



The Parker Ranch installation in Hawaii

Solid-State Solutions for Municipal Lighting: What You'll Need to Know

April 19, 2011

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Midwest Energy Efficiency Alliance
DOE Technical Assistance Program
Team 4 – Program & Project Development &
Implementation

- Who we are and what we're doing
- SSL primer
- SSL benefits and pitfalls
- How to prepare a successful SSL project
- Upcoming meetings and events
- Resources
- Q&A



“The Midwest Energy Efficiency Alliance (MEEA) is a collaborative network advancing energy efficiency in the Midwest to support sustainable economic development and environmental preservation.”

- Role of the organization in the region/with members
 - Policy efforts to advance energy efficiency
 - Disseminate key info and create networking opportunities
 - Implement and administrate energy efficiency programs

DOE's Technical Assistance Program (TAP) supports the Energy Efficiency and Conservation Block Grant Program (EECBG), the State Energy Program (SEP) and the Better Buildings grantees by providing state, local, and tribal officials the tools and resources needed to implement successful and sustainable clean energy programs.



TAP offers:

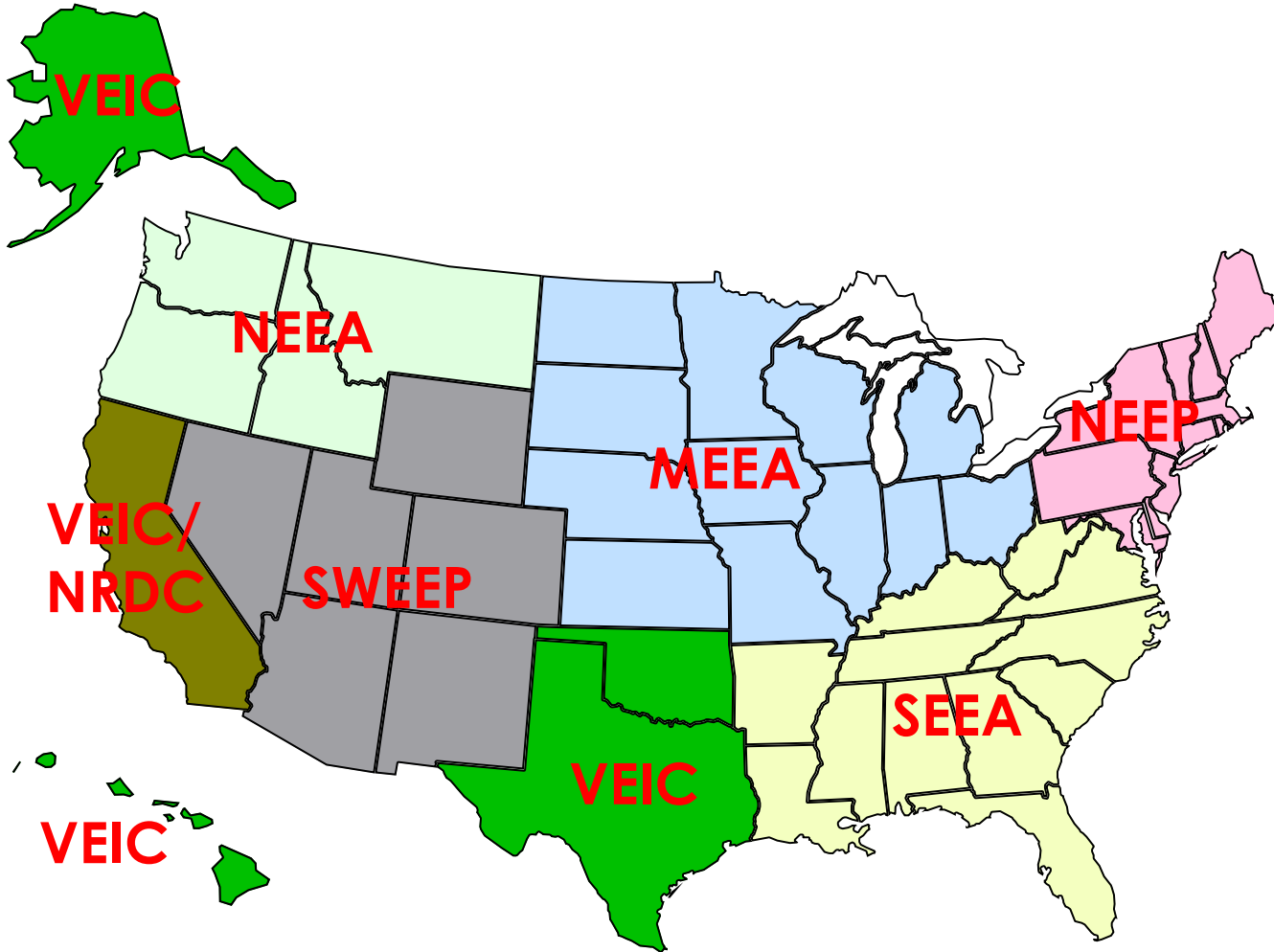
- One-on-one assistance
- Extensive online resource library, including:
 - Webinars
 - Events calendar
 - TAP Blog
 - Best practices and project resources
- Facilitation of peer exchange

On topics including:

- State and local capacity building
- Energy efficiency and renewable energy technologies
- Program design and implementation
- Financing
- Performance contracting

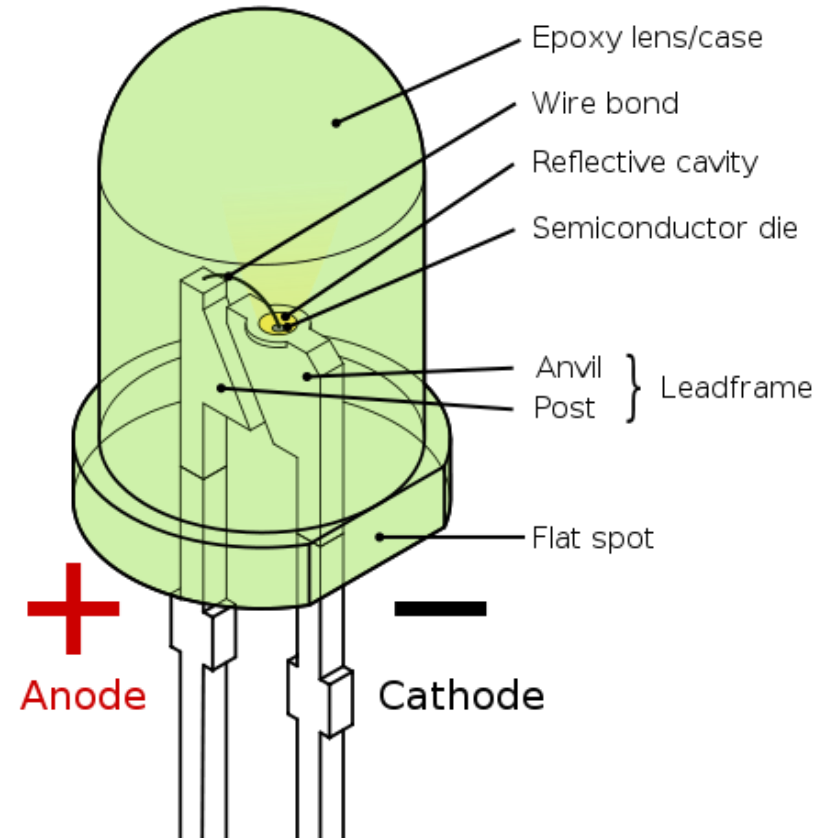
<p>State and Local Capacity Building</p>	<ul style="list-style-type: none"> • Trainings • Workshops • Peer-to-peer matching
<p>Technical</p>	<ul style="list-style-type: none"> • Renewable energy siting and development • Review of technical specs for RFPs • Strategic planning, energy management, and conservation strategies • Green building technologies • Building codes
<p>Program Design and Implementation</p>	<ul style="list-style-type: none"> • Policy and program development • Coordinating rate-payer funded dollars with ARRA projects and programs • Sustainable community and building design • State and regional energy efficiency and renewable energy assessments and planning • Energy efficiency and renewable energy portfolio program design elements
<p>Financial</p>	<p>Program design support and guidance on financing mechanisms such as:</p> <ul style="list-style-type: none"> • Revolving loan funds (RLFs) • Property-assessed clean energy (PACE) • Loan loss reserves and enhanced credit mechanisms
<p>Performance Contracting</p>	<ul style="list-style-type: none"> • Designing and implementing a performance contract • Leveraging private investment • Reducing institutional barriers • Tracking and comparing programs

Who We Are: Team 4



ACEEE, NRDC: National Support

- Most SSL based on light-emitting diodes (LEDs)
- Not a new technology
- LED brightness, color, and lifetime have been improving over the years
- Key benefit: energy savings
- In recent years, cost-effective general illumination with LEDs has become feasible
 - Energy savings of around 50% for municipal lighting possible; YMMV



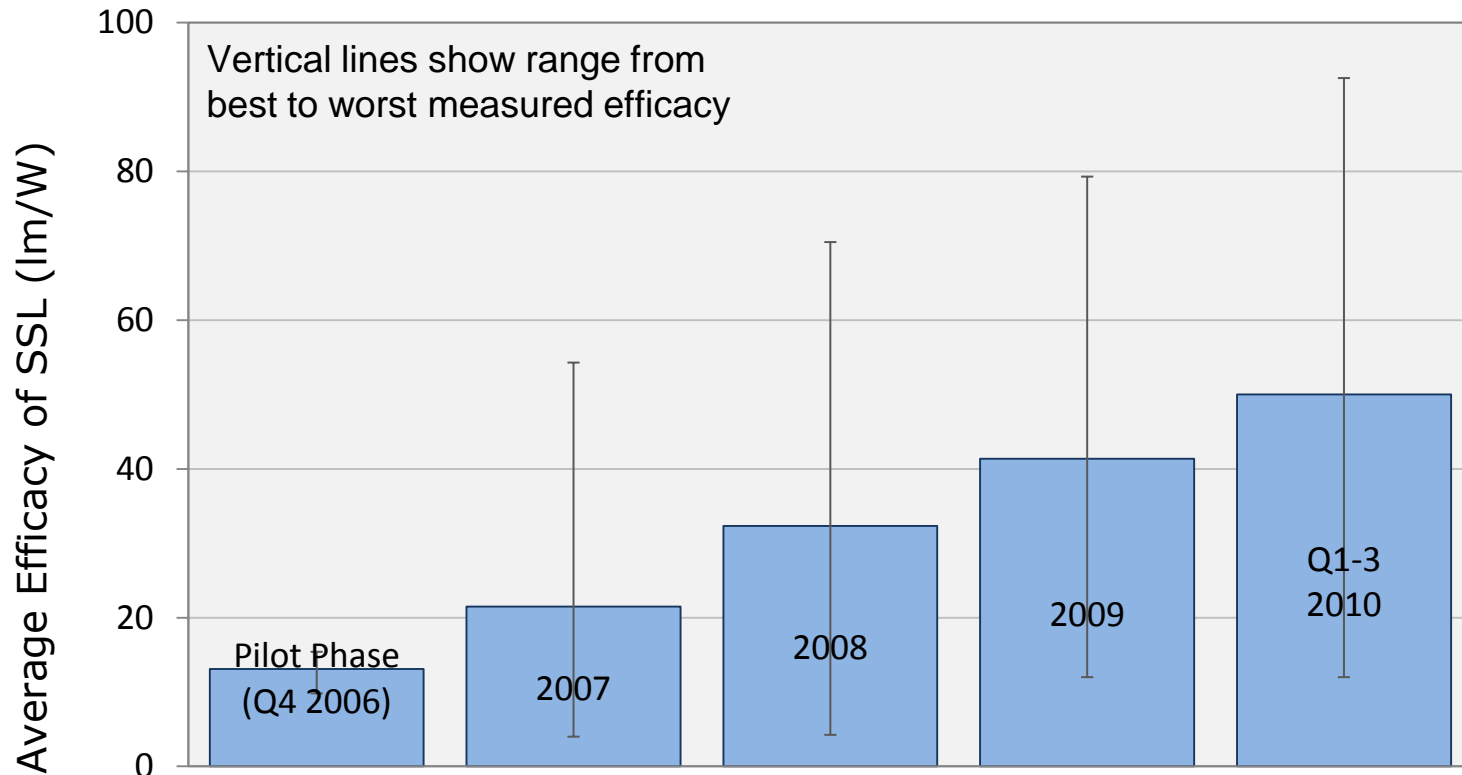
- SSL Technology Has Been Evolving Over Time...
 - Initially: Indicator lights
 - Then: niche lighting (effect lighting, holiday lights, traffic signals)
 - Now: general illumination
 - Tomorrow: Better general illumination, residential market, OLEDs



SSL Performance is improving day by day

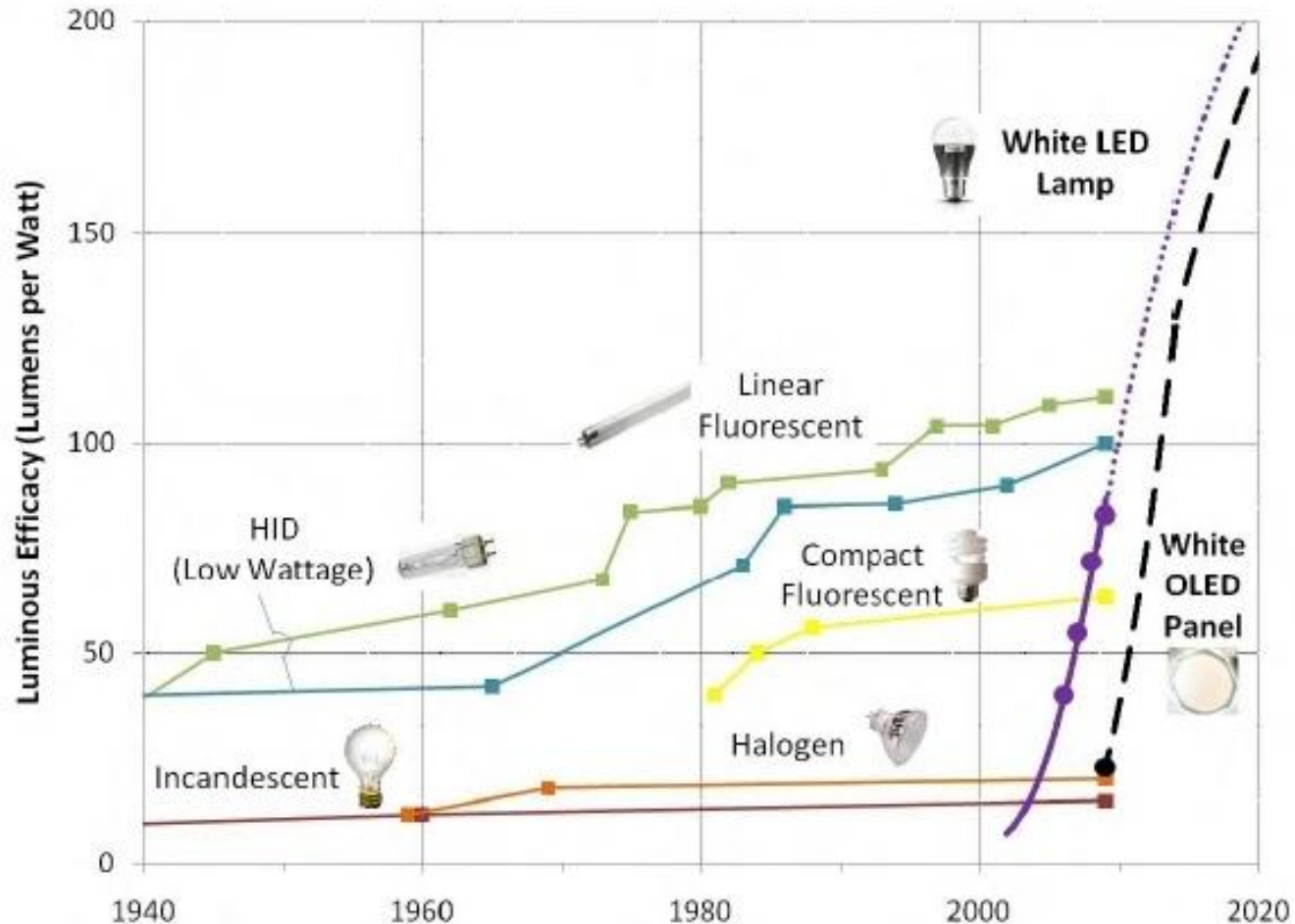
(Product cycle is around six months)

CALiPER Yearly Results



Source: CALiPER Summary Report, Round 11, 2010

SSL Performance is improving day by day



Source: Navigant Consulting, Inc – Updated Lumiled’s chart with data from product catalogues and press releases

- Other benefits
 - Uniformity
 - Controls integration
 - Color rendering and security
 - Night vision
 - Less light pollution
 - Very long life
 - Instant on/off, rapid restrike



FDR Expressway, NYC

Photo: Ryan Pyle



TJ Maxx Parking Lot, NH

Photo: BetaLED

- SSL still not ready for some applications and markets
- However, municipalities are in good position for adoption of SSL
- Why?
 - Tight budgets
 - ARRA funding available
 - Utility and State incentives
 - High maintenance costs
 - Aging infrastructure
 - Sustainability planning
 - Many municipal applications ripe for SSL (streets, parking)

So why aren't we all making the switch?

- Price Point
- Is it too early?
- What if product underperforms?
- What if our residents hate it?
- What if I get burned?

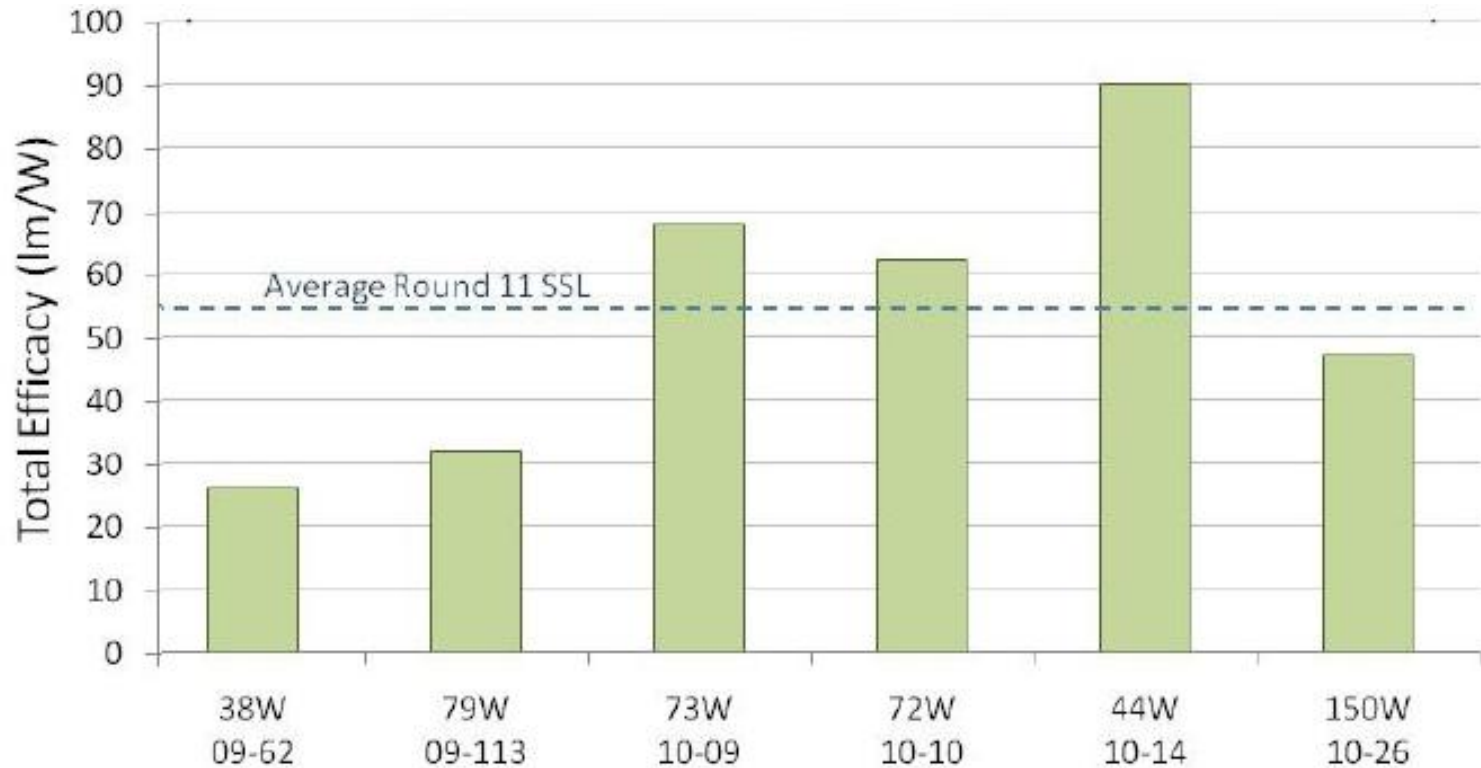


Still significant risk for municipalities who don't do their homework



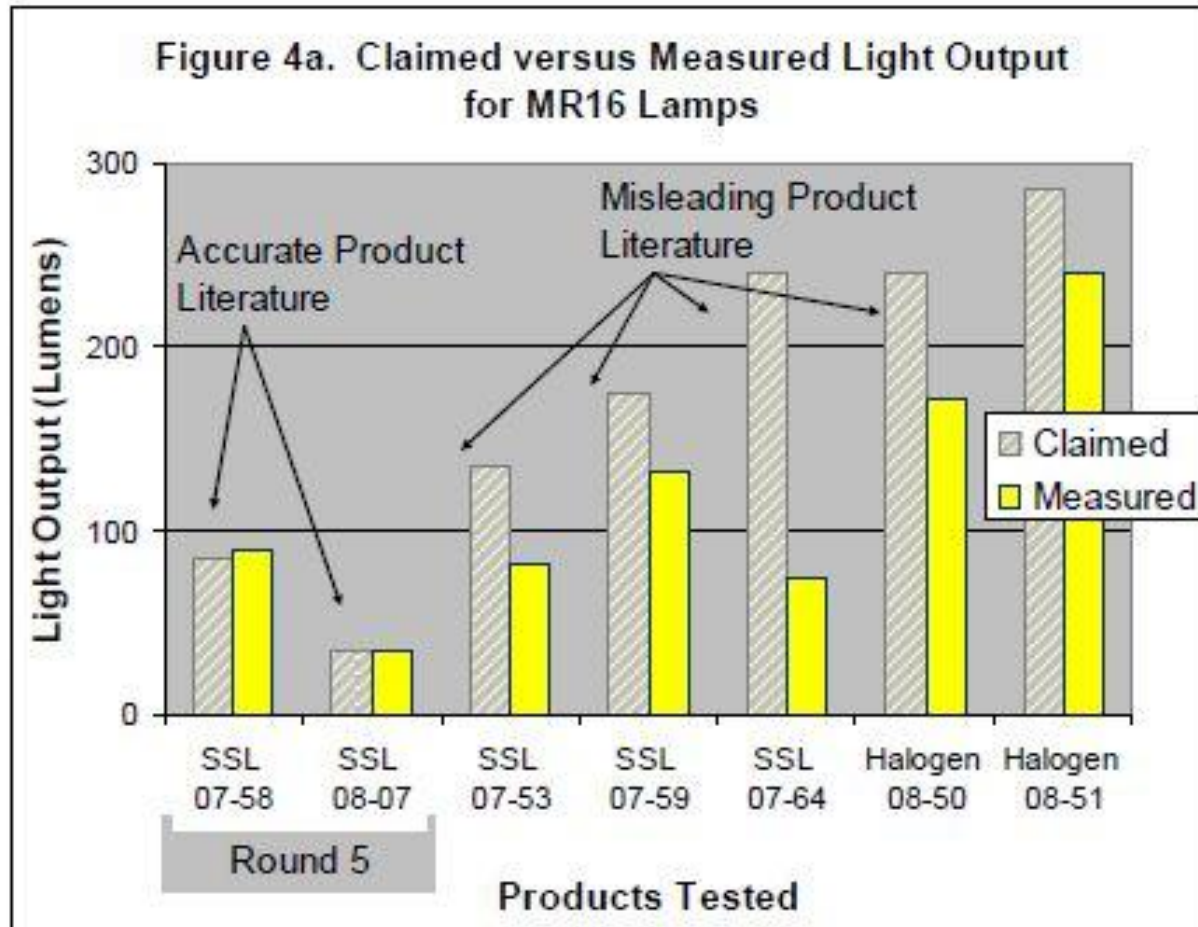
- Not all LED fixtures are created equal
- Manufacturers' and vendors' rose-tinted glasses
- Need to educate community and gain its enthusiasm

Product performance with SSL not a known quantity as with traditional lighting



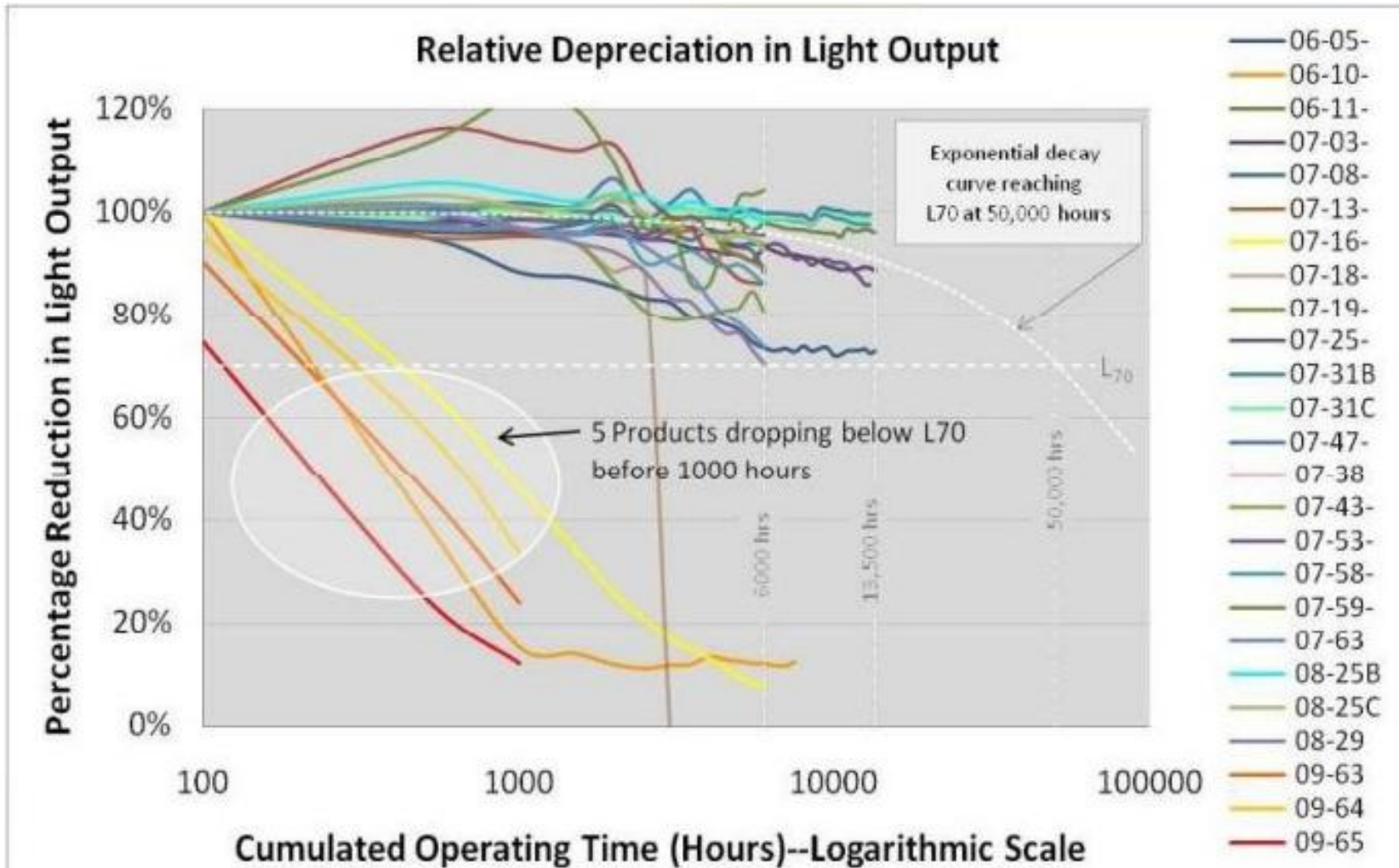
Source: CALiPER Summary Report, Round 11, 2010

Beware overstated performance claims (SSL not only tech facing this issue)



Source: CALiPER Summary Report, Round 5, 2008

Long life not always guaranteed...



Source: DOE CALiPER Summary Report, Round 9

- Don't take manufacturers at their word!
- Collect cut sheets, yes, but verify claims
- Independent testing, the only way to be certain

Cautionary tale

- LED installation meant to last well over 10 years
- LEDs typically considered at end of life when light output has decreased by 30%
- This case: Light output dropped by 10% in just *five months*

LM-79 Report provides key detail on:

- **Color Characteristics:** Correlated Color Temperature (CCT), Color Rendering Index (CRI)
- **Light Characteristics:** Total lumens, Zonal lumens
- **Electrical Characteristics:** volts, amps, watts, efficacy (lumens/watt), off-state power

CALiPER Test Labs

- www1.eere.energy.gov/buildings/ssl/test_labs.html

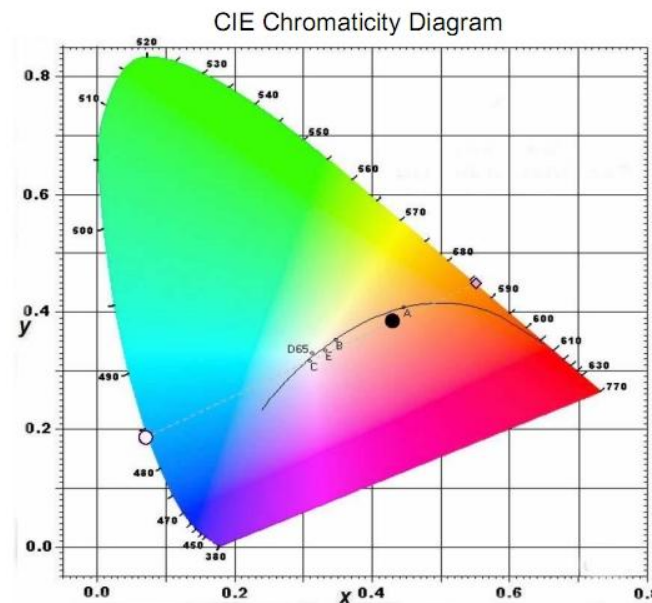
- Color temperature (CCT)
 - Expressed in kelvin
 - Warm, golden light: 2700-3200 range
 - Neutral color: 3200 - 4200
 - Cooler, bluish light: 4200+
 - SSL has higher efficacy at higher CCT, but this is not what the general public is used to



Source: US DOE, GATEWAY Demonstration, Lija Loop

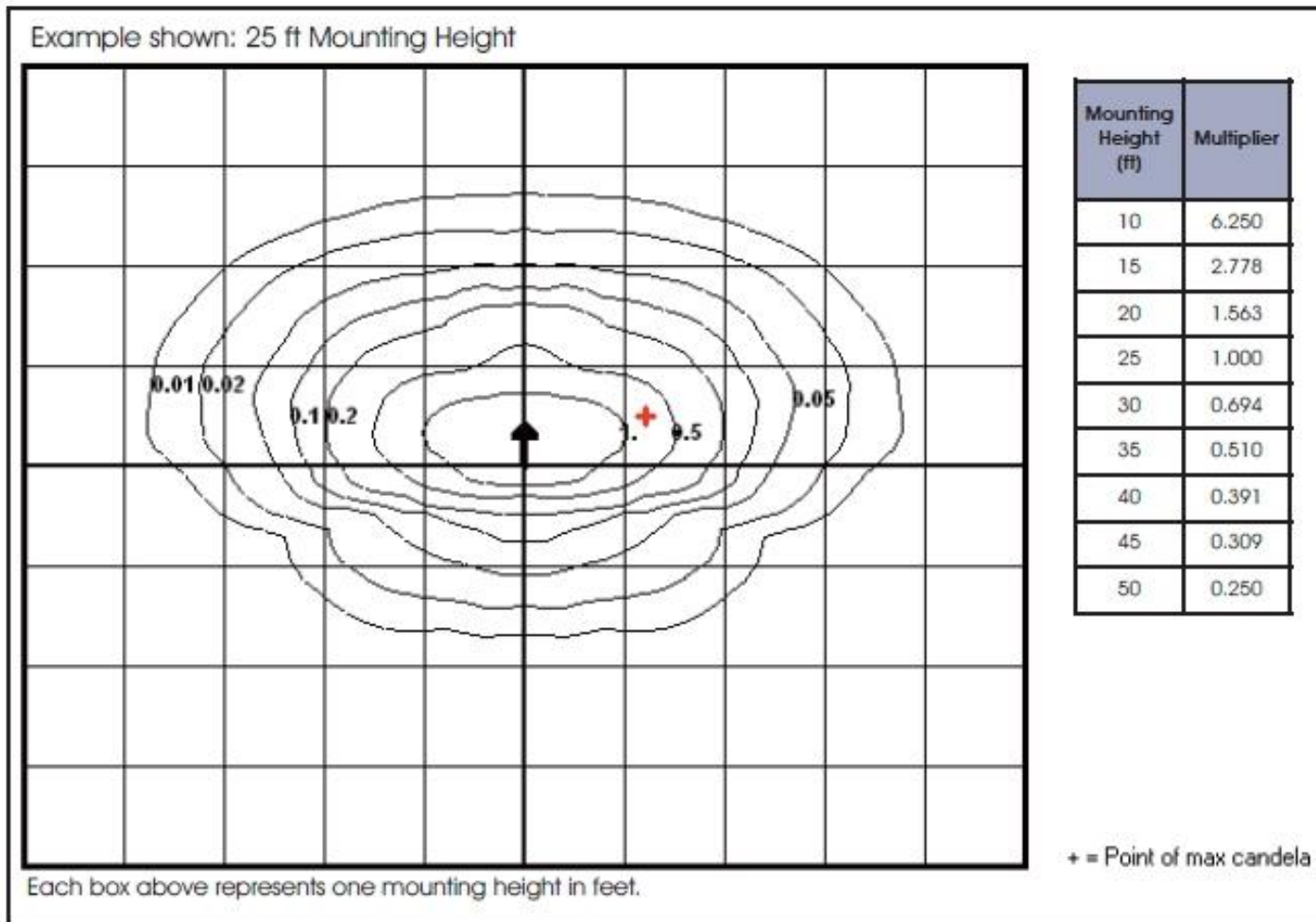
- Color rendering index (CRI)

Lighting Technology	Color Rendering Index (typical)
Low-Pressure Sodium (LPS)	5
Mercury Vapor	17 - 50
High-Pressure Sodium (HPS)	22
Metal Halide	65 - 80
Fluorescent / Induction	82- 90
Light-Emitting Diode (LED)	65 - 85
Sunlight, incandescent light	100



Source: CIE

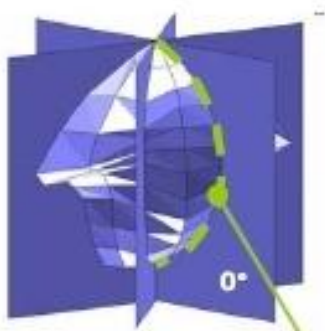
Predicting Lighting intensity and footprint



Source: US DOE, *Walking Through Examples of Real LM-79 & LM-80 Reports* webinar

Various ways to describe distribution...

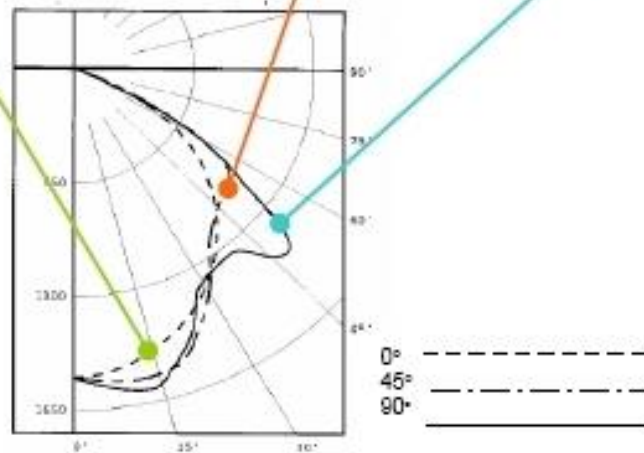
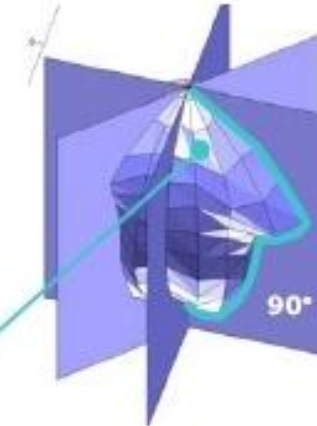
Tri-dimensional candela distribution curve at 0°



Tri-dimensional candela distribution curve at 45°



Tri-dimensional candela distribution curve at 90°

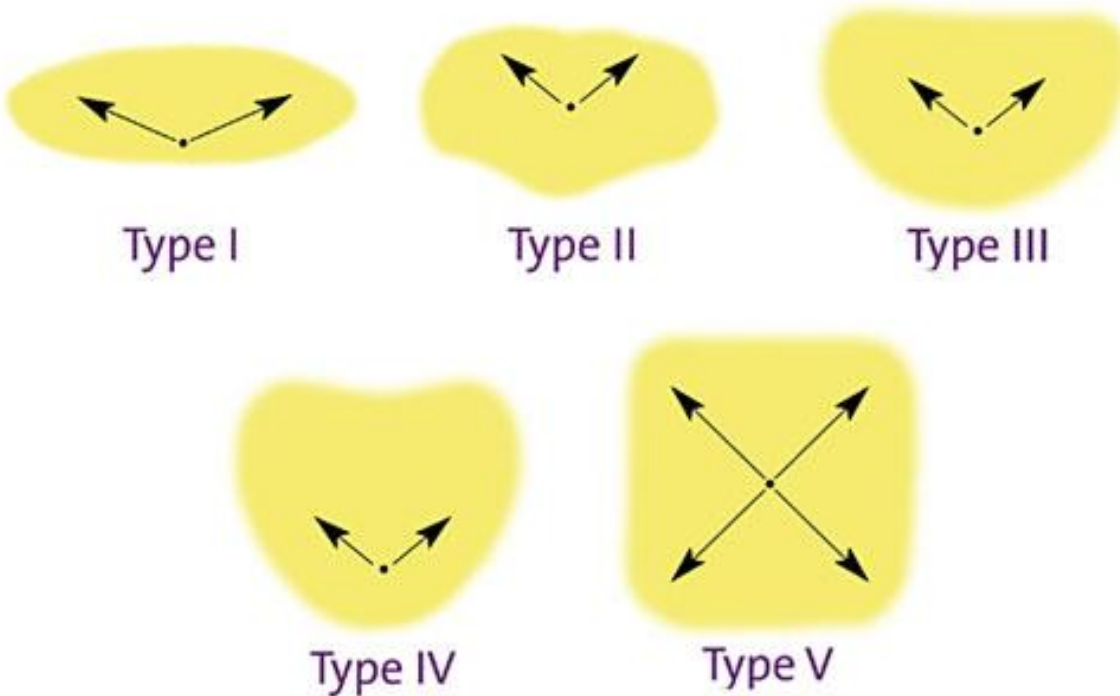


Zonal Lumen Summary

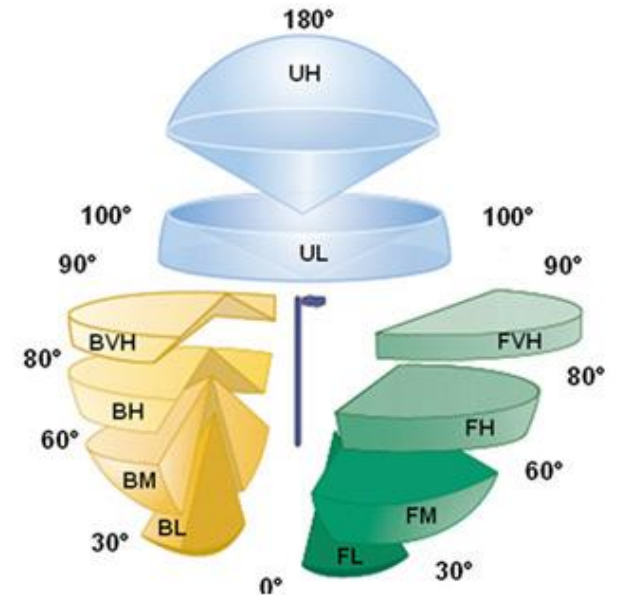
Zone	Lumens
0-10	357.94
10-20	1043.11
20-30	1606.62
30-40	1918.87
40-50	1951.44
50-60	1803.46
60-70	1461.26
70-80	890.06
80-90	336.42
90-100	47.01
100-110	5.87
110-120	0.00
120-130	0.00
130-140	0.00
140-150	0.00
150-160	0.00
160-170	0.00
170-180	0.00

Source: NYSERDA, Technical Guide for Effective, Energy-Efficient Lighting

Typical outdoor luminaire light distributions



Source: IESNA RP-33-99



Source: IESNA TM-15-07

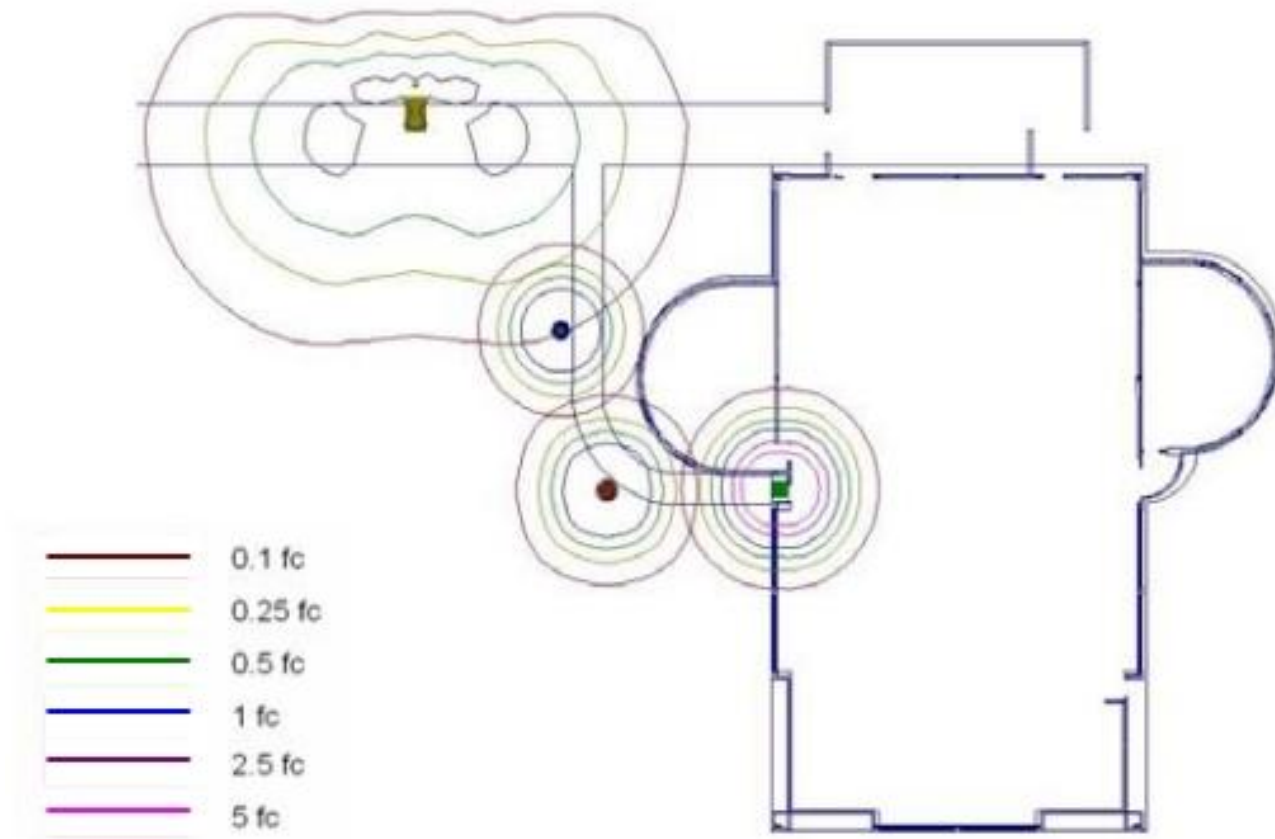
Zonal Lumens

Backlight

Uplight

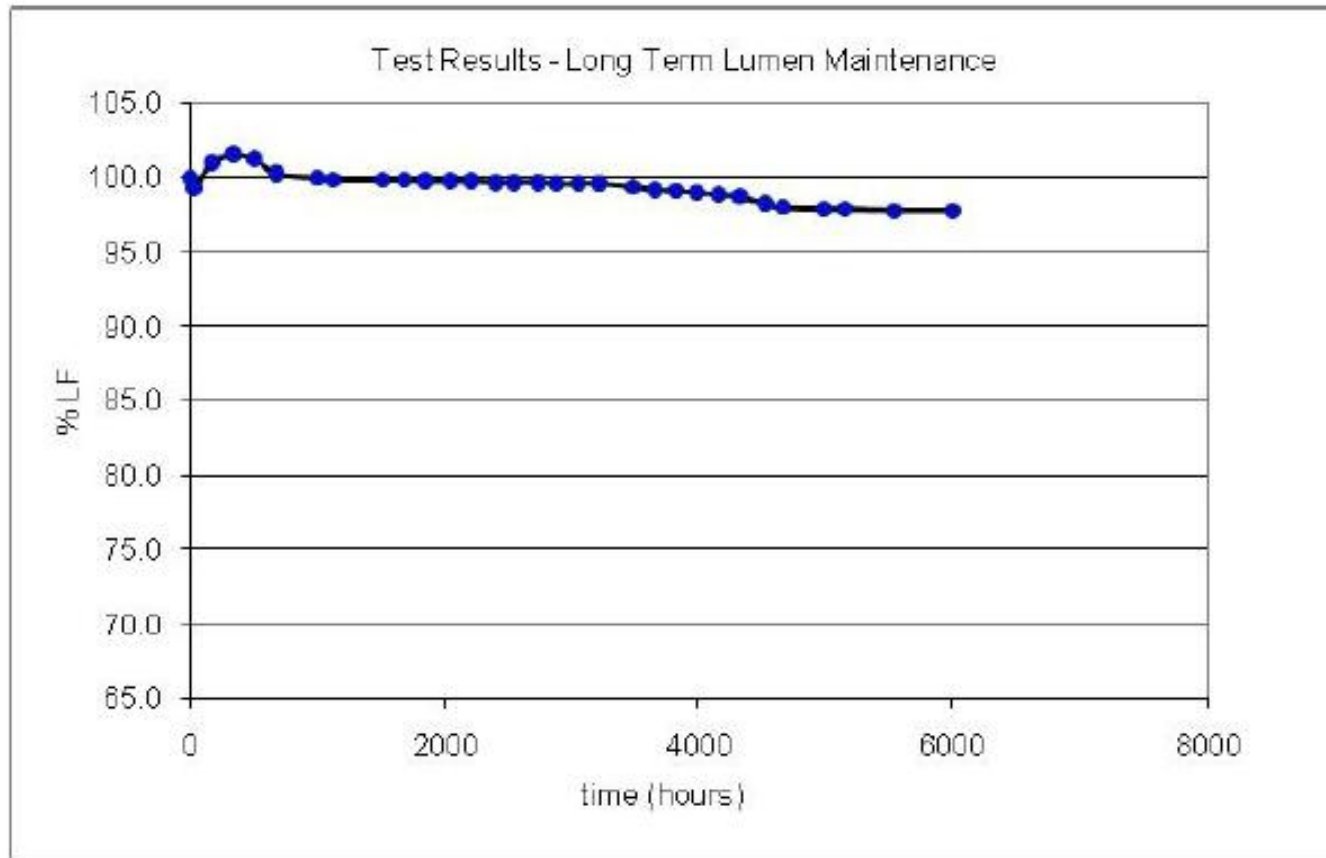
Glare

CAD drawing + .ies file =



- Final notes on the LM-79 test
 - No standardized reporting format
 - Some tests may or may not include additional data
 - Product families may be lumped together

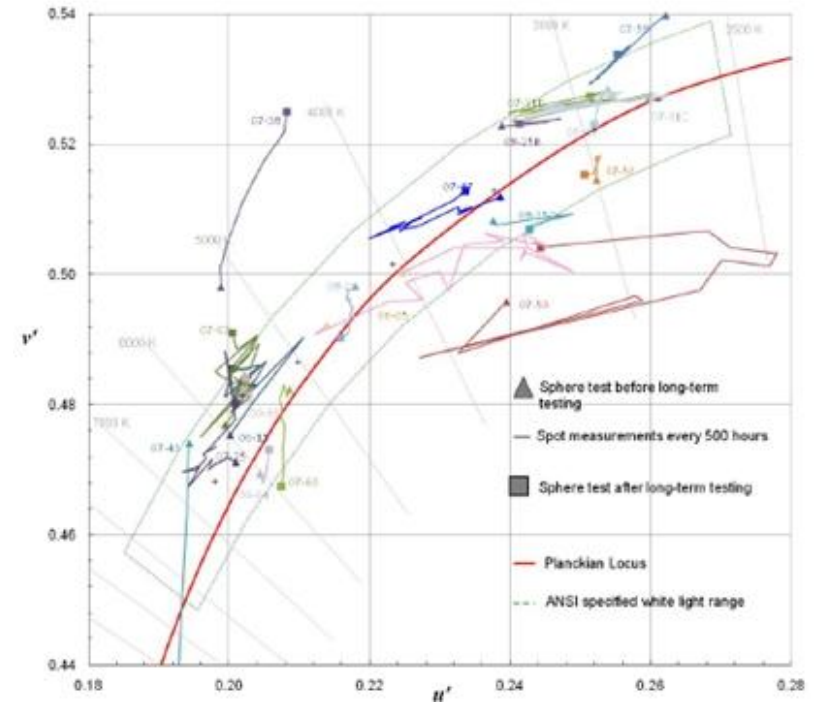
- LM-80 Report provides key detail on:
 - Lumen maintenance – how well an LED maintains its initial light levels (LED chip, **not** luminaire)
 - Color shift – changes in the color of the light over time



Source: Richman,
Understanding
IES LM-79 and
IES LM-80

- Though the LM-80 does test over a long period of time (6,000+ hours), its results aren't meant to be extrapolated to predict fixture life
- TM-21 in late development...

- LM-80 Test
 - Color shift a negative effect and should be evaluated
 - See how test conditions relate to your expected lighting scenario
 - LED Temp (ISTMT)
 - Current, Voltage



- I don't know how to interpret these lab tests!
 - Educate yourself (DOE fact sheet), or get technical assistance (DOE Tech. Assist. or lighting consultant)
 - Can't do this? Call their bluff and *ask anyway*
 - References from other municipalities
 - Have they done this before and how did it go?



- Payback Period answers, “How long will it take me to make up the additional cost of an SSL fixture through energy savings?”
- Need to consider all costs, not just price tag
- Fixture price, Maintenance, Incentives, Annual Usage, Product Life
- Payback Period
 - 0-2 years, no brainer
 - 3-7 years, sound investment
 - 8-10 years, think on it
 - 10+ years, explore other opportunities?



An Illustrative Example

	High Pressure Sodium (HPS)	Light-emitting Diode
Rated Life	24,000 hours	100,000 hours
Initial lumens	6,300	4,468
Average illumination levels (footcandles)	3.54	3.63
Max/Min illuminance ratio	6.04 : 1	2.68 : 1
Correlated Color Temperature (kelvin)	1900	5000
Color Rendering Index	22	75
Input Power (watts)	97	72
Luminaire initial cost	\$150.00	\$725.00
Annualized maintenance cost	\$39.24	--
Annual Hours of Operation	4,380	4,380
Annual Energy Consumption (kWh) per luminaire	425	311
Annual Energy Cost (at \$0.103/kWh) per luminaire	\$43.78	\$32.03
Annual energy savings	N/A	27%
Payback period (without maintenance)	N/A	49 years
Payback period (with maintenance)	N/A	7 years

Source: Adapted from DOE GATEWAY Demonstration, FAA Technical Center

Financial incentives

- Federal Grants
 - Recovery Act
- Utility incentives / State incentives
 - Prescriptive
 - Custom
- Tax Deductions
 - The Environmental Protection Act of 2005 (EPAAct), Section 179D
 - Mostly interior lighting, parking structure lighting may qualify

- Product warranty? 5 years becoming the standard. What constitutes 'failure'?
- Whose LEDs are you using? Are they a known, reputable manufacturer?
- Vendor experience with SSL? References from other municipalities?
- Ingress Protection Rating?

- Light Loss Factors
 - Average ambient temperature
 - Current levels
 - Dirt depreciation
 - Surge protection

- Maintenance concerns
 - SSL offers a reduced maintenance schedule
 - Two maintenance staff + cherry-picker = not cheap
 - Are reduced maintenance needs a good thing for you?



ARRA Provisions

Davis-Bacon Act

Projects that have received federal funding are required to adhere to Davis-Bacon Wage Determinations, which require municipalities (and their contractors) to pay prevailing wages on all ARRA projects.

Buy American Provisions

Project materials are required to be sourced within the United States in order to qualify for ARRA funding, with exceptions for certain product categories.

National Historic Registration Act

It is necessary to determine whether a project involves buildings or facilities on the National Register of Historic Places, and if so, be aware of lighting-related rules or restrictions on the historic property. The State Historic Preservation Office may be able to lend guidance on these matters.

National Environmental Protection Act

ARRA projects are held to the same NEPA requirements of any federally funded project. This means that the same process of determining Categorical Exclusions (CE) and, if necessary, Environmental Assessments (EA) and Environmental Impact Statements (EIS), must be followed.

- Actual SSL installation
 - Residents were not informed of LED retrofit prior to the fact, were not explained benefits, and were not offered chance to offer their opinion
 - Result? LED installation was removed!
 - Make sure your residents know what to expect



- Ensuring minimum light levels are met
 - Know your lighting ordinances or standards (e.g., IESNA RP-8, IES Lighting Handbook)
 - Computer modeling of lighting intensity will help develop lighting performance expectations
 - For best results use lab test data, not manufacturer claims
 - Be aware that required minimum or average light levels must be maintained over the **full lifetime** of the fixture
 - Are we still cutting the mustard at L_{70} ?
 - And, by the way, how will we know when we're at the end of the fixture's life?

- Something to consider, though may be better to take 'baby steps' initially
 - Can help squeeze additional energy savings out of your lighting
 - Does introduce additional costs, but these days controls have less of an effect on payback
 - Dimming, bi-level operation, timers, occupancy sensors
 - Residents may appreciate it!

Be aware that LED fixtures may not be your only (or best) option for next-gen lighting

- Induction lighting
- Plasma lighting
- Ceramic Metal Halide



Municipal Solid-State Street Lighting Consortium Workshops (for Members)

South Central Region - April 2011 (TBD)

Southwest Region - May 2011 (TBD)

North Central Region - June 2011, Detroit

Northwest Region - July 2011 Seattle, WA

Southwest Region - August 2011 San Jose, CA

Northeast Region - May 2011 Philadelphia, PA

Webinar: Commercial Building Energy Alliance (CBEA) High Efficiency Parking Structure Lighting Specification

May 6, 2011 • 12:00 – 1:30pm Eastern

<http://www1.eere.energy.gov/buildings/alliances/resources.html>

Lightfair International 2001

Philadelphia • May 17-19, 2011

2011 IES Street and Area Lighting Conference

New Orleans • September 18-21, 2011



Energy Efficiency &
Renewable Energy

Look to the U.S. Department of Energy
as a key *FREE* resource

<http://www1.eere.energy.gov/buildings/ssl/>

- GATEWAY Demonstrations
- SSL Quality Advocates
- CALiPER
- L Prize
- Next Generation Luminaires & Lighting for Tomorrow
- DOE SSL Fact Sheets
 - <http://www1.eere.energy.gov/buildings/ssl/factsheets.html>

Some Additional Programs & Resources

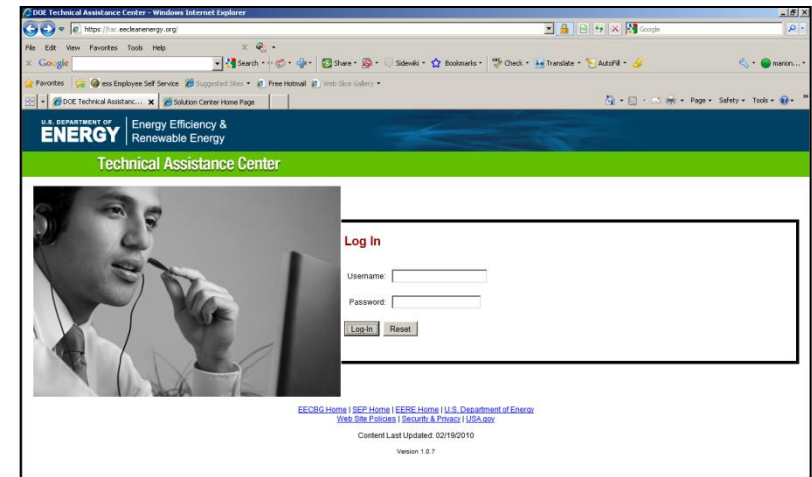
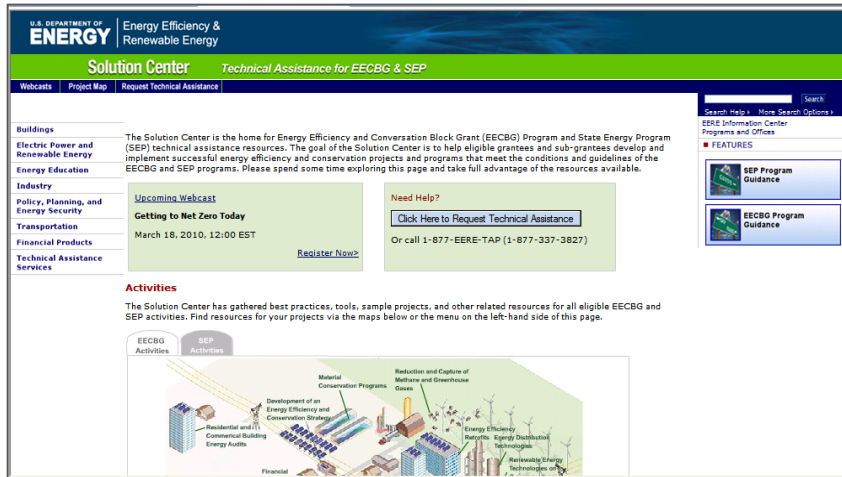
- Evaluating LED Street Lighting Solutions Webcast
 - http://www1.eere.energy.gov/buildings/ssl/consortium-update_webinar.html
- CBEA Parking Lot & Parking Structure Specification
 - <http://www1.eere.energy.gov/buildings/alliances/technologies.html>
- ENERGY STAR
- DesignLights Consortium
- Publications (LEDs Magazine)
- eNewsletters
- Blogs: LightNOW, CrossLight



We encourage you to:

1) Explore our online resources via the [Solution Center](#)

2) Submit a request via the [Technical Assistance Center](#)



3) Ask questions via our call center at 1-877-337-3827 or email us at solutioncenter@ee.doe.gov

Please join us again:

Title: Engaging Financial Institution Partners
Host: Mark Zimring, Lawrence Berkeley National Laboratory
Date: April 25, 2011
Time: 2:00 – 3:30 PM EDT

Title: **Energy Conservation Modeling for Weatherization**
Host: Ed Pierce, Oak Ridge National Laboratory
Date: April 27, 2011
Time: 3:00 - 4:15 PM EDT

Title: **Interactions between Energy Efficiency Program Funded under Recovery Act and Utility Customer-funded Energy Efficiency Programs**
Host: Chuck Goldman, Lawrence Berkeley National Laboratory
Date: April 28, 2011
Time: 2:00-3:30 PM EDT

Title: **Residential Retrofit Program Design Guide Overview**
Host: Vermont Energy Investment Corp.
Date: May 3, 2011
Time: 2:00 - 3:00 PM EDT

For the most up-to-date information and registration links, please visit the Solution Center webcast page at www.wip.energy.gov/solutioncenter/webcasts

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