

1 Federal Regulations which is titled *Performance Standards for Light-Emitting*
2 *Products*. The FDA has issued 21 CFR Part 1040.10 Laser products., Part
3 1040.20 Sunlamp products and ultraviolet lamps intended for use in sunlamp
4 products., and Part 1040.30 High-intensity mercury vapor discharge lamps.

5 In 2018, the FDA posted the statement on the FDA's website, "*LEDs*
6 *(Light Emitting Diodes) are different from laser diodes and are not subject to*
7 *the Federal laser product performance standard.*"¹ This statement does not
8 clarify whether LEDs have never been regulated by the FDA, or if the FDA had
9 been previously regulating LEDs under Part 1040.10 but has now stopped
10 regulating LEDs within Part 1040.10. In either case, this lack of regulation of
11 LEDs violates Congress' mandate in the 1968 Radiation Control for Health and
12 Safety Act to regulate electromagnetic radiation.

13 LEDs were invented in the 1960s, so FDA regulation of Light Emitting
14 Diodes should have occurred long ago. As we can see, however, Part 1040
15 Performance Standards for Light-Emitting Products is missing Subpart 1040.40
16 Light Emitting Diode products.

17 The significance of these statements is that any utility company that sells,
18 installs, or operates LED streetlights is doing so without FDA approval. The FDA
19 has not published studies on the health impacts of LED light and has not
20 published regulations to protect the health and welfare of the public. The

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23 ¹ <https://www.fda.gov/radiation-emitting-products/home-business-and-entertainment-products/laser-products-and-instruments>

1 installation and operation of unapproved, unregulated LED streetlights
2 endangers public health and safety.

3 4 B. Light Emitting Diodes

5 There are two types of light sources: point sources and surface sources.

6 **Point source:** A point source emits light from a curved surface which
7 results in spatially uniform energy, and which can be modeled as a
8 mathematical point. Brightness is measured with luminous intensity in candela.
9 Examples include the sun, a candle, an incandescent light bulb, fluorescent, and
10 High-Pressure Sodium.

11 **Surface source:** A surface source emits light from a non-curved, flat
12 surface which results in spatially non-uniform energy, and which creates a 3D
13 Lambertian mathematical shape. Brightness is measured with luminance in nits
14 (candela per square meter). An example is a Light Emitting Diode.

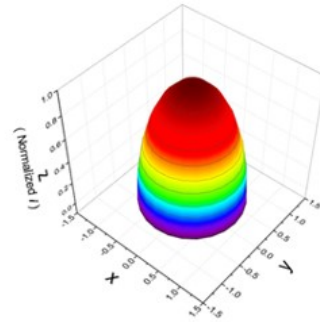
15 Cellular organisms and viruses have evolved with the uniform energy of
16 point source light. The introduction of non-uniform energy from surface source
17 devices has created new type of light. For humans and other biological
18 systems, this surface source LED light is a low-quality light because of its spatial
19 non-uniformity, piecewise spectral power distribution, and square wave flicker.
20 The diagram below shows a comparison of the spatial, spectral, and temporal
21 properties of point source versus surface source light.
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Incandescent vs. Light Emitting Diode (LED)

High Quality Light
Incandescent

Low Quality Light
LED

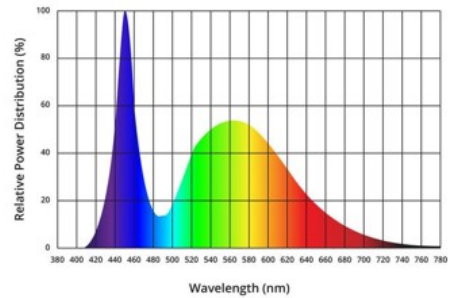
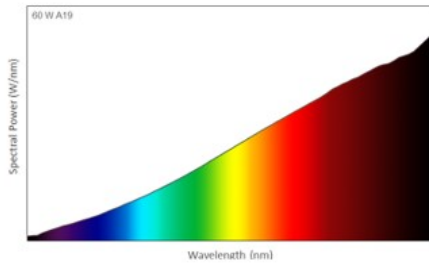
Spatial



Uniform Luminance

Non-Uniform Luminance

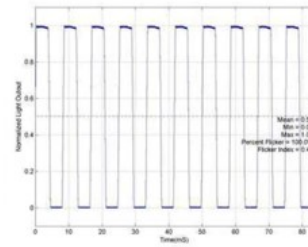
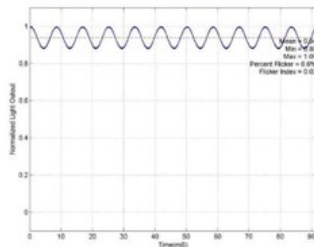
Spectral



Low Blue
Continuously Increasing

Blue Spike
Piecewise

Temporal



Analog Sine Wave

Digital Square Wave

Figure 1 - Incandescent vs. LED

1 The Institute of Electrical and Electronics Engineers has published a peer-
 2 reviewed article by Dr. Nisa Khan that details the calculus mathematics used to
 3 describe the Lambertian shape of a flat-surface source.² Figure 2 from the IEEE
 4 article shows how light from a flat surface LED chip does not produce spatially
 5 uniform energy. This view is a 2D cross-section of 3D space.

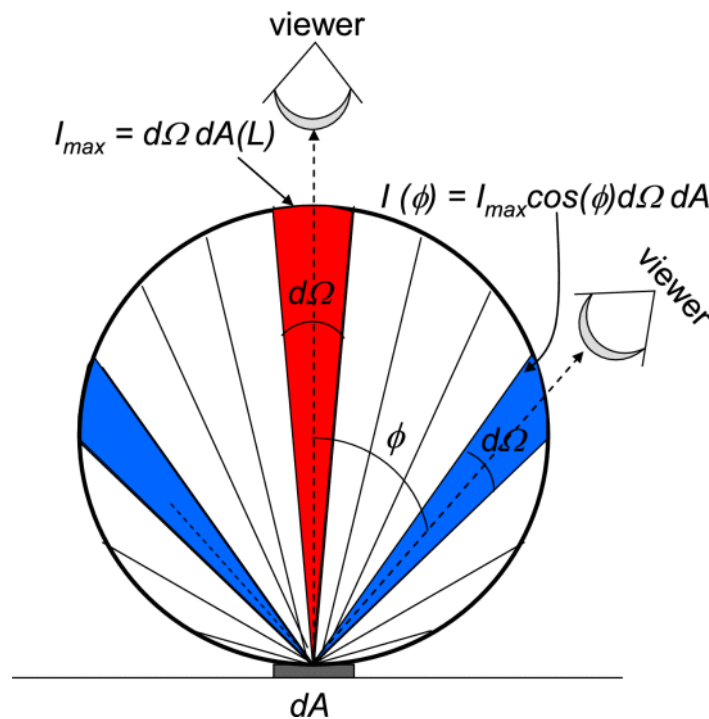


Figure 2 - Lambert's Cosine Law

19 This mathematical proof that LED light is spatially non-uniform is of
 20 utmost importance for the installation and operation of LED products. LED light
 21 has different energies and characteristics at every point in 3D space which

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 23 ² <https://ieeexplore.ieee.org/document/8879542>

1 means that previous formulas, calculations, and regulations that assumed
2 uniform luminance cannot be used with LED products.

3 4 C. Health, Safety, and Comfort

5 The low quality of LED light has been shown to have significant negative
6 impacts on human health, safety, and comfort, including causing epileptic
7 seizures, migraines, panic attacks, nausea, loss of balance, reduced visual
8 perception, anxiety, anger, agitation, and eye injury.

9 10 1. Neurological Health, Safety, and Comfort

11 The FDA has not set standards to protect all members of the public,
12 including those who are especially sensitive to LED light. It may be that LED
13 light is so toxic that it cannot be used for the purpose of illumination. Just
14 because there are already hundreds of millions of LED sources already in the
15 environment does not justify continuing to allow harm to members of the
16 public who are sensitive to LED light.

17 The study Daily blue-light exposure shortens lifespan and causes brain
18 neurodegeneration in Drosophila was published on October 17, 2019.³ The
19 study concluded that "*blue light may cause brain degeneration as well as*
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³ <https://www.nature.com/articles/s41514-019-0038-6>

1 *retinal damage and reduce the lifespan.*"⁴ This is extremely significant as
2 many LED products emit excessive amounts of blue wavelength light.

3 There is a lack of formal, supervised study of the impacts of the
4 spatially non-uniform energy of LED light on humans. However, there is
5 significant documented evidence via personal stories of serious negative
6 reactions to LED light that cannot be explained by the square wave flicker or
7 blue wavelength light alone. LED light is very dense and yet within that
8 density, the energy is non-uniform. Exactly how this effects our nervous
9 system has not been formally studied in detail, and yet we already know the
10 consequences from the telling of personal experiences.

11 MarieAnn Cherry testified to the New York State Public Service
12 Commission on May 16, 2022.⁵ Ms. Cherry opened her testimony by saying,
13 *"I have epilepsy and migralepsy. I cannot neurologically tolerate any LED*
14 *exposure, and I am thrown instantly into violent seizures from the briefest*
15 *strike of LED light."* Ms. Cherry does not experience these seizures when
16 exposed to incandescent or High-Pressure Sodium light. The difference is
17 the spatially non-uniform energy from LEDs that trigger Ms. Cherry's
18 seizures. These LED lights are currently used in public streetlights,
19 preventing Ms. Cherry from using the public roads when these LED
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23 ⁴ <https://www.news-medical.net/news/20191018/Blue-light-and-fruit-flies-a-warning-for-humans.aspx>

⁵ <https://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=21-02623&CaseSearch=Search>

1 streetlights are turned on. The FDA has not regulated LED products so that
2 people like Ms. Cherry are protected from life-threatening seizures. This
3 means that the FDA has not set health, safety, and comfort requirements for
4 spatial uniformity, peak luminance and peak radiance, spectral power
5 distribution, and square wave flicker.

6 Elaine Dennehy testified to the Irish Parliament on February 3, 2022.⁶
7 Ms. Dennehy opened her testimony by saying, *"I thank the committee very*
8 *much for this opportunity. I also hope that this can help, in many ways, the*
9 *others who are suffering around the world from light emitting diode, LED,*
10 *sensitivity and artificial light sensitivity. I have been made ill from LEDs since*
11 *2007. It is more than a sensitivity; it is a disability. I am disabled by my*
12 *environment, like so many others, and excluded from society. This is also an*
13 *accessibility issue."* The fact that the use of LED light excludes Ms. Dennehy
14 from society is a serious concern. Utility companies must understand the
15 toxicity of spatially non-uniform LED light and its impacts on human nerves
16 and consider these factors in the installation and operation of LED products.

17 Additional References:

- 18 a. NYSPSC Case Number 21-02623⁷
19 b. Soft Lights Foundation Documented Stories of LED Harm⁸

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22 ⁶ https://www.oireachtas.ie/en/debates/debate/joint_committee_on_disability_matters/2022-02-03/2/

23 ⁷ <https://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=21-02623&CaseSearch=Search>

⁸ <http://www.softlights.org/stories/>

1 c. LightAware Charity Documented Stories of LED Harm⁹

2 d. Soft Lights Foundation Collection of Research Articles¹⁰

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4 2. Eye Health, Safety, and Comfort

5 The energy from LEDs is measured both with luminance and radiance.
6 The FDA has not set maximum safety standards using either metric. The
7 FDA has not set standards for preventing eye damage or discomfort.

8 The company Fireflier published the article What is Photobiological
9 Safety Standard? in April 2021¹¹. The article concludes, *“the risks posed by*
10 *these new sources of light are also rooted in their intrinsic characteristics:*
11 *high optical output in a small package (producing a high radiance*
12 *level) associated with significant blue light emission. The combination of*
13 *these two factors can potentially increase the risk of photochemical damage*
14 *of the retina, in comparison with the incandescent lamp and the fluorescent*
15 *lamp.”* FDA regulation of LED light is a necessity.

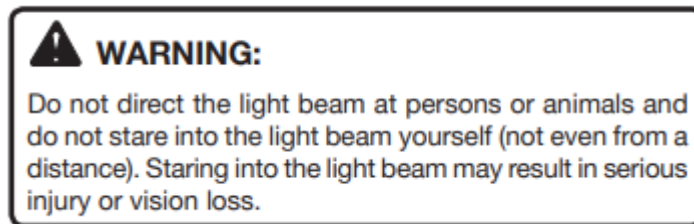
16 The operator’s manual for the Ryobi P705 Flashlight includes the
17 following: **“WARNING: Do not direct the light beam at persons or**
18 **animals and do not stare into the beam yourself (not even from a**
19 **distance) Staring into the light beam may result in serious injury or**

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23 ⁹ <https://lightaware.org/about/individual-stories/>

¹⁰ <https://www.softlights.org/resources/>

¹¹ <https://fireflier.com/what-is-photobiological-safety-standard/>

1 **vision loss.**” The warning also refers to children, who along with infants are
2 an identified high-risk population vulnerable to LED-exposure harm. Babies
3 often lack an adult’s automatic, self-protective aversion response to bright or
4 intense light, and will stare directly at the source. The parenthetical “(not
5 even from a distance)” indicates a high level of danger.



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11 Ryobi’s decision to include “not even from a distance” is significant.
12 LEDs emit very dense light that can travel long distances with very little
13 dispersion, so Ryobi is correct about the dangers. Utility companies that sell,
14 install, or operate LED streetlights that are known to be dangerous and have
15 no FDA approval and no FDA regulations are liable for the injuries caused by
16 LED streetlights.

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18 D. Existing Standards for Illumination

19 Existing standards for illumination are based on point source light. These
20 standards assume that the light is spatially uniform. An example is the
21 Illuminating Engineering Society RP-8-18 Recommended Practice for Design and
22 Maintenance of Roadway and Parking Facility Lighting was written for point
23 source light such as High-Pressure Sodium. Because LEDs emit spatially non-

1 uniform light, utility companies cannot use standards such as IES RP-8-18 for
2 LED streetlights. A new standard must be written that accounts for the spatially
3 non-uniform light.

4 Cree Lighting is the first company in the industry to admit that the
5 industry has been measuring LED light incorrectly.¹² Cree states, *"Not one of*
6 *the existing metrics takes into account the non-uniform emitting surface of a*
7 *LED luminaire."* This statement is very important for utility companies to
8 understand. Cree is stating what no utility company has so far admitted, which
9 is that LED light is spatially non-uniform and that there are no measurement
10 standards that are taking this spatial non-uniformity into account. Cree also
11 writes, *"We also bring a call for urgency to this work. Without a speedy*
12 *agreement on metrics for measuring LED intensity, photometry, and LED*
13 *spacing, we will be installing millions of LED luminaires for street lighting*
14 *purposes that are not suitable for use, could even be described as dangerous,*
15 *and that will be costly to replace."*

16 Existing devices that measure light in far-field cannot be used to measure
17 surface light due to lack of precision and lack of firmware and software designed
18 to process spatially non-uniform light.

20 E. Energy Efficiency Claim

23 ¹² <https://online.flippingbook.com/view/702884488/>

1 The definition of **energy efficiency is providing the same quality of**
2 **service using less energy.** This means that when LED light is compared
3 against High-Pressure Sodium light, the light quality must be equivalent in order
4 to state whether LED is more energy efficient than High-Pressure Sodium.
5 Since LED light is spatially non-uniform, has a piecewise spectral power
6 distribution shape, and has square wave flicker, the light quality of LED is much
7 lower than the light quality of High-Pressure Sodium. Therefore, the claim that
8 LEDs are more energy efficient than High-Pressure Sodium cannot be made
9 because the two sources are not providing the same quality of service. LED
10 light is simply a low-quality light.

11 In general, the utility companies have falsely equated luminous efficacy
12 with energy efficiency. When two lighting products emit the same quality of
13 light, then luminous efficacy is equivalent to energy efficiency. For example, for
14 two LED products, one with a luminous efficacy of 60 lumens per watt and the
15 other at 100 lumens per watt, the 100 lumens/watt LED is more energy
16 efficient. However, for two lighting products that have different output
17 qualities, such as a comparison between High-Pressure Sodium and an LED,
18 luminous efficacy does not equate to energy efficiency. Utility companies
19 cannot truthfully claim that LED streetlights are energy efficient when compared
20 to HPS because the two products provide different quality of service and
21 therefore no energy efficiency comparison can be made.

22 Figure 3 shows LED streetlights on the left and HPS streetlights on the
23 right. The photo shows the excessive and dangerous glare, the toxic blue/purple

1 wavelengths, the zebra pattern on the ground from the non-uniform luminance
2 and the exceedingly high peak luminance.



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Figure 3 - LED vs. HPS Streetlights

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F. Conclusion

Light Emitting Diodes emit an entirely different type of light than incandescent because the light is emitted from a flat surface, thus creating non-uniform luminance. In addition, LEDs have a piecewise spectral power distribution and square wave flicker. The quality of LED light is much lower than the quality of High-Pressure Sodium light. The low quality of LED light causes serious negative health effects, including seizures, migraines, and emotional trauma, as well as a high risk of eye injury. LED devices are not energy efficient because they don't produce the same quality of light as HPS.

1 In just the past two decades, LEDs have proliferated across the world in
2 almost unimaginably large numbers, almost entirely without regulation. This
3 has led to very serious negative consequences for the health, safety, comfort,
4 and civil rights of the public.

5 Congress has mandated that the FDA regulate electromagnetic radiation
6 from electronic products, including visible light. Therefore, utility companies
7 must either petition the FDA or wait for the FDA to issue CFR 21 Part 1040.40
8 LED products which will regulate spatial uniformity, peak luminance and peak
9 radiance, spectral power distribution, and square wave flicker to ensure the
10 health, safety, comfort, and civil rights of the public, especially those who are
11 LED light-disabled.

12 13 **III. UTILITY COMPANY REBUTTALS**

14 We anticipate that the utility companies will attempt to rebut the facts.
15 In this section we provide responses to their anticipated rebuttals.
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17 18 A. Health Studies

19 A utility company may respond that they are unaware of any formal peer
20 reviewed studies that show negative impacts on human health from LED lights.
21 The counter to this argument is that the utility companies have installed LED
22 products without waiting for the FDA to study the health effects of LED light.
23 The FDA has not published studies on how spatially non-uniform LED light

1 affects the neurological system. The FDA has never stated that LED light is
2 safe.

3 In addition, there are many studies which show that the blue wavelength
4 light from LEDs is unsafe and that the square wave flicker from LEDs is unsafe.
5 Many of these studies are available on the Soft Lights Foundation website.¹³

6 Also, because LEDs have been released into society without waiting for
7 the peer reviewed studies, we have all now become subjects in a giant real-life
8 experiment. The personal stories of harm from LED light now form the basis of
9 a study. Many documented stories of harm can be found on the Soft Lights
10 Foundation website.¹⁴

11 B. Illuminating Engineering Society

12 A utility company may claim that the IES is studying the health effects of
13 LED light and is collaborating with the American Medical Association. This claim
14 is untrue. The IES is making no effort that we are aware of to study the health
15 effects of LED light and the AMA stopped investigating LED light after
16 publication of their 2016 report on the harms of blue wavelength light.¹⁵

17 The IES also falsely claims that LEDs are point sources and that LED light
18 has the same characteristics as High-Pressure Sodium. The IES has failed to
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22 ¹³ <https://www.softlights.org/resources/>

¹⁴ <http://www.softlights.org/stories/>

23 ¹⁵ <https://www.ama-assn.org/sites/ama-assn.org/files/corp/media-browser/public/about-ama/councils/Council%20Reports/council-on-science-public-health/a16-csaph2.pdf>

1 create a version of IES RP-8-18 that accounts for the spatial non-uniformity of
2 LED light. The IES has no standards that can be used for the photometric
3 layout of LED streetlights.

4 5 C. Industry Standards

6 A utility company may claim that they are simply using industry standard
7 equipment and that LEDs are what is available. The counter to this argument is
8 that utility companies are part of the industry, and it is their own decision to
9 switch to LEDs. The decision to switch to LED was a financial decision for utility
10 company which brought in new revenue. The claim that the utility company is
11 essentially forced to use LED streetlights because LEDs are what is available is
12 unsupported. As soon as the utility companies inform their suppliers that they
13 need High-Pressure Sodium or Low-Pressure Sodium streetlights, the supplier
14 will provide.

15 16 D. Light Quality

17 A utility company may claim that light quality is only subjective and
18 cannot be quantified. This is an untrue claim.

19 Spatially, light can be quantified as uniform or non-uniform and the
20 luminance in 3D space can be graphed. The higher the degree of uniformity,
21 the higher the quality.

22 Spectrally, light can be quantified in terms of whether the energy
23 distribution is the same across all wavelengths, or if the energy is smoothly

1 increasing from low blue to high red, or if the energy distribution has peaks and
2 valleys. Blue wavelength light is the most toxic in a nighttime environment, so
3 the more blue wavelength energy, the lower the quality of the light.

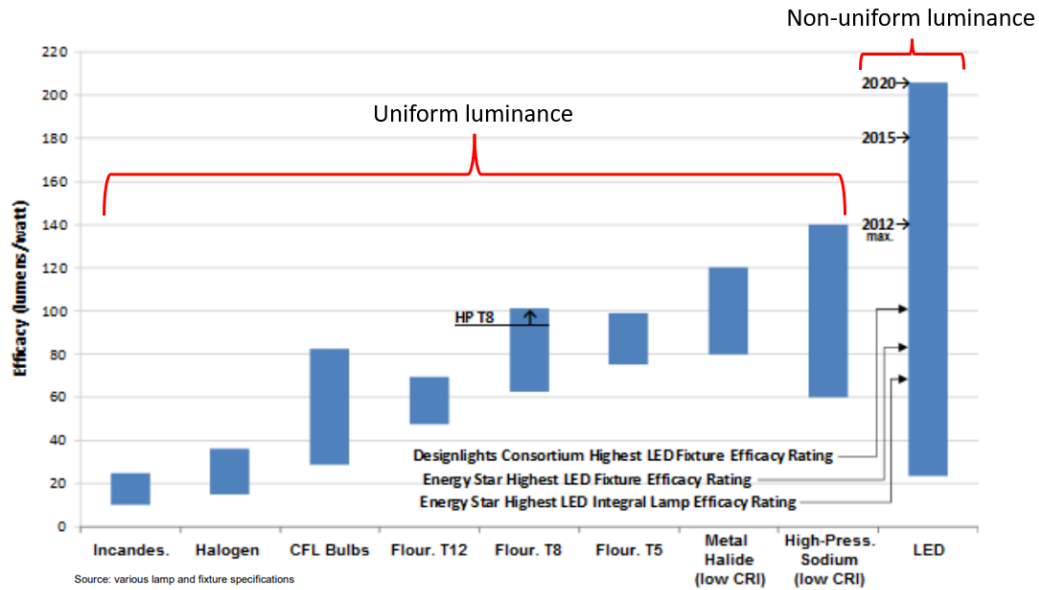
4 Temporally, sine wave flicker is higher quality than square wave flicker.

6 E. Energy Efficiency

7 A utility company may claim that LED streetlights are necessary for
8 saving energy. This is an untrue claim. High-Pressure Sodium streetlights are
9 already efficient. Replacing a 100-watt HPS with a 50-watt HPS would be a
10 50% energy savings without sacrificing safety and without introducing the
11 toxicity of LED light. Switching to Low-Pressure Sodium would save even more
12 energy.

13 Figure 4 is a luminous efficacy comparison of different lamp types. Notice
14 that LEDs are the only lamp type shown in the chart that emits non-uniform
15 luminance. Also notice that LEDs are similar in luminous efficacy to High-
16 Pressure Sodium. Not shown on the chart is Low-Pressure Sodium which has a
17 luminous efficacy approaching 200 lumens per watt, which is better than
18 LEDs.¹⁶

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¹⁶ <https://ieeexplore.ieee.org/abstract/document/605090>



Source: [Centerpoint Energy - https://www.centerpointenergy.com/en-us/Documents/Commercial-Industrial-Docs/Lighting-Guide.pdf](https://www.centerpointenergy.com/en-us/Documents/Commercial-Industrial-Docs/Lighting-Guide.pdf)

Figure 4 - Energy Efficiency Comparison

F. Color Rendering

A utility company may claim that LED streetlights provide superior color rendering. This is a claim that only serves to distract from the actual issues. At night, the key concern is contrast. Rod cells in the eye are 7 times more efficient than cone cells at converting light to signals, although with a loss of color determination. However, at night it is psychologically disturbing to see green grass when the surrounding environment is not illuminated by sunlight.

CRI is useful for indoor lighting, during daytime hours, when the goal is to emulate sunlight, such as in a classroom or office setting. However, at night when streetlights are in use, using high CRI lighting is counterproductive and unwanted.

IV. TARIFFS

A utility tariff is the pricing structure that the utility company charges the consumer for a service. The Iowa PUC regulates these prices and approves or rejects requests for price changes by the utility company. In the case of LED area and street lighting, the Iowa PUC has allowed the utility companies to reduce the quality of the light as compared to HPS and yet still charge the same rate as HPS. For example, the tariff sheet from Interstate Power and Light Company shows the same rate for a 7,500-9,000 lumen light of \$7.25, regardless of the fact that the LED emits a much lower quality of light, with the LED emitting toxic non-uniform luminance, piecewise spectral distribution, and square wave flicker.

Lights:

<u>Lumens Range</u>	<u>LED Typical (Watts)</u>	<u>HPS Wattage</u>	<u>Monthly kWhs (Range)</u>	<u>All Rates</u>
3,000 – 4,500	45 & below		15 - 22	\$ 7.25
5,000 – 6,500	46 - 69	70 & below*	22 - 34	\$ 7.25
7,500 - 9,000	70 - 89	100	28 - 45	\$ 7.25
9,500 - 16,000	90 - 110	150	36 - 67	\$ 8.50
12,500 - 27,500	111 - 140	250	50 - 104	\$15.85
15,000 - 50,000	141 - 270	400	100 - 160	\$21.53
		1,000	370	\$49.46

Figure 5 - Lighting Tariffs¹⁷

¹⁷

https://wcc.efs.iowa.gov/cs/idcplg?IdcService=GET_FILE&allowInterrupt=1&RevisionSelectionMethod=latest&DocName=1719268&noSaveAs=1

1 The Iowa PUC has an obligation to protect the consumer and the
2 ecosystem from this type of reduction in quality of service. The FDA has not yet
3 approved LED products and has not published the safety regulations for LED
4 products. In addition, low-quality LED light is devastating for human health and
5 the ecosystem. To discourage the use of low-quality LED light products, the
6 Iowa PUC should set the tariffs for LED street and area lights to be substantially
7 higher than for HPS and LPS.

8 **IV. REGULATORY AUTHORITY**

9 The Iowa Administrative Code Chapter 199 provides authority to the Iowa
10 Utilities Board to regulate the actions of the utility companies.
11

12 **1.4 Duties of Commission**

13 The board regulates electric, gas, telephone, and water utilities; and certain sanitary sewer
14 and storm water drainage facilities. The board regulates the rates and services of public
15 utilities pursuant to Iowa Code chapter 476; certification of electric power generators
16 pursuant to chapter 476A; construction and safety of electric transmission lines pursuant
17 to chapter 478; and the construction and operation of pipelines and underground storage
18 pursuant to chapters 479, 479A and 479B.

19
20 As described in chapter 199.1.4, the Iowa PUC is directed to regulate the
21 rates and services provided by utility companies. As indicated by the tariff
22 sheets, the Iowa PUC regulates the types of lights used for street and area
23 lighting. The Iowa PUC therefore has authority to regulate the quality of light

1 emitted by area and street lights to ensure the protection of the public health
2 and welfare.

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4 **V. RELIEF**

5 The Soft Lights Foundation respectfully requests the Iowa Utilities Board
6 to take the following actions:

- 7 A. Require Iowa utility companies to wait for FDA approval and regulation
8 of LED products prior to the sale or installation of any LED area or
9 streetlight.
- 10 B. Adjust the utility tariffs for street and area lights to properly reflect the
11 difference in light quality and damage to human health and the
12 ecosystem. The tariff rate charged for the low-quality LED light
13 product should be set substantially higher than the rate charged for
14 the higher quality HPS or LPS product.
- 15 C. Direct Iowa utility companies to inform consumers via their website
16 that:
- 17 i. LEDs have not been approved by the FDA and that the FDA has
18 not developed regulations for LEDs;
 - 19 ii. LED light is a low-quality light, not an energy efficient light;
 - 20 iii. LED light has been shown to cause significant negative health
21 effects.
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