U.S. Department of Energy
Energy Efficiency and Renewable Energy

DOE and the SSL Learning Curve

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LED City Council Meeting
Austin, TX
January 26, 2010

DOE Solid-State Lighting Program

CALiPER

GATEWAY Demonstrations

lighting facts
A Program of the U.S. DOE

L-PRIZE℠

Retailer Energy Alliance

NGL2009

LIGHTING for tomorrow

Technical Information Network

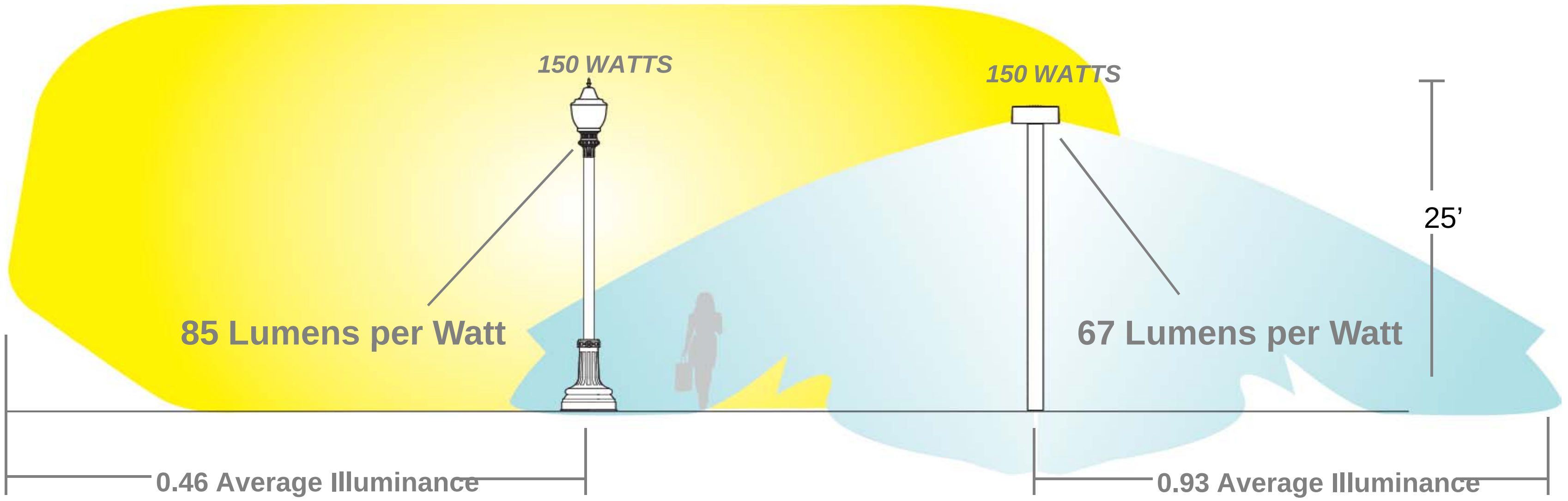
STANDARDS

ENERGY STAR®

- Draft Outdoor Criteria released for public comment in July 2009
- October 2009 webcast addressed comments and proposed revisions to the draft criteria
- DOE to complete criteria for transition to EPA
  - May incorporate a new NEMA metric intended to correlate with power density (in development)
- Luminaire (generic) vs. site-level (specific) evaluation of performance

Luminaire Efficacy - Not the Whole Story

Same source, same ballast, different performance



Source: J Howley, GE Lighting

- Although the luminaire on the left is 27% higher in fixture LPW, it produces less than half the average illumination on the ground
- Even "downward efficacy" doesn't ensure delivery to actual target

GATEWAY Demonstration Program

- Purpose: demonstrate new SSL products in real world, general illumination applications that:
  - Save energy
  - Match or improve illumination
  - Cost-effectiveness

Photo: Ryan Pyle

- More than 50 projects investigated to date

Many Lessons to be Learned

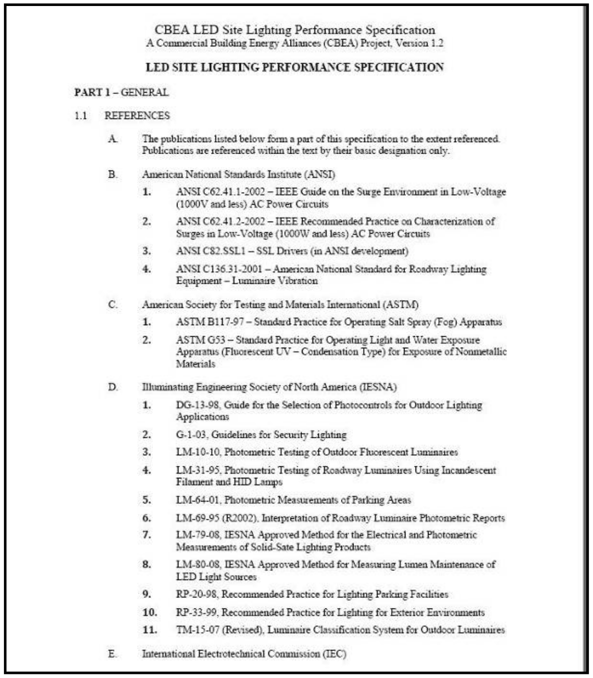
- LEDs continue to be an evolving, dynamic technology
- Everyone is on a learning curve
  - No 50k+ hour product has been on the market for even a single life cycle
  - Issues can be expected; some old, some new
  - Assumptions may change as experience develops
- In general, we recommend a measured approach to implementation

Solid-State Street Lighting Consortium

- Rapid rise in interest, due in part to Recovery Act funding for LED street lighting demonstrations
- Need to leverage efforts of multiple cities evaluating LED street lighting products
  - Minimize duplication of effort, spread risk
  - Collect/analyze/share information and experience
  - Contribute to and tap into large pool of knowledge to maximize individual investment
- Membership open to municipalities, utilities, energy efficiency organizations

Future Street Lighting Performance Specification

- To be developed with input from Consortium members
- Similar format to Parking Lot Lighting Specification* developed under REA
- Public document for use by any municipality
  - Either all or in part



CBEA LED Site Lighting Performance Specification
A Commercial Building Energy Alliances (CBEA) Project, Version 1.2

LED SITE LIGHTING PERFORMANCE SPECIFICATION

PART 1 – GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by their basic designation only.

B. American National Standards Institute (ANSI)

1. ANSI C62.41.1-2002 – IEEE Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits
2. ANSI C62.41.2-2002 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000W and less) AC Power Circuits
3. ANSI C82.SSL1 – SSL Drivers (in ANSI development)
4. ANSI C136.31-2001 – American National Standard for Roadway Lighting Equipment – Luminaire Vibration

C. American Society for Testing and Materials International (ASTM)

1. ASTM B117-97 – Standard Practice for Operating Salt Spray (Fog) Apparatus
2. ASTM G53 – Standard Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV – Condensation Type) for Exposure of Nonmetallic Materials

D. Illuminating Engineering Society of North America (IESNA)

1. DG-13-98, Guide for the Selection of Photocontrols for Outdoor Lighting Applications
2. G-1-03, Guidelines for Security Lighting
3. LM-10-10, Photometric Testing of Outdoor Fluorescent Luminaires
4. LM-31-95, Photometric Testing of Roadway Luminaires Using Incandescent Filament and HID Lamps
5. LM-64-01, Photometric Measurements of Parking Areas
6. LM-69-95 (R2002), Interpretation of Roadway Luminaire Photometric Reports
7. LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurements of Solid-Sate Lighting Products
8. LM-80-08, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources
9. RP-20-98, Recommended Practice for Lighting Parking Facilities
10. RP-33-99, Recommended Practice for Lighting for Exterior Environments
11. TM-15-07 (Revised), Luminaire Classification System for Outdoor Luminaires

E. International Electrotechnical Commission (IEC)

*Available at:
http://www1.eere.energy.gov/buildings/alliances/rea_subcommittees.html

LEDs and their Competition

- **High-pressure sodium**
  - Pros
    - Very inexpensive
    - Excellent efficacy (photopic)
    - Good optical control
    - Good rated lifetime
  - Cons
    - Poor color rendition
    - Little apparent potential for improvement

LEDs and their Competition

- **Induction**
  - Pros
    - Relatively inexpensive
    - Long rated life
    - Good color rendition
  - Cons
    - Poor optical control
    - Efficacy compromised by trapped light
    - Little apparent potential for improvement

Visual Uniformity Comparison

The following photos were taken on the same evening, on the same street (Willamette Bluff in Portland, OR), with the same camera settings.

All luminaires are new and mounted on identical new poles, spaced for optimal performance given the road contours.

High Pressure Sodium

max (lux)	24.1
min (lux)	2.6
avg (lux)	9.96
avg:min	3.83
Watts	115
PF	0.93
CCT	2097

~21.2 lm/W

in drivelanes

Induction

max (lux)	11.2
min (lux)	0.5
avg (lux)	3.02
avg:min	6.04
Watts	79
PF	0.98
CCT	2759

~9.4 lm/W

in drivelanes

LED

max (lux)	27
min (lux)	6.3
avg (lux)	11.56
avg:min	1.83
Watts	110
PF	0.99
CCT	6667

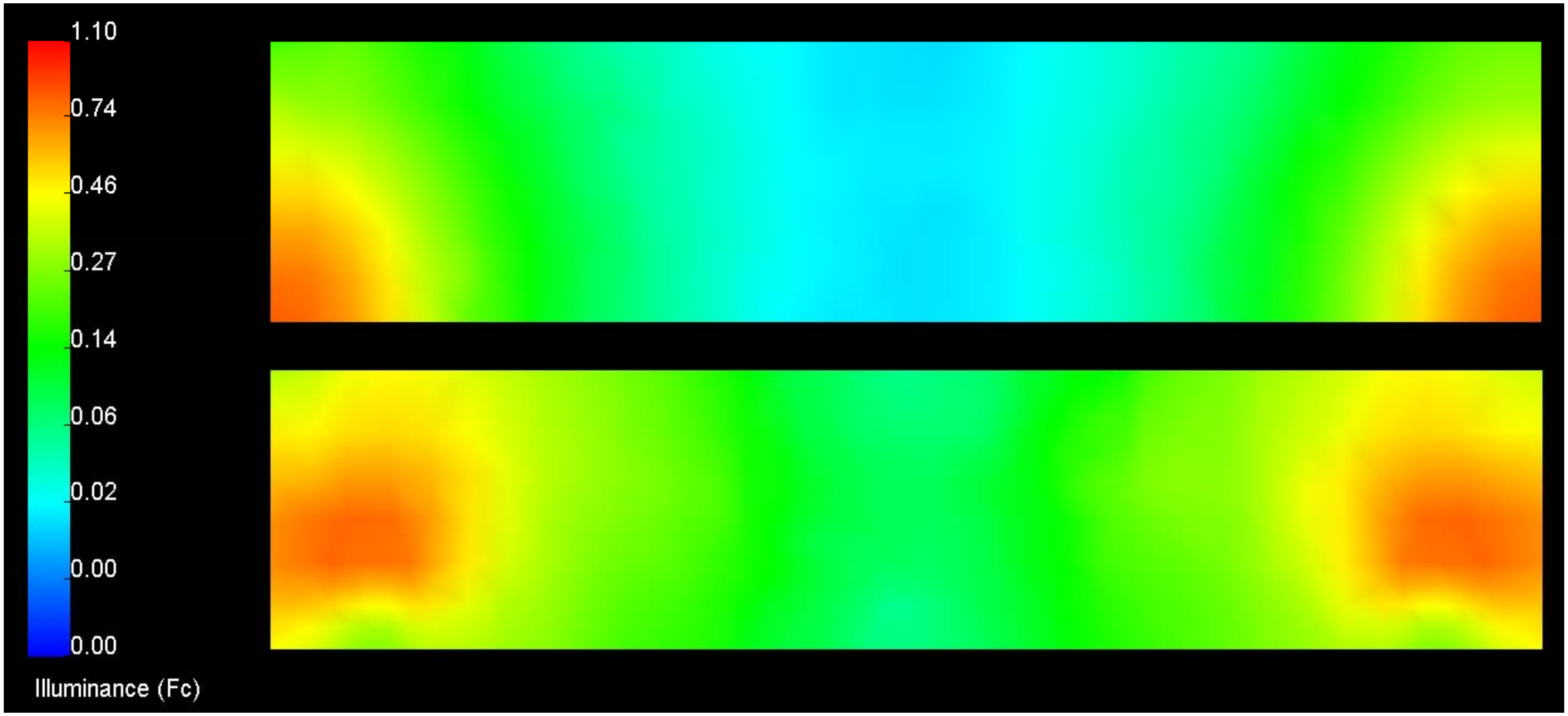
~25.8 lm/W

in drivelanes

Modeled Uniformity Comparison

Equal Wattage

Type III induction (above) vs. LED (below)*



*Not the same products installed on Willamette Bluff shown in the preceding photos.

LEDs and their Competition

- **Next-generation ceramic metal halide**
  - Pros
    - Excellent efficacy
    - Good optical control
    - Good rated lifetime
  - Cons
    - Lower apparent potential for improvement
    - Possible non-passive failure if not replaced *before* end of life (according to product literature)

65% smaller than HPS lamps—design flexibility for small, high-performance luminaires.

Main Summary Points

- LEDs offer a lot of potential to users, but are still relatively young and continuing to evolve
- Everyone is on a learning curve
- Various resources are available or under development that can help along the way
- Collaborative activities with peers is a relatively low cost, low risk approach for users to advance quickly up the curve

Final Thoughts

With a hypothetical $300K to spend…

Option A	Option B	Option C
3,000 Type A luminaires @ $100	500 Type A luminaires @ $200	50 Type A luminaires @ $200, 50 new poles at $1500
	500 Type B luminaires @ $200	50 Type B luminaires @ $200, 50 new poles at $1500
	500 Type C luminaires @ $200	50 Type C luminaires @ $200, 50 new poles at $1500
		Installation design @ $10,000, 2-year formal evaluation @ $35,000

Maximum quantity ↔ Maximum educational value

Final Thoughts

We recommend:

- Diversification of investment
- Investing with a focus on self-education rather than maximizing quantities, for now
- Continued due diligence, and objectivity

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