



More than 80 percent of the population of the United States lives in areas where the night sky is above the threshold for “polluted” status, defined as when artificial brightness is greater than 10 percent of the night’s natural light. Seeing a truly dark sky is only getting harder in the United States. The volume of artificial light is growing by at least 2 percent annually, meaning that light pollution will double in less than 50 years.

A growing body of research shows light pollution harms human health. Being exposed to excessive light at night reduces the body’s production of melatonin, a chemical that has antioxidant properties, helps induce sleep, boosts the immune system, and lowers cholesterol. In addition, melatonin helps the thyroid, pancreas, and adrenal glands. Light during the nighttime, even at low levels, can seriously impede melatonin production. When you add in disrupted circadian rhythms, there’s a laundry list of light pollution health concerns.

As with many human endeavors, the effects of artificial light are problematic for other species too. In the animal kingdom approximately 30% of vertebrates and 60% of invertebrates are nocturnal and artificial lighting effects the life and sleep cycle of these life forms. Nocturnal animals, such as sea turtles, moths and amphibians, that avoid bright lights to stay hidden from predators can find themselves attracted to dangerous conditions by the

presence of continuous lighting. Studies also show that plants planted near bright streetlights may bloom out of season and leave buds vulnerable to damage by cold temperatures. This could affect fruit orchards and crops.

In fairness, this causal relationship remains an ongoing debate. There are those in the scientific community who remain skeptical, especially to claims that cancer is a byproduct of light pollution. By and large, however, it is established science that light pollution does far more harm to humans and the environment than good.

## What Is Light Pollution?

Light pollution is unintentional, misdirected or unwanted artificial illumination. It is commonplace in virtually every inhabited area around the world.

According to the National Optical Astronomy Observatory, there are three main types of light pollution: glare, light trespass, and skyglow that includes over-illumination and clutter. Glare from unshielded lighting is a public-health hazard causing loss of contrast, visual discomfort, and unsafe driving conditions. Light trespass occurs when unwanted light enters a property, for instance, by shining light into a bedroom window of a person trying to sleep. Skyglow refers to the glow effect that can be seen over populated areas. Skyglow is the combination



of all the reflected light and upward-directed (unshielded) light escaping up into the sky. All three affect the natural day-night/light-dark cycle under which all species and ecosystems on Earth have evolved.

Poorly-designed, high-intensity LED lighting is contributing to the problem by emitting a large amount of “cold” blue light. Discomfort from blue-rich LED lighting can decrease visual acuity, resulting in concerns and creating a road hazard. Blue light also operates at a wavelength that suppresses melatonin, one that has five times greater impact on circadian sleep rhythms than conventional street lamps.

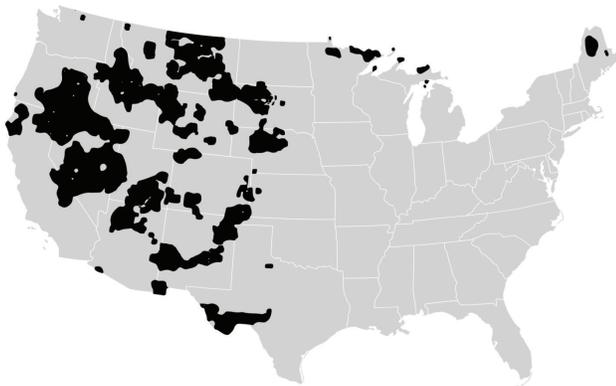
## Measures to Prevent Light Pollution

According to the International Dark Sky Association and other sources, these actions can lesson light pollution:

- Use warm-colored LED light sources emitting less impacting, blue color spectra. Lamps for outdoor

## Losing the night

Where to find the last pristine skies in America



Source: Falchi et al., 2019

THE WASHINGTON POST

areas should have a correlated color temperature of 3000 K or lower.

- Aim lights downwards, instead of wasting light by directing it above the horizontal plane. Shielding the light source will minimize glare and light trespass.
- Dimmers, motion sensors and timers can help to reduce average illumination levels and save even more energy.

Light pollution is reversible. For example, Tucson, Arizona has long led the way in reducing light pollution and recently reduced “sky glow” by 7 percent after converting street lights.

## What is the USA doing to fight light pollution?

In 1958, the city of Flagstaff, Arizona, passed the country’s first dark-sky ordinance. To protect the darkness for research at its Lowell Observatory, the city banned the use of commercial searchlights. Scofflaws could be punished with a \$300 fine, 90 days in the city jail, or both.

At least 18 states, the District of Columbia and Puerto Rico now have laws in place to reduce light pollution. The majority of states that have enacted so-called “dark skies” legislation have done so to promote energy conservation, public safety, aesthetic interests and astronomical research capabilities. Municipalities in a number of states have also been active on this issue, adopting light pollution regulations as part of their zoning.

New Hampshire, for example, has made it a priority to preserve dark skies as a feature of rural character. To that end, state law encourages municipalities to adopt ordinances and regulations to conserve energy and minimize light pollution (N.H. Rev. Stat. Ann. §9-E:3). The effect of beach front lighting on avian and marine life is also a concern in many coastal states.

In Florida, for example, a statewide model lighting ordinance guides local governments in developing policies to protect hatching sea turtles.

The most common dark skies legislation requires the installation of shielded light fixtures which emit light only downward. Replacement of unshielded with fully shielded lighting units often allows for use of a lower wattage luminaire, resulting in energy savings. Other laws requiring the use of low-glare or low-wattage lighting, regulate the amount of time that certain lighting can be used, and incorporate Illuminating Engineering Society (IES) guidelines into state regulations.

Texas is the only state with a law in place specifically aimed at reducing light pollution around military installations. In 2007, the Texas Legislature amended an existing law regarding the regulation of outdoor lighting to authorize state counties, at the request of the military, to adopt measures governing the use of outdoor lighting within five miles of a military installation.

On the federal level, from 2014-2016 the US Department of Energy's Outdoor Lighting Accelerator (OLA) worked with 25 partners (including three states, 16 cities and 6 regional energy networks) committed to upgrade 1.3 million street lights that will ultimately save cities an estimated \$48 million/year.

## LEDs: Light Pollution Solution

Less than a generation after its introduction, LED lighting is poised to eclipse all earlier technologies in terms of market share and workplace lighting quality. LED is better for the environment too, because it uses only a small fraction of the energy of HID or fluorescent lighting, plus lasts longer to reduce the amount of waste being added to landfills.

However, environmentalists accused LED manufacturers of adding to the light pollution problem rather than solving it as a result of LED's short-wavelength or "blue light" emissions. As mentioned earlier, blue-rich light not only increases the amount of glare sensed by the human eye but also the visible light pollution.

The blue light problem resulted from early LED technologies that were only able to achieve efficacy expectations (100 lumens per watt +) with cooler CCTs (5000K or higher). As more phosphor is added to achieve the warmer CCTs, the efficacy does go down. The latest LED chips are much more efficient, and now 100+ lm/w is achievable in the 3000K range.

In addition, encasing an LED above and to its sides will channel light downwards where it is needed. Shielding



*Appleton Mercmaster LED Generation 3 Series Luminaires*

minimizes glare and light trespass. This is known as "full cut off lighting." Another solution is merging LED with sensors. By turning lighting on and off in response to movement, these sensors ensure outdoor areas are illuminated only when necessary. Adaptive lighting is another solution. On streets that experience little traffic, it reduces light levels at certain times of night when the area is unused.

## Emerson's Answers

As an industry leader and a corporate citizen in our communities, Emerson seeks to improve quality of life, reduce the impact of our operations and products on the environment, and leave the planet in a better place for future generations. Our environmental stewardship is reflected in Appleton™ Mercmaster™ and Areamaster™ LED luminaires.

The Appleton Mercmaster LED Low Profile and Mercmaster LED Generation 3 Series luminaires offer multiple lumen outputs from 3,500 to 25,000 lumens. Models are available with 3,000K (warm white) CCT and an optional visor that completely shields the luminaire, providing full cutoff. The Dark Sky Association has endorsed these products with the IDA Seal of Approval as being Dark Sky Friendly.

The Appleton Areamaster Generation 2 LED floodlight offers 3000K color and, as long as the end user installs at a 90° angle and uses the visor, it adheres to dark sky lighting strategies. Featuring new optic designs for superior uniformity and coverage, Areamaster Generation 2 LED luminaires provide HID equivalent lighting that saves over 75 percent in energy costs and practically eliminates maintenance burdens. Like the Mercmaster, they are certified for NEC/CEC Class I, Division 2 and Class II



*Permian Basin, United States,  
West Texas to Southeastern New Mexico*

hazardous locations, marine and wet locations, as well as ATEX/IECEX Zone 1, 21 and Zone 2, 21.

## **LED Case Study: Permian Basin**

Spanning West Texas to southeastern New Mexico, the Permian Basin is one of the most prolific oil and natural gas geologic basins in the United States. Besides its famed energy reserves, the Permian Basin is also valued by astronomers for its pitch-black night skies, a natural phenomenon that has been threatened in recent years by oil and gas companies' floodlights. Required for nighttime visibility, each floodlight is powerful enough to safely illuminate several acres of oilfield.

Conventional HID floodlights have been sources of blinding glare due to a lack of shielding, poor placement, or incorrect aiming. To combat this problem, a collaborative effort between the members of the Permian Basin Petroleum Association, the Texas Oil and Gas Association, the American Petroleum Institute and the McDonald Observatory resulted in a series of lighting best practices. Emerson strongly supports this endeavor and the goals it strives to accomplish.

Emerson, through its Appleton brand, has partnered with Permian Basin drillers to minimize creeping light pollution caused by conventional floodlights, with a targeted goal of preserving the dark skies needed to conduct astronomical research and education at the nearby McDonald Observatory. This world-renowned observatory sits atop the Davis Mountains under some of the darkest

night skies in the continental United States. Over the past decade, the sky along the observatory's northern horizon, in the direction of the Permian Basin, has been steadily brightening, due to new exploration for oil and gas. Without reducing the skyglow from these operations, the research for which the McDonald Observatory is famous will be compromised.

Oil and gas operators in the Permian Basin quickly got on board the Dark Skies Initiative when they realized that recommended lighting improvements — such as warm white LEDs and glare-reducing shields — not only reduce light pollution, but also save energy, improve visibility and enhance safety on the work site.

Last year, more than 300 Appleton Areamaster Generation 2 LED Luminaires were installed on three booster stations of a major Emerson Permian Basin customer. Visors on the floodlights shield the lights and point them downward to reduce glare, limiting light intensity from the luminaire in the region between 80° and 90° from the ground and helping customers comply with Permian Basin lighting ordinances. Because the Areamaster Generation 2 floodlights are based on LED technology, they achieve better overall directionality to focus light only on the intended area, resulting in darker skies overhead. In addition, their warm color temperature (3000K CCT) reduces environmental impact and disruption to natural circadian rhythms in stark contrast with the bluish "daylight" lighting often associated with LED floodlights.

Appleton Areamaster Generation 2 LED floodlights are used throughout the three booster stations to provide illumination without exceeding the minimum number, intensity, and coverage required for safety and basic security. Lighting is divided into separately controlled "zones" to avoid illuminating unused space, and is controlled by timers, sensors, or switches available to facility operators. Where possible retro-reflective or luminescent markers were installed instead of permanent lighting.

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