



NYSERDA



LED Street Lighting Academy

Planning for Success with LED Street Lighting

November 12, 2019

Introduction

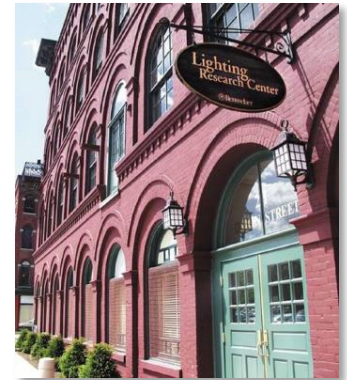
About the Lighting Research Center

*Advancing the effective use of light
for society and the environment*



30,000 sq. ft.
research center
and laboratory

Established in 1988 by
the New York State
Energy Research and
Development Authority
(NYSERDA)



40-60 concurrent projects
in field and lab

~30 full-time faculty and staff

Focus Areas: Energy, Technology
Development, Human Health,
Lighting Benefits, Transportation
and Safety, Product Testing, Plant
Health, Design



15 graduate students

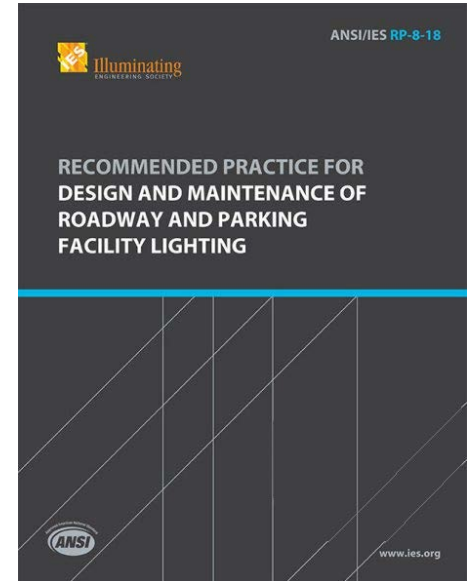
Outline for Today's Webinar

- Lighting performance criteria
- Introducing lighting calculations
- Validating with field measurements
- Controlling light pollution
- NYPA's Smart Street Lighting NY program
- Questions and answers

Lighting Performance Criteria

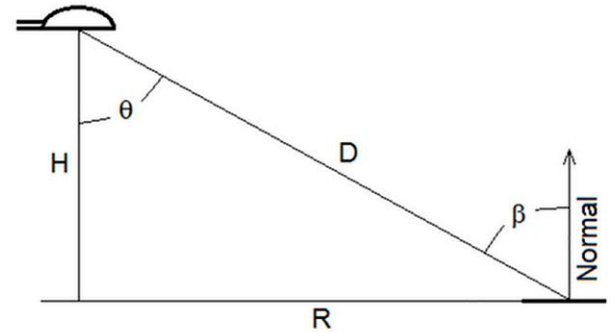
Sources of Lighting Criteria

- Illuminating Engineering Society (IES) Recommended Practice (RP) for Design and Maintenance of Roadway and Parking Facility Lighting (IES RP-8-2018)
- American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide
- Both recommend light levels, uniformity and glare
- Most recommendations are for continuous, “designed” lighting (not partial or utility-pole-mounted lighting)



Light Level - Illuminance

- Illuminance is the amount of light falling on a surface area
 - Footcandles: lumens per square foot
 - Lux: lumens per square meter
 - 1 fc = 10.76 lux, or 1 fc \approx 10 lux
- Relatively easy to calculate and measure
- Many streets have been designed to meet illuminance criteria



$$\text{Illuminance on the Horizontal Plane} = \text{Intensity} \times \cos \theta / D^2$$

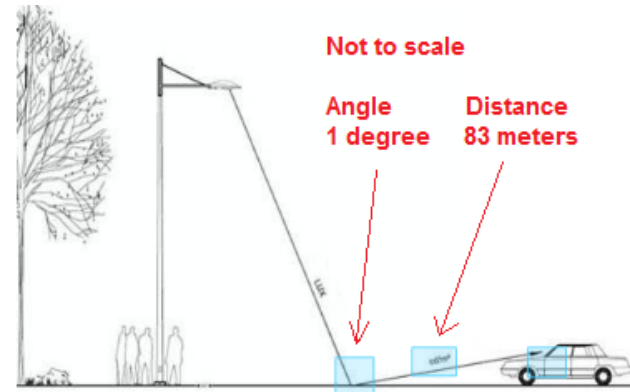
Light Level – Illuminance (cont'd.)

- Illuminance is used to specify light levels for pedestrian areas (sidewalks, crosswalks)
 - High pedestrian use (>100 peds/hour): 10 lux (pedestrians only) or 20 lux (pedestrians and vehicles) average illuminance on walkways
 - Medium pedestrian use (11-100 peds/hour): 5 lux average illuminance on walkways
 - Low pedestrian use (≤ 10 peds/hour): 2-4 lux average illuminance depending upon location



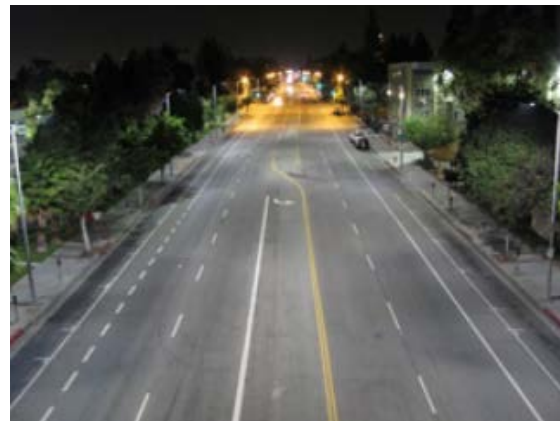
Light Level – Luminance

- Because we do not “see” illuminance but rather the brightness of light reflected from a surface, or luminance (in cd/m^2), lighting recommendations now focus on luminance
 - Of the pavement surface 83 m ahead
 - From the viewpoint of a driver
- Must make assumptions for pavement type
- Very difficult to measure in the field



Example Luminance Recommendations

- Major roads (>3500 vehicles/day):
 - 0.9 cd/m² average luminance
- Local roads (<1500 vehicles/day):
 - 0.5 cd/m² average luminance
- Average luminance values recommended by IES can be approximated in terms of average illuminance for different pavement types:
 - Asphalt: 1 cd/m² \approx 15 lux
 - Concrete: 1 cd/m² \approx 10 lux



Uniformity of Street Lighting

- IES recommends average/minimum luminance ratios to prevent dark areas within lighted streets
- Major roads: Average/minimum ratio should be no greater than 3:1 (high pedestrian user) or 3.5:1 (low ped use)
- Local roads: Average/minimum ratio should be no greater than 6:1



Glare from Street Lighting

- Glare from bright lights scatters light in our eyes similar to looking through a “veil”
- IES recommendations for glare control use a concept called “veiling luminance”
- Can be calculated but not measured



New Designs versus Retrofit Situations

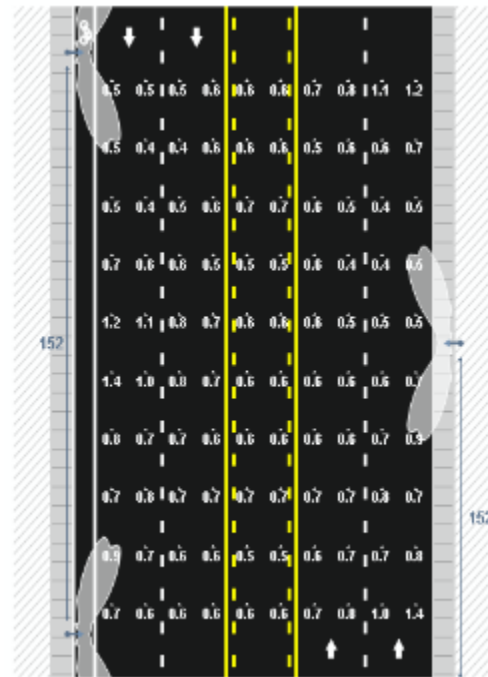
- IES criteria for street lighting apply to new, continuous lighting with pole spacing optimized to meet the required performance for the type of street
- In retrofits (including utility pole-mounted installations) the objective is to match or improve existing lighting conditions, usually based on average illuminance
- If and when it's important, consider aesthetic appearance (e.g., historic downtowns) and glare control – decorative luminaires are likely to have lower (and more visible) mounting heights



Lighting Calculations

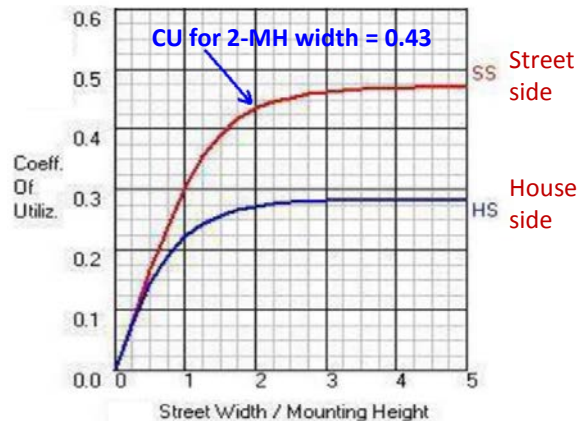
Street Lighting Calculations

- Software tools are available for street lighting calculations
 - Visual Roadway Tool (Acuity Lighting)
 - Street Lighting Tool (Super-Efficient Equipment and Appliance Deployment Initiative)
- Both use photometric data provided by manufacturers in a standard format to calculate based on street geometry



Estimating Average Maintained Illuminance

- Light loss factor (LLF): Lumen and dirt depreciation (typical: 0.7-0.8)
- Streetlight data sheets often publish **coefficient of utilization (CU)**
 - CU: Proportion of lamp/LED lumens that fall on a street (street-side, SS) of a given width (in multiples of streetlight **mounting height**)
 - 2-lane road: 1 mounting height wide (30 ft / 9 m)
 - 4-lane road: 2 mounting heights wide (60 ft / 18 m)
- Pole spacing and road width (in ft or m)
 - If ft, average is in footcandles; if m, in lux (1 fc \approx 10 lux)



Average illuminance =

$$\frac{\text{Lumens} \times \text{CU} \times \text{LLF}}{\text{Spacing} \times \text{Width}}$$

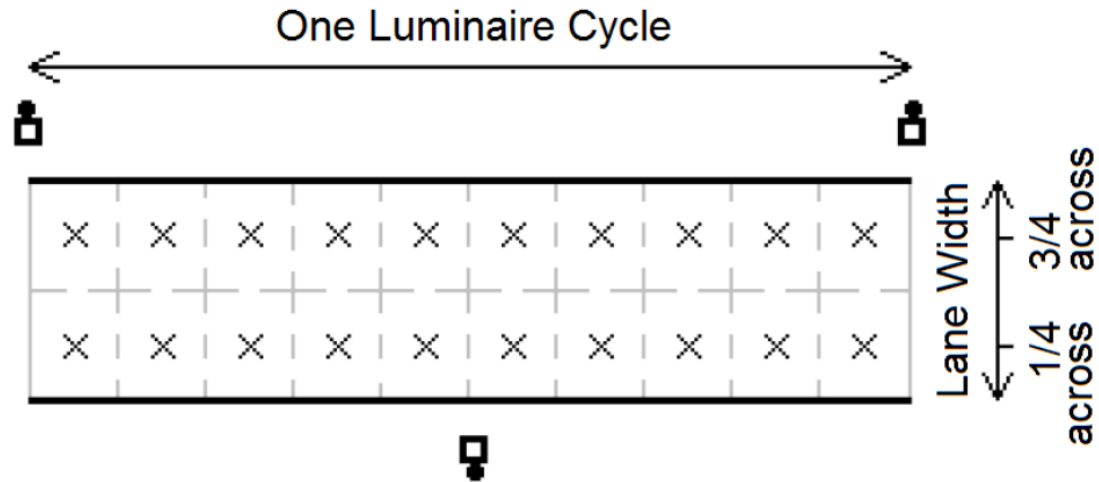
Field Measurement and Validation

Why Make Field Measurements?

- Validate luminaire performance/photometrics
 - Are they providing the expected light output and distribution?
- Confirm that lighting conditions (e.g., light levels, uniformity) meet recommended practices or specifications



How are Measurements Made?

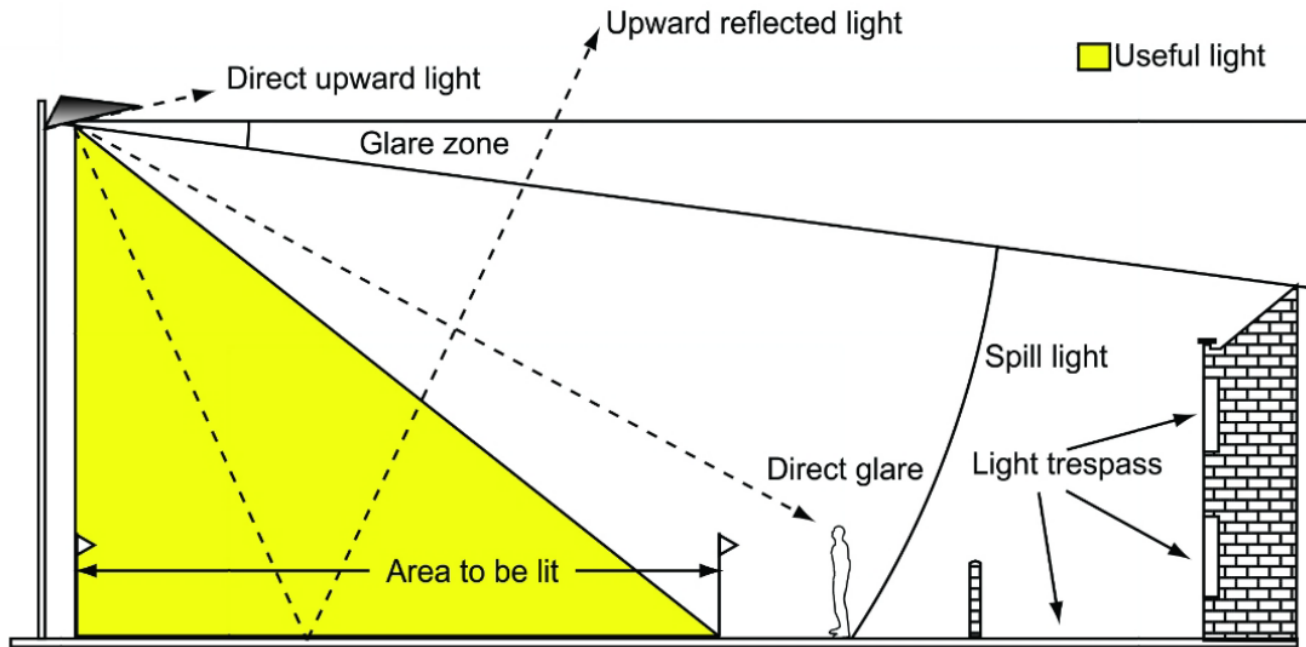


A minimum of 10 equally spaced measurement points per luminaire cycle (more if points would be more than 5 m apart)

Controlling Light Pollution

What is Light Pollution?

- Sky glow
- Light trespass
- Glare



Light pollution is often caused by the way light is emitted from lighting equipment. Choosing proper equipment and carefully mounting and aiming it can make a significant difference.

Environmental Lighting Zones (LZs)

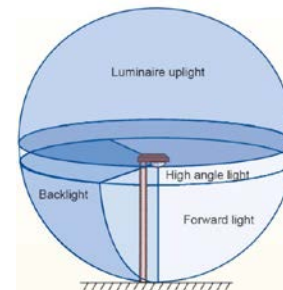
- LZ0: Pristine, natural environment (avoid street lighting)
- LZ1: Low ambient / rural
- LZ2: Moderate ambient / limited nighttime use
- LZ3: Moderately high ambient / suburban
- LZ4: High ambient / urban



Environmental Lighting Zones (LZs)

- Lower lighting zones are expected to have lower light levels
- Recommended maximum illuminances are often lower than recommended practices for street lighting
- Can safety needs be met with reflective markings, signs, delineators?
- BUG zone allowances are stricter for lower numbered lighting zones

| Designation | Recommended Maximum Illuminance Level (E _e) |
|-------------|---|
| LZ 1 | 1.0 lux |
| LZ 2 | 3.0 lux |
| LZ 3 | 8.0 lux |
| LZ 4 | 15.0 lux |





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Smart Street Lighting NY

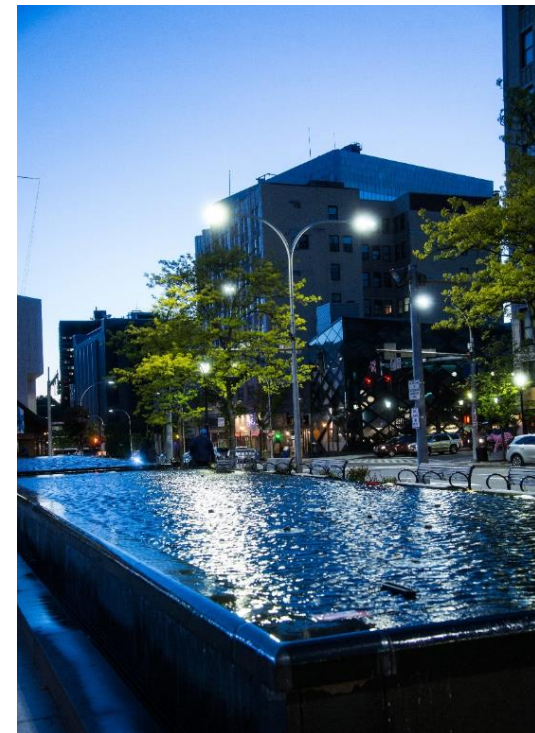
November 12, 2019

Smart Street Lighting NY

- Governor announced NYPA to implement Program in January 2018
- Goal of 500,000 LED street light conversions by 2025
- Significant annual energy and maintenance cost savings to NYS local governments
- Improved quality of light, resident comfort and safety for communities across the state
- Full turnkey street light service

New services available under Smart Street Lighting NY:

- Street Lighting Maintenance Service
- SMART Cities Grant Program



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Smart Street Lighting NY Program Status

| Street Light Category | Status |
|---|-----------------|
| Total street lights in New York State | 1.4 Million |
| NYC street lights converted to LED | 400,000 |
| Smart Street Lighting NY Goal | 500,000 |
| NYPA's street light projects in design/construction | 137,000 |
| NYPA's street lighting projects in development | 201,000 |
| NYPA's penetration in Smart Street Lighting NY goal | 67% in <2 years |



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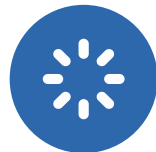


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Full Turnkey Project Implementation



ACQUISITION



DESIGN



CONSTRUCTION



PROJECT FINANCING



O&M SERVICES



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Street Lighting Maintenance Service

O&M SERVICES

- Remove maintenance uncertainty post-ownership
- On-going street light advisor
- Key services:
 - Remote monitoring and troubleshooting
 - Emergency response
 - 24/7 service
 - Detailed progress reports
 - Access to digital platform of street light system



Street Light O&M With Asset Management

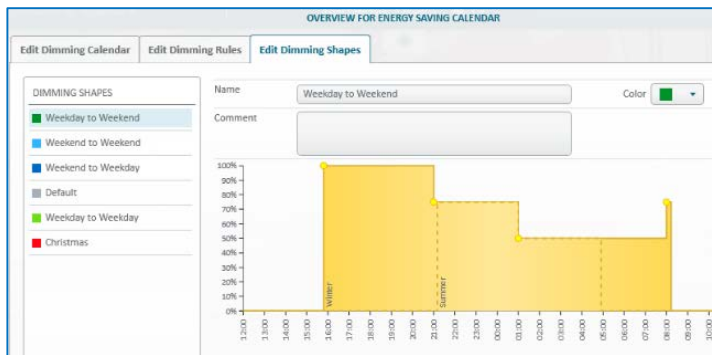
Visual map-based street navigation



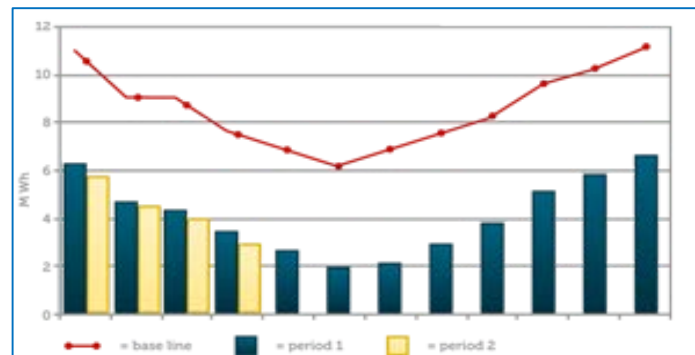
Fault detection & automated notification



Customized lighting and dimming



Real-time energy measurement



SMART Cities Grant

- \$7.5M grant available
- Grants to buy down the cost of hardware and software for SMART city solutions
- Must use NYPA's full turnkey service for the street light LED conversion
- Grant will be offered on a first come first serve basis

| Grant Allocation | | | |
|-------------------------|---------------------------------------|-----------------------------------|--------------------------------|
| Number of Street Lights | Base Grant Amount (No customer match) | Matching Amount (up to 50% match) | Total Amount (Base + Matching) |
| 0 to 500 | Up to \$20,000 | Up to \$40,000 | Up to \$60,000 |
| 501 to 1,000 | Up to \$40,000 | Up to \$80,000 | Up to \$120,000 |
| 1,001 to 5,000 | Up to \$75,000 | Up to \$150,000 | Up to \$225,000 |
| >5,000 | Up to \$100,000 | Up to \$200,000 | Up to \$300,000 |



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Questions



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Coming Next – December 10th @ 10:00 a.m.

Understanding Impacts on the Public

- Does the color temperature of street lighting matter for visibility? For health?
- What are adaptive control strategies and what are their benefits? How can they be implemented?

Thank You!

Questions & Answers