LED STREETLIGHTING: ENVIRONMENT & SAFETY IMPACTS

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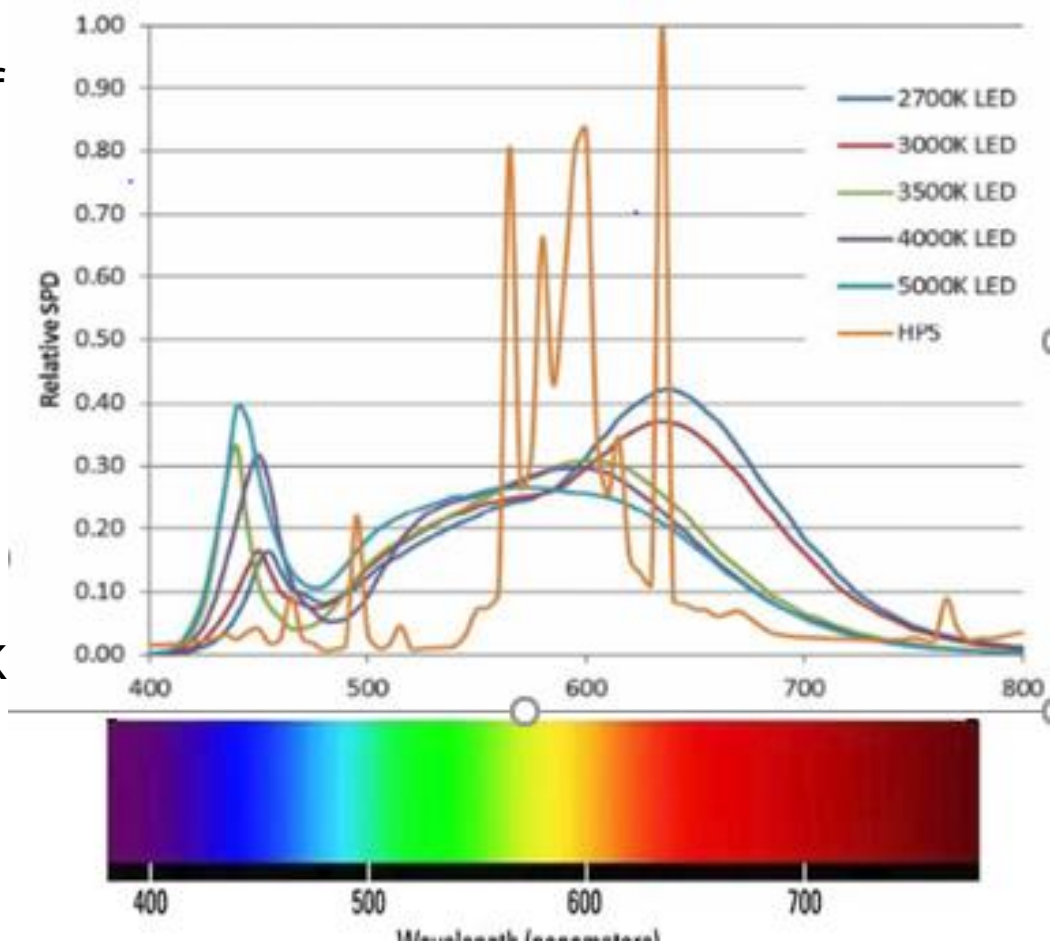
LED lighting has many advantages

- LED luminaires use much less power and need less maintenance than legacy technologies (HPS)
- The light is much better directed, resulting in less light pollution
- Their power can be easily reduced or increased using computer controlled technology
- Hardware prices are dropping and efficiency is increasing- expected to continue to do so.

It is now a case of what LEDs to use rather than whether to use LEDs

The spectra of HPS and LED lighting

- Correlated colour temperature (CCT) in Kelvin is a measure of the spectrum of a light source.
- A higher CCT generally indicates a higher level of blue light
- High Pressure Sodium Sources are ~ 2000 K
- LEDs are generally 3000 K or more – usually 4000K and occasionally 3000 K in New Zealand
- Therefore they emit more blue light than HPS sources



There has been discussion on the impact this choice has on safety and the environment

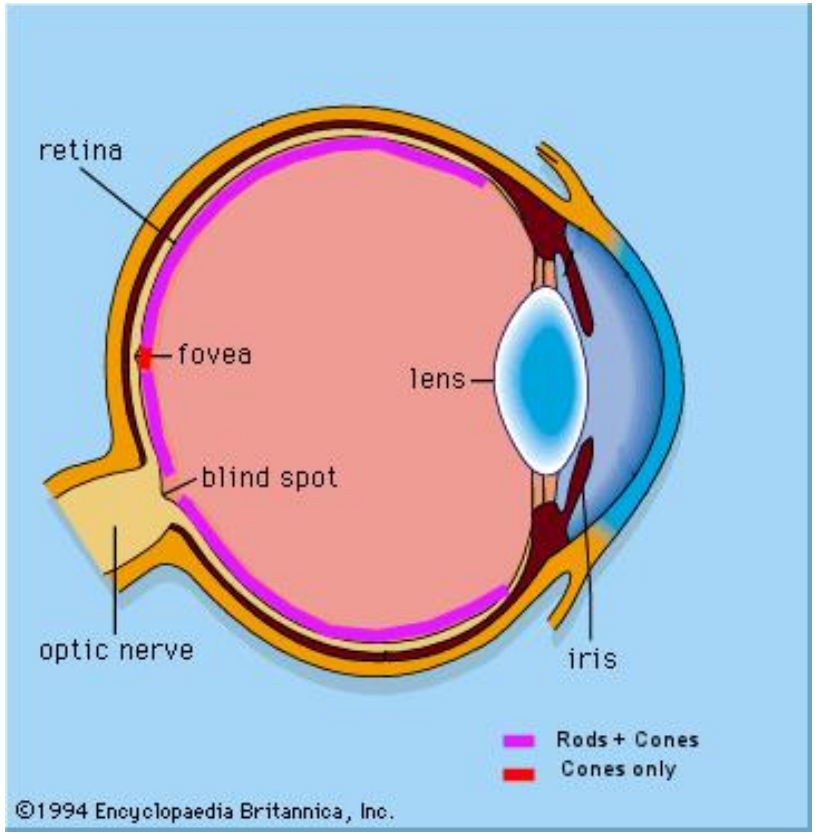
Safety

— Driver fatigue, central vision, peripheral vision and object detection

The environment

— Wildlife, Human health, The visibility of celestial bodies in the night sky.

Rods (peripheral vision) , cones (central vision) and lighting levels



	Condition	Illuminance (lux)	Luminance (cd/m^2)
Photopic (cones)	Bright Sunlight	100,000	
	Overcast Day	10,000	
	Work desktop	400	
Mesopic	Floodlit Pedestrian Xing	30	3
	Category V lighting	10	1
	Category P lighting	2	0.2
Scotopic (rods)	Starlight	0.001	

In practical terms on the road

- To detect off road objects like pedestrians about to cross, drivers use peripheral vision (rods).
- If an object of interest is detected drivers may also use central vision (cones) by moving their heads and eyes.
- To detect on road objects (like pedestrians crossing the road) drivers use central vision (cones)

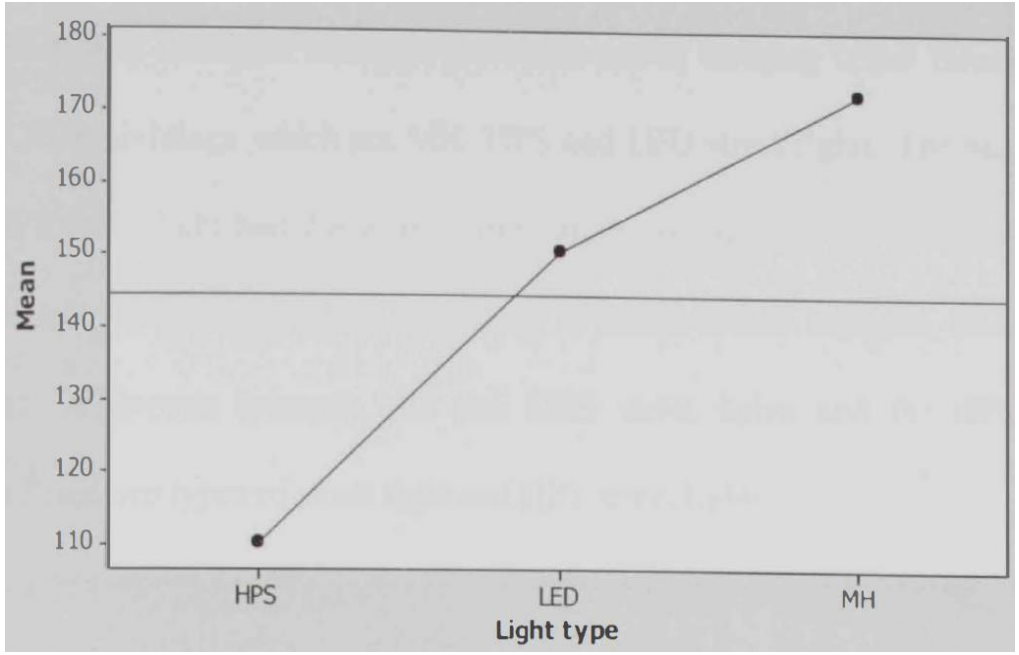
LEDs produce more rod sensitive (peripheral vision) blue light than HPS while still having significant power in the cone sensitive (central vision) part of the spectrum.

They are thus well suited to light roads and may outperform HPS in peripheral vision tasks.

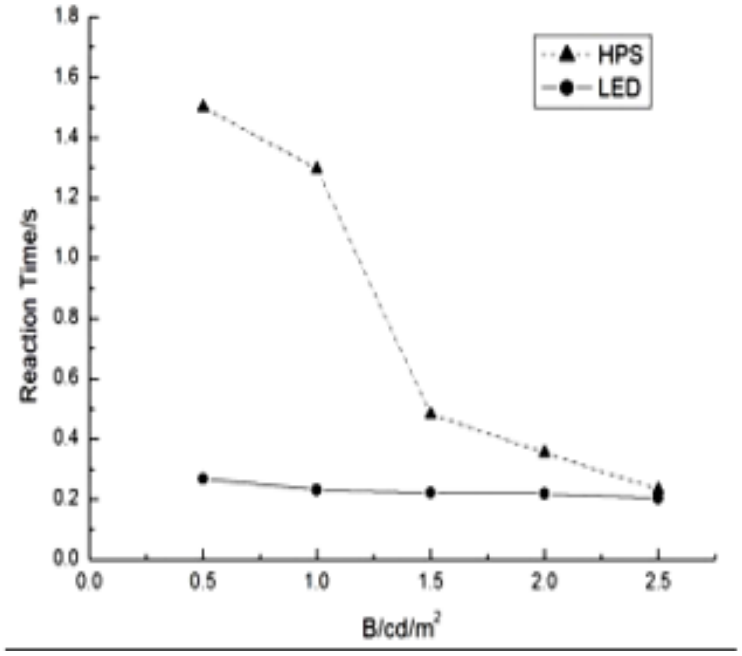
However, there is as yet no crash data to demonstrate a safety advantage

Visibility of objects to drivers- LED Vs HPS

Higher detection distance with LED for peripheral objects



For central objects, HPS reaction times vary with lighting level with LED times constant



Driver Fatigue

Glare may tire drivers

- Disability Glare –No change with spectrum
- Discomfort glare- Bluer light may be worse

More blue light may improve safety by waking drivers up-

- But research evidence is lacking

Blue light loss by yellowing of the eye's lens

Reduces the effectiveness of blue rich lighting for older people.

Blue light loss by absorption by road surfaces

5% more absorption from LED light compared to HPS

Impact on Sky glow

Upward light restricts vision of stars & Milky Way

- Its impact is commonly called Sky Glow
- In major centres only the brightest stars may be seen and subtle structures like the milky way simply lost.
- Sky glow effects extend 50 kms or more beyond the city limits
- Night sky views from rural New Zealand are recognised internationally and are part of New Zealand's "clean and green" image.

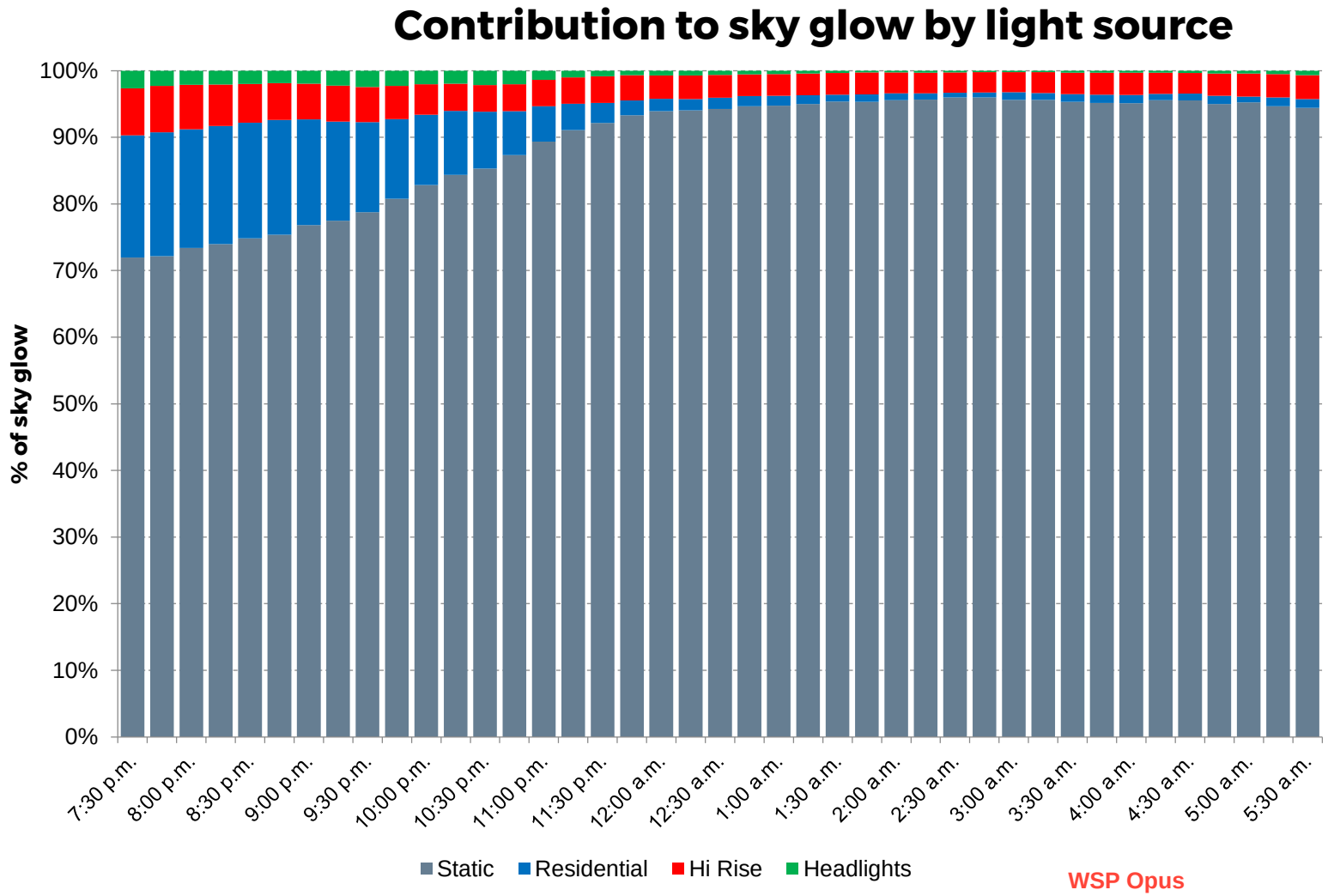
Sky glow facing towards Hutt City

Sky glow facing away from Hutt City

Both photos taken at 1am, 17/12/2017 from Moores Valley road, Lower Hutt

Wellington contribution to Sky Glow by light Source and time of night

Vehicle headlights	3% - 0%
High-rise buildings	7% - 3%
Residential lights	18% - 1%
Static (unchanging)	72% - 96%



WSP Opus

Streetlighting is not the only source of outdoor uplight at night

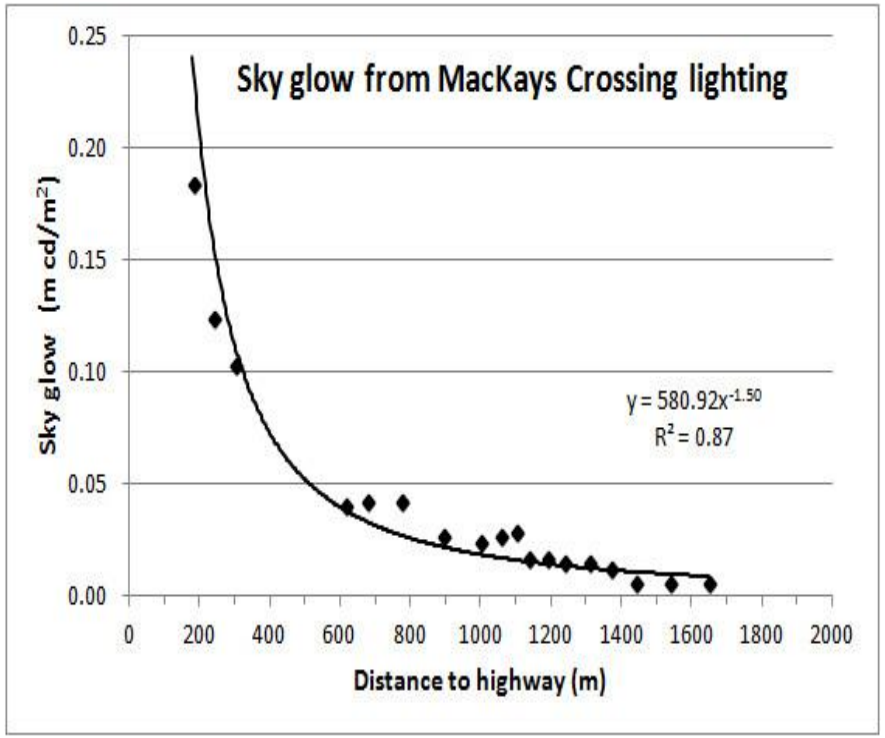
Other contributors include:

Interior light escaping from windows, Architectural and landscape lighting

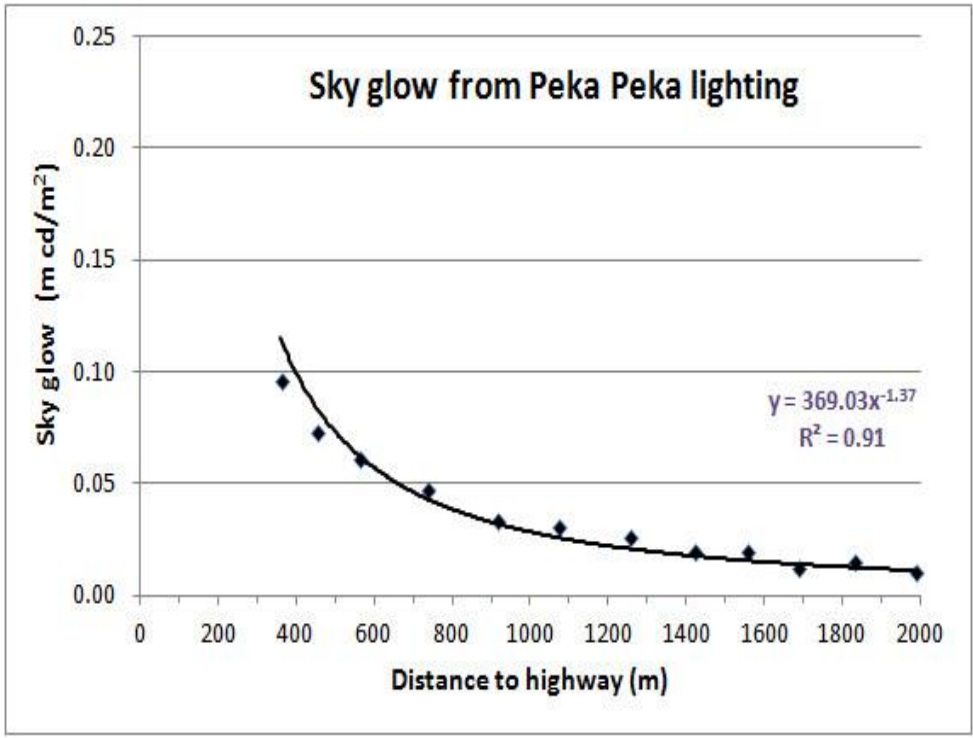
Recreational lighting, Parking lots and garages, Industrial security lighting

Vehicle lighting, Signage/Billboards

Decay of sky glow with distance from rural lighting installations



HPS



LED

Wild life

Street lights can interfere with wild life.

- LEDs Interfere with moths' ability to avoid predatory bats and
- HPS emits UV radiation which causes 'flight-to-light' and high mortality among flying insects.
- Red lighting (used overseas for pedestrians) diverts migratory birds when used at sea.

The difference of impact between HPS and LEDs of various spectra is not well understood and will vary with local concerns.

Human Health

- Blue light hazard-Photo chemical retina damage-from staring at an intense light source-Welding Arc or Sun.
- Age related macular degeneration
- Human Sleep Patterns and Circadian Rhythms

In all these cases streetlights whether LED or HPS are much too weak to have any meaningful disbenefits

Environmental conclusions

- No evidence to support health disbenefits from standards compliant streetlights in NZ be they HPS or LED.
- LED and HPS light sources impact on wildlife but in different ways. No evidence to suggest one is better than the other and the evidence for such impacts from streetlighting is mixed.
- Proper adjustment of streetlights can minimise uplight (which produces sky glow)
- Skyglow from 2 rural, state highway lighting installations, one HPS, one LED decayed to near background level within 2 km.
- Around 70 to 95% of overnight sky glow in the Wellington CBD related to static lighting including streetlighting, industrial lighting, waterfront lighting, billboards etc.

Safety Conclusions

- There is no hard data from crash studies to show whether white LED light is safer than yellow HPS light
- Limited visibility related studies indicate white LED light provides a superior visual environment to HPS light.
- More blue light may help drivers stay alert but no firm evidence yet exists.
- The eye's lens absorb more blue light with age reducing the effectiveness of blue rich lighting for older people.

Footnote -3000K or 4000K LEDs?

- Choice of CCT of an LED depends on several safety, and environmental factors, along with efficiency
- The factors may have different weightings at different locations and pull in various directions
- Evidence is not available at present to definitively state which is better overall
- Therefore fine tuning of white light into specific CCTs of say 3000K or 4000K has no strong overall research basis

The End

-Thanks to the NZTA for funding this work.