LED Street Lighting Colour Temperature and Health Impacts

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Overview

- Health Impacts
- Reaction
- Considerations
- Approach

Health Impacts

Health Impacts

Bright Lights, Big Risk for Breast Cancer

Nocturnal illumination may be suppressing a cancer-fighting hormone.

BY CATHERINE GUTHRIE

PHOTO: JONATHAN BARKAT

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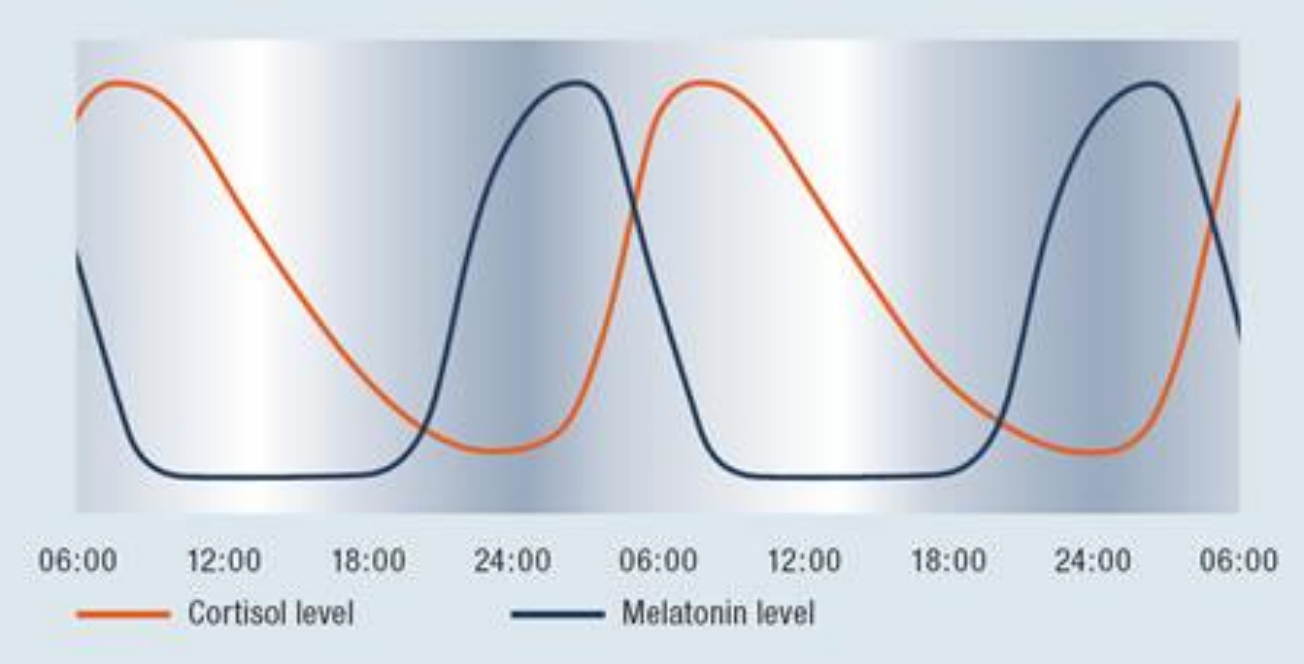
50 SHARES

Example of misinterpreted research

“We've just learned that the streetlight shining in your bedroom window every night is not only annoying; it may be jacking up your risk of breast cancer….”

Health Impacts and Subjective Color



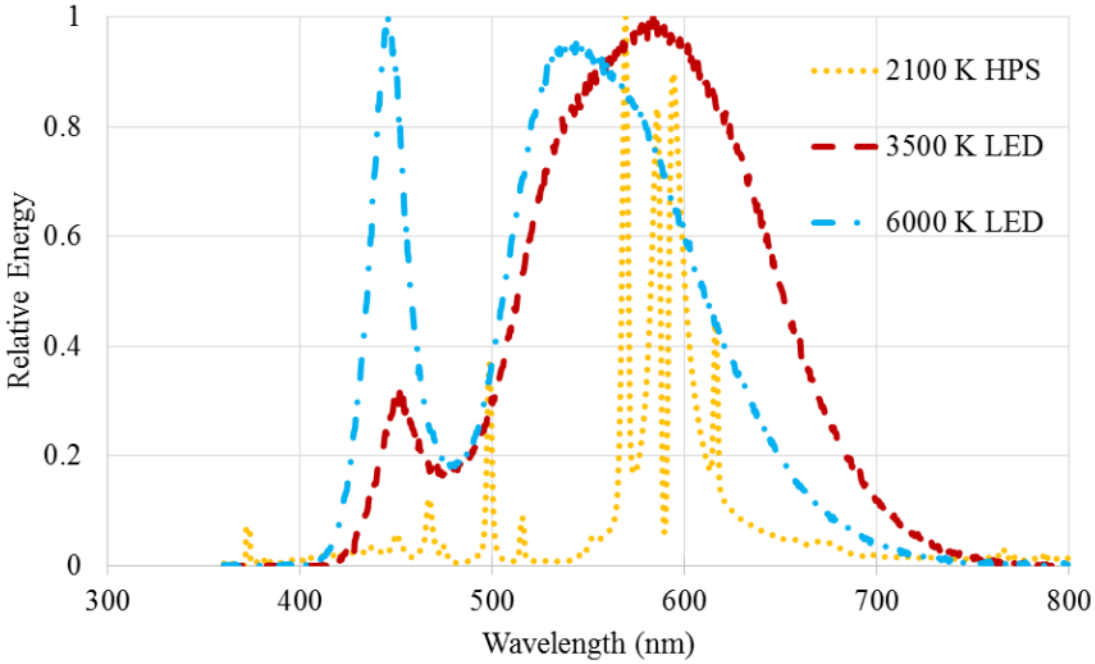
Circadian rhythm, hormone secretion: The hormones responsible for the circadian rhythm in humans are melatonin, which is released in response to increasing levels of darkness and which promotes sleep, and cortisol, which is the biological opposite of melatonin and an indicator of the level of human activeness.

Health Impacts and Subjective Color

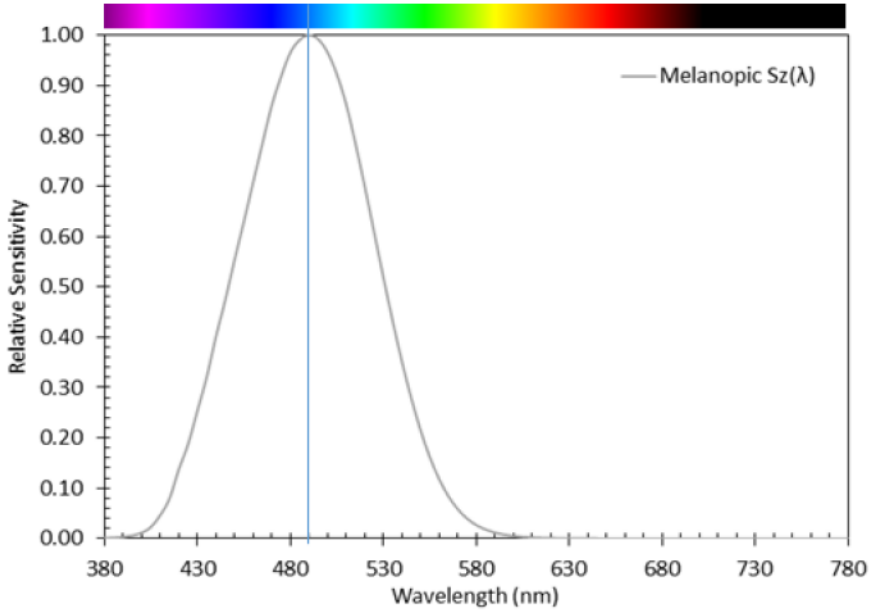
Table 2: Predicted Human Nocturnal Melatonin Suppression from Incandescent and Daylight Illumination [46] of Varying Corneal Illuminances and Durations, Based on Rea et al. [37]

Incandescent			
Illuminance (lx)	Melatonin suppression after 30 minutes	Melatonin suppression after 60 minutes	Melatonin suppression after 90 minutes
0.1	0%	0%	0%
0.3	0%	0%	0%
1	0%	1%	1%
3	1%	2%	2%
10	3%	5%	5%
30	8%	11%	13%
100	19%	25%	27%
300	35%	42%	45%
1000	54%	59%	60%
3000	65%	68%	69%
Daylight			
Illuminance (lx)	Melatonin suppression after 30 minutes	Melatonin suppression after 60 minutes	Melatonin suppression after 90 minutes
0.1	0%	0%	0%
0.3	0%	0%	1%
1	1%	1%	1%
3	2%	3%	4%
10	6%	9%	10%
30	14%	19%	20%
100	29%	36%	39%
300	47%	53%	55%
1000	62%	65%	66%
3000	69%	71%	71%

Marianna Figueiro, et al, 2006 research reported in the Journal of Carcinogenesis



Spectral Content



Impacts (Dosage and Duration)

PNNL data

Combined subset* of readings taken by Naomi Miller, Bruce Kinzey, Rita Koltai, Terry McGowan, Derry Berrigan (*note: not all participants provided readings in every category; not all categories listed)	Reading (Lux)
Vert illuminance from window facing street light, if avail., interior lights off	
-- blinds open	≤0.1
-- blinds closed	0
Vert illuminance from window not facing street light	0-1
Kitchen	30-340
TV from 10 feet away, room light off	0-10
TV from 10 feet away, room light on	2-30
Phone/tablet at reading distance, other room lighting off	0-5
Phone/tablet at reading distance, room lighting on	15-45
Bedside lamp(s) reflecting on magazine/book page	35-350
Max horizontal illuminance at street light nadir - no vegetation interference	5-10
Max horizontal illuminance at street light nadir - some interference	0-5

Reaction

AMA Adopts Guidance to Reduce Harm from High Intensity Street Lights

For immediate release: Jun 14, 2016

American Medical Association (AMA) 2016 report titled *Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting* which has been relayed to the public via various news providers.

The AMA key recommendation is both *"minimizing and controlling blue-rich environmental lighting by using the lowest emission of blue light possible to reduce glare"* as well *as "the use of 3000K or lower lighting for outdoor installations such as roadways...."*.

CHICAGO - Strong arguments exist for overhauling the lighting systems on U.S. roadways with light emitting diodes (LED), but conversions to improper LED technology can have adverse consequences. *In response, physicians at the Annual Meeting of the American Medical Association (AMA) today adopted guidance for communities on selecting among LED lighting options to minimize potential harmful human and environmental effects.*

High-intensity LED lighting designs emit a large amount of blue light that appears white to the naked eye and create worse nighttime glare than conventional lighting. *Discomfort and disability from intense, blue-rich LED lighting can decrease visual acuity and safety, resulting in concerns and creating a road hazard.*

In addition to its impact on drivers, blue-rich LED streetlights operate at a wavelength that most adversely suppresses melatonin during night. *It is estimated that white LED lamps have five times greater impact on circadian sleep rhythms than conventional street lamps*.

Recent large surveys found that brighter residential nighttime lighting is associated with reduced sleep times, dissatisfaction with sleep quality, excessive sleepiness, impaired daytime functioning and obesity.

Recognizing the detrimental effects of poorly-designed, high-intensity LED lighting….. *The AMA recommends an intensity threshold for optimal LED lighting that minimizes blue-rich light.*

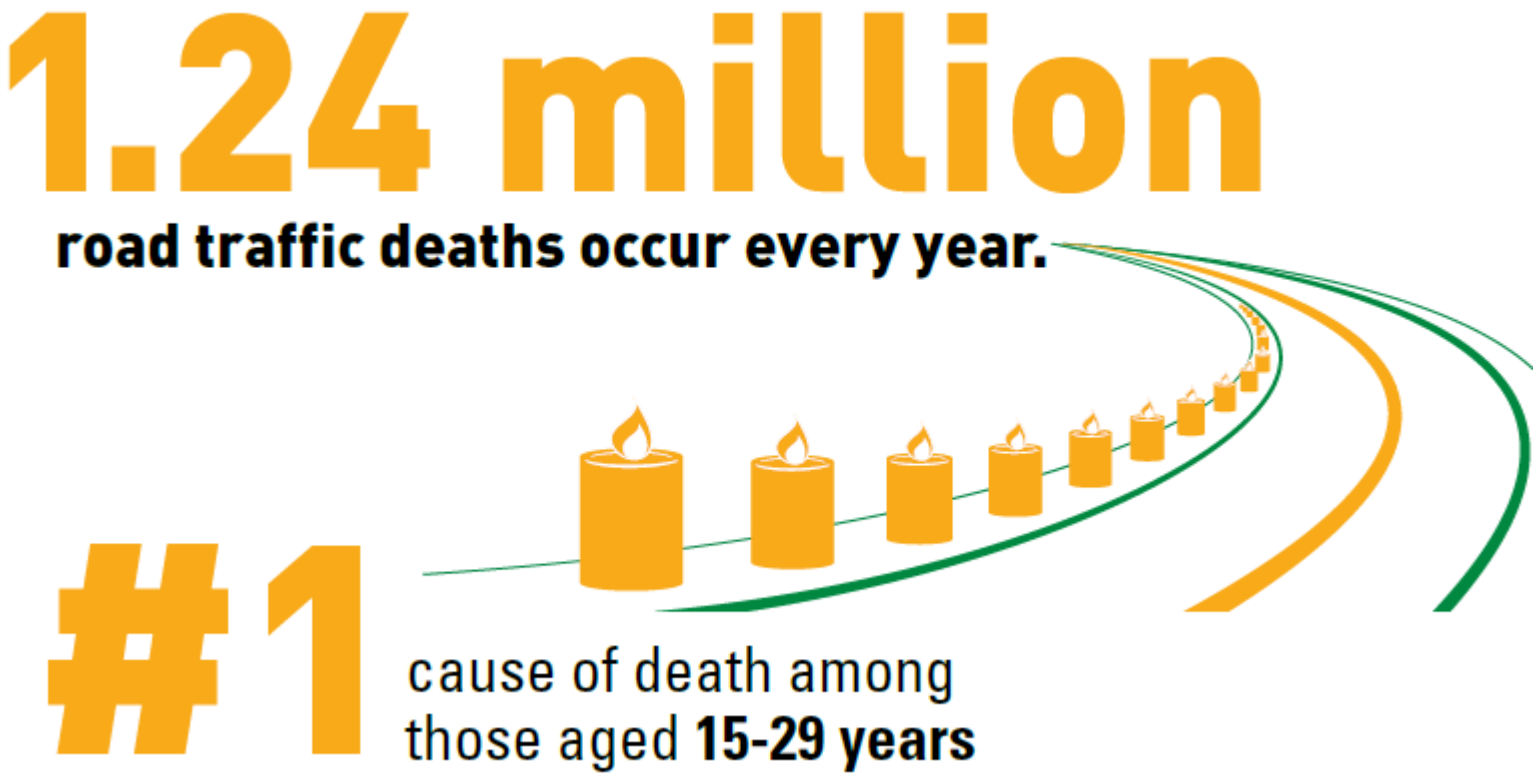
The AMA also recommends all LED lighting should be properly shielded to minimize glare and detrimental human health and environmental effects*, and consideration should be given to utilize the ability of LED lighting to be dimmed for off-peak time periods.*

In response to the 2016 AMA Report, Mark S. Rea, PhD and Mariana G. Figueiro, PhD of the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute prepared a paper which reviewed the effects of LED lighting on humans:

The LRC report concluded *"Correlated Color Temperature (CCT) is not appropriate for characterizing the potential impacts of a light source on human health because the CCT metric is independent of nearly all of the important factors associated with light exposure, namely, its amount, duration, and timing."*

Considerations

Safety - Global Traffic Fatalities

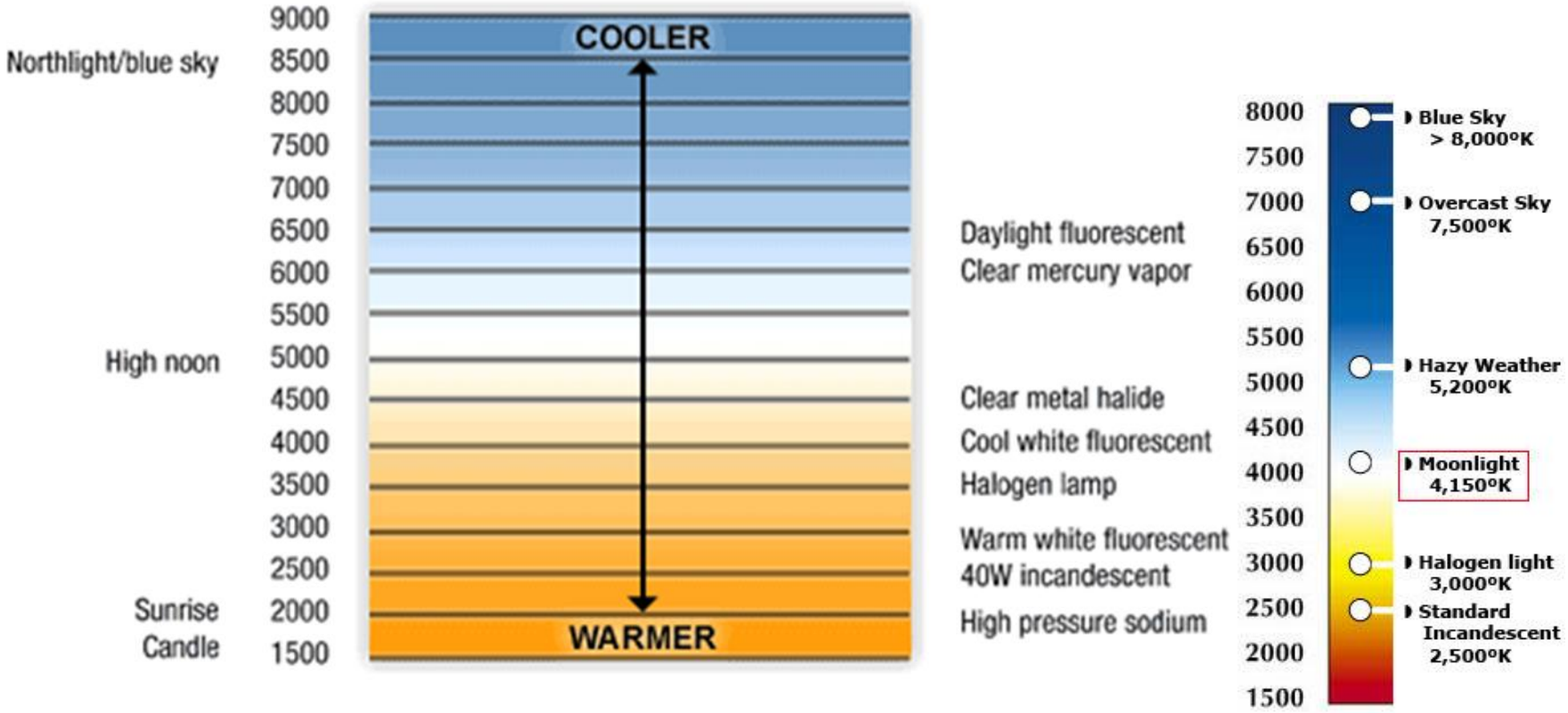


Safety - Effect of Lighting on Crashes

Conditions		Effect	95 % conf.
All		-54 %	-56 %, -52 %
Weather conditions	Fine weather	-54 %	-56 %, -52 %
	Rainy weather	-45 %	-53 %, -37 %
	Foggy conditions	0 %	-15 %, +18 %
	Snowy weather	-26 %	-40 %, +8 %
Road surface conditions	Dry road surface	-56 %	-59 %, -54 %
	Wet road surface	-46 %	-50 %, -43 %
	Snow / ice covered	-22 %	-31 %, -11 %
Road user	Pedestrian	-70 %	-77 %, -61 %
	Bicycle	-60 %	-65 %, -54 %
	Moped	-61 %	-64 %, -56 %
	MC	-26 %	-42 %, -5 %
	Automobile	-50 %	-52 %, -47 %
Accident type	Hit fixed object	-54 %	-58 %, -49 %
	Frontal collisions	-50 %	-55 %, -43 %
	Flank collisions	-46 %	-51 %, -41 %
	Hit animal	-57 %	-63 %, -50 %
	Rear end collisions	-51 %	-54 %, -46 %

Research by
Per Ole Wanvik – Road Lighting and Traffic Safety

Color Temperature Chart



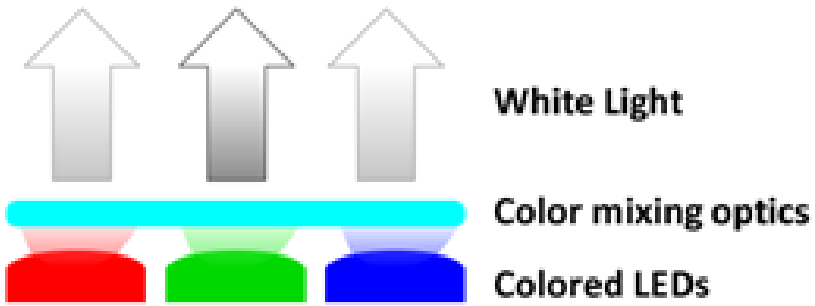
Colour Temperature for LED’s

Phosphoric LEDs use a blue LED chip with a yellow phosphor coating. The color temperature is determined by the mix of blue LED’s and a yellow phosphor coating. The phosphor coating therefore defines the colour temperature

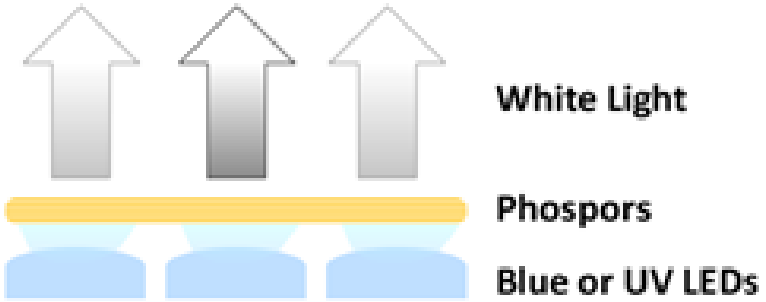
Some products actually use a red LED's in their luminaire . Some have used only red or amber LED's for specific applications (sea turtle friendly)

The technology exists to use a mix Red-Green-Blue (RGB) to produce different colour temperatures which can be changed via lighting controls (sports arenas). Not readily available for street lights at this time.

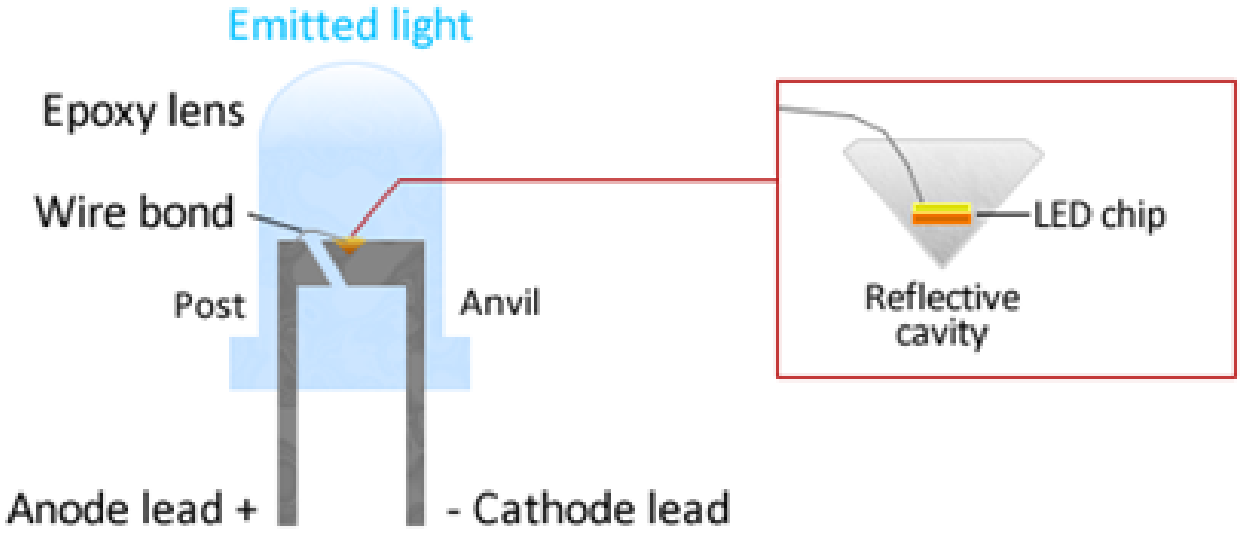
LED Basics



RGB



Typical LED Street Light




5700K
4000K
3500K
3000K

Supplier A

Product A		
4000K	**3000K**	**% Difference**
16349	14868	9.1
16046	14432	10.1
15763	14405	8.6
15697	14153	9.8
13954	14516	-4.0
14747	14532	1.5
20444	18303	10.5
20065	17766	11.5
19711	17733	10.0
19628	17423	11.2
17449	17870	-2.4
18440	17890	3.0
24538	22106	9.9
24084	21458	10.9
23658	21419	9.5
23559	21044	10.7
20944	21583	-3.1
22133	21607	2.4
28633	25833	9.8
28102	25076	10.8
27606	25030	9.3
27490	24592	10.5
24439	25222	-3.2
25826	25250	2.2

Average:	6.6
Max:	11.5
Min:	-4.0

Product B		
4000K	**3000K**	**% Difference**
8330	7398	11.2
8140	7181	11.8
8085	7168	11.3
8178	7042	13.9
7142	7223	-1.1
7496	7231	3.5
11169	10064	9.9
10914	9769	10.5
10841	9751	10.1
10965	9581	12.6
10360	9826	5.2
10050	9837	2.1
12507	11116	11.1
12222	10790	11.7
12140	10770	11.3
12279	10581	13.8
10724	10853	-1.2
11255	10865	3.5
16778	14706	12.3
16396	14275	12.9
16285	14249	12.5
16472	13999	15.0
14386	14358	0.2
15098	14374	4.8

Average:	8.7
Max:	15.0
Min:	-1.2

Product C		
4000K	**3000K**	**% Difference**
4167	3672	11.9
3955	3565	9.9
4083	3558	12.9
4030	3496	13.3
3682	3585	2.6
3800	3589	5.6
5593	4945	11.6
5309	4800	9.6
5480	4791	12.6
5405	4707	12.9
4886	4828	1.2
5100	4833	5.2

Average:	9.1
Max:	13.3
Min:	1.2

Supplier B

Product A		
4000K	**3000K**	**% Difference**
3230	3230	0.0
4070	3970	2.5
4600	4540	1.3
5000	4940	1.2
5750	5480	4.7
4900	4830	1.4
5950	5860	1.5
6720	6490	3.4
7540	7420	1.6
8520	8020	5.9
6660	6490	2.6
8280	8150	1.6
9250	9430	-1.9
10170	10620	-4.4
11420	10850	5.0
8130	8010	1.5
10190	10030	1.6
11720	11540	1.5
12520	12810	-2.3
14090	13430	4.7
9750	9600	1.5
12080	11902	1.5
13750	13550	1.5
15160	15130	0.2
17160	15910	7.3

Average:	1.6
Max:	5.9
Min:	-4.4

Safety and Security

From a safety and security standpoint police forces we have interviewed prefer the more fuller colour spectrum light source with a high colour rendering index over HPS sources. They have noted there ability to undertake surveillance and identification is improved.

Suggest you review with your local police force