Soft Lights Foundation

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March 7, 2022

BY EMAIL

To researchers John Bullough, Naomi Miller, Arnold Wilkens, Robert Fisher, Michael Siminovitch, Kay Fitzpatrick, Elizabeth Mazzae, Jessica Cicchino

Re: Point Source versus Surface Source

Dear Researchers,

The LED Display Industry correctly differentiates between point sources of light and surface sources. For example, the brightness of an LED television may be rated with a luminance of 300 nits. This differentiation is almost entirely missing from the LED lighting industry. For example, the brightness of an LED streetlight is perhaps 500,000 nits, but this information is nowhere to be found.

Supporting documents that we have collected make it crystal clear that research that ignores the dramatic differences between a point source and a surface source is invalid. Advocacy groups that use this invalid research are endangering the health and safety of the public and the earth's environment, damaging the reputation of their organization, and creating a liability.

Point Source

A point source (point means mathematical point) emits light uniformly in all spatial directions. While the emitter itself may be a sphere or a cylinder or similar curved shape, the emitter may be considered a mathematical point for the purpose of calculations because the energy emitted is generally the same in all directions. For cylindrical emitters, we will ignore the endpoints. Examples of point sources include the sun, a candle, an incandescent, and High-Pressure Sodium. The brightness of point sources is measured with luminous intensity in candela.

All biological systems, including humans, have evolved with point sources of light, most notably the sun, but also more distant stars and fire. The moon is not an emitter, but rather a reflector of sunlight. The human nervous system is thus designed to receive and transmit energy from uniform light sources, typically light reflected from objects, thus enabling the system of vision.

Surface Source

A surface source (surface means flat, non-curved surface) emits light in only the forward direction. Since the surface is flat and not curved, the light rays are emitted at random angles and cross each other, resulting in overlap. This overlap is most dense in the center of the flat surface and continuously reduces in density towards the edges. The mathematical name for this shape is a

Lambertian. The energy emitted by a surface source is non-uniform, producing different radiance, spectral power distribution, and temporal properties at each point in space. The brightness of surface sources is measured with luminance in nits (candela per square meter).

A surface source is a new type of light, probably never before seen in the history of the planet. Biological systems are not evolutionarily adapted to this new type of light. For a human, the non-uniform energy from a surface source is received by a nervous system designed only for uniform energy. As the varying energy levels are received by the nerves, the results are unpredictable. While some people may saturate, others may overload, resulting in epileptic seizures, migraines, panic attacks, agitation, anger, nausea, loss of vision or loss of motor function.

The ability to place surface sources of light everywhere, sometimes referred to as layering, has created a situation where there are now billions of sources of light to contend with instead of the singular source of light from the sun. Many of these surface light sources are directly visible to the eye. While we are trained from birth to not look directly at the sun, the excessive number of surface sources now in operation makes it exceedingly difficult to avoid being subjected to direct rays from surface sources. This direct light reduces vision and increases trauma.

Point Source versus Surface Source

Our assertion that there are two types of light sources, and that those light sources are vastly different, is corroborated by other sources of information. Figure 1 is a slide presentation from Seoul National University noting how brightness is measured differently for point sources and surface sources of light.

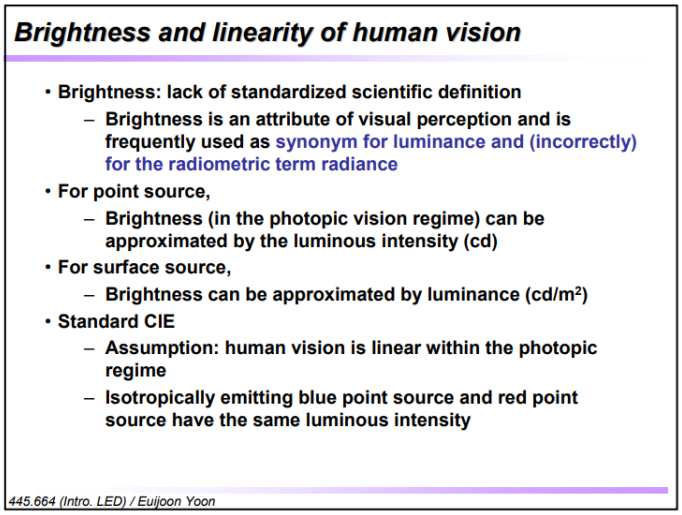

Figure 1 – Brightness of Two Source Types[1]

Figure 2 is a graphic from the utility company Evergy.[2] The graphic shows the non-uniform energy distribution of flat surface LED light.

[1] Seoul National University - https://ocw.snu.ac.kr/sites/default/files/NOTE/791.pdf
[2] https://www.evergy.com/ways-to-save/resources-link/equipment/led-flood-and-area-lighting

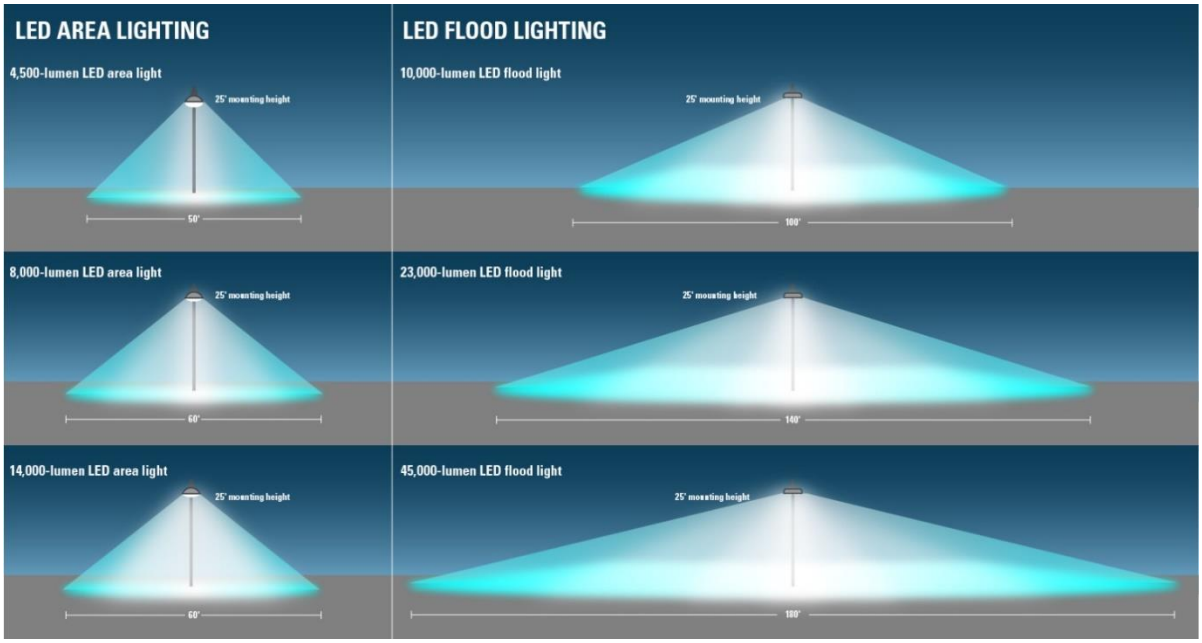

Figure 2 - LED Non-Uniform Light Distribution

A document posted at Rensselaer Polytechnic Institute also describes point sources and surface sources.[3] Lambda Research Corporation, the makers of TracePro, also describe the differences between point sources and surfaces in their ray tracing software.[4]

In summary:

> **Point Source:** Sun, candle, incandescent, High-Pressure Sodium. Brightness measured with luminous intensity in candela. Uniform energy. "point" means mathematical point.
>
> **Surface Source:** LED, laser. Brightness measured with luminance in nits (candela per square meter). Non-uniform energy. Dangerous. "surface" means flat, non-curved surface.

Energy Efficiency

To be energy efficient, a new technology must provide the same service as the previous technology but using less energy. The LED lighting industry has ignored the part that the new

[3] https://sites.ecse.rpi.edu/~schubert/Light-Emitting-Diodes-dot-org/Sample-Chapter.pdf

[4] https://www.led-professional.com/resources/downloads-pdf/lambda-white-paper-march-2015/at_download/file

technology must provide the same quality of service as the previous technology. By ignoring this critical part of the definition, the LED lighting industry has falsely claimed that surface source LEDs are more energy efficient than point sources of light.

There are numerous links to sources confirming that energy efficiency does not just mean providing any type of light. Energy efficiency means providing the same uniform illumination that is provided by incandescent and HPS.

- **United States Department of Energy** - "Simply put, energy efficiency means using less energy to get the same job done."[5]
- **West Virginia Department of Environmental Protection** - "Energy efficiency means using less energy to accomplish the same task."[6]
- **Environmental and Energy Study Institute** - "Energy efficiency simply means using less energy to perform the same task."[7]
- **United Kingdom Department of Energy and Climate Change** - "*On a technical level, energy efficiency is the relationship between the energy consumed and the output produced by that energy, often called 'energy services', for example the number of miles travelled for a gallon of fuel. Increasing energy efficiency means using either less energy to provide the same level of energy services, or using same level of energy to provide a higher level of energy services."* [8]
- **Law Insider** - Energy Efficiency means a decrease in customer consumption of electricity or natural gas achieved through measures or programs that target customer behavior, equipment, devices, or materials without reducing the quality of energy services.[9]

The LED lighting industry, including government and non-government agencies such as the US Department of Energy, California Energy Commission, California Lighting Technology Center, Underwriters Laboratories, and Illuminating Engineering Society, have chosen to ignore the "without reducing the quality of energy services" part of the definition of energy efficiency.

Instead, the LED lighting industry has chosen to use only luminous efficacy, measured in lumens per watt, as the sole criteria for considering energy efficiency comparisons. Using only lumens per watt for an energy efficiency comparison is invalid. It is impossible to compare the energy efficiency of a laser beam and an incandescent because the first is a surface source and the second is a point source. The two light sources provide different services, and an energy efficiency comparison cannot be made.

Similarly, the energy efficiency of a surface source LED and point source High-Pressure Sodium cannot be made. LEDs emit non-uniform energy, while HPS emits uniform energy. LEDs are rated at 120 lumens per watt, and HPS is similarly rated at 120 lumens per watt. However, we cannot say that both light sources have equivalent energy efficiency because they are two different products, with LED

[5] https://www.energystar.gov/about/about_energy_efficiency
[6] https://dep.wv.gov/daq/EnergyEfficiency/Pages/default.aspx
[7] https://www.eesi.org/topics/energy-efficiency/description
[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/65598/6918-energy-efficiency-strategy-statistical-summary.pdf
[9] https://www.lawinsider.com/dictionary/energy-efficiency

providing a non-uniform directed beam, and HPS providing uniform illumination. Due to the non-uniformity and directional nature of LEDs, LEDs are a low-quality light that is toxic to human health.

Standards and Regulations

The Illuminating Engineering Society publishes IES RP-8-18 for Roadway and Parking Lot Lighting. This standard incorrectly states that LEDs are point sources. The IES RP-8-18 standard is not valid for surface sources, and yet the majority of cities in the USA use IES RP-8-18 for surface source LED emitters, resulting in invalid photometric layouts and unacceptable and dangerous lighting conditions.

6.5.2.2 Optical System. With LEDs, manufacturers are much better able to control the light distribution and as a result offer a very broad choice in optical systems. LED luminaires employ a number of small point sources of light. This allows for far greater optical efficiency than can be achieved with traditional high intensity discharge sources, which utilize large lamps. The small light sources enable excellent beam control with a high level of light beam efficiency.

Figure 3 - IES RP-8-18

The National Highway Transportation Safety Administration Federal Motor Vehicle Safety Standard for vehicle lighting does not differentiate between point sources and surface sources. NHTSA has allowed the auto industry to self-certify that LED headlights comply with FMVSS-108, even though that is not possible since FMVSS-108 is only applicable to point sources. The result of NHTSA not understanding the difference between point sources and surface sources is shown in Figure 4.

Figure 4 - LED Headlight Glare

There are no regulations for LED flashing lights such as on vehicles or signs, which has allowed the lighting industry to create dangerously high luminance LED flashing light systems that have been purchased and are in use by emergency responders and cities.

Consequences

The majority of LED lighting industry researchers have failed to differentiate between point sources and surface sources. This failure to account for the non-uniform energy of surface source light means that research using flat surface sources such as LEDs produced unusable results, unless the researcher specifically accounted for metrics such as luminance, spectral power distribution, and flicker at each point in space and at extremely precise accuracy, perhaps to the picometer or femtometer. Any research that treats light from an LED the same as light from an incandescent is invalid.

The failure to account for the differences between point sources and surface sources has led to the false claim that LEDs are more energy efficient than incandescent or HPS. For a new technology to be more energy efficient than a previous technology, the new technology must provide the same service as the previous technology. Since LEDs are surface sources, not point sources, LEDs do not provide the service of uniform illumination. LEDs are just a dangerous, low-quality light. An energy efficiency comparison cannot be made between surface source LEDs and point sources.

The majority of standards and regulations have not been updated to differentiate between point sources and surface sources. These publications include NHTSA FMVSS-108 for vehicle lighting, IES RP-8-18 for Roadway and Parking Lot Lighting, FHWA Manual of Uniform Traffic Control Devices, energy efficiency codes, building codes, and city codes. The result is the use of improperly regulated or unregulated dangerous and toxic flat surface light.

The impacts of surface light sources on those with epilepsy, lupus, migraines, Sjogren's, Irlen's, autism, PTSD, and others has been significant and widespread. People who do not saturate when exposed to non-uniform electromagnetic radiation are suffering epileptic seizures, agitation, migraines, panic attacks, nausea, loss of vision, loss of motor skills, an inability to think or concentrate, skin rashes, loss of sleep, and increased blood pressure.

As the energy from the exceedingly high-density light from a surface source reaches human eye cells, the energy must then dissipate. Due to the excessive peak radiance, the result is chemical and thermal damage to the eye. Similar results can occur to the skin.

Next Steps

Lighting industry researchers must understand the differences between point sources and surface sources. Any research involving a flat surface source such as LED must include the conditions of the experiment including peak radiance, peak luminance, absolute spectral power distribution, and flicker rate up to at least 10,000 Hertz.

Any claim that LEDs are more energy efficient than a point source of light is invalid. Such claims must be eliminated from documentation and websites.

Sincerely,

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