



# LED WATCH

James Brodrick

## ARE LEDs CAUSING AN INCREASE IN LIGHT POLLUTION?

Before jumping to conclusions, consider context

One of science's biggest "Caution!" signs applies to the interpretation of research findings. Researchers are taught to be scrupulous in the way they design and carry out their studies, and equally careful in how they interpret the results—sometimes to the chagrin of the public, which tends to prefer easy answers and black-and-white conclusions rather than shades of gray and food for thought. But science is complex and nuanced, and often those who don't specialize in the field under investigation lack the context to fully understand the results. That's how even the best studies sometimes get cited by journalists and others to justify overly simplistic conclusions the researchers themselves would disagree with.

A recent example has occurred with an excellent study on the growing levels of light emission from the Earth, published in the November 22 issue of the journal *Scientific Advances*. In a nutshell, the study, led by a prominent scientist at the German Research Center for Geosciences, found that despite the adoption inroads made by energy-efficient LED lighting—which includes street and area applications that often demonstrate a substantial reduction in wasted light—the Earth continues to steadily increase in outbound radiance transmitted into outer space. Much of the flurry of news coverage spawned by this finding focused on the idea of a "rebound effect," in which the cost reductions from LEDs are simply motivating the spread of additional and unnecessary lighting—with the implication that this largely negates the energy savings that have been achieved.



### WHAT THE STUDY MEASURED

The study employed digital data obtained between 2012 and 2016 from the Visible Infrared Imaging Radiometer Suite Day-Night Band (VIIRS) sensor on an Earth-observing satellite of the U.S. National Oceanic and Atmospheric Administration. In a nutshell, the data reveal an average global increase in light at night traveling upwards at a relatively steep (i.e., near-vertical) angle in the spectral band 500-900 nm. Over

the time frame examined, many (but not all) geographic areas increased in detected upward radiance, and many lighted areas increased in size. The size of these increases tended to be larger in poorer countries and smaller, or even flat (as was the case in the U.S.), in wealthier countries—not a surprising result, given that poorer countries have relatively large unfulfilled needs for exterior lighting, compared to wealthier countries.

However, these particular measurements don't include the origins of the light detected (e.g., whether from street lighting, building interior or façade lighting, signage, gas flares or any other source). Nor can the measurements indicate how efficiently that light is being generated and used, whether the illuminated areas are underlighted or overlighted according to accepted standards, or what the corresponding light pollution or related environmental impact is except in very broad terms (e.g., more light at night in general means greater environmental impact).

### WHAT IT ALL MEANS

First, it's important to draw distinctions between what's happening in North America compared to other locations around the world. While we generally have a good handle on lighting conver-

sions and additions in our own country, and can usually find the money to ensure quality installations, other countries may see a greater need to devote expenditures solely to having lights installed and may have other priorities as well. Also, it's important to reiterate that the increases detected involve all light at night emitted from all sources, not just street and area lighting, although that application surely plays a significant role.

There's no question that converting municipal street and outdoor lighting from high-pressure sodium and metal halide to LED has reduced energy use in the U.S. on both a per-luminaire basis and nationally, and many cities—Los Angeles, Detroit and Philadelphia, for example—have experienced substantial energy and cost savings by converting their streetlights to LED. However, the finding that such energy savings may continue to be offset to a degree by the growth of lighting from other applications in no way detracts from the savings that have already been achieved by converting U.S. street lighting to LED, nor from the merit of pursuing additional conversions. In fact, continuing to improve the energy efficiency of outdoor lighting installations is made even more critical by the fact that the growth in installations is likely to continue outpacing efficiency improvements, given that the lighting in many parts of the world—especially developing countries—falls significantly short of that employed in the wealthiest economies.

Newly populated areas, such as those on the outskirts of cities and towns, become illuminated to facilitate nighttime travel, commerce and perceived safety, and continued infill within existing city boundaries likely has a similar effect. Far from being a wasteful use of lighting (as long as proper design is followed), this is an inevitable byproduct of population increase, urbanization and gross domestic product (GDP) growth

is the question of how much lighting is truly needed to provide the desired services. Exceeding this amount should be avoided, as should reliance on poorly designed lighting systems that allow light to escape or that even direct it in unwanted directions. The increased light levels revealed in the satellite data from this study undoubtedly contain a great deal of both types—that produced as an inevitable byproduct of lighting our envi-

## Much of the flurry of news coverage focused on the idea of a 'rebound effect'

(which makes lighting more affordable). The increased efficacy of light sources allows many previously deprived areas to obtain the benefits of lighting while minimizing the increase in energy use.

### NAVIGATING TRADE-OFFS

All manmade lighting is "unnatural" and thus, has potentially undesirable side effects. Some of these are unavoidable if we're to continue to enjoy the benefits. For example, because we see objects by means of the light reflected off them, it's inevitable that some of the light we produce will wind up in the night sky. What's also probably unavoidable is a continuing increase of light at night around the world, as the global economy continues to grow. What can and must be addressed, however,

is the question of how much lighting is truly needed to provide the desired services. Exceeding this amount should be avoided, as should reliance on poorly designed lighting systems that allow light to escape or that even direct it in unwanted directions. The increased light levels revealed in the satellite data from this study undoubtedly contain a great deal of both types—that produced as an inevitable byproduct of lighting our envi-

ronment (both interior and exterior), and that representing sheer waste—with the exact division between these two types remaining unknown. Importantly, the results of this study were never meant to imply that the continuing pursuit of increased efficiency and lowered cost of lighting technology is inappropriate—any more than they meant to imply that increasing worldwide GDP is inappropriate. The results do clearly underscore, however, that measures to mitigate wasteful lighting practices and their consequences are taking on critical importance as the general use of outdoor lighting continues to grow throughout our entire planet.

**James Brodrick** is the lighting program manager for the U.S. Department of Energy, Building Technologies Office.