

# Wasted Light



By Doug Palin

Remember what "Night" looked like from the older films of the twentieth century? There were shadows on the ground, and the entire scene was uniformly "dim" because, well, it was "night". There were shadows because they were actually filmed during the day but were grossly underexposed. Neutral density filters (dark, dark "sunglasses for the camera") were used, some with a not-so-neutral "bluish" cast to them.

A similar effect is what is possible with LED outdoor lighting. Extremely even illumination, somewhere between moonlight and "dusk". It's possible from a physical (optical) standpoint because the LED source is so small that almost all of the light-energy is controlled. The light generated from the LED is directed, controlled, REFRACTED into the DIM areas of the scene, which in outdoor lighting applications are the areas farthest from the light source, or mid-way between the poles. This is a good thing, within limits.

For those readers who haven't a glimmer of where I'm going with this, I'm going to contrast the new, optically optimal source (Light Emitting Diodes) with the source we are all too familiar with: High Intensity Discharge, or HID.

HID sources are relatively HUGE in size compared with LED. The arc tube on a High Pressure Sodium lamp (used for outdoor lighting) is between three and five inches long. Nearly all of the light is emitted from the sides of the arc-tube, and

if no shielding or optical control is used (as in some "Acorn post-tops") the light just "escapes" in every direction. But outdoor streetlights DO provide shielding and optical media, and so the light is directed, controlled, reflected, refracted into the DIM areas. Kinda/sorta.

In a post-top Acorn-type luminaire, the arc tube is vertical, and the light is emitted mostly sideways toward the horizon and also spraying up into the heavens and some of it hits the ground. Prismatic optical designs try to control this downward, but you can really only "bend" light about 30 degrees with a prism, so the light that's going up at a 45 degree angle might actually only "bend" downward that 30 degrees, but still ends up going upward at a 15 degree angle and into the night sky. Basically ONLY light that's emitted below 120 degrees from nadir has any chance at hitting the ground.

In a refractor "bowl" streetlight, the arc tube is horizontal. Half of the light wants to go up, so the optics designers provide a reflector to re-direct that light downward. The other half of the light wants to go down, and the prismatic "bowl" refractor bends those rays (as much as 30 degrees) into the Type III or Type II pattern. And the light that wants to go STRAIGHT down to that place we call NADIR, may get "bent" out to about 30 degrees to one side or other. The result is a fair amount of light spread out into the pattern and a BUNCH of light "puddling" up under the luminaire (certainly within one mounting-height of the pole).

In a "cutoff" streetlight, once again the arc tube is horizontal. That half of the light going up gets handled the same as the refractor streetlight, but . . . HELLO, the refractor is gone, and it's replaced with a nice piece of flat glass. So the light that wants to go downward, DOES. Nearly half of the light emitted by the arc tube just "escapes" from the luminaire with not even the slightest bit of "urging" to go anywhere but directly down. The "puddling" of light under the pole is now a deluge and that's just WASTED LIGHT. According to Kodak, about 18% of it bounces off the surfaces of the street and up into the heavens. It also makes the brightest part of the pavement BRIGHTER, and affects eye adaptation, making the DIM parts of the pavement harder to see.

Summarizing the HID streetlights, they produce LOTS of lumens, and they do put LOTS of it on the ground (just not efficiently in the DIM areas). But they do produce nice big AVERAGE light levels. And the present RP8 document favors AVERAGES. Remember if you light part of an area to ten footcandles and an equal part to zero, you have an average of five footcandles. But High Pressure Sodium has to produce Lots and lots of light (much of it wasted) just so we can get a little bit of it focused into the dim areas.

The light that HID's waste is converted from electricity, so I guess you could say that we are wasting energy by using "cutoff" streetlights. In the case of a 250watt HPS, 288 watts producing 30,000

lumens and we're wasting roughly half of it because the arc tube is much bigger than a pin-head and we just can't economically control a source that big.

On the other hand, had LED's been invented before HID sources, our "science" of outdoor lighting may have looked much different. We might have concentrated much more on the direction of the light with respect to the viewer, the contrast generated by that directional flux and the visibility of the scene. Because of their optical "near-perfection" LED's can create that "Extreme Uniformity" that mimics moonlight (although a lot brighter), but let's not fool ourselves: if LED streetlights are not utilized with the correct distance between poles, and mounting heights, this extreme uniformity can reduce contrast and in some cases reduce visibility of objects on the road, (even though the road looks well-lighted). Plainly, we need more research. Given this new tool for outdoor lighting, what qualities of the lighting application (directionality, pole-spacing, mounting height, driver position, and many other quantifiable attributes) actually yield visibility to the driver or user of the space? Because visibility is why we light the street.

In this time where energy has become an ever-increasing vital commodity, we owe it to ourselves and future generations to re-examine why we require that our designs waste so much light within a few feet of the pole.

*Continued on page 43*

## **Wasted Light . . .**

*Continued from page 42*

### **Puppy-puddles**

*During my tenure as product manager in lighting factories around our country, I got involved in most of the literature on “my” products. Often, we had to use representations of an isofootcandle diagram in a small format, just to indicate a general shape of a particular lighting distribution. You see these all over our industry’s literature. MarCom folks tend to shorten our technical names for things, and the word “isofootcandle” was just too much for them to verbalize several times a day. One day, a graphic designer at a Lithonia division I was working for said “that looks like a puddle that a puppy would have made . . . a stain, kinda” . . . so every time one of these isofootcandle shapes had to appear on a page, they started calling it a “puppy puddle”. Later, I moved on to Cooper, and took that “name” with me . . . and it’s still used there. In progression, Day-Brite, Ruud, and others started calling the isofootcandle representations “puppy puddles” and who knows where it will go from this column.*

Doug Paulin, LC, CLEP is Director of General Illumination for Leotek Electronics USA of Santa Clara. Previously, he held positions ranging from product manager to marketing manager for manufacturers including Lithonia Lighting, Cooper Lighting, Thomas Day-Brite Lighting and Ruud Lighting. Past IESNA Board VP and committee chair, he currently serves on IESNA Industrial, Roadway, Security, Environmental-Outdoor, Research committees.