



OPERATION  
**DARKSKY**

PILOT PROJECT BY

**LUMICAN**

## “Operation Dark-Sky”

We are inviting municipalities interested in environmentally conscious lighting to participate in a pilot program evaluating our unique ‘dark sky friendly’ streetlights designed to protect the environment and our communities.

## ABOUT US

Lumican is a mission-based company committed to reversing light pollution. Our mission is to provide innovative market-driven solutions that reverse light pollution, reduce energy consumption, improve the health and safety of our communities and protect the environment.

Light pollution is not commonly understood, the information in this package is intended to highlight the key issues and introduce a potential solution available to municipalities.

## LIGHT POLLUTION IS REVERSIBLE

Unlike other types of pollution, light pollution is completely and immediately reversible. We can enjoy the full restoration of our night skies and complete reversal of the myriad health, safety, and environmental impacts of light pollution **immediately upon correcting the problem.**



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LED streetlights are quickly being adopted by municipalities because of their significantly lower energy and maintenance costs. The speed of adoption and long lifespan means that **many communities will be stuck with light polluting LEDs for decades.**

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## LED STREETLIGHTS EQUAL ENERGY SAVINGS

### ENERGY BILL SAVINGS

Municipalities that switch their streetlights to LED have significantly lower energy costs. LED streetlights are 40-60% more energy efficient than traditional forms of lighting; when paired with smart controls such as dimmers or sensors, they can become as much as 80% more energy efficient.<sup>1</sup> When the city of Los Angeles installed more than 150,000 LED streetlights, **their annual energy usage decreased by 63%, saving the city \$8 million a year in energy costs.**<sup>2</sup>

### MAINTENANCE COST SAVINGS

Decreased maintenance costs also account for a substantial part of the overall savings involved in adopting LED streetlights. LEDs have a much greater lifespan than alternative light sources, **ranging from 25,000 to 300,000 hours.** Also, the components of LED streetlights are less fragile and can withstand extreme weather conditions better than those found in other forms of lighting. This all adds up to less money spent on upkeep. In LA, **annual streetlight repairs went from 70,000 to 46,000 after the switch.**<sup>3</sup>



### CARBON FOOTPRINT

Energy savings for municipalities **translate directly into reduced carbon emissions**, even more so in areas that still get energy from coal powered plants.

## LED STREETLIGHTS AND LIGHT POLLUTION

Streetlighting is the main contributor to light pollution, mainly due to poorly designed fixtures. New LED fixtures are often significantly brighter than the lights that they replace, and very rarely shielded. What's more, the blue-rich light produced by LEDs has been found to contribute to light pollution more than warm light from older sources.<sup>4</sup>

The image below shows a satellite view of Los Angeles from 2010, and again in 2012 after they began their transition to LED streetlights. Because blue light cannot be captured by satellites, the ground-level light pollution is actually *underrepresented* in the second photo.<sup>4</sup>



Over time, areas of the Earth that are already artificially lit have only grown brighter and brighter. From 2012 to 2016, artificially lit areas expanded by 2.2% per year, with a total radiance growth of 1.8% per year.<sup>5</sup> In the United States, municipalities have already installed over 5.7 million LED street and area lights.<sup>6</sup> With so much emphasis put on the energy efficiency of LEDs, we have eagerly adopted this technology with little to no thought about the unintended consequences.

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*“The transition from sodium lights to LEDs, the so-called ‘lighting revolution,’ was supposed to reduce energy consumption and bring back starry skies, but new satellite data indicate it’s not working out that way.”*

*– Jan Hattenbach, Sky & Telescope*

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## THE PROBLEM WITH LIGHT POLLUTION

Many municipalities are becoming aware of light pollution and the negative effects of blue-rich light due to push back from concerned citizens and recommendations from institutions including the American Medical Association (AMA) and the International Dark-Sky Association. In 2016, the **AMA published a study showing that exposure to blue-rich light at night negatively affects human health, road safety, and the environment.**<sup>7</sup>



### HEALTH

Exposure to blue-rich light at night impacts human health negatively, interfering with the production of melatonin and thus our crucial circadian rhythms of activity and rest. It has been repeatedly linked to disrupted sleep, depression, weight gain, breast cancer, and several other health issues by independent peer-reviewed studies.



### ENVIRONMENT

Blue-rich artificial light at night has harmful effects on all types of wildlife, flora and fauna alike, but especially birds, mammals, insects and aquatic life. Exposure to light pollution disrupts natural daily and seasonal rhythms of behavior, development, and reproduction, even in migratory species that only use cities as brief stopover points.



### SAFETY

The bright white light from LED streetlights creates glare that reduces driver visibility. The effect is worse in poor driving conditions because blue light reflects off of water vapor more than amber light, making blue-white LEDs less effective in rain, fog and snow.

This bright blue-white light also causes what are called “star-bursting” visual disturbances, especially in drivers over 40 years old who are losing their 20/20 vision – the majority of the driving population.



### SKYGLOW

Blue-rich light travels further through the atmosphere and creates more skyglow than amber light. Skyglow is slowly erasing our view of the stars, which hurts recreational stargazing and professional astronomy alike. More and more people are organizing to protect the visibility of our stars, including the Royal Canadian Astronomy Association and Light Efficient Communities (LEC). These groups uniformly recommend warmer color temperature lights.

## THE PROBLEM WITH BLUE LIGHT


Correlated color temperature (CCT) is measured in degrees Kelvin, with lower Kelvin indicating a warmer light source.



**1,900K**  
Candle



**2,200K**  
High Pressure Sodium Lamp

 Lumicana  
LED Street Light



**2,700K-3,000K**  
Warm White Halogen Incandescent



**4,000K-4,500K**  
Natural White Metal Halide



**4,800K**  
Direct Sun



**5,000K-6,000K**  
Day White LED Light  
Cool White LED Light

Color temperature is a quantitative measurement of the qualitative appearance of white light. Lights that have high color temperatures produce more blue wavelengths, making them appear “cooler” or bluer. Conversely, lights with low color temperatures produce more yellow, orange, and red wavelengths, making their illumination appear “warmer.”

In the past few decades, the international standard for streetlighting has been high-pressure sodium (HPS) lamps. These lights produce the warm amber illumination that people are used to, approximately 2,200K. Unfiltered white LED light is 6,500K – and **it is the high blue content in this light that is the problem.**

Blue wavelengths are shorter than those of most of other colours, which means they are more reflective, and prone to scattering which is problematic for light pollution. (In fact, the disproportionate scattering of blue light is why the sky is blue.) Blue wavelengths also inhibit melatonin production in animals, because we have evolved to associate the blue sky with daytime.

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*“Recognizing the detrimental effects of poorly-designed, high-intensity LED lighting, the AMA encourages communities to minimize and control blue-rich environmental lighting by using the **lowest emission of blue light possible to reduce glare.**”*

- American Medical Association Press Release

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## EFFECTS OF BLUE LIGHT AT NIGHT ON HUMAN HEALTH



Exposure to artificial light at night, particularly blue-rich light, is harmful to human health. Numerous studies have showed that exposure to artificial light at night inhibits the production of melatonin in a wide variety of animals, including humans. This disrupts the circadian rhythm, our natural sleep and wake cycle, leading to a variety of sleep disorders including insomnia and sleep deprivation syndrome. The decrease in melatonin and disruption of sleep can snowball into serious health conditions including obesity, diabetes, depression, and cancer. Research teams at Tulane School of Medicine discovered that not only does exposure to blue-rich light at night lead to increased cancer risk, it also renders chemotherapy drugs ineffective because of its inhibition of melatonin, a known antioxidant and anti-carcinogen.<sup>8</sup>

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Blue-rich LED streetlighting is five times more effective at suppressing melatonin production than high pressure sodium lamps, given the same light output.

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## EFFECTS OF LIGHT POLLUTION ON THE ENVIRONMENT



### NOCTURNAL ECOSYSTEMS ARE FRAGILE

*"When we add light to the environment, that has the potential to disrupt habitat, just like running a bulldozer over the landscape can."*

– Chad Moore, National Park Service

Wildlife depends on a daily cycle of light and dark. Exposure to artificial light at night can affect the behavior and survival of a wide variety of nocturnal animals, by altering their movement throughout the landscape – causing disorientation, misorientation, attraction to or repulsion from a light source – and accelerating or slowing their development over the course of the year. And animals need sleep too, of course, and are not exempt from the inhibitory effect of artificial light on melatonin. In these ways, artificial light can impact the foraging, migration, communication, and reproduction of animals, with the potential to lead to the collapse of entire populations, or even entire species.<sup>9</sup>

Crops and trees are also vulnerable to artificial light.<sup>10</sup> Constant exposure to light, common in urban centers, poses a novel threat to photosynthetic species, all of which have evolved under a consistent balance of day and night. Urban skyglow can impact yearly production rates of agriculture, especially in farming areas that are close to large city centers.

Flowering plants rely on both daytime and nighttime pollinators. One recent study has shown that artificial light at night reduces the visits of nocturnal pollinators by 62%.<sup>11</sup> This study also showed that visits from daytime pollinators cannot make up for this decline in visitation at night. Because of this, plants that were exposed to artificial light at night showed a 13% reduction in fruit production.<sup>11</sup>

## A GLARING PROBLEM

*"Glare has a strong effect on the normal visual function, causing a serious threat to safety. The cumulative effect of glare also threatens the physiological health of the human body. So, it's very important to reduce the glare on roadways."*

– Yadan Lin

Associate Professor and Director of the Vision and Color Research Laboratory at Fudan University

Blue-rich white light from LED streetlights looks brighter to the human eye than the warm light from HPS lamps, even when the two light sources are illuminating at the same intensity (in lux). Studies have shown that discomfort glare, which makes it harder for the eye to focus on objects, peaks in the blue part of the spectrum. Full cutoff shields can dramatically reduce discomfort glare and light leakage.

*"High-intensity LED lighting designs emit a large amount of blue light that appears white to the naked eye and create worse nighttime glare than conventional lighting. Discomfort and disability from intense, blue-rich LED lighting can decrease visual acuity and safety, resulting in concerns and creating a road hazard."*

– AMA Report: Human and Environmental Effects of LED Community Lighting

## CRIME AND STREET LIGHTING



### BRIGHTER ISN'T ALWAYS BETTER

*"We can have very little confidence that improved lighting prevents crime, particularly since we do not know if offenders use lighting to their advantage."*

- National Institute of Justice Report to Congress

Although people often equate more light with more safety, this is not necessarily always the case. The few studies conducted to date on the relationship between street lighting and crime have produced inconclusive results: one 2007 review of lighting experiments in North American cities showed that increased street lighting did not coincide with a drop in crime rates in some cities, but did in others; even in places that showed a decrease in crime, the results were inconsistent.<sup>12</sup> Other studies have shown a correlation between brightly lit alleyways and crime, pointing to the fact that more light allows criminals to see in cars without a flashlight, which could otherwise alert someone to their presence, and also gives criminals the visibility needed to "case" a scene, i.e. determine if anyone is around.<sup>13</sup> Additionally, improperly shielded and overly bright lighting casts dark shadows in which criminals can hide.

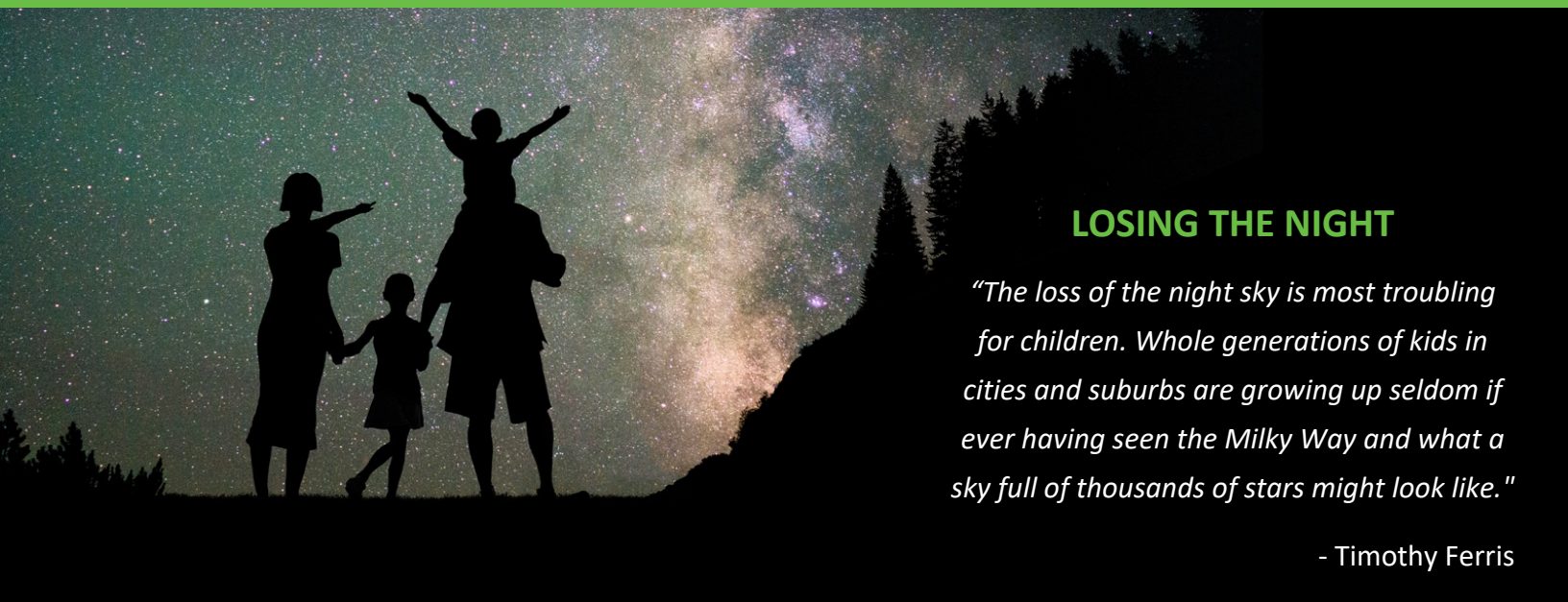


On the left, the man cannot be seen beyond the glare from the nearby house light.

On the right, the man becomes visible when the glare is manually shielded.



## ERASING OUR VIEW OF THE STARS



### LOSING THE NIGHT

*"The loss of the night sky is most troubling for children. Whole generations of kids in cities and suburbs are growing up seldom if ever having seen the Milky Way and what a sky full of thousands of stars might look like."*

- Timothy Ferris

The cloudy haze of light pollution is a barrier separating us from the wider universe, and one that is only getting wider with time. Entire generations of kids have grown up ignorant of the night sky that inspired their ancestors and gave rise to the modern age of science and technology. Meanwhile, professional astronomers have to travel further and further away from civilization to view the stars, while their local observatories become obsolete due to increasing sky glow.

SKYGLOWPROJECT.COM

The Bortle Scale, shown here, is a method of quantifying night sky brightness above a particular location. Color ratings are determined by the visibility of celestial objects such as constellations and planets, which are obscured by light pollution.

## ASTRO TOURISM



Only 20% of North Americans and 40% of Europeans can see the Milky Way from where they live,<sup>5</sup> and many of these people are beginning to feel its absence. A growing number of communities and private properties have made the conscious choice to switch to dark sky friendly lighting, in order to do their part to preserve and protect the night sky. Meanwhile, the new industry of “astrotourism” has blossomed, as people begin to search for locations that offer an unpolluted view of the night sky.

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The town of Jasper holds an annual Dark Sky Festival attracting local and international visitors, which keep the town bustling at about 90% capacity for two weeks, during a time that would otherwise be the quietest of the year. Northumberland, U.K., attribute their ability to maintain dark sky status to many of the 1.5 million visitors that come each year, ensuring year-round business.<sup>14</sup>

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In 2017, the world's largest travel fair focused on astrotourism as one of its main topics.<sup>15</sup> Star parties and dark sky festivals are popping up in pace with growing public interest in stargazing, astronomy, and northern lights. One survey conducted after the 2018 solar eclipse showed that 20 million adults traveled from their home to another area specifically to be able to better view the solar eclipse.<sup>16</sup>

## LIGHT POLLUTION IS COMPLETELY REVERSIBLE

### AN IMMEDIATELY REVERSIBLE PROBLEM

We can enjoy the full restoration of our night skies and complete reversal of the myriad health, safety, and environmental impacts of light pollution **immediately upon correcting the problem.**

In 1994, an earthquake in Los Angeles caused the power grid to go down at around 4:30 AM. People went out on the streets – a recommended thing to do during an earthquake – and, looking up, saw the stars. Many saw the Milky Way for the first time. That morning, 911 was flooded with calls from concerned citizens who were confused and alarmed by what they saw in the sky, completely unfamiliar with a natural view of the stars.

### RECOMMENDATIONS FOR OUTDOOR LED LIGHTING

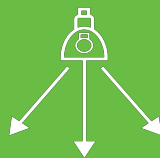
International Dark Sky Association recommendations for outdoor LED lighting are as follows:

- ✓ Choose fully shielded fixtures that emit no light upward
- ✓ Choose “warm-white” or filtered LEDs to minimize blue content
- ✓ Employ adaptive controls such as dimmers, timers, and motion sensors
- ✓ Consider dimming or turning off lights during low-traffic hours
- ✓ Avoid the temptation to over-light because of the cheap brightness of LEDs
- ✓ Only light the relevant area in the amount required for particular tasks

Light only where,  
and when needed.



Properly shield all  
outdoor lights.



Use dimmers,  
timers, and sensors.



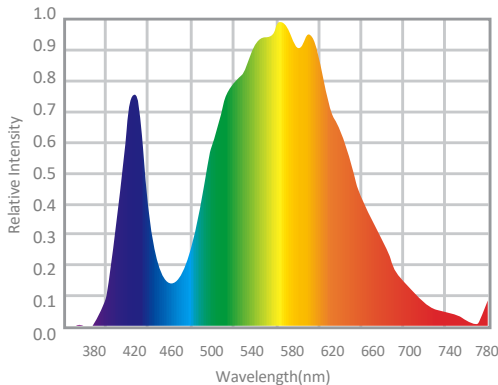
Use the lowest blue  
content possible.





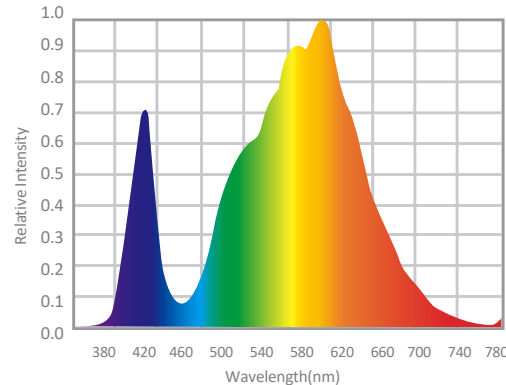
**SOLUTION: REMOVE THE BLUE**

NOTE: The measurements shown below were taken outside with a professional-grade spectroradiometer.



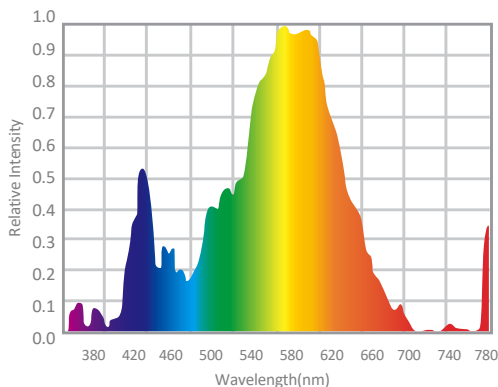
**4000K**

Notice the blue peak in a 4000K LED (Leotek). This light is a common choice for municipalities.



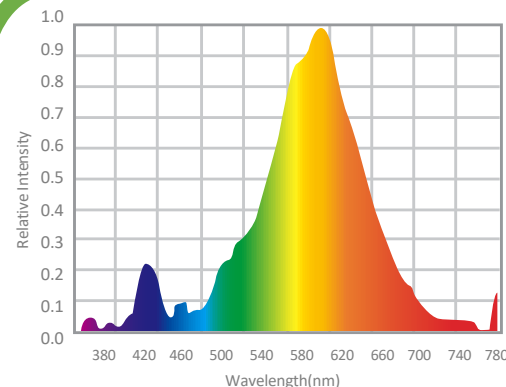
**3000K**

Again, we see a strong blue peak produced by this 3000K LED (Phillips). This is another common choice of municipalities.



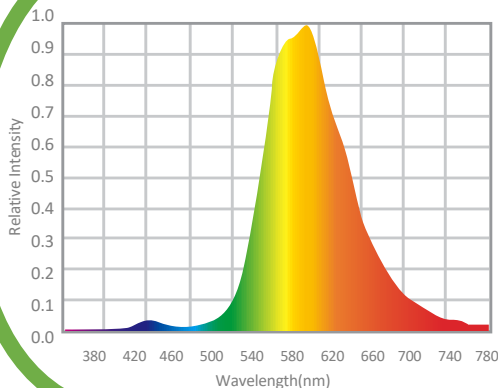
**2700K**

This is the lowest CCT LED made by our competitors. The blue content is lower than the 4000K, but still in the harmful range.



**2200K**

Our Lumicana 2200K LED imitates the warm amber glow of HPS lamps, which communities strongly prefer.



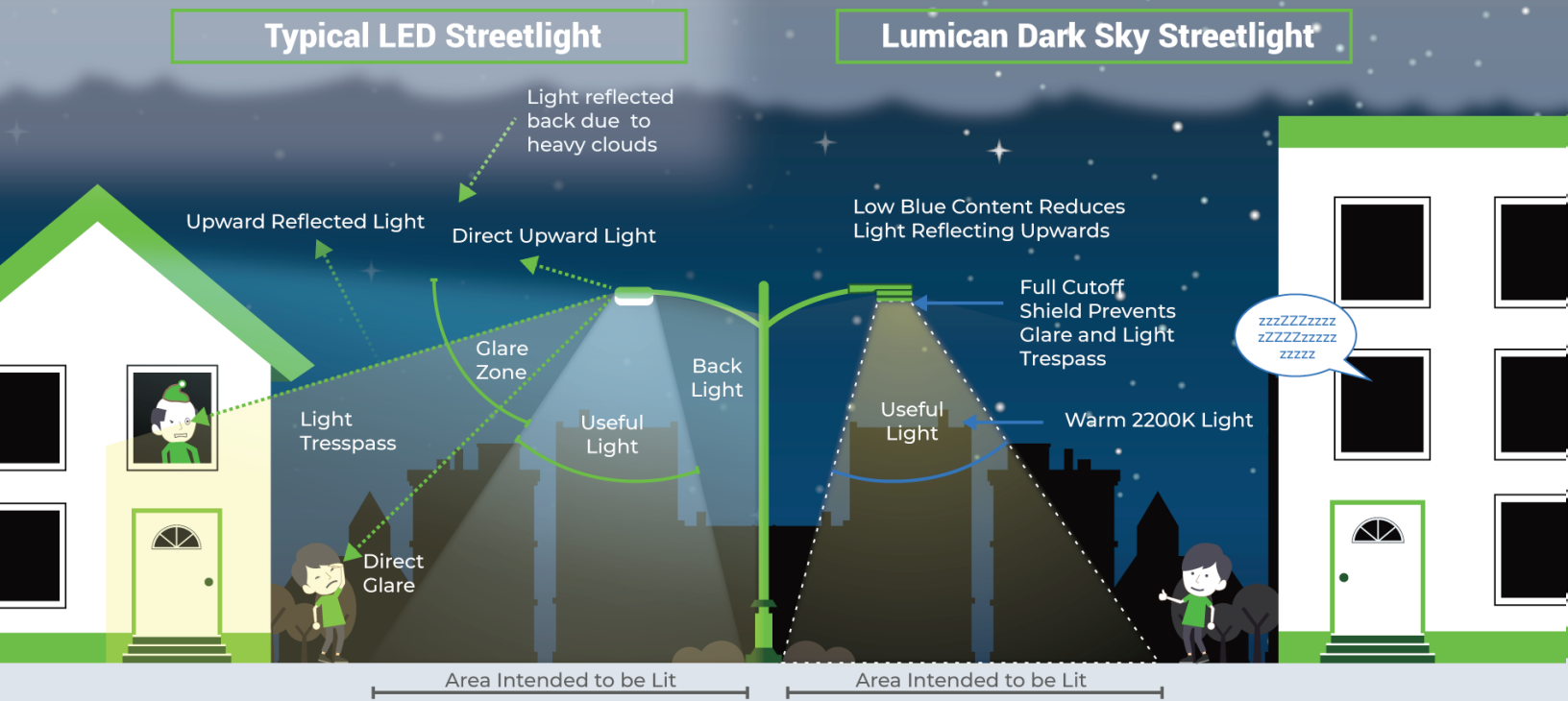
**1700K**

Our brand new Lumicana 1700K LED has the lowest blue content of any LED streetlight on the market by far.

**LUMICAN LIGHTS HAVE THE LOWEST BLUE CONTENT**

These graphs show the spectral distribution of five LED light sources, *i.e.* the range of colors each produces. The dark blue on the left is the problematic blue light which experts recommend be kept at 'lowest possible' levels. **Truly low levels of blue light are only achieved at 2200K and 1700K.**

**SOLUTION: SHIELDING LIGHT TRESPASS AND GLARE**



**COMPARE: SHIELDING TO REMOVE LIGHT TRESPASS AND GLARE**

We are first to design full cut-off modular shields that not only direct the light downward, but also shape it where you want the light pattern, in order to reduce light trespass. This decreases glare and improves visibility, while also drastically reducing the refraction of light during rain, snow and fog that can make poor driving conditions.



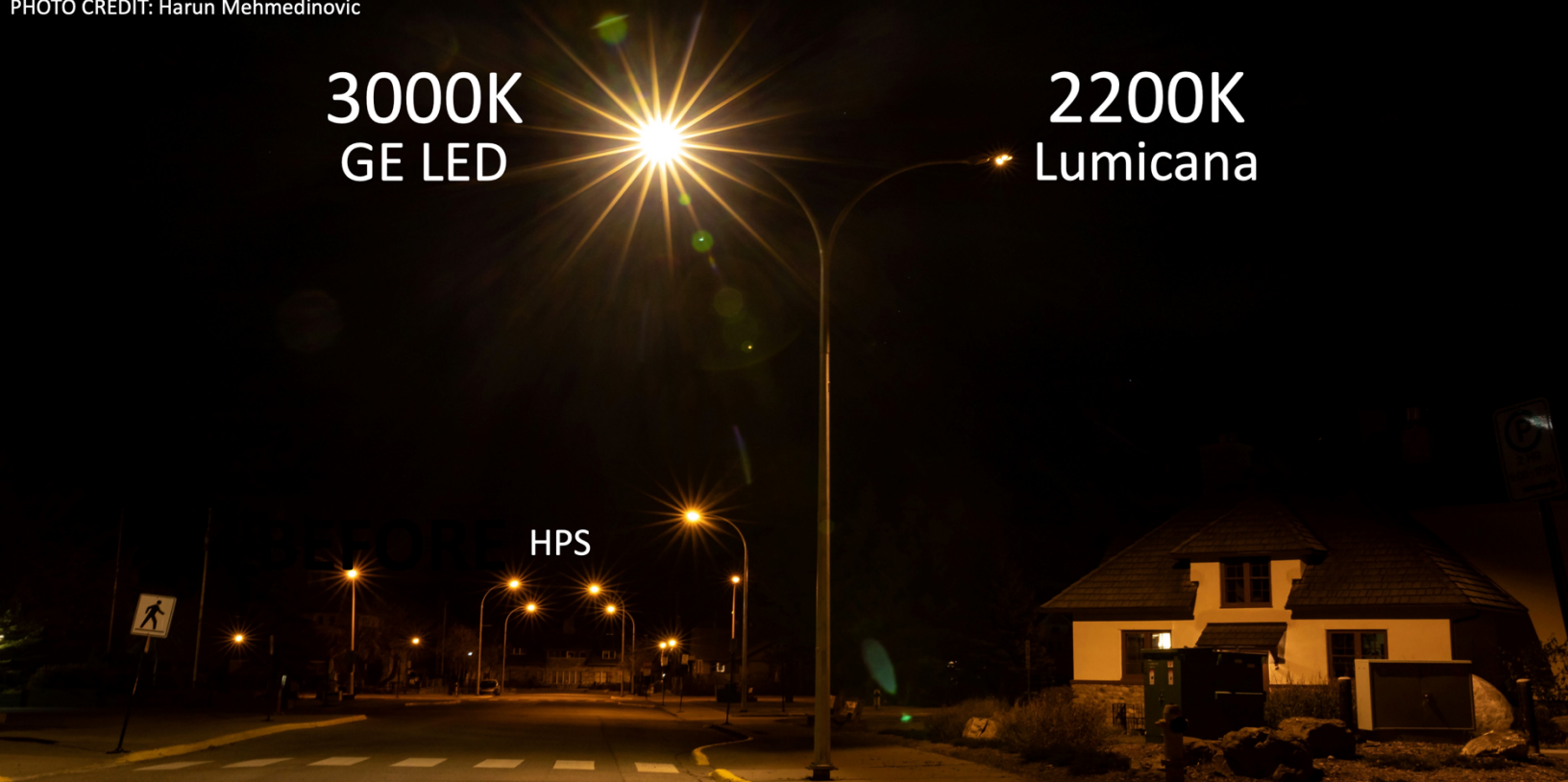
A lack of shielding causes light trespass into the windows of this home



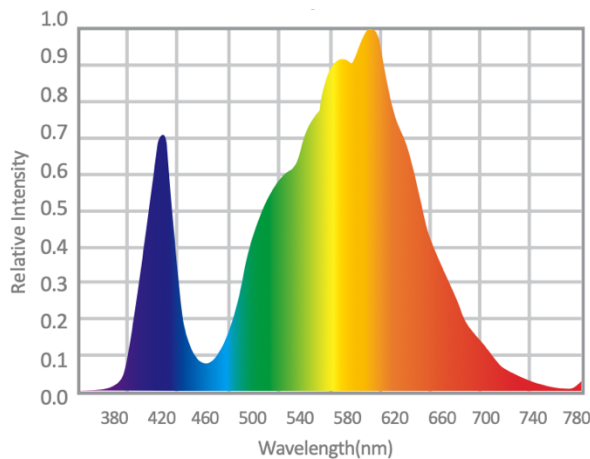
Our modular shield completely eliminates light trespass

**COMPARE THE GLARE**

PHOTO CREDIT: Harun Mehmedinovic

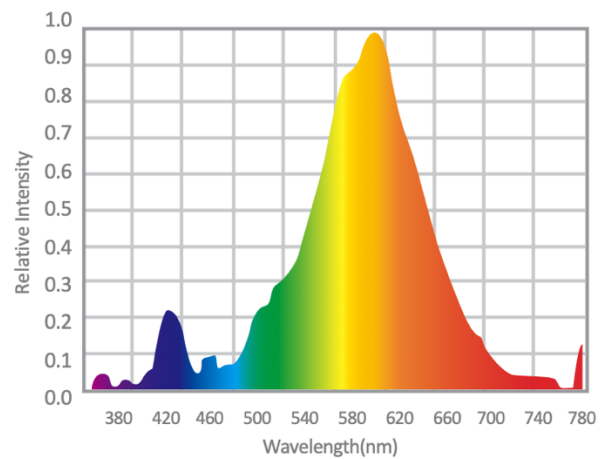


Note: Notice the photo above is comparing these lights on a dual head pole. The building on the right is a historic library and the intention was to illuminate the building and parking lot.



**3000K**

Notice the pronounced peak of blue light emission and the lack of shielding which causes blinding glare and light scatter



**2200K**

Our warm fully-shielded fixture matches the amber glow of traditional HPS lighting, without any dangerous glare

## MEET OUR DARK SKY FRIENDLY STREETLIGHT

### LOWEST BLUE

This 2200K color temperature luminaire emits negligible amounts of blue light, achieving the lowest color temperature in the LED streetlighting market.

### IDEAL COLOR TEMPERATURE

Our Lumicana fixture was designed with an innovative core technology allowing us to achieve the familiar, warm amber glow of traditional high pressure sodium (HPS) lamps while maintaining efficiency.

### MODULAR SHIELDS

Our modular shield allows municipalities to shape the cone of illumination to fit the needs of each individual neighborhood, and direct light where it is needed and block where it isn't. The dramatic reductions in light leakage that result have earned us the first ever zero B.U.G. rating.

### SMART

Our LED luminaires are 'control ready' to be easily integrated into systems of dimmers, timers, sensors and other smart technologies that meet the specific needs of each area. We like dimming technology that automatically turns lights down during low traffic periods, decreasing light pollution and power consumption even further.

### LONGER LIFESPAN

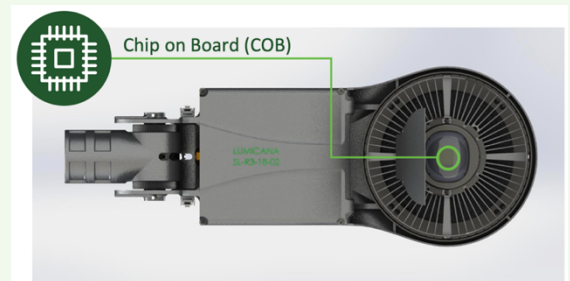
Innovative cooling technology is the key differentiator to our longer lifespan and higher efficacy. This allows us to run LEDs in excess of 100,000 hours, with even greater efficiency in the range of 140-280 lumens per watt, depending on input voltage and light distribution.

### HIGHLY EFFICIENT

Our efficiency ratings are among the highest for lowest correlated color temperature (CCT Value). Our streetlights will earn municipalities significant savings both in total energy consumption and reduced maintenance costs.

### IDA APPROVED

After undergoing an extensive evaluation, our shielded 2200K streetlights have been awarded the International Dark-Sky Association Fixture Seal of Approval.





## A COLLABORATIVE PILOT PROJECT

**Our pilot project is a collaboration of proactive concerned citizens, not-for-profit organizations, local governments, and growing companies that care about light pollution.** We are proud of this work and delighted to support better lighting, better health and safety and a better environment with our innovative, efficient, environmentally friendly streetlight.

### APPLY TO PARTICIPATE IN THE PILOT PROJECT

**Submit the application form accompanying this package by email to [darksky@lumican.com](mailto:darksky@lumican.com).**

**If an application form was not provided,  
email us to request an application for the pilot project.**

Successful applicants will have a test site installed with dark-sky friendly 2200K streetlights. Our research department works to find grants and rebates to fund energy-efficient lighting upgrades, and we are happy to provide support to applicants throughout the submission processes.

## PROTECTING OUR STARRY SKIES FOR FUTURE GENERATIONS IS A SHARED RESPONSIBILITY

## Thank you for joining us on our journey to reverse light pollution!

To learn more about light pollution, visit the International Dark-Sky Association at [darksky.org](http://darksky.org). As the recognized authority on light pollution, the International Dark-Sky Association leads the way globally in the mission to preserve the night.

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- 1 The Climate Group LED Report - [theclimategroup.org/sites/default/files/archive/files/LED\\_report\\_web1.pdf](http://theclimategroup.org/sites/default/files/archive/files/LED_report_web1.pdf)
  - 2 U.S. Department of Energy LED Adoption Report - [energy.gov/sites/prod/files/2015/07/f24/led-adoption-report\\_2015.pdf](http://energy.gov/sites/prod/files/2015/07/f24/led-adoption-report_2015.pdf)
  - 3 Spec Grade LED - [specgradeled.com/energy-efficient-led-street-lighting-offers-enormous-cost-savings](http://specgradeled.com/energy-efficient-led-street-lighting-offers-enormous-cost-savings)
  - 4 Kyba CCM. Is light pollution getting better or worse? *Nature Astronomy*. 2018; doi:10.1038/s41550-018-0402-7
  - 5 Falchi F, Cinzano P, Duriscoe D, Kyba CCM, Elvidge CD, Baugh K, *et al*. The new world atlas of artificial night sky brightness. *Science Advances*. 2016;2: e1600377.
  - 6 IEEE Spectrum - [spectrum.ieee.org/green-tech/conservation/led-streetlights-are-giving-neighborhoods-the-blues](http://spectrum.ieee.org/green-tech/conservation/led-streetlights-are-giving-neighborhoods-the-blues)
  - 7 American Medical Association - [ama-assn.org/ama-adopts-guidance-reduce-harm-high-intensity-street-lights](http://ama-assn.org/ama-adopts-guidance-reduce-harm-high-intensity-street-lights)
  - 8 Tulane University - [ohr.tulane.edu/news/releases/pr\\_072514.cfm](http://ohr.tulane.edu/news/releases/pr_072514.cfm)
  - 9 Davies TW, Smyth T. Why artificial light at night should be a focus for global change research in the 21st century. *Global Change Biology*. 2017;24: 872–882.
  - 10 Bennie J, Davies TW, Cruse D, Gaston KJ. Ecological effects of artificial light at night on wild plants. *Journal of Ecology*. 2016;104: 611–620.
  - 11 Knop E, Zoller L, Ryser R, Gerpe C, Hörler M, Fontaine C. Artificial light at night as a new threat to pollination. *Nature*. 2017; doi:10.1038/nature23288
  - 12 City Lab - [citylab.com/equity/2014/02/street-lights-and-crime-seemingly-endless-debate/8359/](http://citylab.com/equity/2014/02/street-lights-and-crime-seemingly-endless-debate/8359/)
  - 13 Illinois Criminal Justice Info Authority - [darksky.org/wp-content/uploads/2014/09/Chicago-Alley-Lighting-Project.pdf](http://darksky.org/wp-content/uploads/2014/09/Chicago-Alley-Lighting-Project.pdf)
  - 14 Daily Mail - <http://www.dailymail.co.uk/travel/article-2520721/Northumberland-site-Europes-l>
  - 15 Inquirer - [lifestyle.inquirer.net/256448/astro-tourism-bicycle-tourism-take-spotlight-in-worlds-largest-travel-fair](http://lifestyle.inquirer.net/256448/astro-tourism-bicycle-tourism-take-spotlight-in-worlds-largest-travel-fair)
  - 16 University of Michigan - [news.umich.edu/a-record-number-of-americans-viewed-the-2017-solar-eclipse](http://news.umich.edu/a-record-number-of-americans-viewed-the-2017-solar-eclipse)

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