

Hazardous Light Pollution from Digital Electronic Billboards

By Roland Dechesne 2012-07-11

Billboard lighting is a major source of light pollution and a new twist on billboards will to 'ratchet up' the light output. Digital electronic billboards (EBBs), or as they are known in the industry, Commercial Electronic Variable Message Signs (CEVMS), are harmful to human health, visually distracting for drivers and deleterious for community esthetics.



Image credit Scenic.Org

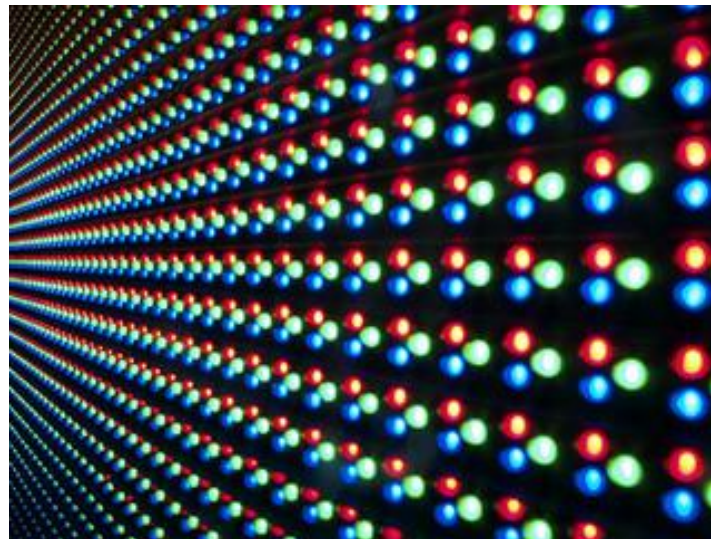


Image credit micmol

EBBs use an array of red, blue and green coloured light-emitting diodes (LEDs) to create an image that can be changed or even render full-motion video. So, unlike standard billboards with a constant flux of light, the new EBBs produce a variable stream of light brightness and spectral variation.

Electronic Digital Billboards as a Health Hazard

It is known that the spectral output of blue LEDs overlaps that of the key detector, melanopsin, which regulates the body's melatonin levels and circadian rhythm, which in turn controls hormonal levels that control diverse biological processes including, weight gain and proclivity for certain types of cancers.

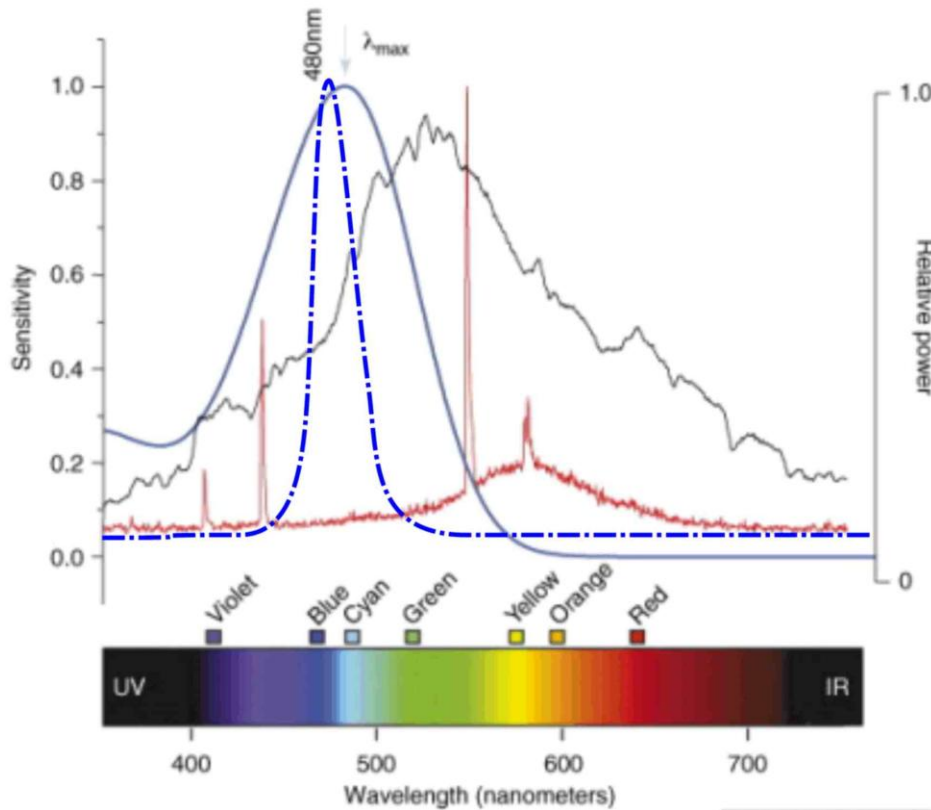


Image credit: modified from [Hankin et al 2008](#).

Melanopsin has peak sensitivity near 480 nm (solid grey-blue line). This may be compared to the typical representative power spectra for natural daylight (irregular black line) and artificial fluorescent lighting (red curve with spikes). The dot-dash blue line is the spectral output of a typical blue LED (data for this curve from [Wikipedia](#)). The range of the visible spectrum between the UV and IR is depicted on the x axis at the bottom of the diagram.

While light at night has significant negative impacts on biological processes, light from the blue LEDs in electronic billboards can be dramatically more damaging to health and to the natural environment due to its peak spectral output falling within the sensitivity range of melanopsin.

In June 2012, the American Medical Association recognized the harm to human health from night time lighting and its members have unanimously adopted policy recognizing that exposure to excessive light at night can disrupt sleep, exacerbate sleep disorders and cause unsafe driving conditions.

Electronic Digital Billboards as a Safety Hazard

Roadway safety is no laughing matter, although sometimes humour can illuminate the truth, as seen [here](#).

There are two main lines of evidence that electronic billboards (EBBs) can reduce safety on roadways. Firstly, there are the traffic safety studies, and secondly, we can examine how EBBs' illumination differs from those types of illumination that are designed to make roadways safer.

EBBs and Traffic Safety Studies

Traffic safety studies fall into one of three categories: post-hoc crash studies, field investigations, and laboratory investigations. Some key conclusions:

- 1) As summarized by Wachtel, J. and Netherton, R. (1980)¹, initial studies on traditional billboards found that they increased the rate of traffic collisions near the signs.
- 2) Early studies of EBBs and collisions indicated that there was an increase of accidents where EBBs were installed. For example, the *Wisconsin Department of Transport (1994)*² found a 35% increase in collisions near a variable message sign.
- 3) Newer studies funded by the outdoor advertising industry, for example Tantala and Tantala (2007)³ and Lee, S.E., McElheny, M.J., and Gibbons, R. (2007)⁴ indicate that EBBs have no significant impact on accident rates. However, those studies are performed in a fashion that Wachtel (2008, 2009)^{5,6} demonstrated had flawed methodology. Specifically, the flaws in experiment design and analysis cited were: i) unwarranted exclusion of pertinent data because of poor assumptions based on vague experimental terms, ii) overstating the amount of traffic by a factor of two, thereby reducing the accident rate by half, and iii) mixing digital and conventional billboard data sets so that EBB data cannot be examined by themselves, iv) as well, roadways with conventional billboards, not roadways without any outdoor advertising, were taken as the baseline. Wachtel (2008) also noted some evidence of statistical misrepresentation.
- 4) Since collisions within short-duration studies are relatively infrequent and hence potentially statistically insignificant, there have been another set of studies that looked at 'accident precursor activities', such as gaze position, lane drift, and unexpected braking which would be more easily quantifiable. These studies find that EBBs increased these behaviours (Beijer, D.D. 2002⁷; Beijer, D.D., *et al.* 2004⁸; Smiley, A., *et al.* 2005⁹; Dingus, T.A., *et al.* 2006¹⁰). The added benefit of this type of study is that it gives some insight into the types of behaviours that EBBs trigger in drivers.



Image credit [International Dark-Sky Association](#)

5) The studies on the use of these signs generally refer to their daytime impact. At night, glare from EBBs could render roadway lighting in the area ineffective. For instance, one of the industry-funded studies previously mention (Lee, S.E., McElheny, M.J., and Gibbons, R. 2007⁴) found that EBBs at night may have a noteworthy impact on accident rates, based on more active glance patterns, as well as more frequent and longer glances towards digital billboards. In this study, the EBBs changed only once every eight seconds, they changed instantaneously with no special effects or video, they looked very much like conventional billboards, and their luminance was attenuated at night. These results need to be followed up due to the relatively small sample size in the study. Does the City of Calgary wish to run this experiment on its citizens?

Some advertising industry-linked authors have argued that EBBs have no greater impact on accident rates than regular billboards, but points 1 and 4 above argue that *all* billboards, and especially lit billboards at night (EBB or not) have a large negative effect on night time driving safety. Furthermore, the data in point 5) indicate that at night EBBs may act as much worse distractions than conventional billboards. Municipalities are thus right to proceed with caution in allowing further distractions for drivers.

EBBs and Roadway Lighting Practices

The *Illuminating Engineering Society of North America* Recommended Practices for roadway lighting (RP-8-00)¹¹ documents their recommended standards for illuminating roadways. In Canada, most municipalities make the case that they have met their duty of care for legal liability if they follow RP-8-00 in their roadway lighting; in essence, this is the City of Calgary's main legal defense in case of lawsuits brought about due to improper roadway illumination practices. As an aside, I note that the City can still be held liable if it did not maintain the roadway illumination system – for example, burned out streetlights, or a failure to repair or replace fixtures that are not meeting RP-8-00 standards.

The *Illuminating Engineering Society of North America's* RP-8-00 recommends specific illumination levels for roads of particular classification and also specifies that glare be minimized where possible. According to the *U.S. Department of Transportation – Federal Highway Administration*, glare may be defined as “any light, either direct or indirect, which reduces the ability to see or produces a sensation of ocular discomfort.” RP-8-00 specifies, as a minimum, that semi-cutoff luminaires be used to reduce glare and notes that full cutoff fixtures provide a better solution. EBBs, with their horizontally-directed light from LEDs, do not meet this criterion. From this we see that EBBs might invalidate the City of Calgary’s general tort immunity from cases arising from roadway accidents where illumination has played a role.

Following this reasoning, the City of Calgary has protected its roadways from non-roadway lighting through the [Land Use Bylaw 1P2007](#). Part 3 – Division 4: Lighting Rules, section 63, Shielding, states “(1) All outdoor light fixtures must be aimed and shielded in a manner that does not direct illumination onto a street or adjacent residential uses.” It is clear that EBBs will contravene this section of the City of Calgary’s Land Use Bylaw.

In [Ottawa](#), when the first digital billboards were installed, the night-time brightness was set at an industry standard of 500 cd/m². In response to a survey, the billboards were dimmed to a maximum night-time brightness of 375 cd/m². After a second survey revealed ongoing concerns about the brightness of the billboards at night, they were dimmed yet again, to a maximum night-time brightness of 265 cd/m². While this was a noticeable improvement over the previous brightness levels, some images still appeared to be too bright. In a third round of dimming, the night-time brightness was further reduced to approximately 220 cd/m². At this brightness level, the billboard operation retains legibility, while reducing the potential for driver distraction and visual impacts on nearby properties. Note that this reduced brightness level is lower than the U.K.’s Institute of Lighting Engineers’ recommendation for maximum brightness in most areas by more than a factor of three.

The glare from roadway illumination is so detrimental to safe driving is underscored by the fact that, in 2009, the American Medical Association¹² advocated for non-glare roadway lighting, citing studies on glare and visibility.^{13,14,15,16,17,18}

Electronic digital billboards’ negative effects on roadway lighting can be reduced if certain practices can be implemented. For starters, reducing or eliminating the amount of white or light colours, such as yellow, in displayed graphics is a simple way to reduce the brightness of electronic digital billboards.

Electronic Digital Billboards and Community Esthetics

The City of Calgary's [Community Standards Bylaw 5M2004](#) is used to regulate neighbourhood nuisance, safety and liveability issues. It can be shown that EBBs likely run afoul of two aspects of this bylaw.

Firstly, since they are brightly illuminated and have changing displays, they are more obvious than traditional billboards. This means that they are more apparent from farther away, and can impinge visually into residential neighbourhoods in a manner that traditional billboards cannot. In essence, they are unsightly from greater distances.

Secondly, EBBs are sources of illumination, and section 43 (1) of the Community Standards Bylaw states "No owner or occupier of a Premises shall allow an outdoor light to shine directly into the living or sleeping areas of an adjacent dwelling house." Since the illuminating elements in an EBB (typically LEDs) are aimed horizontally, this problem will be difficult to avoid.

More general information on electronic billboards and their impact on their surroundings are available at [Scenic.Org](#).

Do we even need these electronic billboards, or any billboards for that matter? São Paulo, Brazil, decided to find out in 2006 by banning all forms of outdoor advertising under the "[Clean City Law](#)." 15,000 billboards came down shortly thereafter. According to a 2011 survey, 70 percent of city residents find the ban beneficial. People might assume that vibrancy derives from lights and advertising campaigns, yet the ban in São Paulo showed that the city's inhabitants and cultural heritage brought the true flavour.

Summary and Recommendations

Electronic Billboards will be a visual blight on the City. As the City strives to make sure that it is esthetically pleasing through the use of public architecture, and enshrines, through the Community Standards Bylaw, a particular measure of what is acceptable, why would we allow EBBs to pull us backward into a world of ugliness?

Light at night has been shown to cause significant health and environmental impacts. Blue light, such as produced by the blue LEDs on electronic billboards, has the greatest negative impact because it closely matches the spectral sensitivity of melanopsin, the light-sensitive molecule that helps regulate the circadian rhythm. These problems could be mitigated by emphasizing the use of red and green LEDs in these displays (allowing red, orange, yellow and green images to be rendered correctly) and minimizing the amount of blue.

Electronic billboards represent a significant threat to traffic safety due to their 'designed-in' distracting nature, which has been demonstrated over and over again in well-designed traffic studies. The social cost of a single accident may nullify any financial gain that the

City of Calgary may accrue. Is the City prepared to reduce public safety for the benefit of advertisers?

The City of Calgary has previously examined a 6-second 'dwell' time for images on EBBs. Studies of EBBs has shown that even with an 8 second 'dwell' time there is substantial risk for distraction of drivers and some jurisdictions use 'dwell' times as long as 2 minutes. The nighttime brightness of EBBs has been noted in a number of studies, with Ottawa determining that values of 220 cd/m² were acceptable; however this is likely to be context sensitive, with areas near residential neighbourhoods needing stricter guidelines. Glare is the key factor to regulate – this can be facilitated by reducing brightness levels and the use of darker imagery, staying away from broad swaths of white or yellow. Studies cited above indicate that cluttered areas with many buildings and intersections show the greatest negative impact of EBBs – this should be taken in to account in deciding if EBBs are to be allowed in the City of Calgary.

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