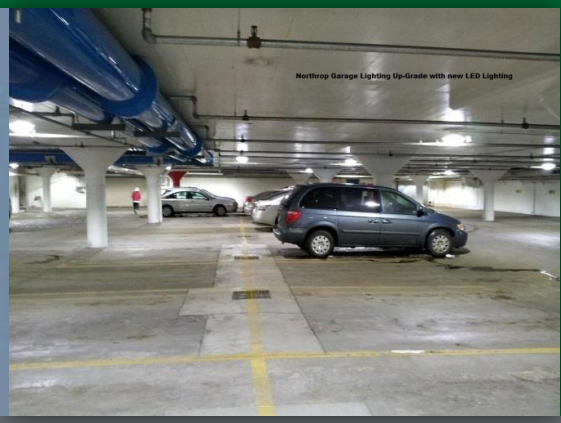
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

LED Solutions for the Dark Hours

What you need to know for success with LEDs for outdoor use



The Grainger Show

February 16-18, 2015
Orlando, FL

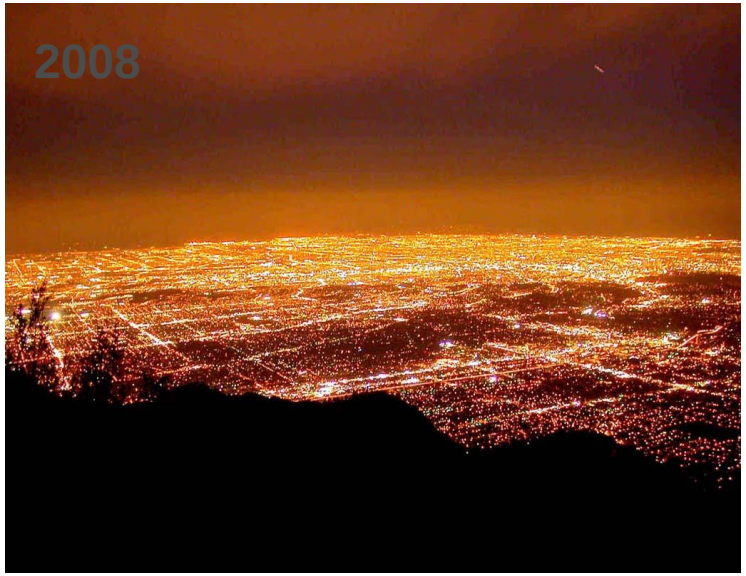
Jeff McCullough

Pacific Northwest National Laboratory

Outline

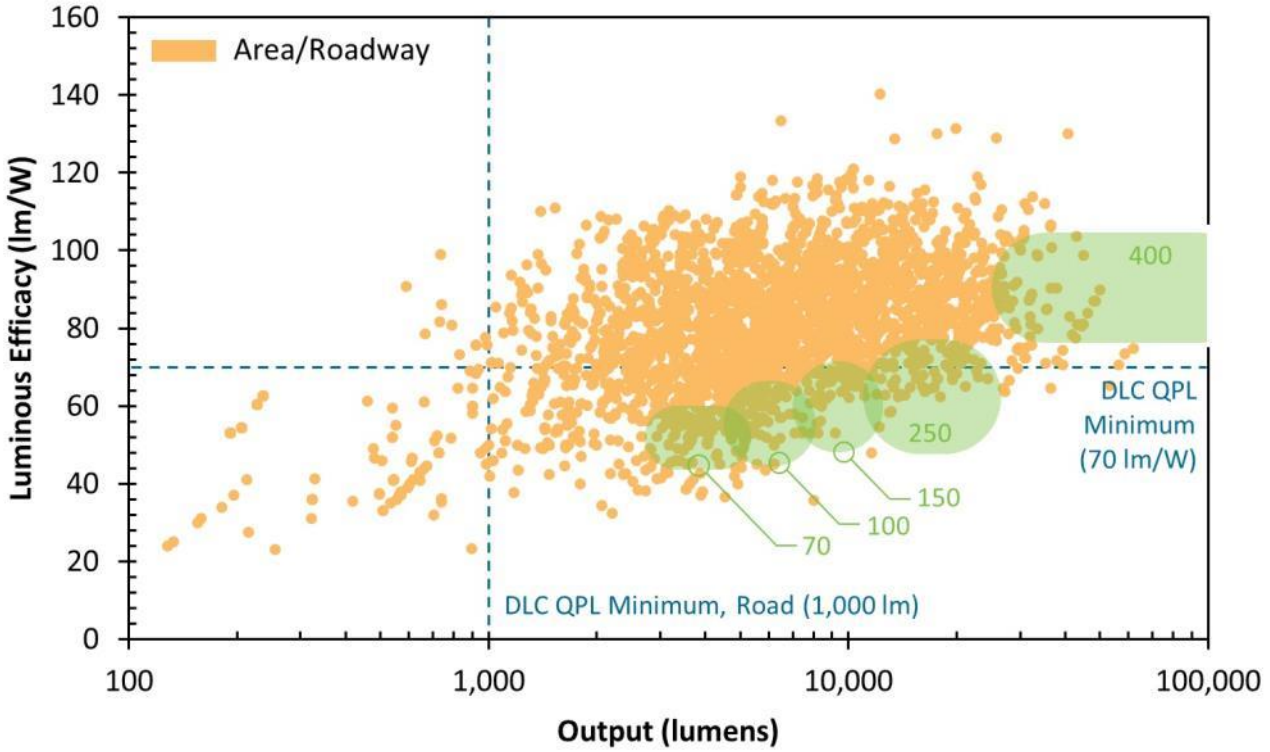
- LED lighting is showing up in
  - street lighting
  - parking lots and garages
  - gas stations
  - other outdoor areas
- what you need to know for success with LEDs for outdoor use
  - How does LED compare to traditional sources?
  - How much energy is LED saving in installations to date?
  - Doing more with less: lighting uniformity and distribution
  - What problems have been experienced in installations to date?
  - What about maintenance savings?
  - What about controls?
  - What about costs?

Then… and Now!



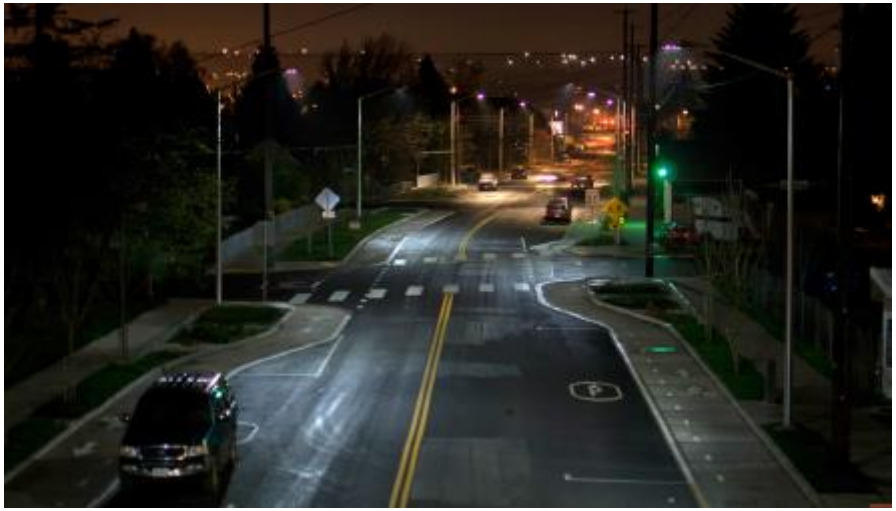
- City of Los Angeles LED Street Lighting Program
- 115,000 street lights installed to date
- $5.4M in annual energy savings
- Lessons along the way related to procurement, commissioning, monitoring, control — more to come

LED Outdoor: Area/Parking/Roadway



- Many options with better efficacy and comparable output to most parking or area lighting (<400w)
- Still struggling to meet output of larger (>400w) applications
- Note many products with efficacies below current technologies

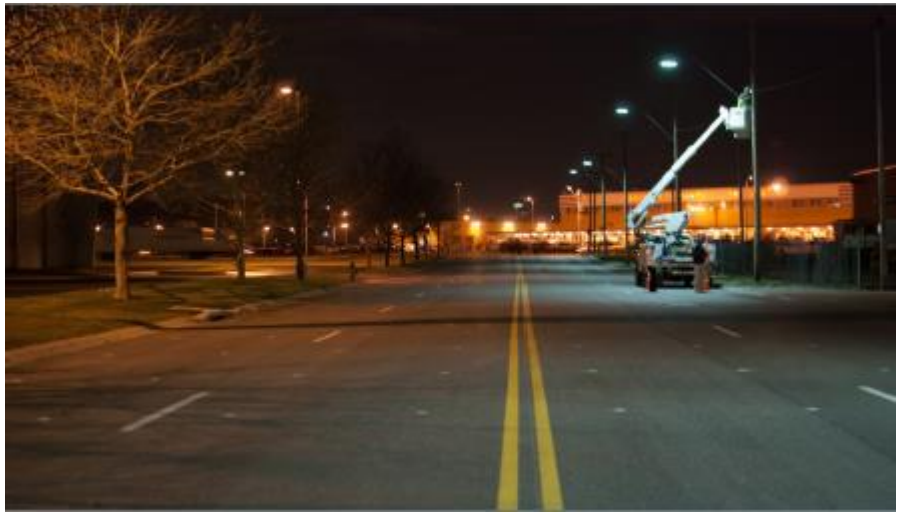
LEDs for Street and Roadway Lighting



Portland, OR

Philadelphia, PA

New York, NY



Kansas City, MO

Three Municipal Streetlight Programs

	Boston	Las Vegas	Seattle
Number of LED Replacements to Date (4/2014)	34,000	44,000	42,800
Total Inventory of Streetlights	64,000	54,000	85,000
Most Recent Date of Install	Ongoing	Ongoing (some intersections and decorative remain)	Ongoing (arterial streets; residential completed)
Incumbents Replaced	MV/HPS Cobra heads, post tops. shoebox	HPS Cobra heads	HPS Cobra heads
Average Energy Savings	69.5% across all applications (>85% in shoebox)	56%	49-67% (all recent installs at upper end of range)

Source: DOE Webinar, April 14, 2014

LED Streetlighting Failure/Defect Rates - Boston

Installs	Dates	Number Returned to Mfr	Failure/Defect Percentage
Phase I – 3000 Residential Units	November 2010 to March 2011	97 Units	3.2%
Phase 2 – 20,000 Lights, Residential, Commercial and Collector	April 2011 to November 2012	156 Units	0.8%
Phase 3 – 3000 MV Post tops	November 2012 to April 2013	88 Units	2.9%
Phase 4 – 10,000 Shoebox (6000 so far)	April 2013 to the present	30 Units (so far)	0.5%
Overall (34,000 to date)		**371 Units**	**1.1%**

Source: DOE Webinar, April 14, 2014

LED Streetlighting Failure/Defects/Abuse

- Overall rates for Las Vegas – 0.5%, Seattle – 0.8%
- Causes include
  - Power supply
  - Broken/disconnected/pinched wiring
  - Broken hinges or other structural component
  - Bullet wound (2)

- Once installed and operating, callbacks for faulty operation are very low; most are “out of the box” type failures.
- Occasional infrastructure issues, need for other upgrades become evident.
  - Older conductors may cause issues.
  - Photocontrols should be upgraded to high quality, long-life to match the LEDs.
  - Electronics are more sensitive to poor power quality than iron transformers.

Source: DOE Webinar, April 14, 2014

LED Streetlighting O&M Impacts

- In all cases, outages and complaint rates dropped significantly:
  - Las Vegas – 80% reduction
  - Seattle – at one point 5000 trouble tickets in queue caused up to 4 month delay in response time; current outages average less than 200.
  - Boston – annually responded to >9000 complaints (of all types) prior to conversion; in FY14 expect this to drop to ~6500 and continue improving as the transition continues
- Some previous "problem areas" eliminated? E.g., bridge vibration in Seattle causing rapid failure of HPS lamps.
- Reduced requirement to spend time relamping is allowing crews to catch up on deferred maintenance and provide better service elsewhere; in most cases reduced work load is being absorbed by attrition and retraining.
- Reduced inventory and associated storage area requirements – 30% reductions reported by both Las Vegas and Boston.

Source: DOE Webinar, April 14, 2014

I-35 Bridge Long Term Measurements

- LED lights installed on new bridge Sep 2008
- Two luminaires tested before installation and after 20,300 hours of operation

I-35 Bridge Illuminance Measurements over Time

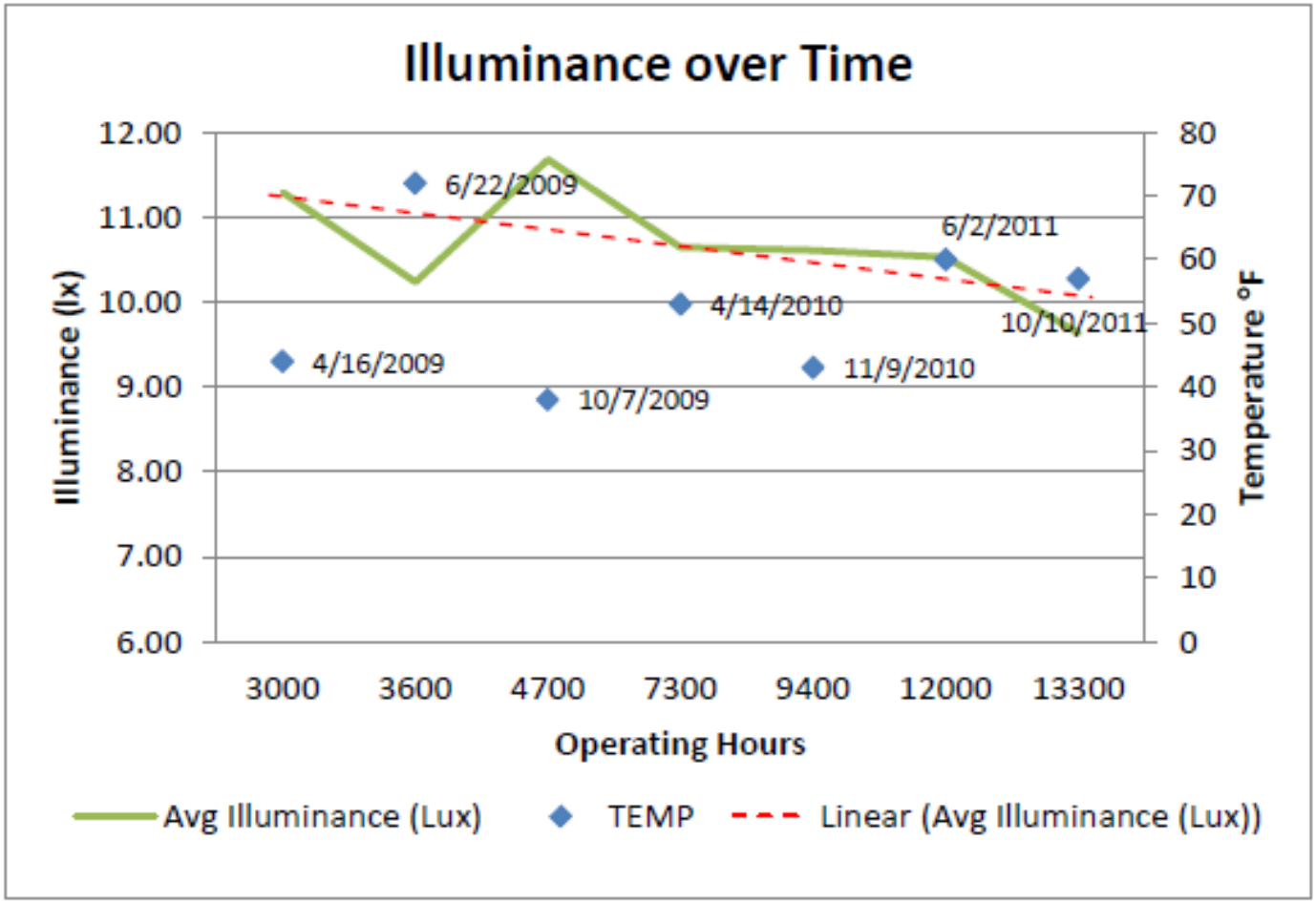
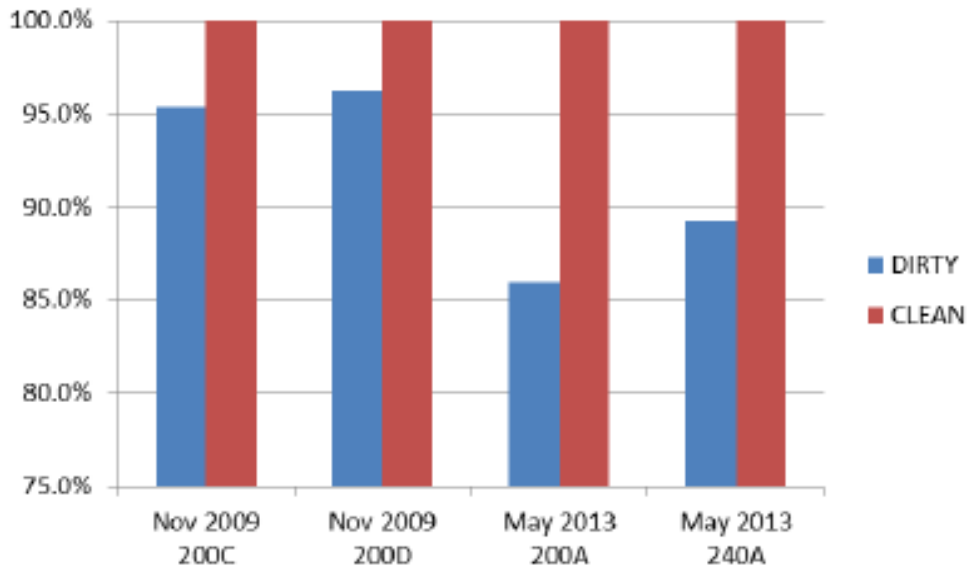
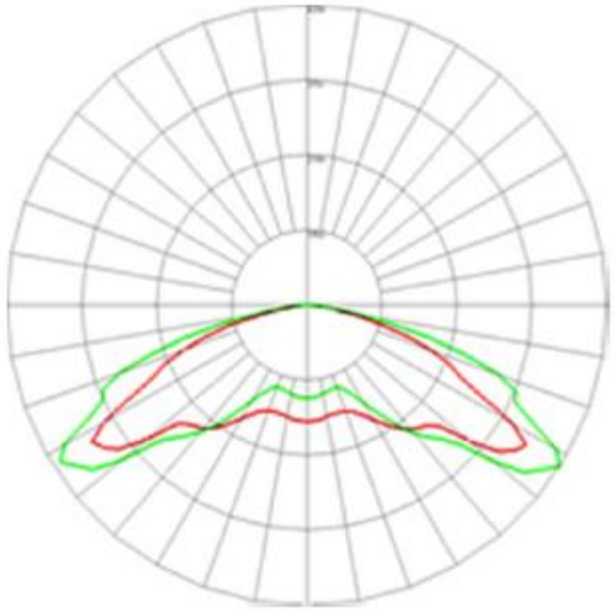


Figure ES.1. Average illuminance readings from the MMS, southbound lanes, shown with the lowest ambient temperature reported for those same dates.

I-35 Bridge Installation – Dirt Depreciation



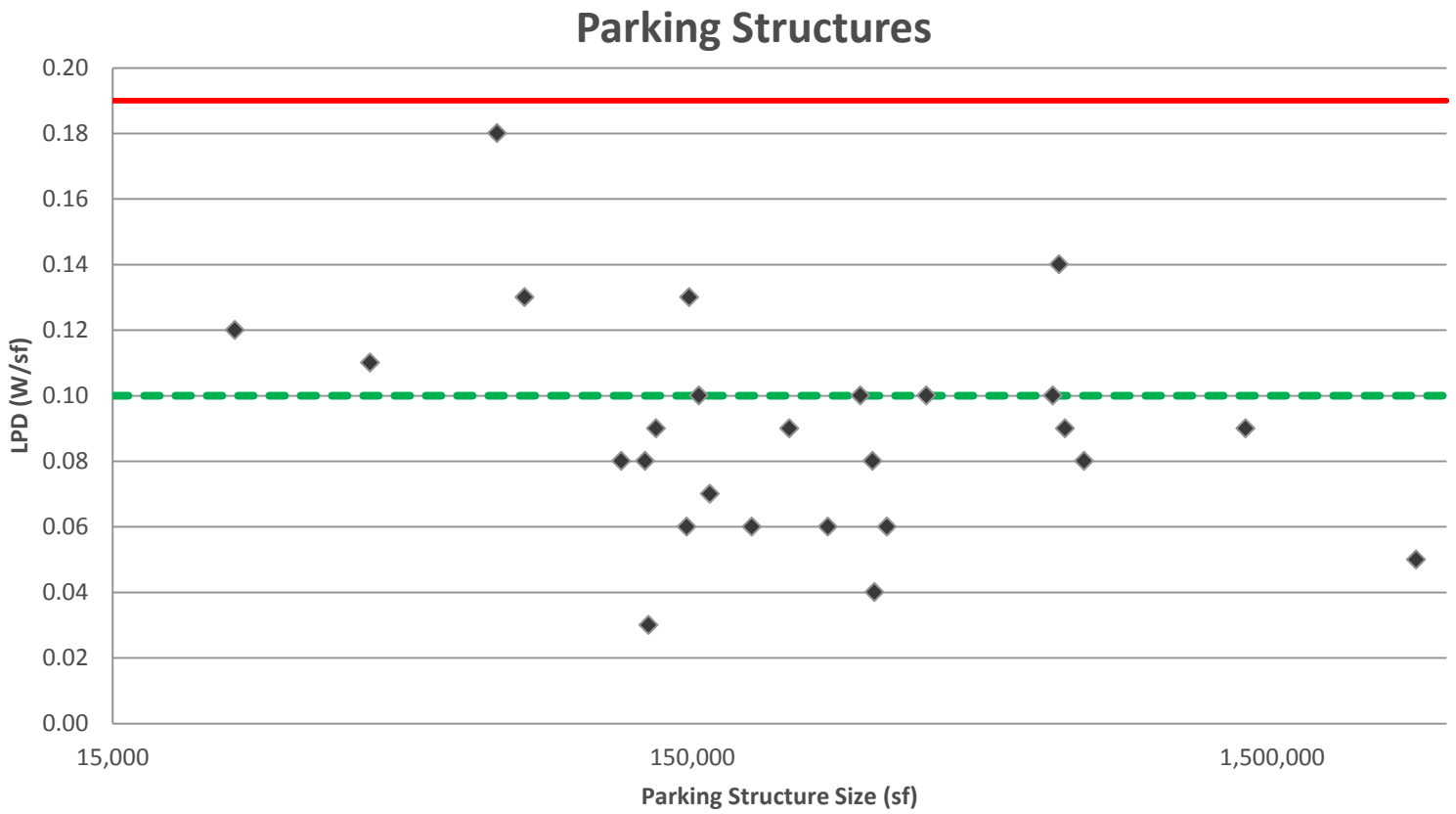
Measured dirt depreciation of four luminaires. Estimated operating time was 5000 hours for those tested Nov 2009 and 20,300 hours for those tested May 2013.



Distribution effects of dirt for one luminaire. Red line shows dirty luminaire; green shows the same luminaire clean.

LEDs for Parking Lots and Structures

Case Studies from the LEEP Campaign



- Gray values are LEEP data points
- Red line (0.19 W/sf) is current code
- 0.18 W/sf value is an outlier to the other LEEP parking garage installations
- Green dashed line is for reference: most of the installations have been at or below .10 W/sf

LEEP Campaign Year 1 Awards Results – Retrofit Sites

#	Site	Site Type	Energy Saving Technology	Energy Savings		Payback
				%	kWh	
1	Cox Enterprises	Lot	Metal halide	50%	1.7 M	< 4 yrs
2	MC Realty Group	Structure	FL+controls	76%	2 M	≈ 2 yrs
3	Regency Centers	Lot	LED	88%	0.123 M	≈ 2 yrs
3	Marine Base Quantico	Lot	LED	85%	0.006 M	≈ 25 yrs
3	Walmart Stores, Inc	Lot	LED	82%	0.3 M	≈ 2 yrs
4	MGM Resorts Intl	Structure	LED	80%	4 M	≈ 2 yrs
4	Thedacare	Structure	LED	86%	0.15 M	N.R.
4	Univ. of Minnesota	Structure	LED + controls	90%	0.076 M	N.R.

Source: DOE LEEP Campaign

- N.R. = Not reported

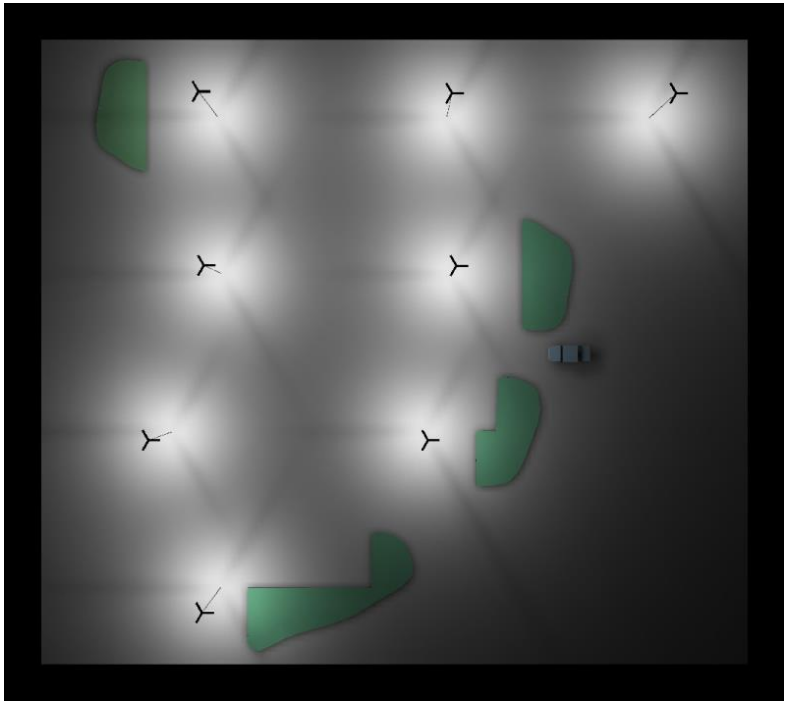
LEEP Campaign Year 1 Awards Results – New Construction

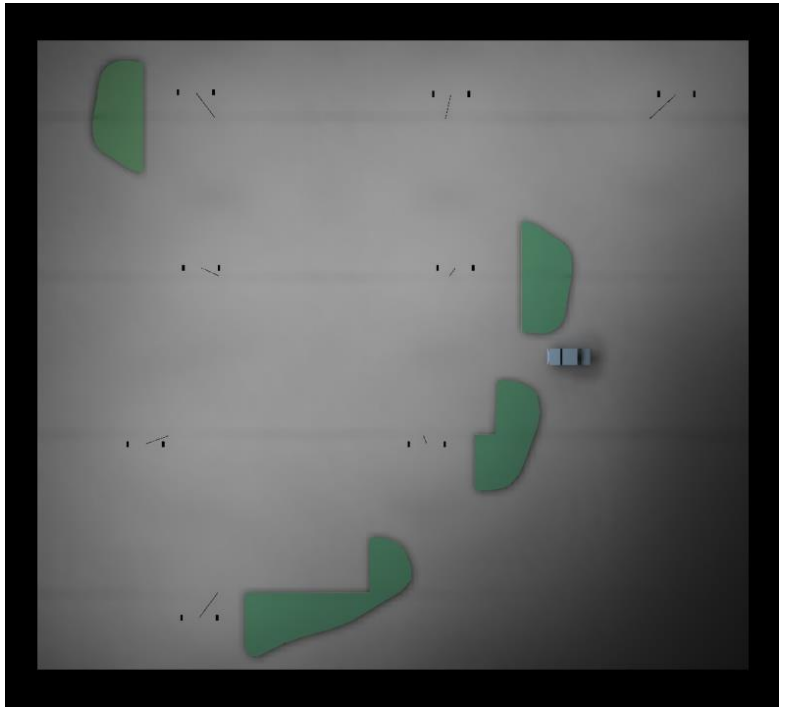
	Site	Site Type	Energy Saving Technology	Energy Savings		Payback
				%	KhW	
5	Walmart Stores, Inc	Lot	LED	81%	0.386 M	≈ 2 yrs
6	JBG Companies	Structure	LED+controls	84%	0.5 M	N.R.
7	Walmart Stores, Inc	Lot	LED	84%	0.184 M	≈ 2 yrs
8	JBG Companies	Structure	LED+controls	84%	0.5 M	N.R.

Source: DOE LEEP Campaign

- N.R. = Not reported

Uniformity vs Less Light





Questions to Ask for Parking Area Projects

- How much lighting and what type of lighting is needed?
  - What quality of lighting is desired?
  - More lighting ≠ better lighting
  - New practices and technology allow for different lighting choices and increased flexibility
- Will the site consider using lighting controls?
  - Occupancy
  - Daylight
  - Or Timed / scheduled
  - Reduce low lighting setting of controls if possible
- What financial incentives exist?
  - Monetize electrician labor - $250 to replace a parking lot fixture is a national average
  - What about local utility or efficiency incentives?
- Who is making lighting recommendations?
  - Consider a lighting designer or an engineer
  - LEEP Campaign has 3rd party lighting designers for technical support

Source: DOE LEEP Campaign

What's Next: Networked Outdoor Lighting Controls

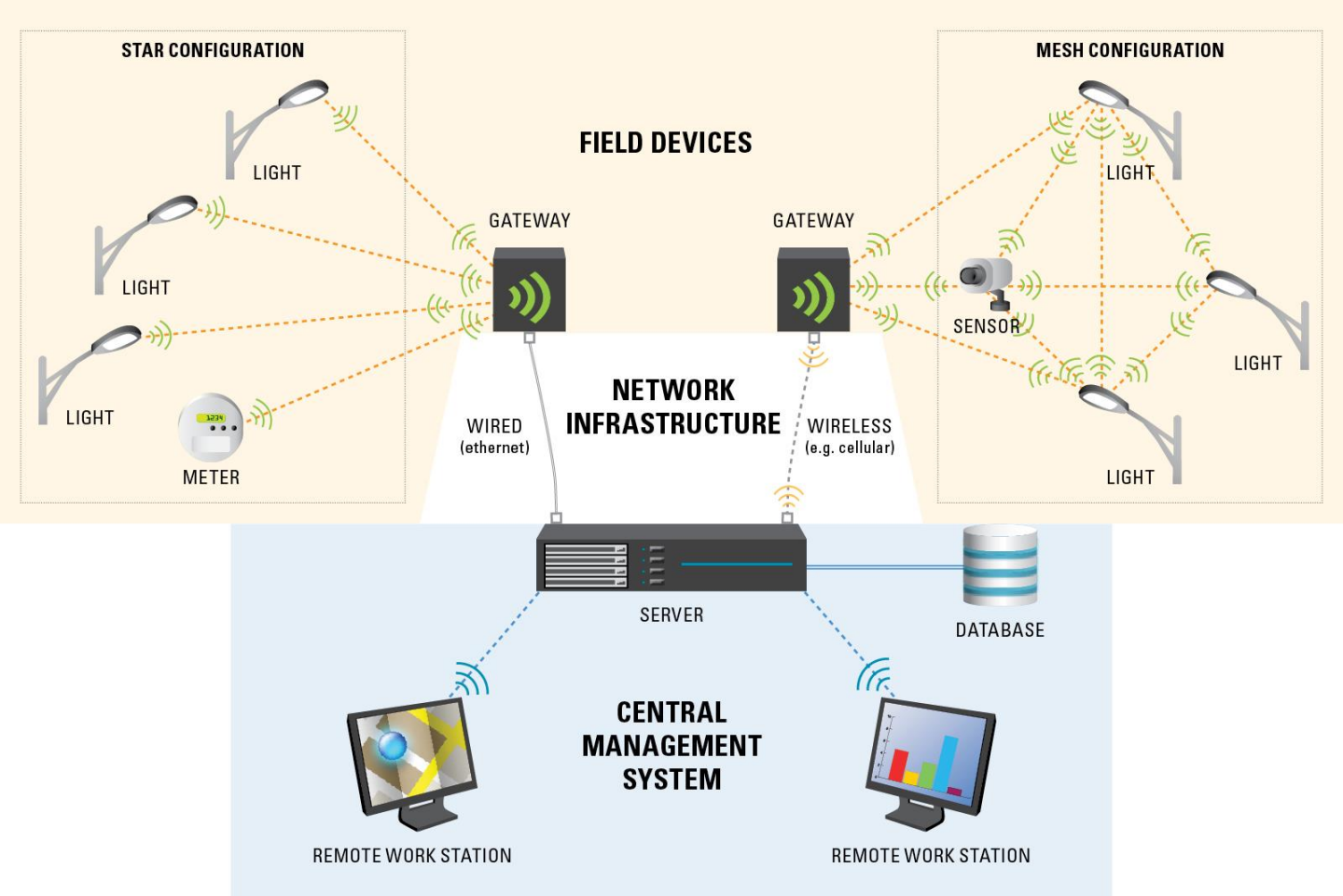


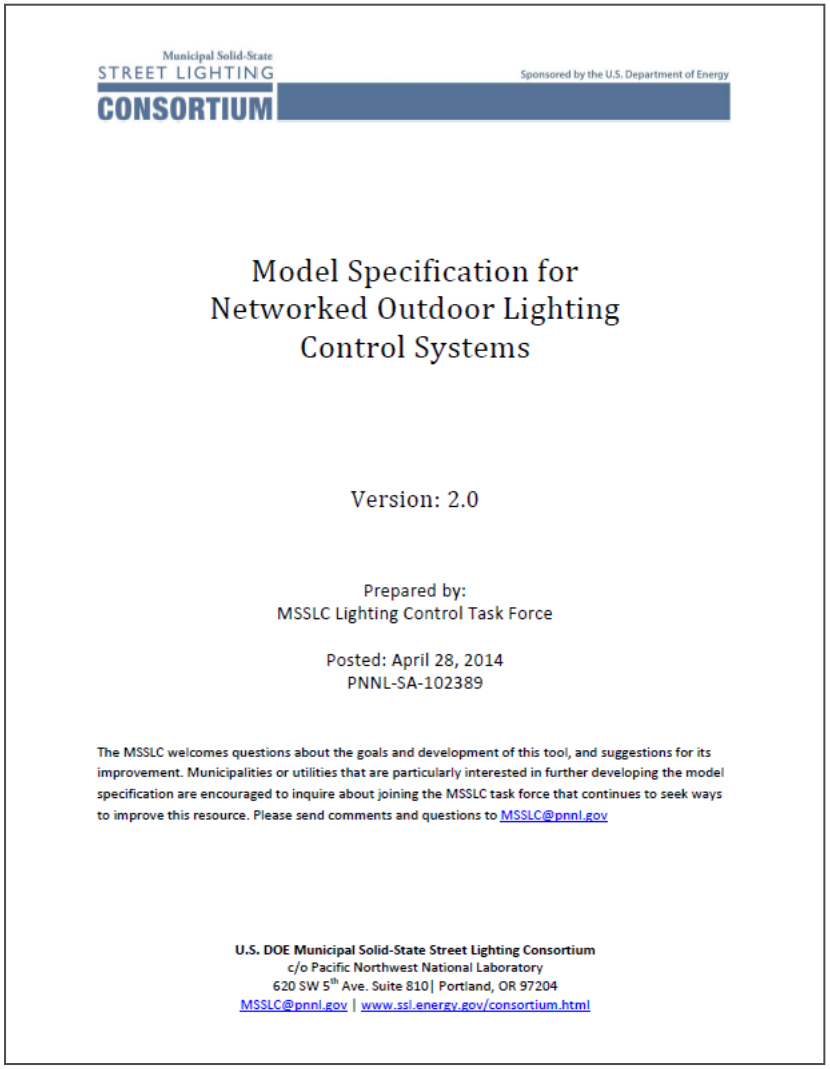
Image source: CTLC for MSSLC

What's Coming? New Form Factors

Source: Fred Maxik, Lighting Science

Resource from the Municipal Consortium

- Helps cities, utilities, and other local agencies accelerate their adoption of networked outdoor lighting systems
- Further reduce the energy and maintenance costs of operating streetlights



Municipal Solid-State STREET LIGHTING CONSORTIUM

Sponsored by the U.S. Department of Energy

Model Specification for Networked Outdoor Lighting Control Systems

Version: 2.0

Prepared by:
MSSLC Lighting Control Task Force

Posted: April 28, 2014
PNNL-SA-102389

The MSSLC welcomes questions about the goals and development of this tool, and suggestions for its improvement. Municipalities or utilities that are particularly interested in further developing the model specification are encouraged to inquire about joining the MSSLC task force that continues to seek ways to improve this resource. Please send comments and questions to MSSLC@pnnl.gov

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Thank You

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PNNL

www.ssl.energy.gov