

HIDDEN PLANET

LED lights are meant to save energy. They're creating glaring problems

(Data from National Park Service)

At night, bright stars often blanket the dark sky. At least, they used to.

 Enable evening sounds

As societies developed, stars became less visible on the horizon. In one county in Washington state, the clarity of the night sky was marred by lights radiating upward and obscuring the view. This light pollution would only grow worse.

Chelan County, 2018

 Enable evening sounds

An unexpected increase in pollution came after Chelan County shifted to LED streetlights, which shine brightly while using less energy than traditional bulbs. One year after the change began, the additional glare masked about half of the previously visible stars.

Chelan County, 2019

 Enable evening sounds

What happened there is not unique.

 Enable evening sounds

By Kasha Patel, Kati Perry, Daniel Wolfe and Emily Sabens

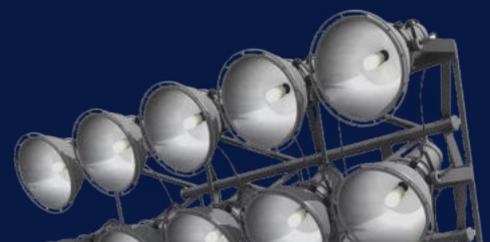
June 23 at 6:00 a.m.



In recent years, cities, towns and small communities across the world have taken part in a radical revolution — of our lightbulbs. Traditional orange-tinged high-pressure sodium bulbs are being swapped for more energy-efficient, whiter and brighter LED (light-emitting diode) lights. But the rise of LEDs is also illuminating new problems for our night sky, as well as our health.

Over the past decade, scientists found, the night sky has become nearly 10 percent brighter each year because of artificial lights, mainly LEDs emitting too much glare. Streetlights are part of the problem, as are sources such as illuminated billboards and stadium lights.

Those same outdoor lights are also affecting our health. Common types of LED lights contain higher proportions of bluer wavelengths, which



can affect people's nighttime patterns. They disrupt our circadian rhythms, lower the performance of our immune systems and increase the occurrence of certain diseases, including cancer.

"People need to understand LED lights are being installed everywhere, not just streetlights, but they're blasting up in all directions," said Jim White, senior energy efficiency engineer with the Chelan County Public Utility District who helped with the county's LED transition.

But he added, "It's one form of pollution that we could solve."

Agencies and organizations such as the National Park Service and the American Medical Association have recommended ways to reduce light pollution and its harmful effects on life. The changes begin with what type of LED light to buy in the first place.

Shedding light on the issue

The concern has come to light in recent years with the emergence of new LED technology. LED lights are the Olympic marathon runners of light bulbs: They consume up to 90 percent less energy and can last up to 25 times longer than traditional incandescent lights.

As the most energy-efficient bulb on the market, it's no surprise that so many people are adopting the technology. The Energy Department estimated LEDs made up about 19 percent of all lighting installations in 2017, saving about 1 percent of total energy consumed in the United States. By 2035, the lights are



Lights near stadiums can often be the brightest light source of a city and can be minimized by using timers or dimmers.

expected to comprise 84 percent of lighting installations. Roadways, parking, building exteriors and area lights — which are applications typically high in lumens, a measure of brightness — are expected to see nearly full conversion to LED lights by 2035.



LED lights at lower temperatures, preferably at 2700 Kelvin or lower, emit less blue light and should be used when possible.

White was excited to have Chelan County, located in the middle of the state with a population of about 80,000 people, be part of the LED light revolution. Starting in 2014, the Chelan County Public Utility District began meeting with local governments, communities and agencies to discuss what it would take to replace their streetlights. In 2018, it embarked on a \$1.9 million project, partially funded by a state grant from the Washington State Department of Commerce, to replace nearly 3,700 high-pressure sodium streetlights

(about 60 percent of their outdoor street and area lights) with LEDs.

The energy savings were discernible. After the transition, the new lights conserved 2,612,491 kilowatt-hours — enough to power about 120 all-electric homes in the county for a year.

But there were downsides, too: Researchers with the National Park Service found the LED lights washed out more of the stars, particularly near the horizon.

“You can tell the lighting gets bigger, so it extends higher into the sky ... the entire sky got brighter,” said Li-Wei Hung, an astronomer with the National

Park Service who published a study on the LED transition in Chelan County. “Just a few years ago, this [was] really new knowledge for us. Does the change to LEDs really decrease the light pollution or increase it? We [didn’t] exactly know.”

Camera data showed the sky over local Burch Mountain was 60 percent brighter after the county completed the switch in 2019 compared with 2018. The new artificial light stood at 3.69 times the natural light level after the transition; before the transition, artificial lights generated 2.30 times the natural light. White said the increased pollution was “a total surprise” because the Public Utility District had tried to direct lights toward the ground, but the light still scattered.

Detailed nightglow data from individual cities is hard to come by, making the transition in Chelan County an important case study in understanding both the good and bad effects of LED lights. Yet observations and anecdotes indicate Chelan County is not alone. From 2011 to 2022, reports from citizen scientists indicated the average night sky got brighter by 9.6 percent each year, which researchers attribute to LED light replacements. Some cities, such as D.C., paused a transition to LEDs after residents complained about the bright lights disrupting their sleep.

The bluer LED lights clearly outline
Baltimore’s metro area when viewed
from the International Space Station.

Baltimore

*Chesapeake
Bay*

Meanwhile, older amber-colored lights
of the D.C. metro area have a
contrasting orange glow.

Maryland and
D.C. border

Source: NASA, September 15, 2020

But why does light from LED bulbs appear more prominent in the night sky than other types of lighting? The answer lies in LED's blue light.

The problems with blue light

LED lights emit more blue light than regular bulbs. Blue light travels at shorter wavelengths (450 to 495 nanometers) and higher frequencies, causing air particles to oscillate faster and scatter in the atmosphere more than other colors. The blue is redirected in several different directions across the sky. That's also why our sky appears blue.



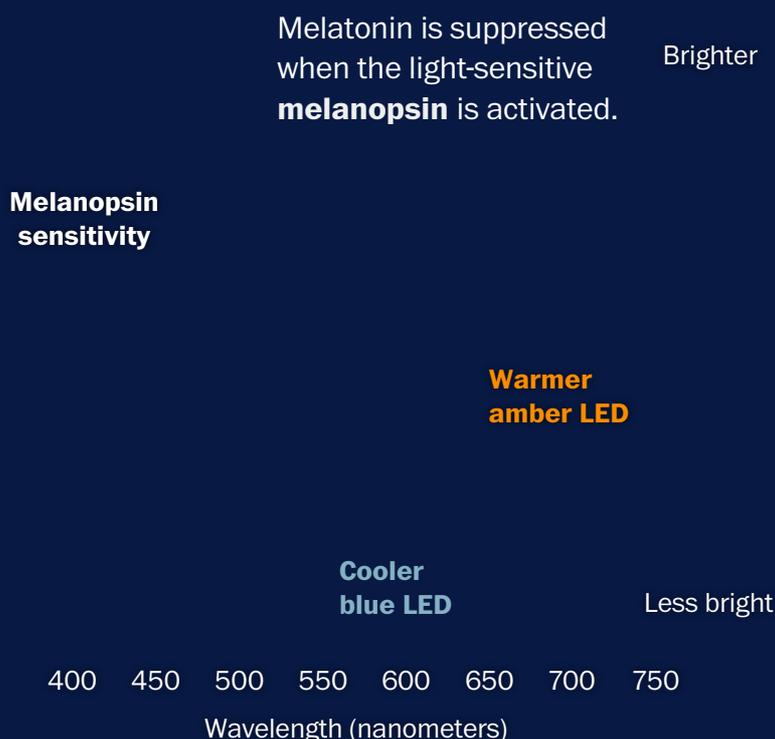
Hooded street lamps help contain the direction of the lights away from the environment.

The human eye is also acutely sensitive to the wavelength of bluer lights. You may recall two types of photoreceptors in our eyes called rods and cones, which help us recognize colors and shades. In recent decades, scientists have identified the function of another photoreceptor called the intrinsically photosensitive retinal ganglion cell, or ipRGC. These photoreceptors are sensitive to shorter wavelengths and help keep people alert by suppressing a hormone called melatonin, which plays a role in our sleep.

“One of the hallmarks of our circadian clock is this time production of melatonin. Melatonin is correlated with sleepiness,” said Manuel Spitschan, a neuroscientist at the Technical University of Munich and the Max Planck Institute for Biological Cybernetics. “When you expose people to light at night or in the evening, you will suppress the production of melatonin.”

Spitschan explains that when bluer light hits our eye, the ipRGCs start firing rapidly because of a light-sensitive molecule called melanopsin, which converts photons into an electrical signal to the brain to suppress melatonin production. The more photons captured by the ipRGC, the stronger the signal produced by the photoreceptor, leading to the suppression of melatonin.

Melanopsin's sensitivity to blue LED light



Source: Manuel Spitschan (TUM)

Without melatonin to trigger sleepiness, people are more likely to stay awake longer. Disruptions in our circadian rhythm have been linked to cancer cases, such as breast cancer, and labeled probably carcinogenic by the World Health Organization. Other research has shown interruptions to our circadian rhythm are linked to some heart problems.

“We’re more sensitive to blue light at night than we are during the daytime,” said Chris Kyba, who quantifies artificial light in the night environment at the GFZ German Research Center for Geosciences.

Solutions to limit light pollution around you

There is a world where more energy-efficient LED lights exist and don’t significantly disrupt nightscapes or our health.

Light pollution “can get better with LEDs, but there has to be a lot of attention paid to the design,” said the National Park Service’s Ashley Pipkin, a biologist and co-author of the Chelan County light pollution study.

These solutions, from buying a certain type of LED light to making changes that block the glare, can happen at the city level and for individual homes.

Choosing the right light, and brightness, for your needs

The National Park Service says one way to reduce night sky light pollution is to be intentional about where lighting is located: Is a light really needed in that spot? And what’s the appropriate brightness for that light use?

Pipkin explained that we typically think of light bulbs based on wattage, or how much energy the bulb consumes, but our focus needs to change with LEDs. LEDs use fewer watts than traditional incandescent light bulbs, and people should choose a light based on lumens, often marked as brightness.

Many people use much brighter LED lights than necessary, especially outside. Ideally, you can buy a much lower-wattage LED and still have the same level of brightness as an incandescent light bulb. A 30-watt LED bulb has the same

number of lumens as a 250-watt incandescent bulb, according to the National Park Service. However, Pipkin added, “the industry does not often provide enough options with low lumens.”

Additionally, replacing every traditional bulb with an LED bulb may be unnecessary. “You don’t need a whole lot of wattage to light up the street corner,” White said.

Use warmer LED lights

Light temperature on the Kelvin scale

Not all LED lights are the same. When you go to the store, you may see some LED lights labeled at 4,000 Kelvin, 3,000 Kelvin or even 2,000 Kelvin. These temperatures correlate with the light’s appearance of warmth (yellow) or coolness (blue).

The colors shown are an approximation of the various color temperatures.

Because our eyes are sensitive to blue light at night, doctors recommend buying LED lights with warmer-color hues, such as yellow or amber. That means using LED lights below 4,000 Kelvin. On average, LED lights at 4,000 Kelvin are about 29 percent blue. Lights at 3,000 Kelvin are about 21 percent. These days, there are LED

lights available as low as 2,000 Kelvin. Warmer hues also scatter less in the atmosphere than the cool blue light.

But light manufacturers are slow to move to warmer hues, said Mario Motta, a retired cardiologist who helped write the AMA’s recommendations on reducing light pollution. When he was writing the recommendations more than five years ago, he recalled getting pushback from companies that already bought a surplus of the lights with the highest level of blue light.

Chelan County's White said there isn't enough demand for manufacturers to produce many lights as low as 2,000 Kelvin yet. "We need more people asking for it and insisting on it," he said.

Block or limit the light



Use blackout curtains to block out outside lights from entering your bedroom and disrupting your sleep.

While directing LED light beams down can help reduce light pollution, it may not necessarily eliminate it — as seen in Chelan County. Bright light with a lot of blue, Pipkin said, can bounce off the ground and

In your home, blackout curtains can prevent streetlights spilling into bedrooms, which can help curb the impacts on your sleep.

Motion detectors, timers and dimmers can also reduce the hours of unnecessary light while saving more energy.

Direct light beams down

For lights outside your home or in public spaces, experts say to direct light downward. Avoid uncovered or exposed lights that emit light upward and horizontally. The angle

and height of the light can also affect the spread of the beam.



scatter into the night sky, still contributing to light pollution. That's why it's important to buy LEDs at warmer temperatures, with low lumens.



Since transitioning Chelan County's streetlights to LEDs, White and his colleagues haven't yet implemented further

alterations. They plan to make changes after more-advanced commercial products become available, some that could allow the lights to dim after a set time at night or brighten when vehicles are approaching.

Light fixtures that allow for motion detection or dimming can save energy while reducing the light's footprint on the surrounding environment.

With better changes in the future, White hopes night stars will fill the sky once again.

"I love to get my telescope out and see the rings of Saturn and the stars and the moons on the other planets. We tried everything we could using the best available technology to do this," said White. "It's a common problem for everyone to be aware of."

How to limit light pollution

Use more amber or lower-temperature (such as 2,700 Kelvin) LED bulbs

Blackout curtains can prevent outside light from entering your home

Apply motion
detection or dimming
to light fixtures

Hooded street lamps
can help direct
and contain light

Use timers or
dimmers on lights

About this story

The National Park Service captured the images showing the night sky and light pollution in Chelan County. To create a full picture of the night sky, NPS stitched together 47 different photographs, a process that can leave seams between individual image, some of which are visible in the images in the story. The trees visible in the foreground do not appear in the original images. Evening sounds are from the Natural Sounds and Night Skies Division at the National Park Service. Solutions for reducing light pollution are from the National Park Service.

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