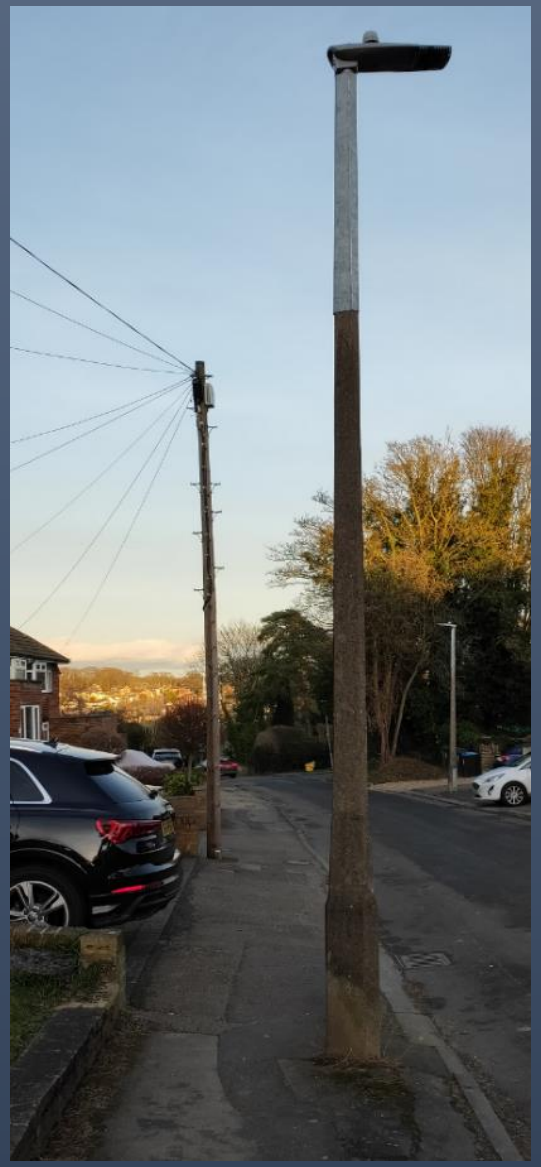


LED Streetlights and Blue Light Concerns

Introducing Myself

- Electrical & Electronic Engineer
- 35 years in product development
- Military radar, automotive instrument panels, electric vehicle power etc..
- Specialised in LED illumination and display technology

I have no commercial or particular campaigning interest in these matters.

- Write requirements
- Design
- Quotations
- Source components
- Manufacturing

- Automotive environmental standards often lead the way
- banned fluorescent lamps 20 years ago (Hg)
- banned chrome-passivated screws

NEW TECHNOLOGY

- Risks
- Opportunities

First Impressions of Street Lighting

- Many documents, but requirements are scant
- With HCC refurb/replace budget of £5.6m, maybe some influence.

Fundamental Objectives

- Enable cars, kerbs etc. to be visible at night, to avoid collisions
- Provide guidance
- Not cause harm to wildlife or people or environment
- Aesthetic
- NO requirement to be able to determine true colour of objects

Derived Requirements

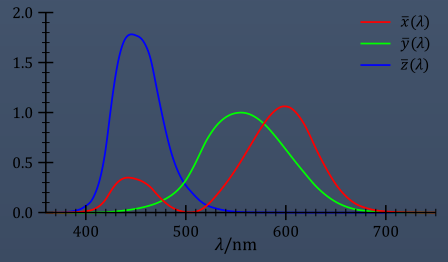
- Illuminance of roads & paths
- No light “spill”
- Spectrum optimised to minimise disruption to sleep, wildlife, astronomy etc.
- No flicker
- Low glare

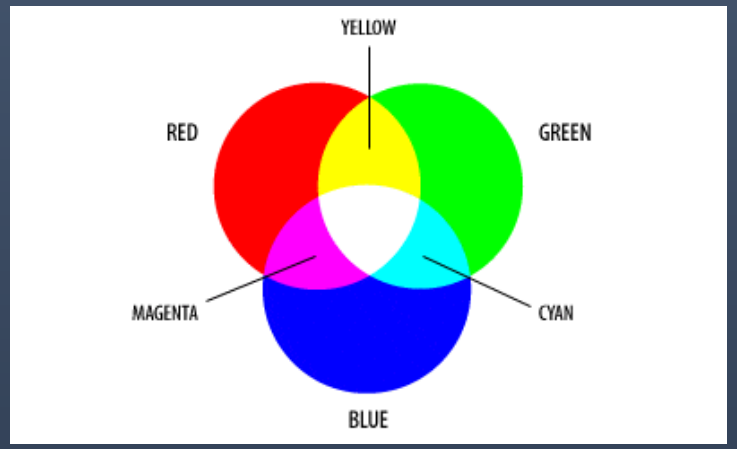
Environmental Factors

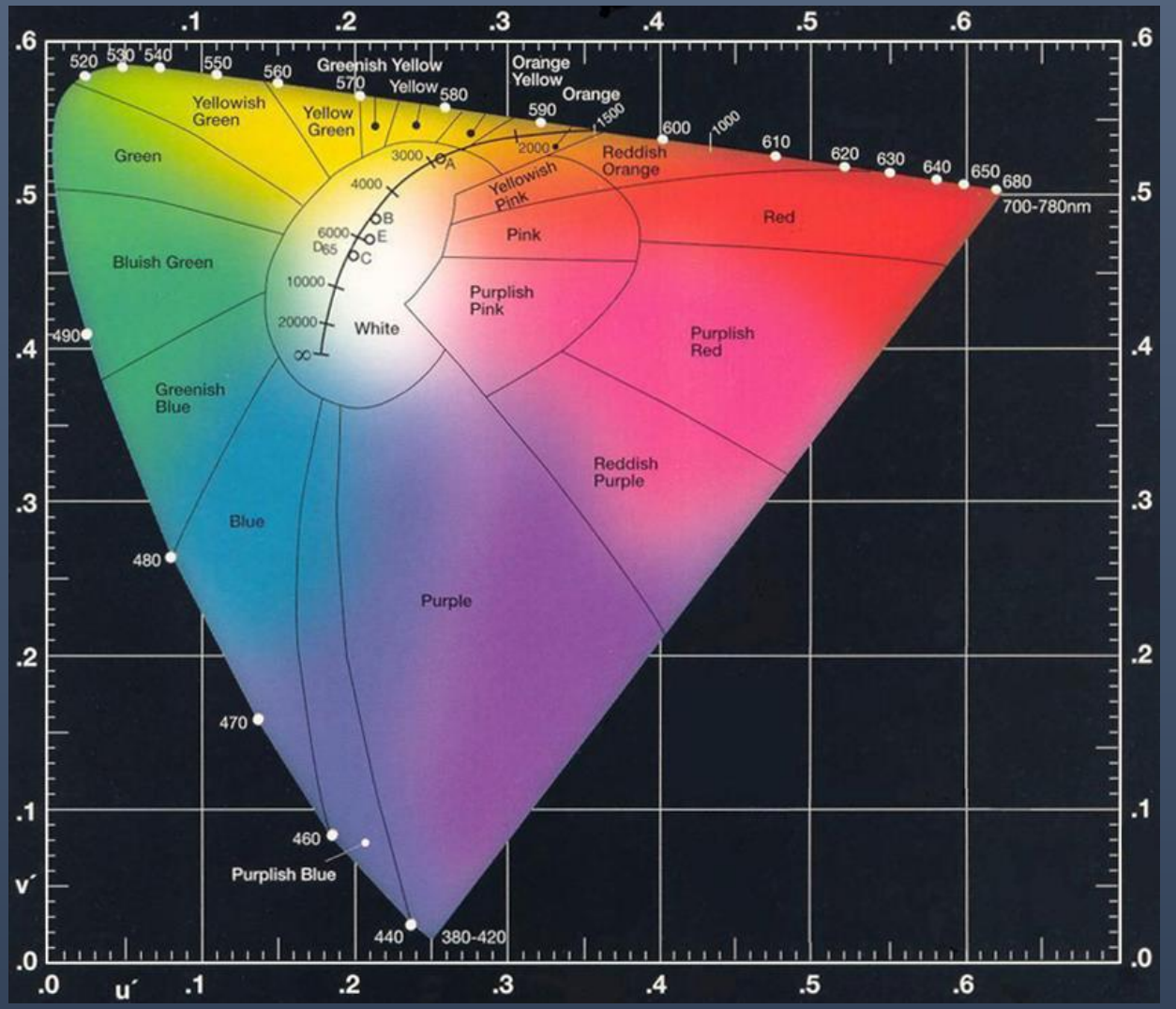
- Energy consumption in use
- Materials used in manufacture, in terms of recyclability and quantity
- Aesthetics
- Pollution
- Serviceability
- Spill (a.k.a. Obstructive light; light pollution)
- Spectrum

The Science - Spectrum

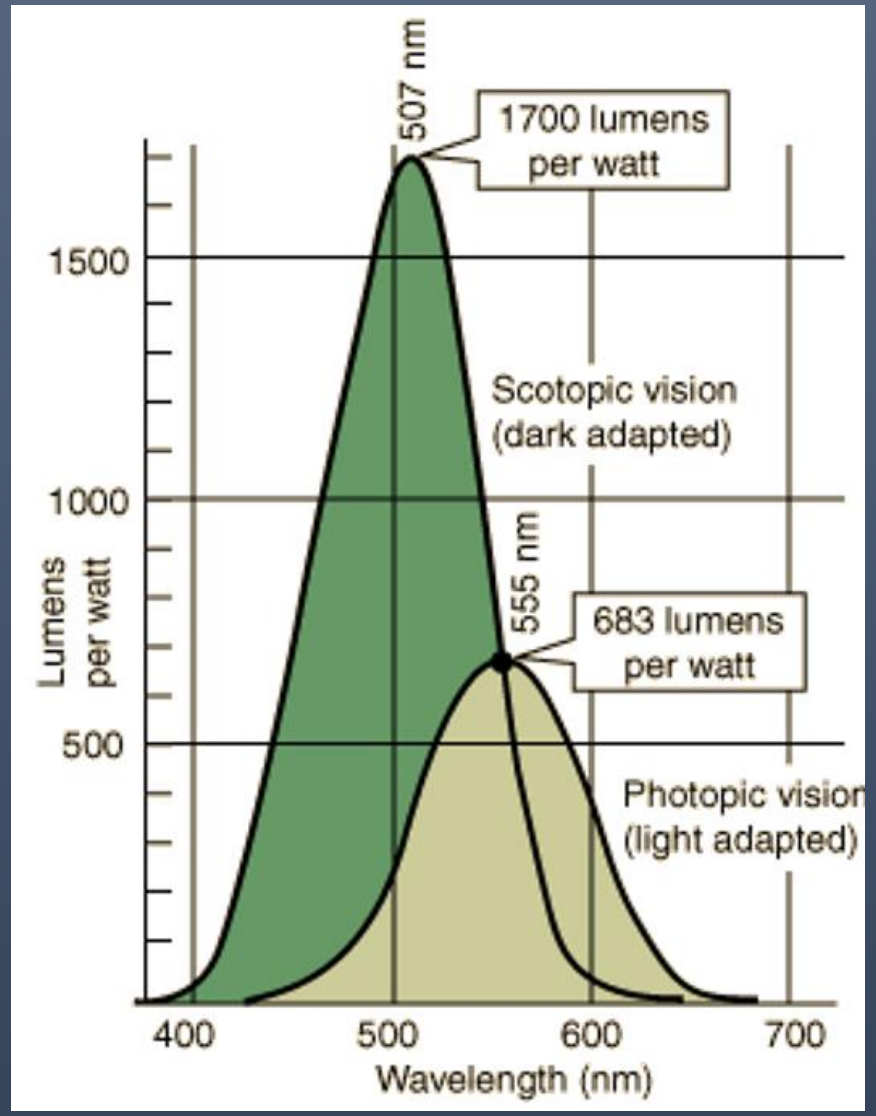
- Visible light is composed of a spectrum of colours ROYGBIV

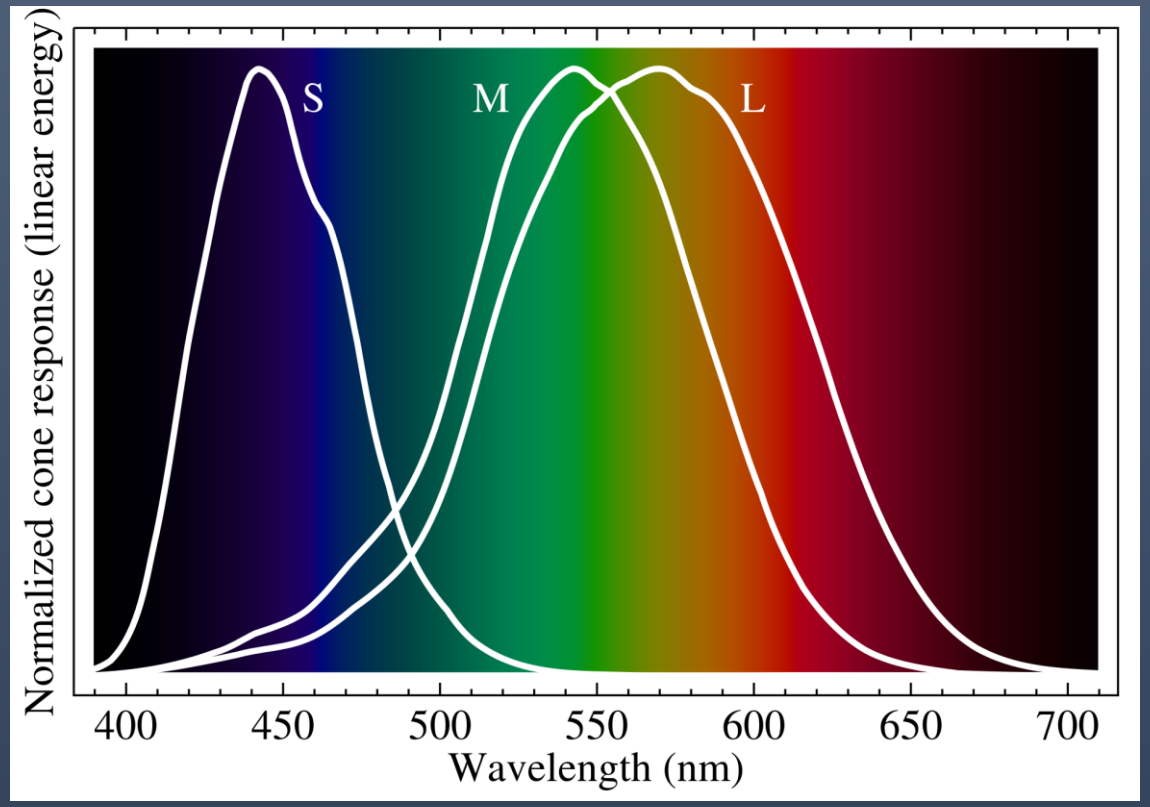




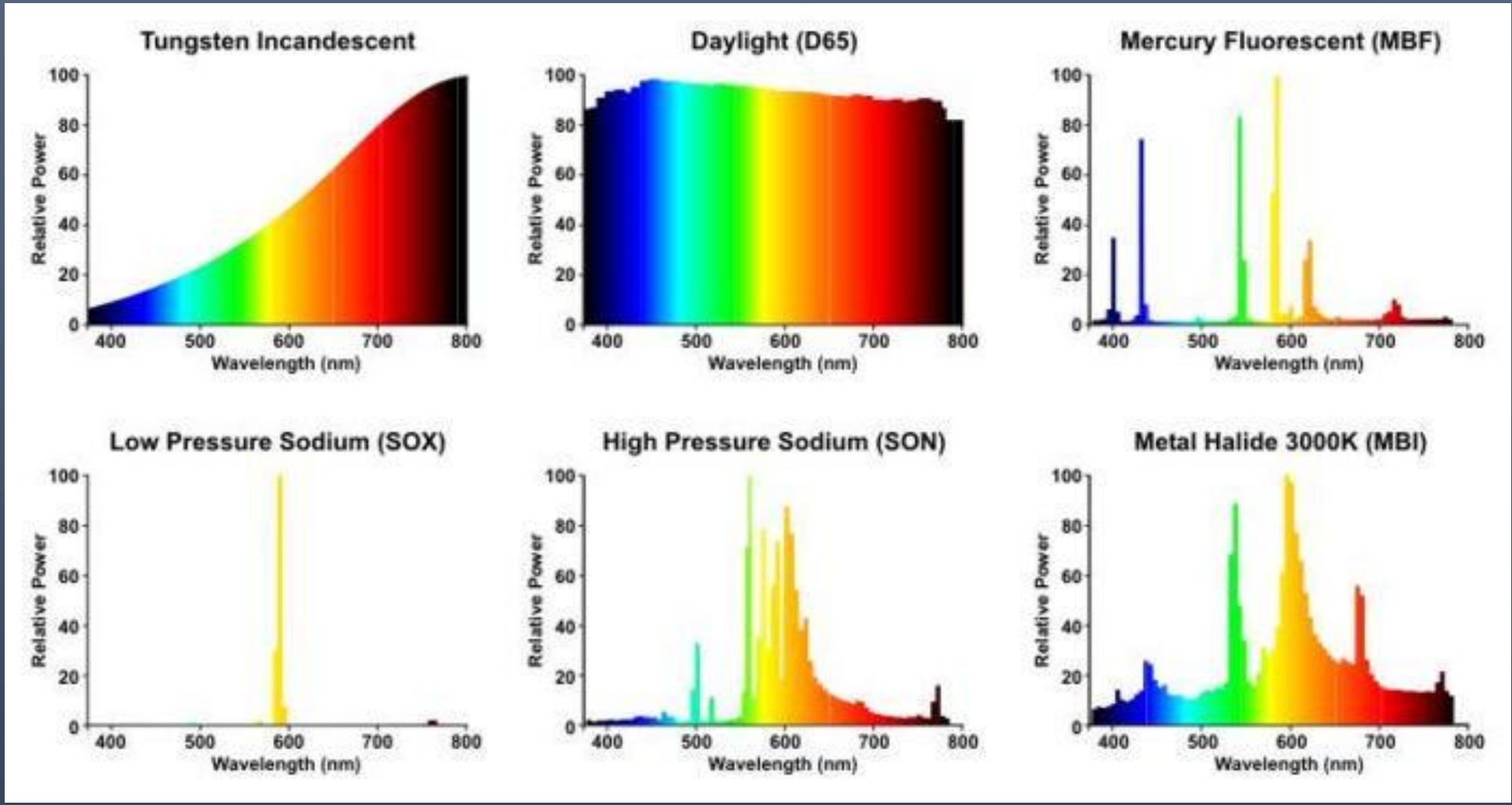


Perception of Colour – Rods & Cones



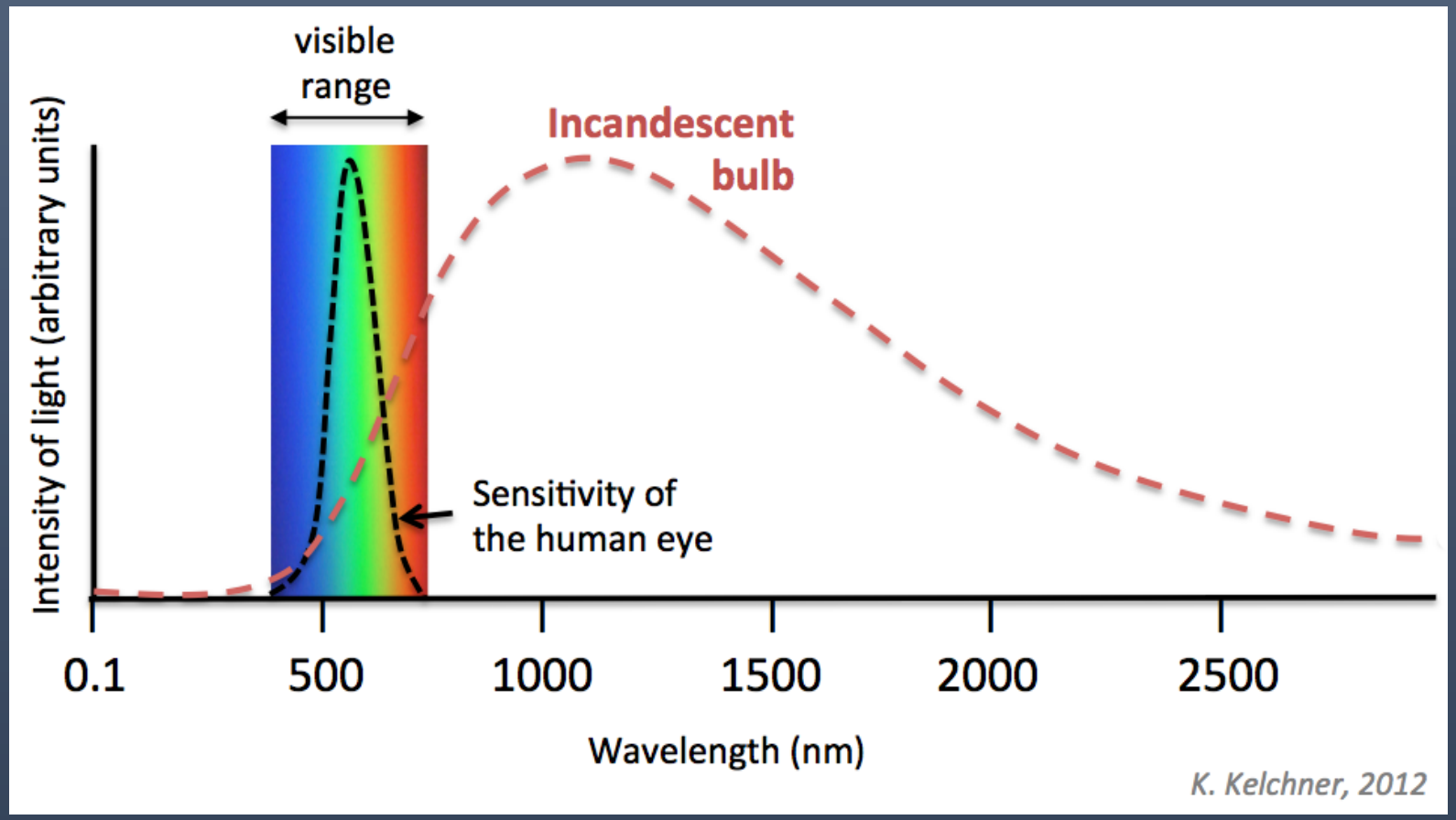


Spectra of Sources

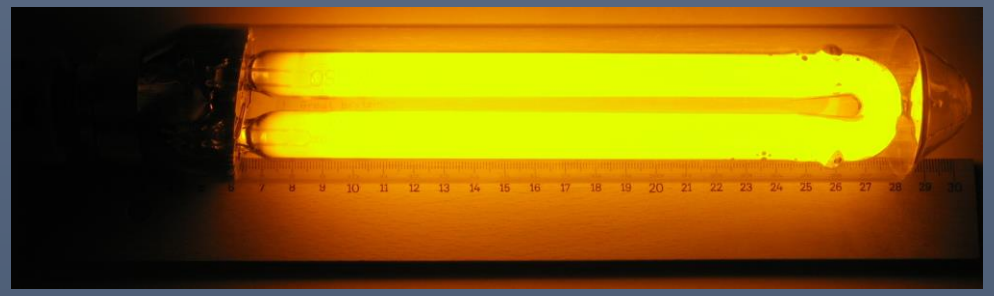


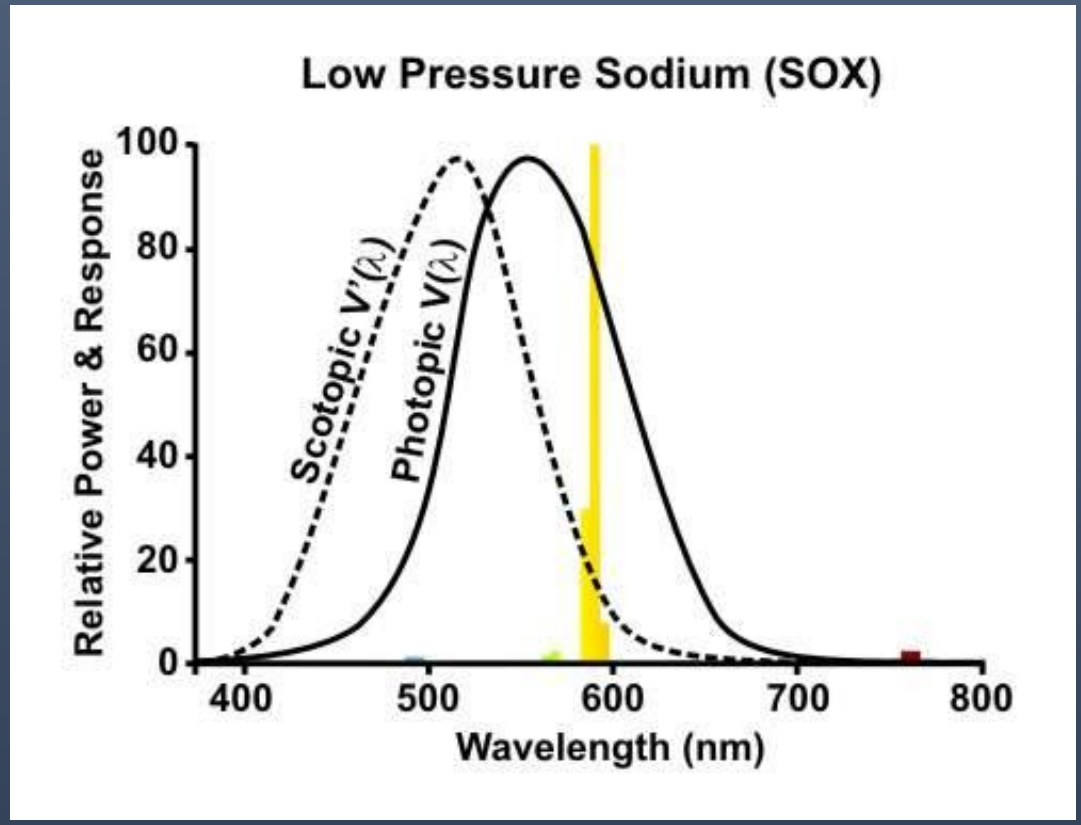
Sources of Light

- Incandescent – “black body radiator”
- Very little blue content
- Hotter ➔ more visible light
- Hotter ➔ more blue

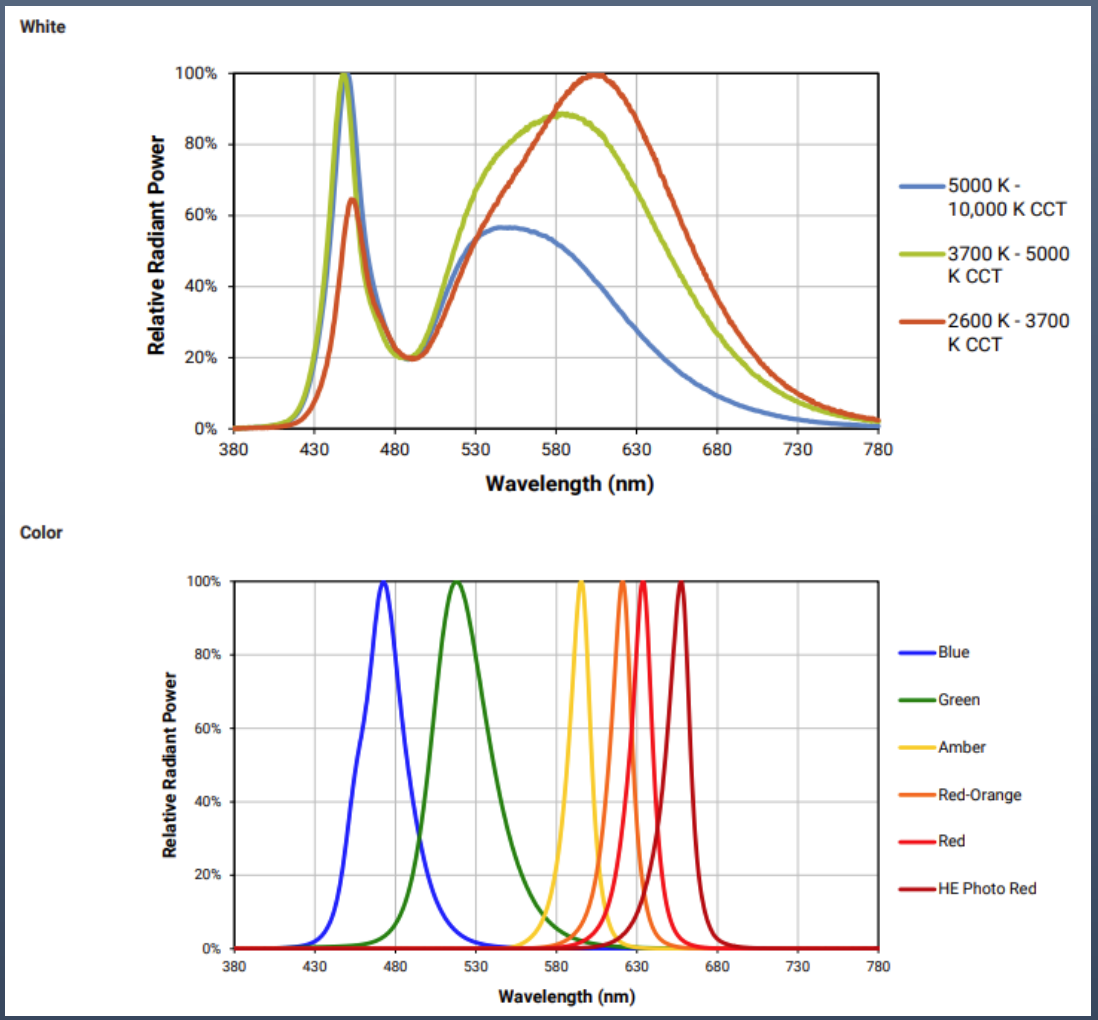


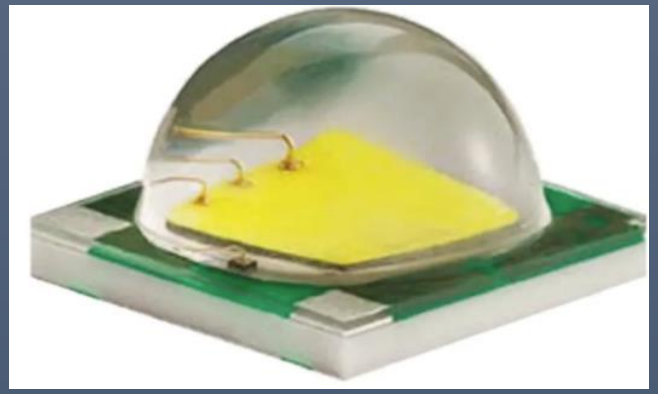
Low Pressure Sodium

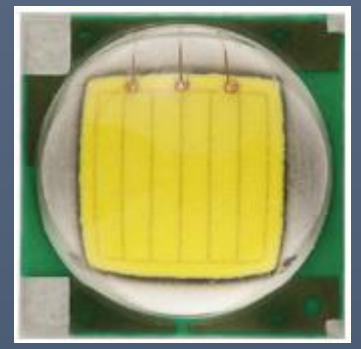


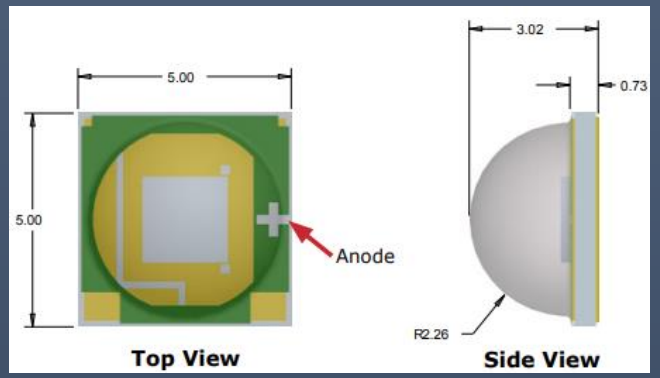


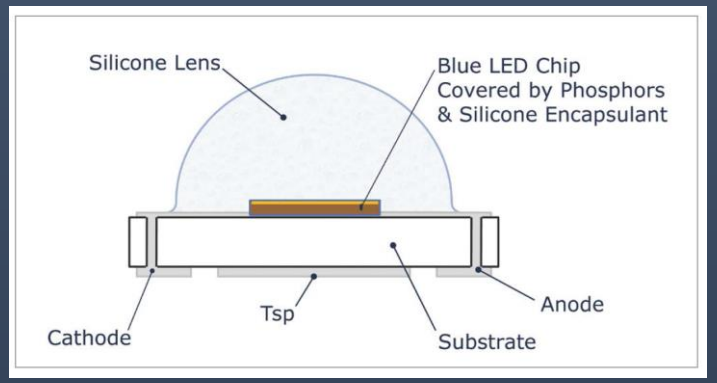
White LED







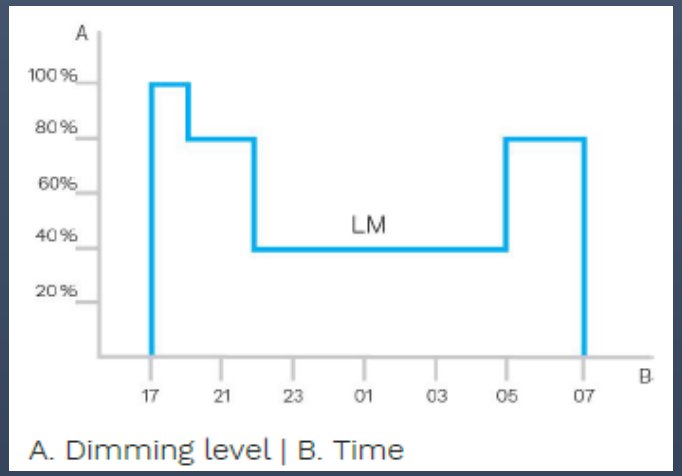




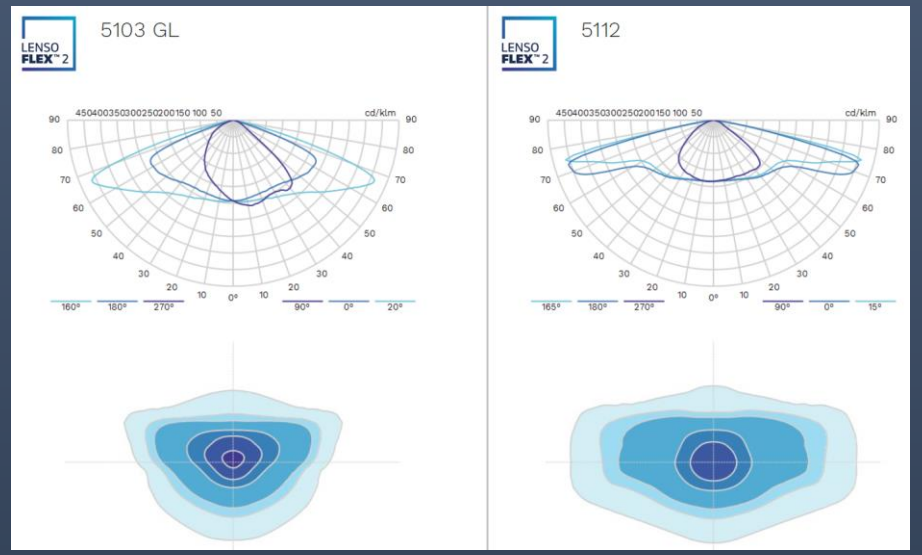
Pure LEDs and blue with yellow phosphor.

Hertfordshire Street Lighting

- 115,000 lights
- 75,000 of which are dimmed or turned off for periods of the night.
- All (I think) now converted to LED
- Digitally controlled for on/off and dimming
- 48W each, and around 5,000 lumens
- 4,000K colour temperature (cool white)

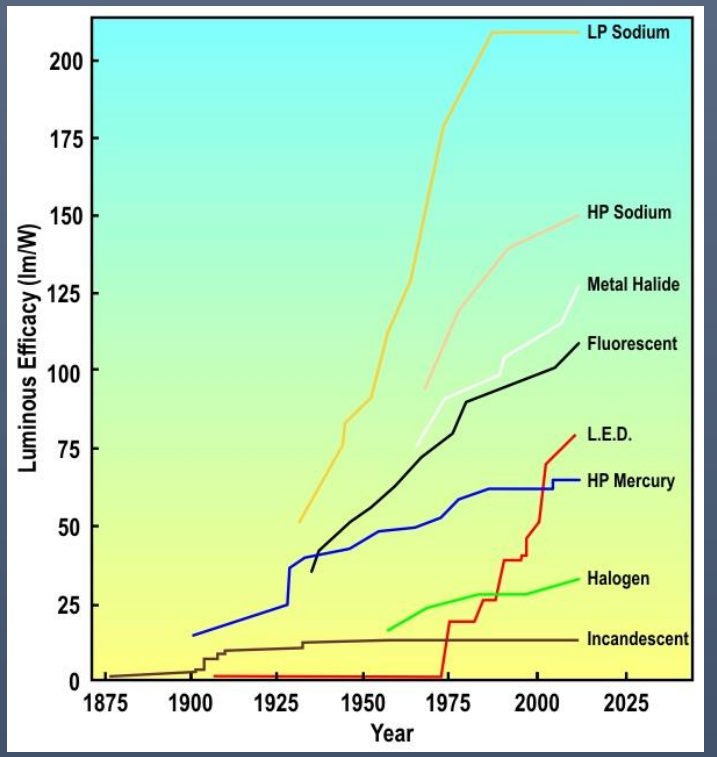


illustration



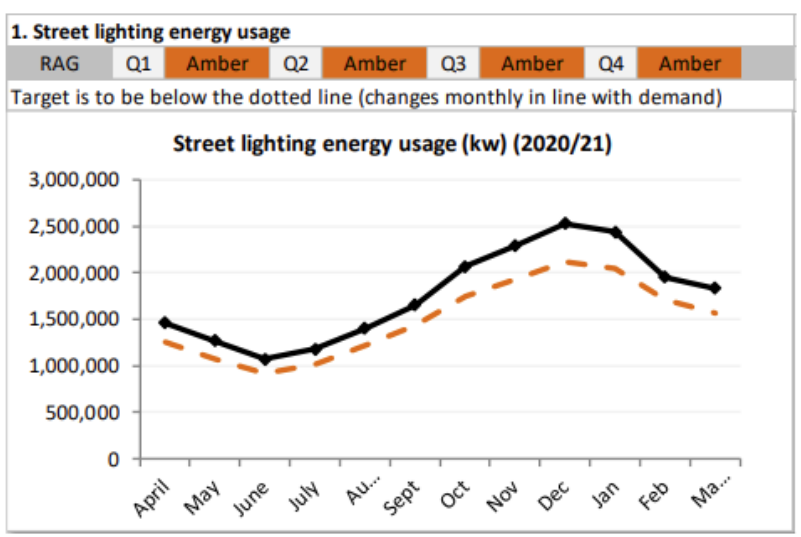
Opportunities from LED

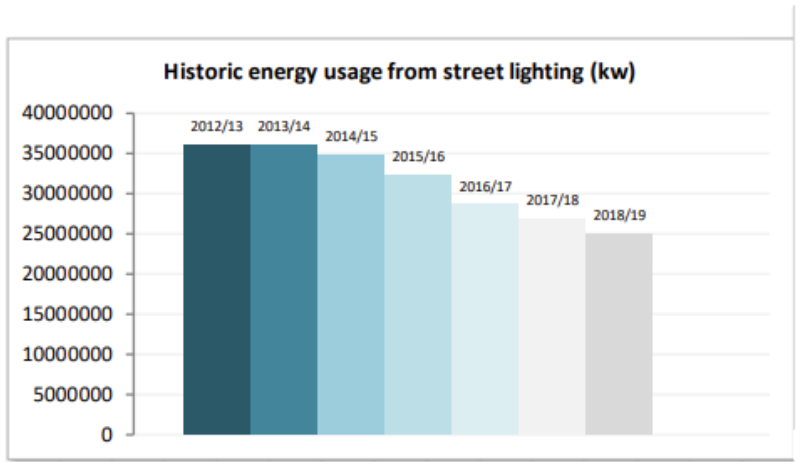
- Centralised Control - reduce energy
- Dimming – optimise brightness during night and to compensate for ageing
- Long Life – reduce servicing costs
- Small Point Source - Accurate beam design, reduce “spill”, even coverage
- Light Weight, Small & Robust – serviceable, Light-weight pillars



OPPORTUNITIES YET TO BE REALISED

- Colour Tailored
- Light Weight, Small & Robust – serviceable, light-weight hinged pillars (currently 10kg, need cherry-picker, car-safe?)



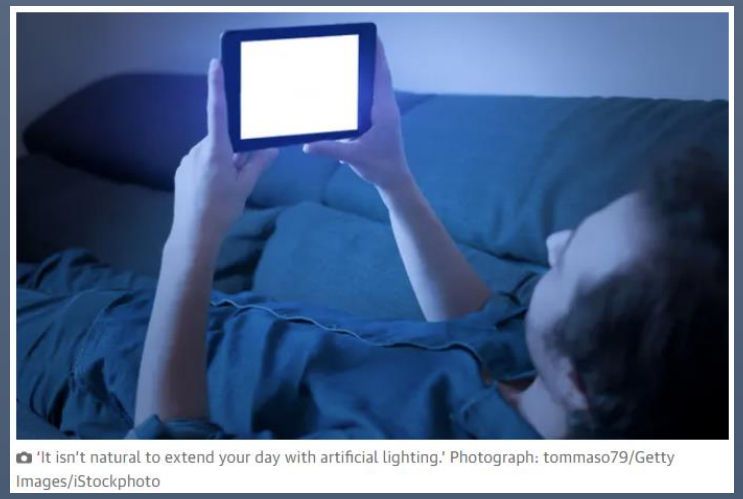


HCC Data

- Should be MW, not GW, surely!
- 22W/luminaire seems a bit high.

New Risks from LED

- Glare
- Flicker
- Multiple Shadows
- Poor Colour Rendering Index (CRI)
- Higher Blue Light Content



'It isn't natural to extend your day with artificial lighting.' Photograph: tommaso79/Getty Images/iStockphoto

Concerns long been reported regarding phone screens

- Sleep Deprivation
- Mood
- Wildlife evolved with red dusk light
- Humans have extended evenings with fire-light, mostly red.
- Moon (and stars) only natural source of blue light at night

Children's eyes are more sensitive to blue light. Photomontage: Getty Images/Cavan Images RF/Guardian Design Team

Guardian

Standards and best practice documents

- mention the risk
- Not quantified
- Little understood
- No specific advice, beyond minimising "spill"

New Risks from LED

2017 Annual Report of the Chief Medical Officer, authored by John O'Hagan, Public Health England

"We evolved to experience a reddening sky as we move into the evening. Our melatonin levels should start to increase to prepare ourselves for sleep and to facilitate the body's repair mechanisms. When we get up in the morning, the sunlight should suppress our melatonin levels, whilst serotonin production is increased to prepare us for activities of the day."

"…24-hour light may have an adverse effect on flora and fauna."

"In the early 2000s a type of sensor was discovered in the eye, in addition to the long known about rods and cones, which was also sensitive to light. Intrinsically photosensitive retinal ganglion cells (iPRGCs) were identified as the main sensors for entraining our circadian rhythms."

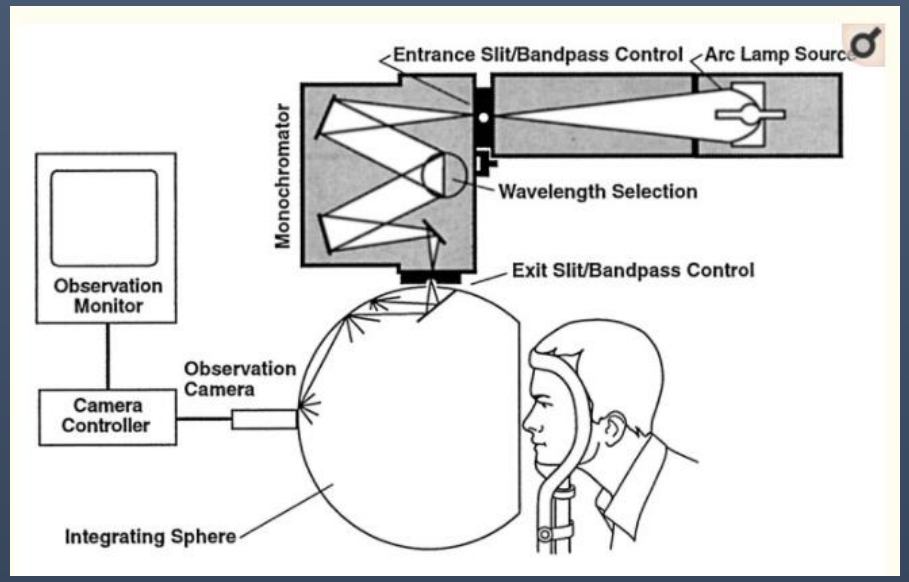
"melatonin suppressed was most effective at a wavelength of about **480 nm (blue light)**."

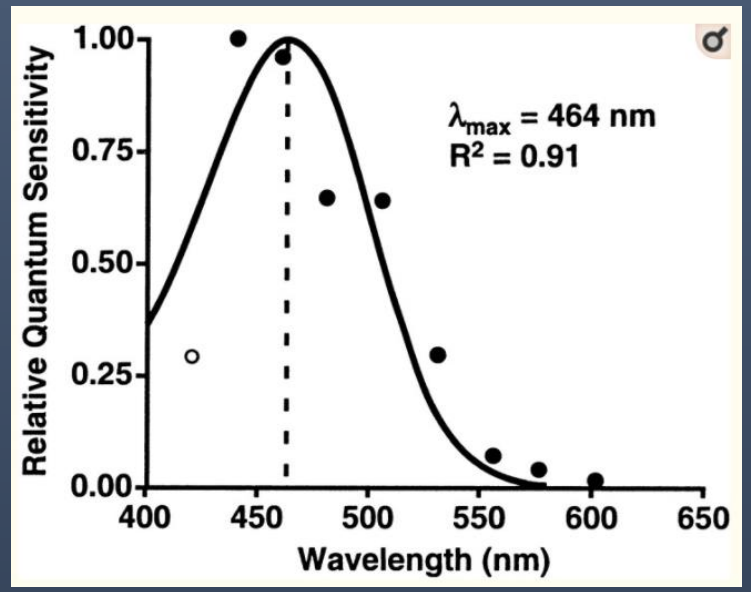
Guardian

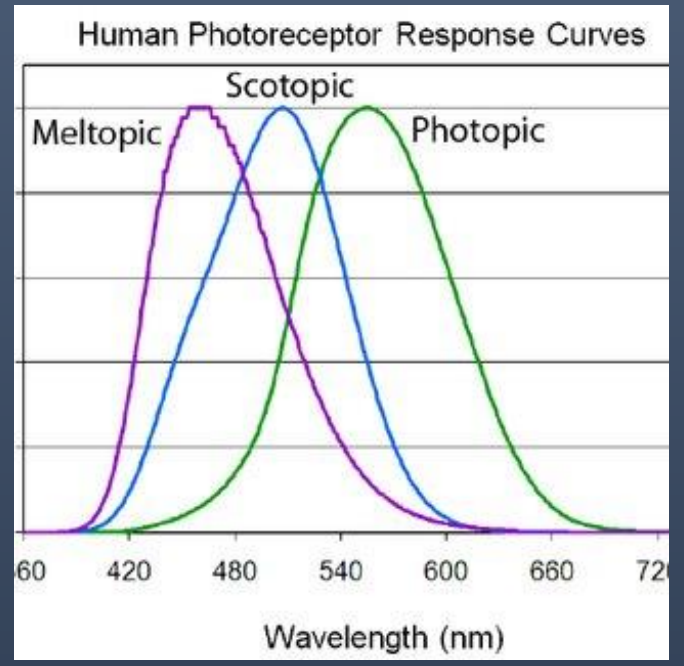
Recent Game-Changer -1

- 2001 Discovery of biological mechanism –Characterisation of “meltopic” spectrum
- Intrinsically-photosensitive retinal ganglion cells, “ipRGCs”

…entering “Melanopsin Age” [Lucas et al, Trends Neurosci. 2014]



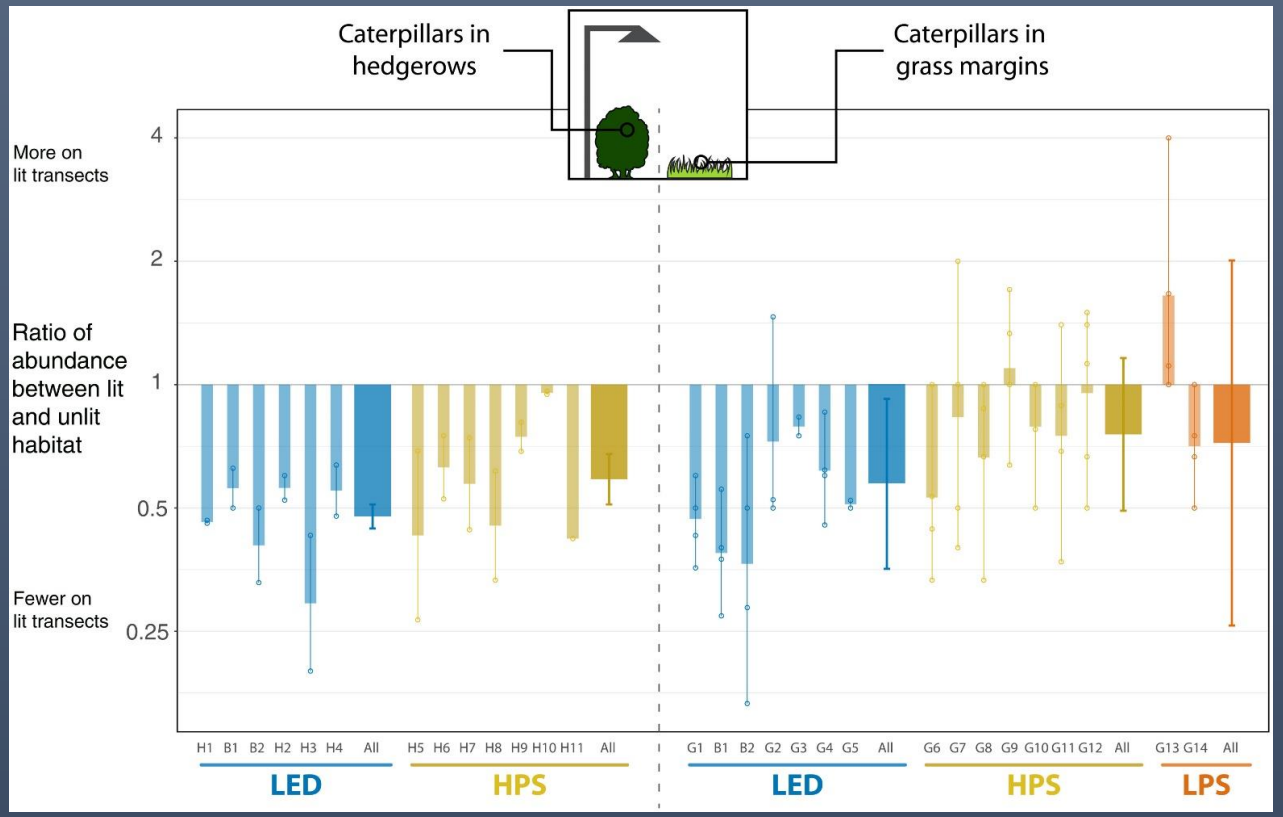




“…Novel Circadian Photoreceptor” US Journal of Neuroscience 2001 72 subjects in night time experiments

Recent Game-Changer -2

- Boyes et al., Sci. Adv. 2021; “Street lighting has detrimental impacts on local insect populations”



Douglas Boyes, of the UK Centre for Ecology and Hydrology:
“We found numbers that you’re not really used to ecology.”
“..substantial consequences for insect populations and ecosystem..”

“Artificial light at night (ALAN)”

- Dramatic effect on insect populations
- LED lighting was worse than control (sodium lighting)

Future

Worcestershire Council “bat highway”, 2019: red LEDs adjacent to nature reserve.

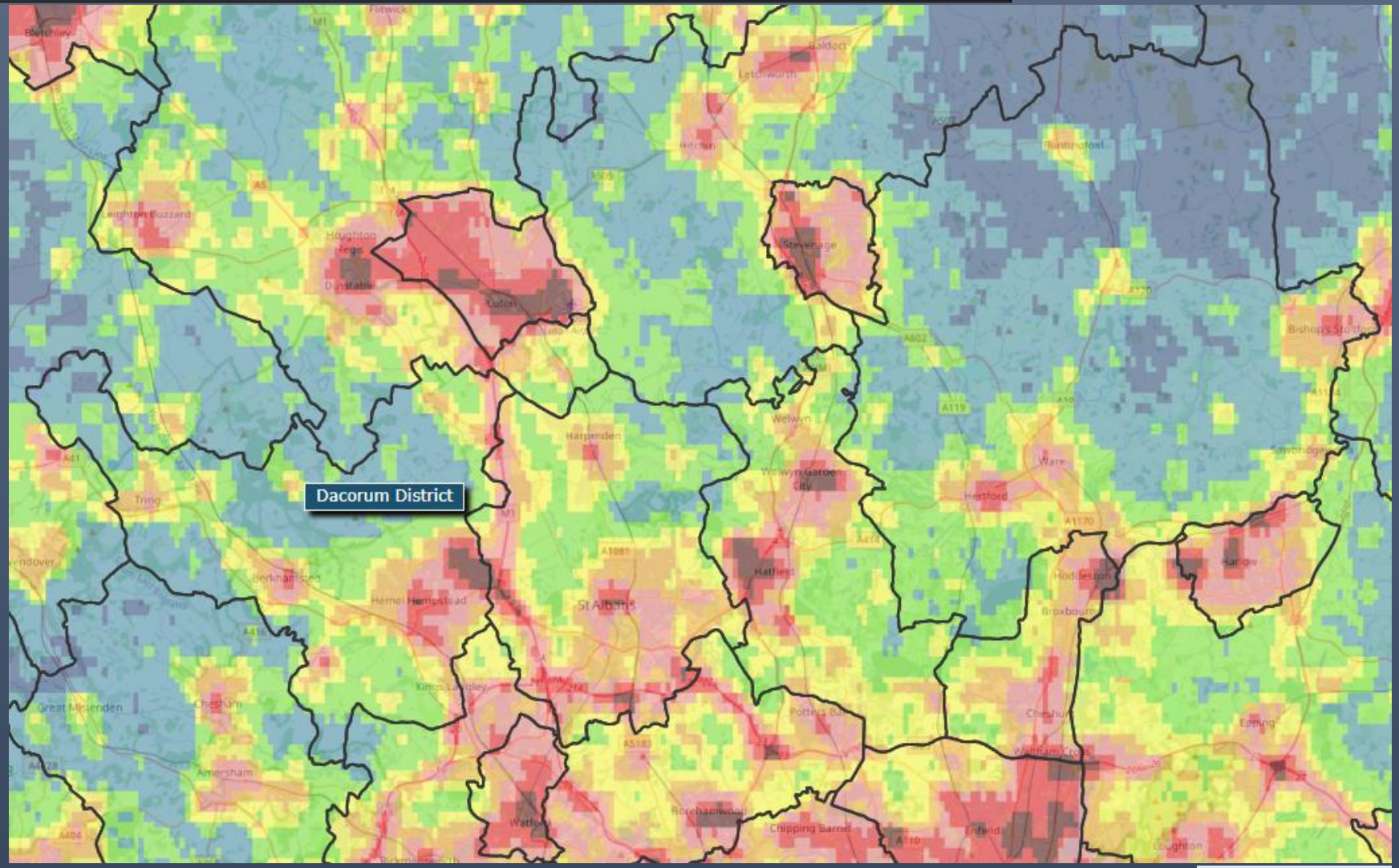
Customers asking for sodium colour

- Installation Place：Thai　Bangkok　Expressway
- Appliance used：LLM0729A（2200K）
- Number of appliances：960 units

Same color temperature as conventional high –pressure sodium lamp.
Provide safety when driving at night, while being energy-efficient.

Revolutionary Solutions

Replace flood-lighting with modern technologies



Data from satellite September 2015 at 1.30 am

less artificial light at night (ALAN)

The countryside charity CPRE

Technical Solutions

- Vehicle Advanced Driver Assistance Systems (ADAS) (radar etc.), collision avoidance, may obviate streetlights
- Illuminate hazards only
- “intelligent LED road studs” - programmable

‘Eco-friendly’ lights found to be worse than sodium ones – but both contribute to insect decline, says study

The study was the first to examine the impact of LEDs in a real-world setting. Photograph: Douglas Boyes/Science Advances

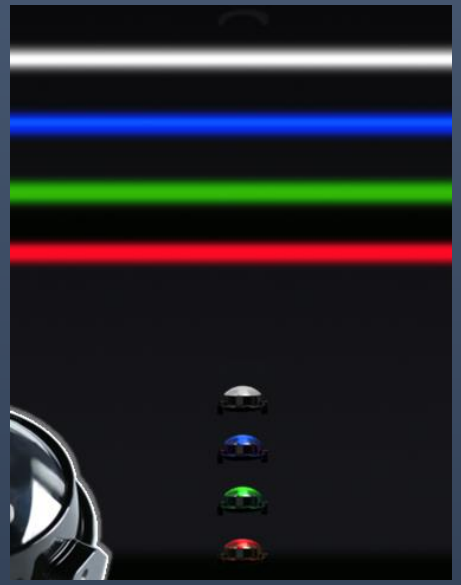
Philips “ONROADLED”

Technical Solutions

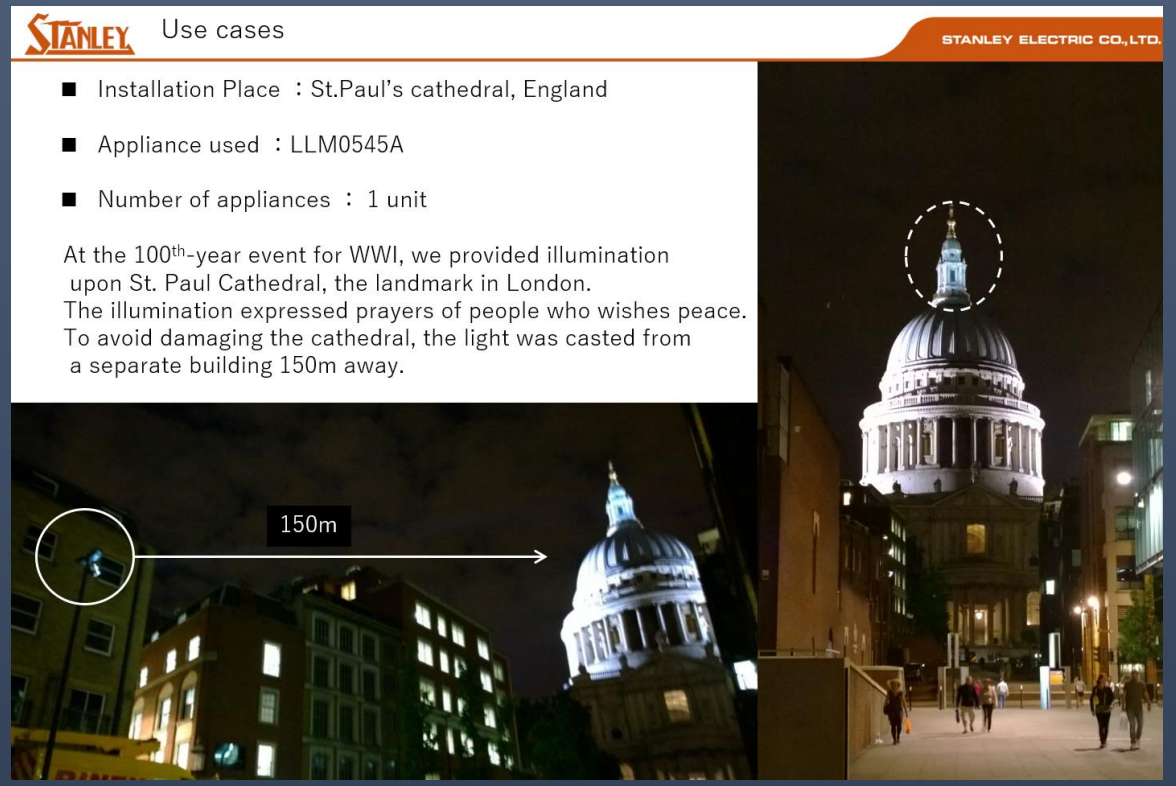
Red & amber LEDs in luminary, rather than blue with phosphor

- feasible, but more costly in current market.
- Maybe economies of scale will change this in future years.

Narrow Beams and Lines – Less Waste

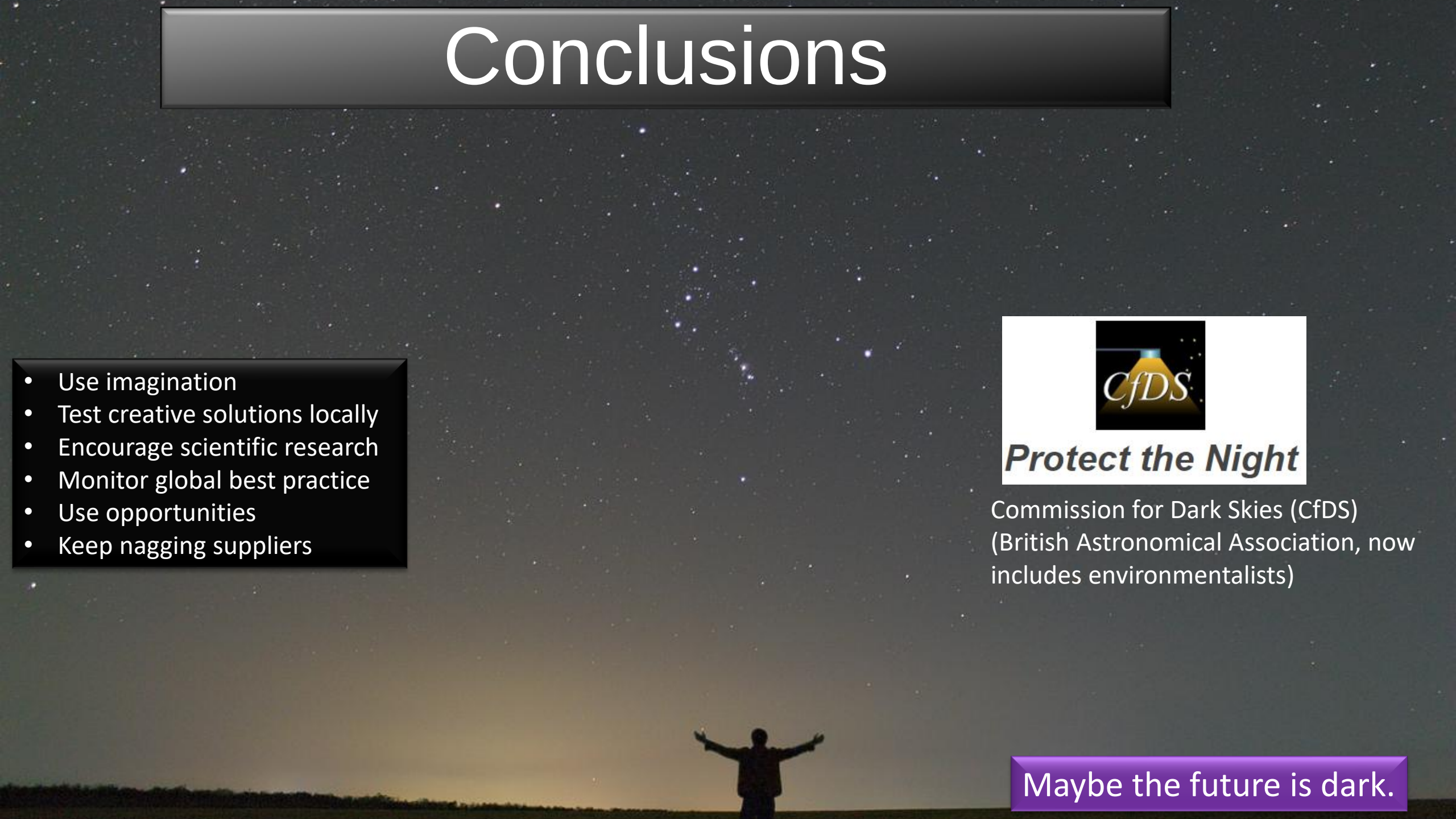


- 1/2 beam angle 2.5°×70°
- Platform edges
- Crossings



Conclusions

- Use imagination
- Test creative solutions locally
- Encourage scientific research
- Monitor global best practice
- Use opportunities
- Keep nagging suppliers



Commission for Dark Skies (CfDS)
(British Astronomical Association, now includes environmentalists)

Maybe the future is dark.