90-110° 0%: >110°	35 lm/W	≤6500K	50	50,000 hrs	5 years
5) Wall-wash Luminaires	575 lm	≥50%: 20-40°	40 lm/W	≤5000K	50	50,000 hrs	5 years
6) Parking Garage Luminaires	2,000 lm	≥30% 60-80°, ≤25% 70-80°	60 lm/W	≤5700K	50	50,000 hrs	5 years

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

FEDERAL ENERGY MANAGEMENT PROGRAM

A FEMP Outdoor SSL Initiative

Resources for Outdoor SSL Applications



LED lighting installed in the parking garage of the Frances Perkins Building, U.S. Department of Labor headquarters, Washington, D.C.

Outdoor Solid-State Lighting in the Federal Sector

The Federal Energy Management Program (FEMP) is encouraging Federal agencies to accelerate the thoughtful application of outdoor solid state lighting luminaires. The FEMP Outdoor SSL Initiative offers a unique opportunity for the Federal sector to lead a large-scale implementation effort focused on an SSL application that is ripe for near term implementation through a process that recognizes the technology's potential, as well as its challenges. This initiative is intended to help Federal energy managers overcome the widespread misinformation they are encountering, learn about this technology and its unique attributes, and provide the tools needed to make good decisions that result in cost effective energy savings, and good quality lighting.

As part of this initiative, FEMP will leverage existing SSL outdoor tools and materials, and will develop new ones as needed to meet the unique needs of Federal agencies. This paper provides an overview of existing outdoor SSL resources developed by the US Department of Energy's SSL Program and other Federal initiatives including:

- SSL Street/Roadway Lighting
- SSL Site (Parking Lot/Garage) Lighting
- General SSL Resources

Street/Roadway Lighting

A variety of resources are available for facility managers interested in pursuing SSL street and roadway lighting, including DOE SSL GATEWAY demonstration project results, a Fitted Target Efficacy Calculator, and DOE CALiPER test results.

Municipal Solid-State Street Lighting Consortium Fact Sheet – The Consortium shares technical information and experiences related to LED street and area lighting demonstrations. The Consortium also serves as an objective resource for evaluating new products on the market intended for street and area lighting applications. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/consortium_fs.pdf

DOE SSL GATEWAY Demonstration Project Results – DOE GATEWAY demonstrations showcase high-performance LED products for general illumination in a variety of commercial and residential applications. Demonstration results provide real-world experience and data on state-of-the-art solid-state lighting (SSL) product performance and cost effectiveness. The following studies have been completed on Street/Roadway lighting:

- **LED Roadway Lighting: Palo Alto, California**
Assessment of energy, economic, and performance impacts of replacing high-pressure sodium street lights with LED and induction street lights. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_palo_alto.pdf

According to the U.S. Department of energy, no other lighting technology offers as much potential to save energy and enhance the quality of our building environments, contributing to our nation's energy and climate change solutions.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_market_factsheet.pdf

- **LED Street Lighting: Lija Loop, Portland, OR**

Analysis of the energy and performance impacts of replacing eight high-pressure sodium street lights on one residential street with LED luminaires.

http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_lija_loop.pdf

- **LED Roadway Lighting: I-35W Bridge**

Analysis of Phase 1 results, completed in September 2008, Phase 2 involves long-term monitoring to evaluate lumen depreciation, physical effects, and performance impacts over time. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_i-35w-bridge.pdf

continued >

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 60W incandescent replacement will use 10 watts.

L Prize Competition Requirements

- Exceptional efficacy
- Long life
- Form factor identical to lamps they replace
- Additional details specified for
 - Quality
 - Performance
 - Mass manufacturing

Competition Requirements

60W Incandescent Replacement Lamp

- *More than 90 lm/W*
- *Less than 10 watts*
- *More than 900 lumens*
- *More than 25,000 hour life*
- *More than 90 CRI*
- *Between 2700-3000 K CCT*

PAR 38 Halogen Replacement Lamp

- *More than 123 lm/W*
- *Less than 11 watts*
- *More than 1,350 lumens*
- *More than 25,000 hour life*
- *More than 90 CRI*
- *Between 2700-3000 K CCT*

21st Century Lamp

- *To be defined in a future L Prize Program Announcement*

Winning Lamp Coming to Market Soon



L PRIZE[®]
WINNER

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

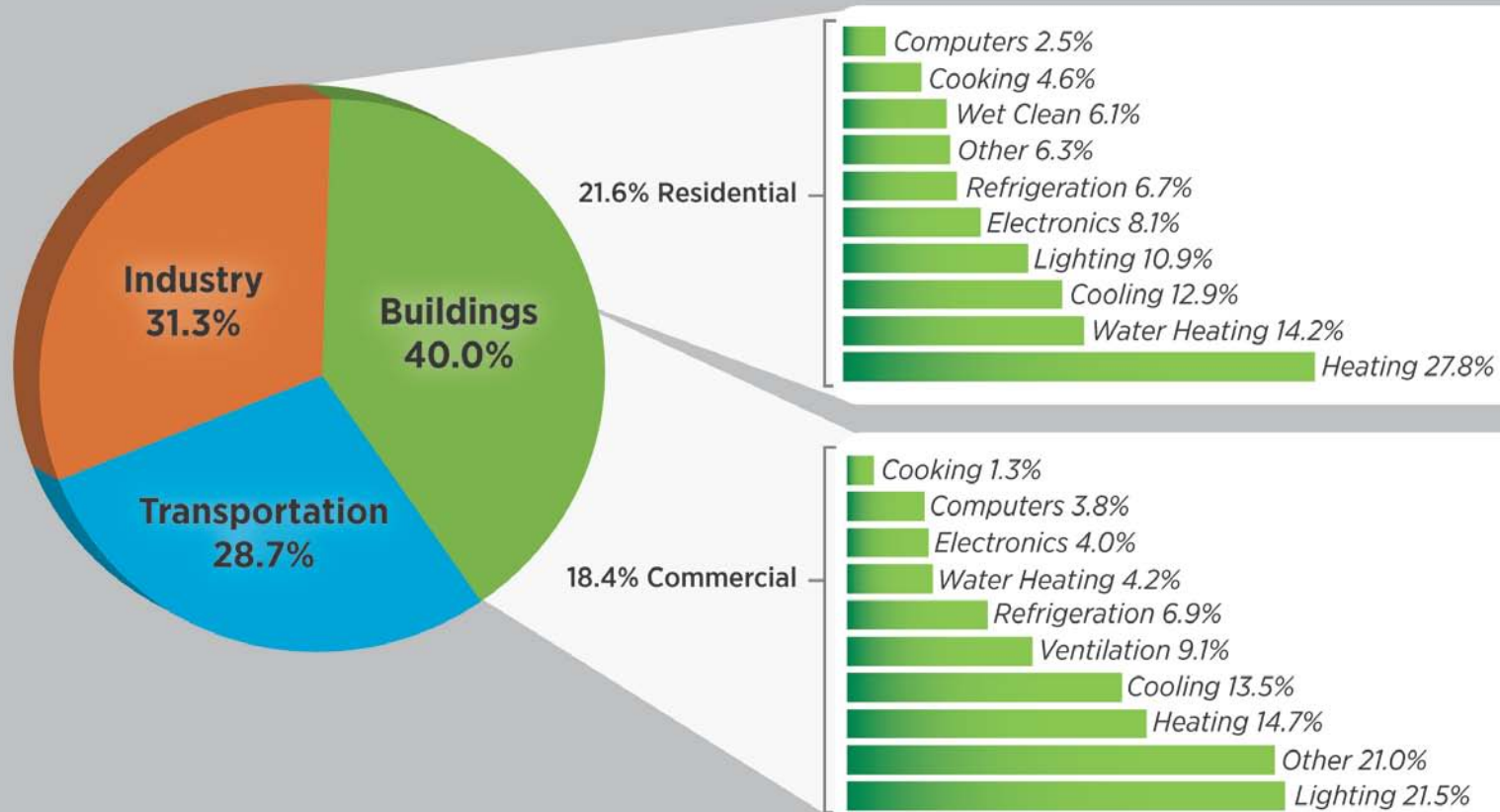
Philips LED L Prize Audit Tool

- Calculate energy savings for the 10 Watt A-shape retrofit LED
- www.usa.lighting.philips.com/lightcommunity/trends/l-prize/
- Additional resources available

- 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://buildingsdatabook.eren.doe.gov/>
Tables 1.1.3, 2.1.5, 3.1.4

Note: The "Adjust to SEDS" percentage for the residential and commercial end-use splits were distributed among the other categories.

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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



Tufts University



Old Orchard Mall

Parking Structure Information Energy Usage

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

DOE Energy Savings Estimates of LEDs in Niche Lighting Applications (January 2011)

Parking Structure Information Costs

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

Table from Parking Structures 3rd Edition: Planning, Design, Construction, Maintenance, and Repair (2001)



*Unpainted concrete
Embassy Suites, Portland, OR*



*Ceiling and columns painted white
Arizona State University, Tempe, AZ*

Parking Structure Information

Possible Use of Controls

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.*

Parking Structure Information

Possible Use of Controls

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



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

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

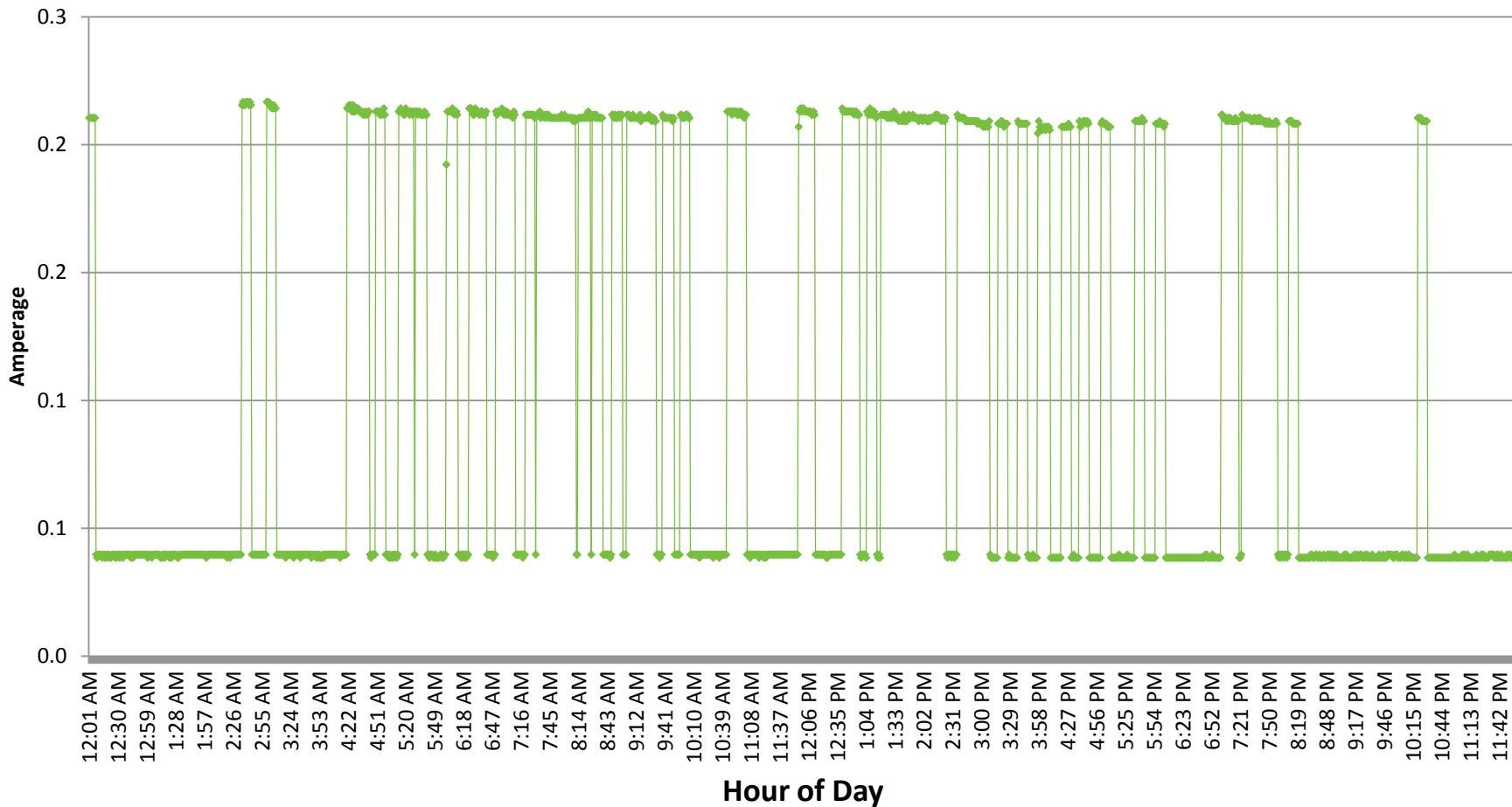
0 (low) – 5 (high) and Weighted Score: 0 (low) – 100 (high)

Metric	Federal Energy Savings	Cost Effectiveness	Probability of Success	Weighted Score
Weighting	50%	30%	20%	100%
Interior LED Value	2.5	3.0	4.5	61
Bi Level Garage/Parking Lot/Pedestrian Lighting Value	0.9	4.0	5.0	53

Controls Sample Usage Data

Thursday, January 27

Daily Fixture Amperage

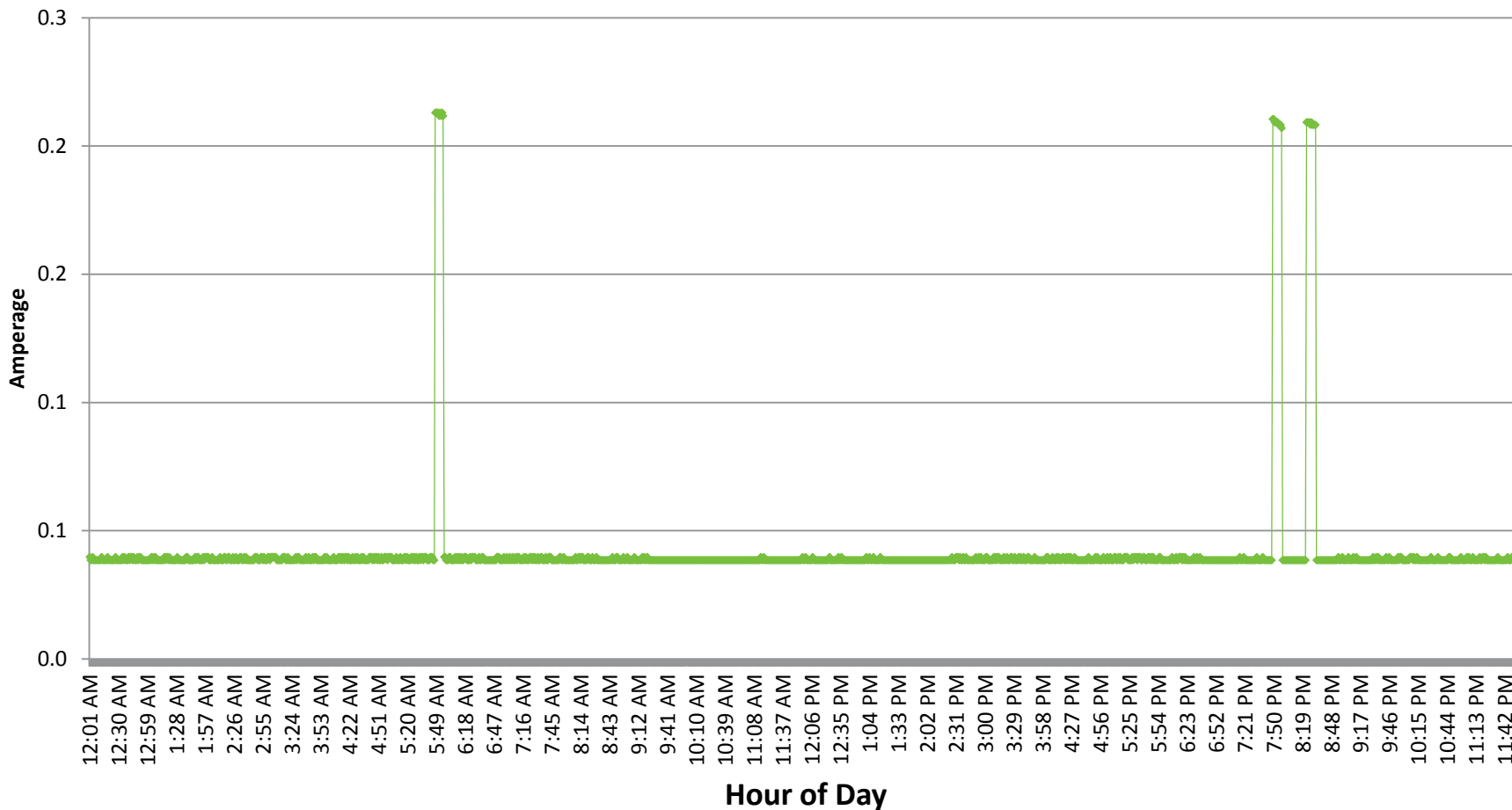


Preliminary Data – Department of Labor

Controls Sample Usage Data

Saturday, January 29

Daily Fixture Amperage



Preliminary Data – Department of Labor

Results

- Operating profile
 - Operating in high state \approx 30% of time
 - Operating in low state \approx 70% of time
- Time out of sensor affects savings
- One way traffic affects usage



*LED on left/HPS on right
Department of Labor Headquarters,
Washington, D.C.*

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*



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

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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.



Bentley Medical, San Francisco, CA

Energy Conservation

1. 0.18 W/sf

Background

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

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



*Hotel, Cupertino, CA
Source: PNNL*

www.irs.gov/irb/2008-14_IRB/ar12.html#d0e4216/

Specification Overview Lighting Requirements

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

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



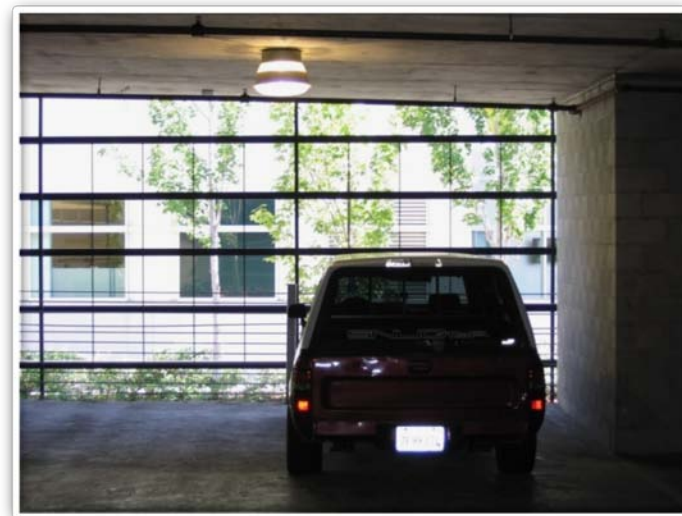
LED



Induction

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

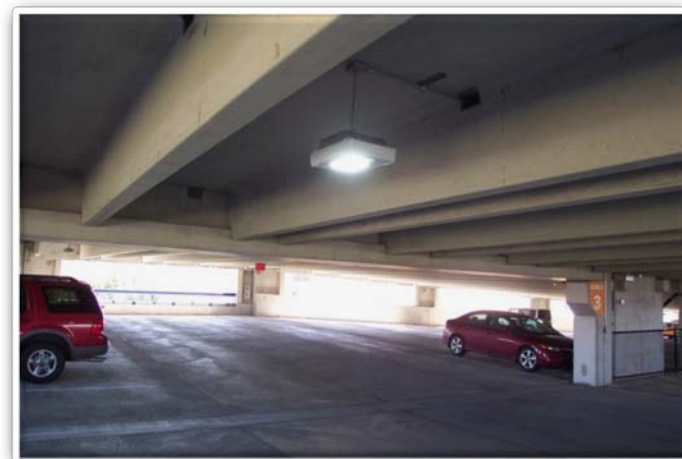


*Electric lighting & daylight
Hotel, Cupertino, CA*

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



*Universities at Shady Grove,
Rockville, MD*

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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



Natick Collection

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

- \approx 41,400 sf

Federal money from tax deduction

- Final amount per tax bracket

Tax Bracket	0.18 W/sf
10%	\$2,484.00
15%	\$3,726.00
25%	\$6,210.00
28%	\$6,955.20
33%	\$8,197.20
35%	\$8,694.00

Contains:

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

Commercial Lighting Tax Deduction

Tax Deduction | FAQs | Projects | Standard 90.1 | Technologies | Lighting Quality | Directory | Resources

Guide to the Energy Efficient Commercial Buildings Deduction

- [Introduction](#)
- [The Energy Efficient Commercial Buildings Tax Deduction](#)
- [Commercial Buildings Tax Deduction \(All Systems\)](#)
- [Commercial Buildings Tax Deduction \(Partial Systems\)](#)
- [Commercial Buildings Tax Deduction \("Interim Lighting Rule"\)](#)
- [Building Types Covered](#)
- [Who Gets the CBTD](#)
- [Project Certification \(All or Partial Systems\)](#)
- [Project Certification \(Interim Lighting Rule\)](#)

Appendices

- [EPA Act 2005 \(Public Law 105-58\) \(1.49 mb\)](#)
- [Section 1331: Energy Efficient Commercial Buildings Tax Deduction \(56 kb\)](#)
- [Internal Revenue Bulletin 2009-26, June 26, 2009](#)
- [NEMA comments on IRB](#)
- [Guidance on Energy Policy Act Commercial Building's Tax Deduction Certification Letters \(84 kb\) \(56 kb\)](#)

[EfficientBuildings.org](#)

Introduction

According to the U.S. Department of Energy, lighting represents 40% of the average commercial building's electric bill, followed by motors/HVAC (40%) and other equipment (20%).



For years, energy-efficient lighting solutions have been available that can reduce lighting energy costs while maintaining or potentially improving lighting quality. According to the Energy Cost Savings Council, energy-efficient lighting projects generate an average 45% return on investment, paying for themselves in just 2.2 years. Due to energy codes and its economic advantages, energy-efficient lighting is now a common feature in new construction; lighting is generally considered the easiest, most profitable investment in energy-saving building systems.

According to the Department of Energy, however, only 20% of existing commercial buildings feature some degree of upgraded lighting technology, while 80% continue to operate lighting systems installed before 1986. The

www.lightingtaxdeduction.org



GE
Lighting

NO ENDORSEMENT

Environmental Information Center

Regulations & Resources

Ads, Articles & Conferences

Products

Tools & Calculators

ecomaginationSM

[Contact Us](#) | [GE Lighting](#) | [GE Electrical](#)

Home

Tools & Calculators

EPAct Tax Deduction
Eligibility Estimator

Legislation Product
Replacement Tool

EPAct TAX DEDUCTION ELIGIBILITY ESTIMATOR

To calculate your estimated tax deduction, fill out the following:

[Print This Page](#)

Single System

Multiple Systems

* = Required information

ESTIMATE TAX DEDUCTION

* Building Type

Parking Garage

* Building Size

Square Footage sq. ft.

Length ft. x Width ft.

* Number of Fixtures

Determine Based on Building Size

Enter Number of Fixtures:

Proposed System Description

* Fixture Wattage of Proposed System

watts/fixture [I don't know my wattage](#)

* Is a [bi-level switch](#) installed?

Yes No Exempt
(Hotel and motel guest rooms, store rooms, restrooms and public lobbies are exempt.)

* Do the [light levels satisfy IESNA guidelines](#)?

Yes No

TO QUALIFY FOR A TAX DEDUCTION:
(Values are based on your building type and size.)

- ASHRAE/IESNA 90.1 (2001) Building Limit: 0.30 watts / sq. ft.
- To be 25% below ASHRAE/IESNA 90.1, building lighting power density must be less than: 0.22 watts / sq. ft.
- Fixture wattage must be less than:

For the maximum tax deduction (\$0.60 / sq. ft.)

- Fixture wattage must be less than:

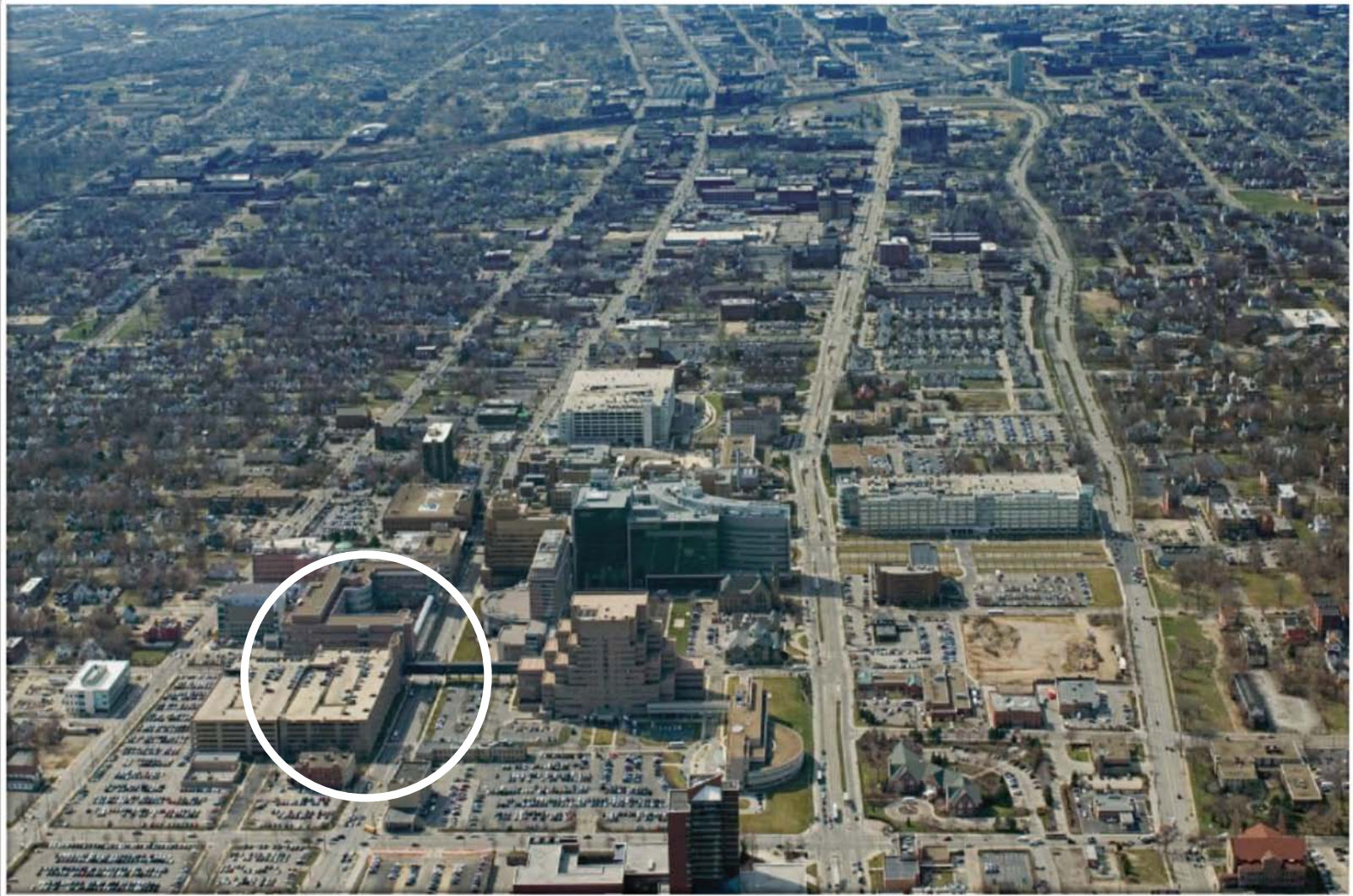
[Calculate My Tax Savings](#)

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



Source: *Cleveland Clinic*

Highlights:

- Hospital
- $\approx 1,000,000$ 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

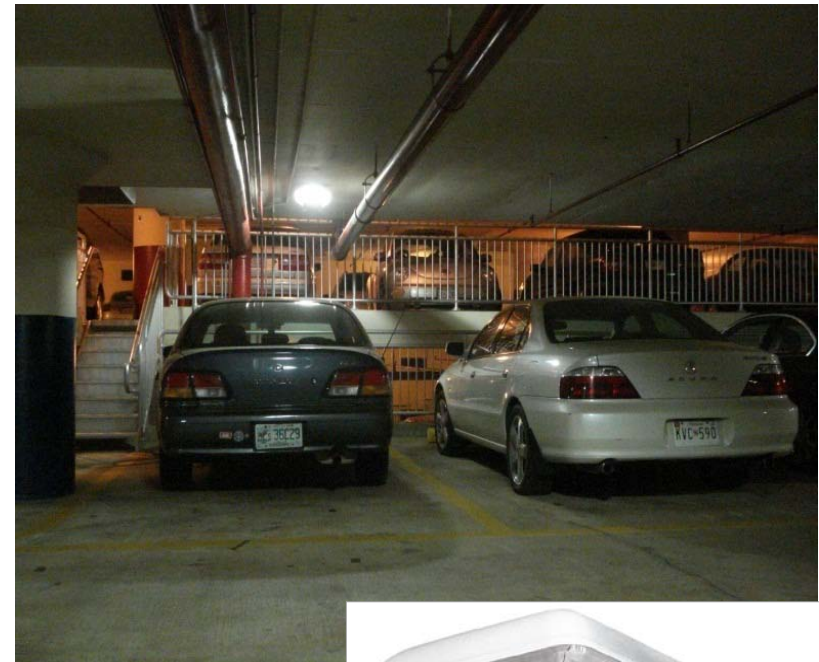
Highlights:

- 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.
- www.wmata.com/business/procurement_and_contracting/solicitations/uploads/RFP-Web.pdf



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



Source: PNNL

LED lighting installed in the parking garage of the Frances Perkins Building, U.S. Department of Labor Headquarters, Washington, D.C.



Close-up of Philips Wide-Lite VizorLED

Michael Myer

Pacific Northwest National Laboratory

michael.myer@pnnl.gov

Jeff McCullough

Pacific Northwest National Laboratory

jeff.mccullough@pnnl.gov

- 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
 - www.buildings.energy.gov/ssl/consortium.html
- U.S. Department of Energy Solid-State Lighting
 - www.ssl.energy.gov

- DesignLights™ Consortium
 - www.designlights.org/
- Illuminating Engineering Society (IES)
 - www.iesna.org
 - TM-21:
 - www.ies.org/store/product/projecting-long-term-lumen-maintenance-of-led-light-sources-1253.cfm
- Philips L Prize Tool
 - www.usa.lighting.philips.com/lightcommunity/trends/l-prize

- GE EAct 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
 - www.irs.gov/irb/2008-14_IRB/ar12.html#d0e4216
- Washington Metropolitan Area Transit Authority (WMATA)
 - www.wmata.com/business/procurement_and_contracting/solicitations/uploads/RFP-Web.pdf