
Somerville Street Lighting


Presentation to the Board of Aldermen
November 24, 2015

Louis Morales
loum@isine.com

Overview

- Reasons for LED plan modification in Somerville
- Overview of street lighting issues
- Requested change to lighting plans
- Demonstration of samples:
 - color, color rendering, and diffusion
 - outdoor lighting supply, protection, and case
- Background slides for your perusal
 - actual longevity and causes
 - Maintenance planning
 - Return-on-investment considerations
 - Rollout plan
 - Test sites for public review
 - staged implementation to control costs

Reasons for LED Modification in Somerville

- 
- Reduce glare
 - Greatly increase visibility
 - Positive health impact
 - Aesthetically positive
 - Lower crime
 - Energy lost to implement is gained in better use of the light generated
 - Good CRI and color
 - Comfort
 - Positive health impact
 - More visibility at lower light levels
 - Aesthetically preferred
 - Low cost changes for much better lighting



Important LED Developments

- LED technology and costs have been changing quickly in the last few years
 - Costs down to \$0.24/watt for the LED components alone
 - Great color and color rendering options are available at good efficiency and cost
 - Failure mechanisms are better known within the industry
 - Exaggerated lifetime and efficiency claims are less common
 - Real efficiencies are increasing
- Customer feedback having effect
 - EnergyStar requirement for lamp color rendering is now 80+
 - Highest selling lightbulb: Cree 60W equivalent
 - color 2700K, CRI 84, 82 lm/W
 - With several years of white LED use, street lighting projects are slowly evolving
 - test sites with choices and feedback mechanisms
 - better lensing
 - Newly developing glare standards
 - Some product offerings for street lighting now have adjustable, directional control
 - Biggest complaint for LED street lighting is glare

Overview of street lighting properties

■ Glare

- Visibility
- Effect on crime
- Glare standards
- Portland OR experience

■ Color and color rendering

- Color temperature
 - Comfort
 - Health
 - Aesthetics
- CRI – Color Rendering

■ Light distribution

Glare – Reduced visibility

- “As this pair of photos illustrates, when glare is present, the eye loses sensitivity to fainter light; shadows become deeper, and when the glare is removed, the eye takes an appreciable time to regain its dark adaptation. [Same scene photos] taken



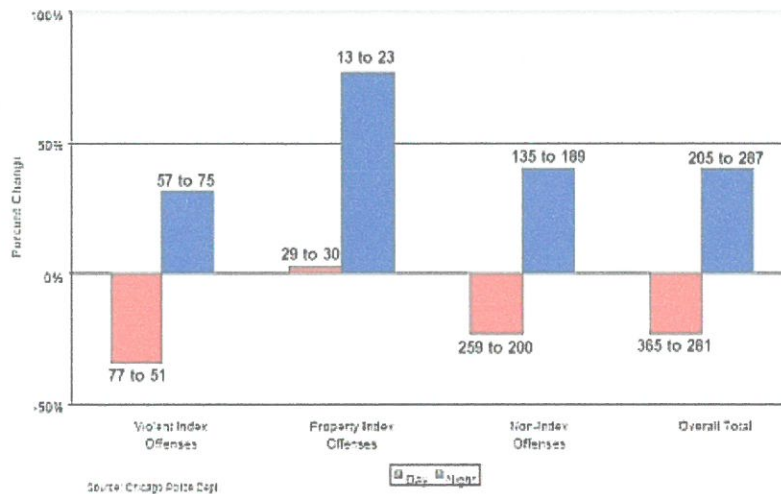
in succession; the first is overwhelmed by the glare of the streetlight; the second shows the scene with that light blocked by the photographer's hand...”

- While specs for a glaring light indicate better efficiency, actual visibility is lowered.

Glaring Light, More Crime

- “Two eight square-block areas were chosen which had similar crime rates; one served as a control, while in the other, alley lighting was increased by increasing light brightness [by 3X]. Six months after the lighting increase found the nighttime crime rate in the test area had

Figure 10 - Change in Reported Incidents in Experimental Area:
Six Months Pre- and Post-Installation of Alley Lights
Day Versus Night Comparison - All Offenses



risen in all categories; violent crime went up 32%, property index offenses were up 77%, non-index offenses up 40%, for an overall increase of 40%. Comparing the daytime crime rate for the same two time periods, the overall crime rate dropped 23% during the daylight hours.”
- Illinois Criminal Justice Information Authority

Glare standards – a work in progress

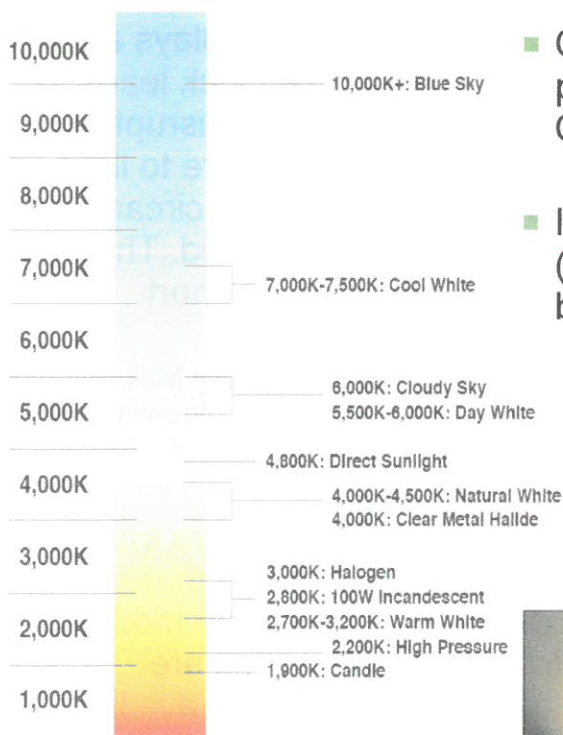
- Blinding light based on old marketing problem for LEDs
 - “If you’ve ever looked directly at a retrofitted LED luminaire...chances are you were blinded by the glare. And when you looked away you probably saw those black spots reminiscent of antiquated flash cameras...
So why do [any] luminaires have exposed LEDs? Such a design model virtually ensures glare. Yet as a lighting professional, I often wonder why LED fixtures are being developed with such little regard for glare control. ...lighting manufacturers were initially so consumed with lumen output that a feature that would lower light output was not part of the discussion.”
- Mis-understood glare measurement results in poor glare performance
 - “[Proper luminaire glare is measured at the smallest point that emits light.] If one measures the entire LED luminaire, it would not account for the “shards” of light emitted from each individual LED. The light emitted from [undiffused] LED luminaire designs is more akin to a series of laser beams in contrast to the homogenous output of a [proper] luminaire.
... new LED luminaires should not be designed with unshielded lamp sources. Effective shielding of LEDs can be achieved, while still providing excellent performance and a dramatic reduction in glare.”

Glare – Portland, OR

■ Portland's Purchase & Conversion of an LED Street Lighting System, U.S. DOE

- “Based on initial feedback from residents that the 4100 lumen output was perceived as too much light, PBOT has been configuring all residential units at the lowest available output level, drawing 29 watts.” 54, 42, and 29W settings were available.
 - Under Lessons Learned: “A generally higher color temperature combined with a smaller aperture (i.e., area from which the light emanates) leads to a common perception of LEDs as being 'brighter' [(glaring)] ...Conducting multiple mock ups with open invitations for public input may help identify such issues earlier in the process.”
- The LED lamps in this case gave 2200 lumens. The original 100W HPS lamps could have been replaced with 19 watt HPS to achieve a similar result.

Color Temperature

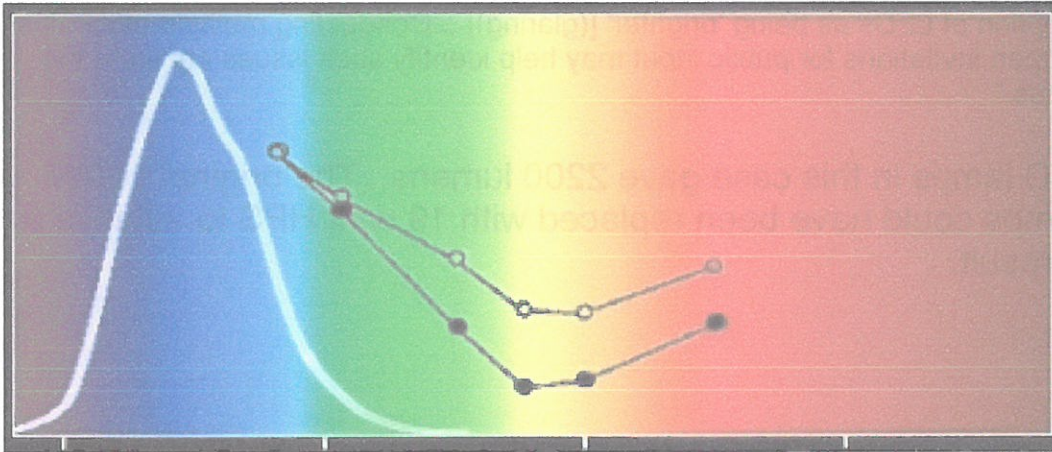


- Color temperature refers to human perceived color of a light source; Correlated Color Temperature (CCT)
- It is expressed in degrees Kelvin (referring to equivalent, perfect black-body radiation thermal temperature)



Color Temperature - Comfort

- “Research shows that the amount of perceived discomfort glare from a light source, especially at night, is strongly dependant on the color composition of the light. ...black lines show the level of reported discomfort experienced by observers viewing light sources of the same intensity, but at different wavelengths [solid dots = subjects in their 20s; open circles = subjects 60-70]. We see a significant increase in perception of glare with a change in light color, especially toward the blue end of the spectrum.”
 - The best results in this study were at about 2500-3000K



Color Temperature - Health

- Circadian Rythm - “...the circadian rhythm in our bodies plays a critical role in maintaining our health. Disrupting this internal clock leads to increased occurrence of a long list of physiological ills: [disrupted sleep, depression, obesity and some cancers]. ...exposure to light during what should be the dark period of night keeps the circadian systems within the body from being correctly synchronized. The light detector for this clock-setting function ... is triggered by short wavelength visible light.”
 - “...in London, where the LED changeover is further along, the Daily Mail reports that round-the-clock white light is disrupting some residents' sleep. ...blue-white light can interfere with the body's production of melatonin.” - Willamette Week (Portland OR)
- Eye Damage - “Photons of shorter wavelengths carry more energy. Because of this, blue and ultraviolet light to create much more "wear and tear" damage to the cells in the retina of the eye than moderate or long wavelengths, leading to vision loss. Children's eyes are particularly susceptible to the phototoxic effects of shortwave light.”

Use warmer colored light at night

Color Temperature - Aesthetics

- Most people prefer 2500K-3500K temperatures and high CRI. Many businesses know this and only use this range:

- Virtually all restaurants
- Display cases
- Museums: "The [J. Paul Getty Museum] exhibit lighting designer, Scott Hersey, and Kevin Marshall, Head of Preparations, selected the Cree 12W LED PAR38 2700K lamp (brand name "LRP38" [CRI 94]) for the exhibition lighting after mockups in a test gallery with similar objects and in collaboration with Jim Druzik, Senior Scientist, the Getty Conservation Institute, and Thomas Kren, acting Associate Director of Collections.

The goal in the lighting selection was to match the color quality of the Museum's standard halogen lamps as closely as possible with no apparent difference between galleries lighted with LEDs and those lighted with halogen..."

The efficiency gap for lower color temperature lighting is gone.

Let's not compromise on this critical feature of life!

CRI - Color Rendering Index

- CRI, determines how accurately a light source makes color appear to the human eye; a higher number is desirable, with 100 being the ideal.

Good light quality



LED Lamps
CRI 80 or above

Bad light quality



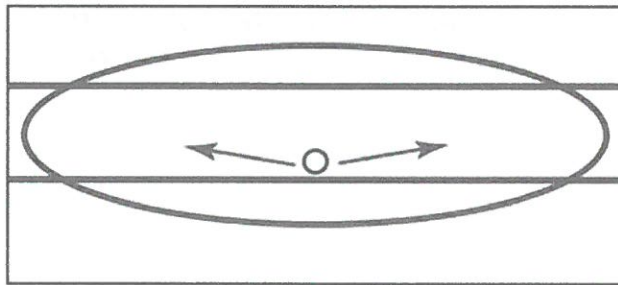
Fluorescent Lamps
CRI 70 or below

Light Distribution

- "Type II distribution is used for wide walkways, ...as well as other long, narrow lighting. This type is meant for lighting larger areas and usually is located near the roadside. You'll find this type of lighting mostly on smaller side streets or jogging paths.

Type II light distributions have a preferred lateral width of 25 degrees. They are generally applicable to luminaires located at or near the side of relatively narrow roadways, where the width of the roadway does not exceed 1.75 times the designed mounting height." LED Lighting Distribution Types - Eye Lighting International

- LEDs main advantage in street lighting is realized by directing desired light specifically on the walkways and sidewalks.
- Virtually all lighting in Somerville is Type II; only this type need be designed to get significant efficiency gain and minimum power use.



Cambridge/Somerville – Chester St.



Somerville/Cambridge – Chester St.



Cambridge Light Fright

- Quotes without a reference came from an excellent summary of facts and research results: Illinois Coalition for Responsible Lighting <http://www.illinoislighting.org>

■ Too glaring & too bright

- Quotes from NECN TV news story about Cambridge reaction (late 2014):
“Far too bright and blue”, “Like a shopping mall parking lot”, “I finally got city to change his lamp [back to HPS]”, “100’s of shadows cast, makes me dizzy”, request to halt installation of LED lights
 - City officials backtrack and defend themselves; plan to add dimming
 - Full story: <http://www.necn.com/news/new-england/Too-Bright-at-Night-270426731.html>
- “Many of our lights are so bright that they dazzle the eye, actually making it harder to see at night, whether we’re trying to spot the pedestrian or pet crossing in front of our vehicle, or the prowler on our property”

■ No effort to improve distribution over original HPS; why were they replaced?

■ Poor color and color rendering (CCT, CRI)

- Appears to be 4500K and <70 CRI

These lamps compromise safety, increase crime, and are aesthetically offensive

Objectively Consider Street Light

- You do not need to be an expert to identify good lighting
 - Can you see images clearly and easily?
 - Do they seem “wrong” or “bad” due to color shifts, or glare?
 - How small an object can you see at a given light level?
 - Are shadows harsh?
 - Look at the environment and at the lamp at various distances compared to other similar lighting. Which is better?
 - Are the right things being lit? Streets and sidewalks, not houses and yards.
- Virtually all retrofit plans now include an invitation to review and a set of choices. At least the Aldermen should be given this opportunity.
 - e.g. Newburyport had a samples set out and a WEB site to vote for favorites by everyone in the town
- Keep in mind that the function of street lighting is to see things clearly at a reasonable cost!
 - Maximizing parametric specs is not an end in itself



Requested Change to Lighting Plan

- Significantly mitigate glare by some method:
 - change the lensing on LEDs
 - use many small LEDs
 - add a simple diffuser or a high-efficiency diffuser (e.g. Fresnel lens-based)
 - Add one good distribution design (type II cobra-head); lower power, less complaints
- Change the specifications for the LED component currently used
 - CRI=80+, Color temperature=3000K (similar to incandescent/halogen)
 - Same physically, and electrically; same manufacturer
 - Almost identical lumen output, but more effective light at the same level
 - Small real cost difference: approximately \$4 for a 90W lamp
- Demonstrate the improved lamp
 - The manufacturer can make these improvements for demonstration
 - I can do this if given samples of the existing lamp and a schematic
- Alternatively, if these changes are not acceptable give us options:
 - allow modification of the lamps ourselves by street
 - allow retention of existing HPS by street
 - better efficiency
 - similar cost-of-ownership