

Spectral measurement of an Arquiled Arquicity R1 LED streetlight installed at Cumeada, Dark Sky[®] Alqueva

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January 2017

Abstract

During late 2016 the national Portuguese electricity operator, Electricidade de Portugal (EDP), changed the streetlights of the hamlet of Cumeada, Reguengos de Monsaraz, Évora, to white light emission diodes technology (LED). The hamlet of Cumeada is within the borders of the Starlight Tourism Destination Dark Sky[®] Alqueva (DSA). We evaluated in lab the spectrum and the CCT of one of those LED. The results revealed the LED luminaires installed in the hamlet are not appropriate for use in a dark skies reserve.

I. INTRODUCTION

IN 2011 the Starlight Foundation certified the Dark Sky[®] Alqueva (DSA) as the first Starlight Tourism Destination (STM) in the world. Amongst the requirements for the viability of a STM, one of the most important regards the parameters of sky quality: "useful time for observing, sky brightness, image sharpness, sky transparency and light pollution control actions" [Starlight, 2009]. The DSA currently has low artificial sky glow (sky brightness) and some places took measures to reduce light pollution (e.g., Monsaraz, Reguengos de Monsaraz). White LED lights are usually very intense with a blue rich content in its spectrum. Apart from health and environmental concerns from short wavelengths rich LED that have been pointed by recent research, white LED are a major source of light pollution since white light suffers more dispersion than the larger wavelengths lights from sodium vapour lamps (HPS and LPS). This effect causes more skyglow over and around the LED sources and diminishes the sky quality in the Reserve.

To minimize sky glow and glare, streetlights should have low lumen output, low blue content on its spectrum, and low Correlated Color

Temperature (CCT). Besides, the optics must provide a light beam with a small angle avoiding dispersion of the light to great distances. The latter is regularly the only requisit that most of the LED streetlights meet.

II. METHODS

We measured the spectrum of an Arquiled Arquicity R1 (CTYR1) LED for outdoor use. The unity in question had an IP66 Optical Block coupled to an IP54 Electrical Housing, according to the lamp specifications.

We used a calibrated fibre optic STE-BW-VIS BLUE-Wave StellarNet Inc. Miniature spectrometer. This compact spectrometer is appropriate to wavelengths in the range of 350 nm to 1150 nm [StellarNet Inc., 2015].

The lamp was installed on a bench and the lab room was kept dark by closing all doors and lights, and assuring no stray or parasite light entered the spectrometer sensor apart from the LED lamp.

A set of ten measurements were made at different distances from the LED source. Given the strong power of the source, special care was taken to avoid saturation of the sensor that could compromise the results. A dark frame spectrum has been taken between each measurement.

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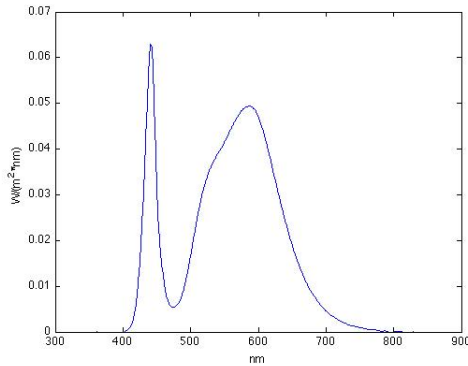


Figure 1: *Spectrum of the Arquiled Arquicity R1 (CTYR1) LED between 300 nm and 900 nm.*

III. RESULTS

Figure 1 presents one of the spectra that was obtained in the Laboratório de Contaminação Lumínica of the Universidade de Santiago de Compostela (LCL/USC). The spectrum obtained in each measurement were very similar to each other. Therefore, this spectrum is representative of all the spectra obtained during our measurements.

The graph shows the lamp has a peak at the 441.5 nm wavelength (blue) of its spectrum. The same peak was also obtained in the other measurements.

For the CCT (Correlated Colour Temperature) of the tested LED we found a mean and uncertainty in the mean of $4069.5 \text{ K} \pm 12.6 \text{ K}$.

IV. DISCUSSION

Our measurements for the tested Arquiled Arquicity R1 (CTYR1) LED streetlight unit show the lamp has a CCT above 4000 K, as stated in the characteristics of the lamp provided by the manufacturer. Although the CCT is not the sole parameter that defines a suitable light source, lamps with $\text{CCT} > 3000 \text{ K}$ are not recommended for outdoors lighting near or within dark skies reserves.

In June 2016 the American Medical Association (AMA) Council on Science and Public Health published a report discouraging the

use of outdoors LED lamps with a CCT above 3000 K, due to detrimental effects on health and on the environment caused by blue-rich LED lighting[AMA, 2016]. Our measurements show that the Arquiled Arquicity R1 (CTYR1) LED lamp has a clear peak on the blue region of the spectrum, with a maximum at the 441.5 nm wavelength.

We have no information on the lumen output that is currently being used at Cumeada. The lowest overall lumen output the possible is always better to minimize light pollution. However, the measured spectrum *per se* is sufficient to not recommended this kind of lamp for outdoors use. Its use within or near the territory of Dark Sky[®] Alqueva may compromise the requisites of a certified Starlight Reserve.

V. CONCLUSION

Due to the measured CCT and to the blue-rich content of its white light, this particular lamp is not recommended as an outdoors light source within or near the Dark Sky[®] Alqueva Starlight Tourist Destination Reserve. In accordance with what is being done in other dark skies protected areas, to minimise the impact on the quality of the night sky we recommend the use of full cutoff luminaires with low CCT ($\leq 2700 \text{ K}$), such as LPS, HPS or amber or pc-amber LED, and a low total lumen output.

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