



More than 99 percent of the population of the European Union (EU) 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. Assuming average eyesight, about half of the EU population has now lost its ability to see the Milky Way galaxy arch across the night sky.

Unfortunately, the nighttime face of the EU is getting brighter every year, and that may be doing harm to the health of human beings, animals and the ecosystem as a whole. For instance, the American Medical Association warns that nighttime lighting is associated with “reduced sleep times, dissatisfaction with sleep quality, excessive sleepiness, impaired daytime functioning and obesity.” Excessive lighting at night is tied to decreased levels of the human hormone melatonin, which has antioxidant properties, helps induce sleep, boosts the immune system, and lowers cholesterol.

As with many human inventions, the effects of artificial light are problematic for other species. Studies by Florida Atlantic University show that light pollution radically alters an animal’s nighttime environment by turning night into day. 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 that rely on light to recognize the season die earlier when planted near bright streetlights.

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 by-product 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.

Some comparatively small but brilliantly lit areas make disproportionate contributions to nighttime radiance. A single international airport, for example, can be 30 times brighter than an entire town.

According to the National Optical Astronomy Observatory, there are three main types of light pollution: glare, light trespass, and skyglow which 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.

## Measures to Prevent Light Pollution

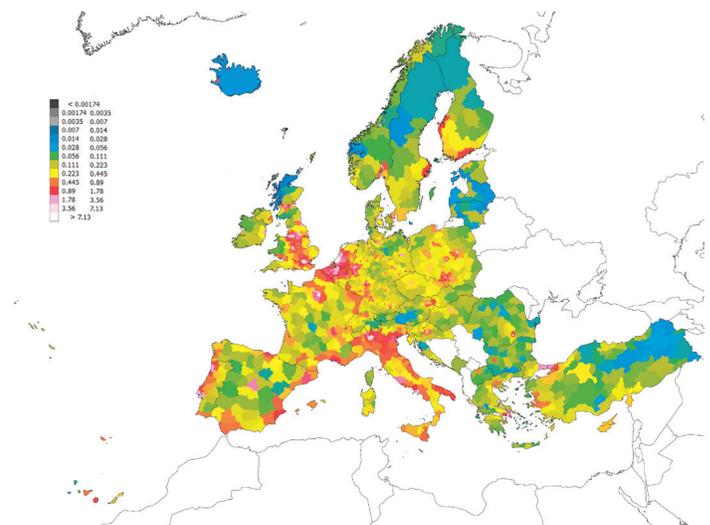
Shielding lights plus the controllability of LED as a directional light source significantly reduces light pollution. Other actions to lesson light pollution include:

- Aiming lights downwards, instead of wasting light by directing it above the horizontal plane.
- Orienting street lights towards a road or pathway, not towards private properties.
- Using smart, adaptive IoT technologies for turning lights on/off, to dim lighting, and to “daylight harvest” light as the sun sets.
- Use light sources emitting less impacting, blue color spectra. Lamps used for outdoor areas should have a correlated color temperature of 3000 K or lower.
- Government measures to regulate the absolute minimum lighting levels necessary to perform an action, such as driving.

Besides light pollution, excessive lighting has indirect implications for the environment from pollution associated with energy production and transmission. Estimates of wasted light in the EU have predicted that the costs amount to €5.2 billion, or 23.5 billion kg of CO2 annually.

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

The EU continues to lead the world in transforming its lighting market towards technologies that reduce all forms of pollution. Several countries, including Italy, Slovenia, Spain, France and Croatia, have implemented regional and national laws against light pollution although these do not apply EU-wide. Others have created areas where the dark sky has a protected status and have successfully positioned this as an asset to develop new eco-tourism services. All EU states recognize that the increasing loss of natural darkness has a negative impact on biodiversity and ecosystems and on the quality of nature and the environment.



*Average zenith artificial night sky brightness. The pollution of the clear night sky doubles at each change of color, starting with pristine conditions (black, not present in Europe), to the white of the brightest lit cities. (Journal of Environmental Management)*

The Czech Republic in 2002 became the first member of the EU to have a national law dedicated solely to reducing light pollution. Slovenia followed shortly afterwards. The UK passed the Clean Neighbourhoods and Environment Act in 2005 criminalizing light pollution. In Scotland, fighting light pollution now falls under the Public Health Act (Scotland Act 2008), while in Northern Ireland it is part of the Clean Neighbourhoods and Environment Act 2011. At the end of 2015, the EU launched its STARS4ALL project, which aims to inform people about light pollution while also promoting approaches to mitigate the problem.

Most notably in Europe, Catalonia implemented multiple decrees in the early 2000s around light pollution. And, on January 1, 2021 France will enact some of the most progressive regulations around outdoor lighting and protecting the night sky.

## Revised GPP Targets Street Lights

In January 2019 the EU revised its Green Public Procurement Criteria for Road Lighting and Traffic Signals, known as the GPP, to give attention to reducing light pollution, lessening energy consumption, and improving overall durability of fixtures. Although not a binding law, the revised GPP advises stakeholders on implementation once they decide to install new lighting. It covers new lighting installations, retrofitting of different luminaires, light



sources, or controls in existing installations, and simple replacement on a like-for-like basis in existing installations.

The GPP update employs an 'As Low As Reasonably Achievable' (ALARA) principle which is consistent with the Low Impact Lighting (LIL) standard promoted by German, Italian and Slovenian members of the European Environmental Bureau over the past decade. ALARA sets appropriate light levels for road lighting and traffic signals. Based on CEN/TR 13201-1:2014, ALARA's performance requirements for different classes, i.e., Class M1 has much higher light requirements than a Class M6 road. There are allowances for reducing light levels when traffic flow is anticipated to be lower by dimming. Of course, ALARA comes with challenges since what is light pollution for one person can be acceptable or even desirable to another. Moreover, as the night has gotten brighter, people's conception of normal levels of light has changed.

Other criteria in the GPP are based on upward light output ratios (RULO) that recommend luminaires be rated with a 0.0% RULO. GPP also establishes limits on Correlated Color Temperature and blue light output to address concerns about annoyance and ecological light pollution. GPP states the CCT of light sources shall be 3000K or less. The G-index, which is directly related to blue light output, is set at 1.5 in ecologically sensitive areas and 2.0 within 100km of an astronomy observatory. The luminaires that are installed must be labeled with RULO, G-Index, CCT, input power, flux codes, and dimming control information, if applicable.

### Reducing Light Pollution With LEDs

Less than a generation after its introduction, LED is poised to eclipse all earlier technologies in terms of market share. The initial rush to adopt LED brought with it the potential for increasing light pollution, as a result of LED's short-wavelength, or blue light, emissions.

Thankfully those issues were resolved. The problem was that early LED technologies were only able to achieve efficacy expectations (100 lumens per watt +) with cooler CCTs (5000K or cooler). 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 or warmer ranges. But, more importantly, efficacy should not be the only measure of a desired lighting scenario. Quality of the emitted light must be included as a measure in these projects. In addition, encasing an LED above and to its sides will channel light downwards where it is needed. Shielding minimizes glare and light trespass. This is known as "full cut off lighting."

### Emerson's Solutions

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™ Generation 3 and Areamaster™ LED luminaires.

The Appleton Mercmaster Generation 3 offers multiple lumen outputs from 3,500 to 17,500; 5000K, 4000K, and 3000K color temperatures; and an optional visor to shield for uplight. It is available in either a Zone 1, 21 or a Zone 2, 21 ATEX/IECEX model. With the addition of the optional visor to create a fully shielded luminaire, it is the perfect solution for applications requiring Dark Sky Friendly solutions.

The Appleton Areamaster Generation 2 LED floodlight offers 5000K, 4000K and 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 hazardous locations, marine and wet locations, and are available as ATEX/IECEX Zone 1, 21 and Zone 2, 21.



*Appleton Mercmaster LED Generation 3 Series Luminaires*

## LED Case Study: Permian Basin

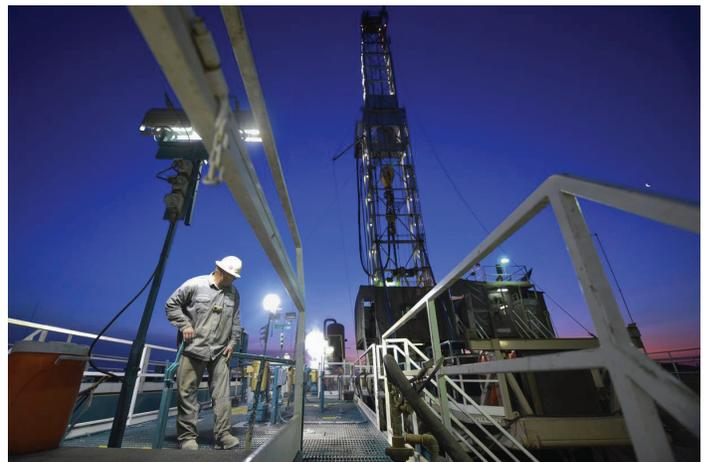
Spanning West Texas to southeastern New Mexico, the Permian Basin is one of the most prolific oil and natural gas geologic basins in the United States. Besides its famed energy reserves, the Permian Basin is also valued by astronomers for its pitch-black night skies, a natural phenomenon that has been 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



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

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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