

Lighting effects on human health and wellbeing

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Indoor environment

- We spend on average 80% of our time indoors
- Poor indoor environments can affect:
 - Health, wellbeing and comfort
 - Productivity
 - Healing
 - Buildings/materials – e.g. heritage, exhibits
- Therefore:
 - Need to monitor/measure air quality, ventilation, T/RH, lighting, noise, etc.
 - Must also consider: occupants, materials, systems, decorations, layout



BRE Environment

- Research and commercial work on quality of indoor environments
- Physical measurements, inspections and assessments combined with engagement with occupants
- Main disciplines: Air pollution (External); IAQ (Indoor air quality); HVAC engineering/building diagnostics; Lighting; Acoustics; Indoor environments (layout, decoration, materials)
- **BRE Lighting** → At the forefront of UK lighting research & consultancy for over 60 years
 - Lighting systems and controls
 - Natural lighting and shading
 - Occupant needs



Lighting and health

- BRE Trust project aimed at giving accessible, up-to-date guidance to building professionals
- Builds on earlier work on daylight and health (for DCLG), lighting in hospitals (for NHS Estates) and wellbeing in healthcare buildings (for BRE Trust)
- Carry out literature review and collect information; hold a workshop for those active in the area
- Partners: Istanbul Technical University, Technical University of Eindhoven
- Key output: a publication giving all findings



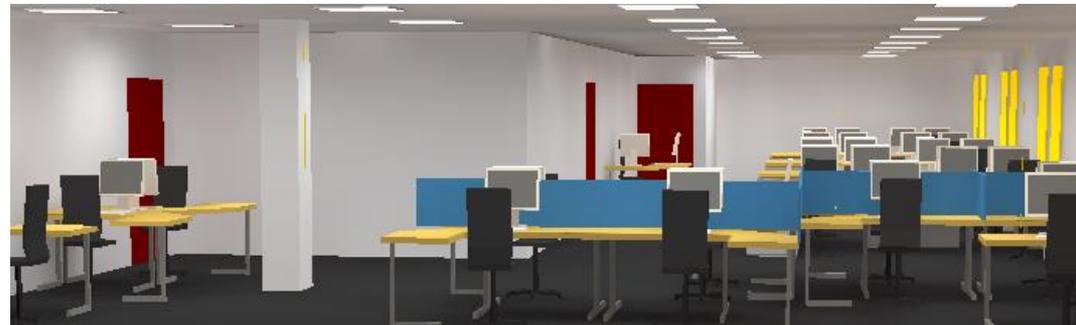
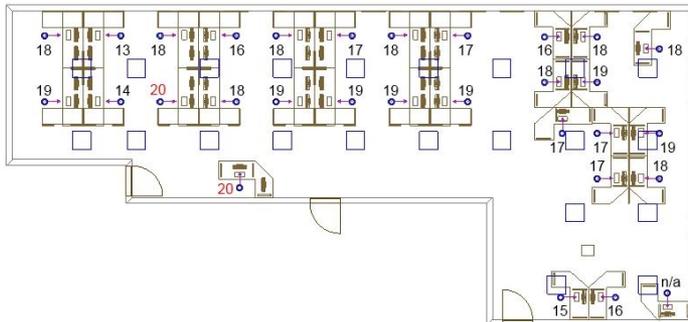
General effects of lighting in buildings

- Visual task performance
- Safety and visual perception of potential hazards → low illuminance, disability glare
- Visual discomfort → insufficient light, high illuminance or luminance contrasts, glare, veiling reflections, shadows and flicker
- Visual discomfort linked with red, itchy eyes, headaches, and pains associated with poor body posture
 - Glare causing headaches, sore eyes, musculoskeletal problems
 - Flicker causing headaches, eyestrain, epileptic seizures
- Mood and wellbeing



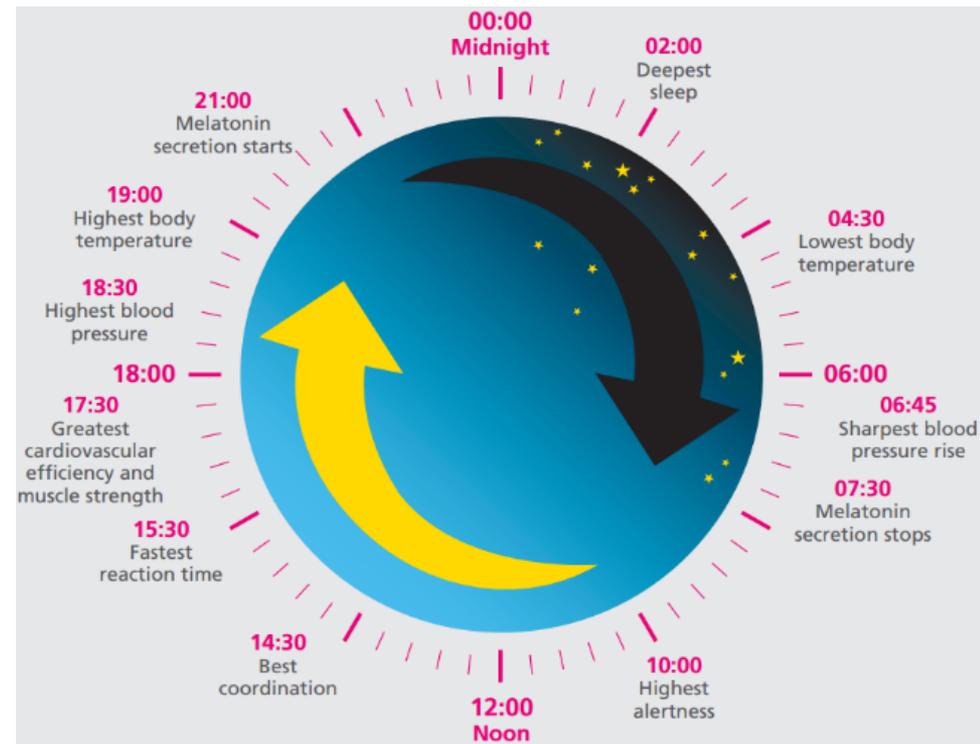
Office space POE study

- Problem: too much bright light coming from above → Sore eyes and headaches
- BRE study:
 - In situ measurements (luminaire luminance; surface luminance; desk illuminance; walls and ceiling illuminance; surface reflectance)
 - Computer modelling (UGR)
- Solution proposed: additional perimeter wall lighting; dimmable lighting; zoned / grouped lighting controls



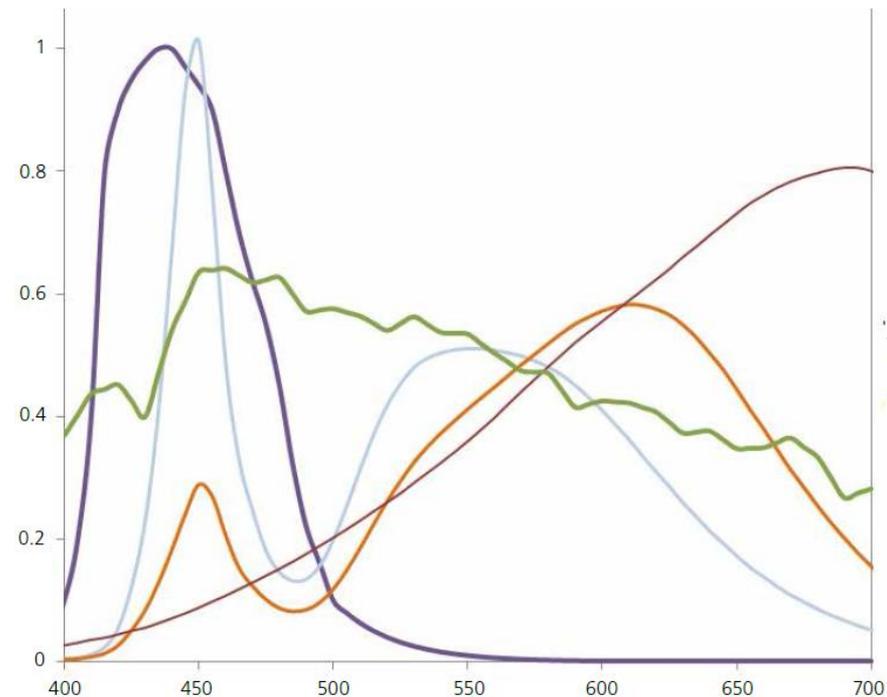
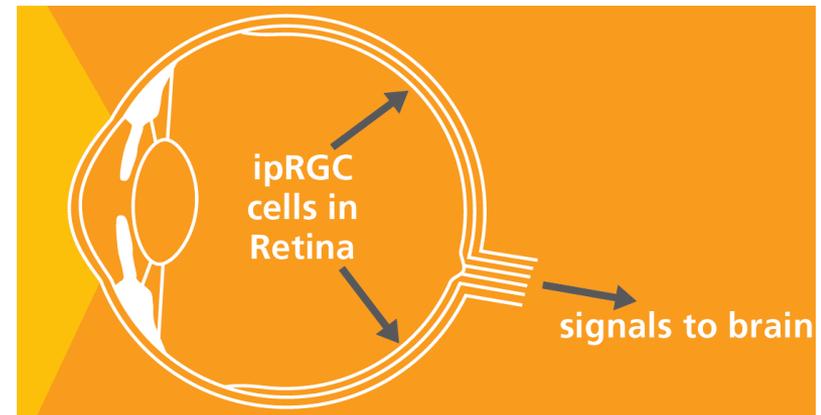
Circadian rhythms

- Powerful entrainment effect of light on circadian rhythms
- Synchronisation with solar day
- Exposure to right light during the day helps regulate our daily rhythms of sleep and alertness
- Exposure to light at night can impact on body clock
- Lack of right light during the day can lead to ‘free running’ rhythms, sometimes with wakefulness at night and sleepiness during the day



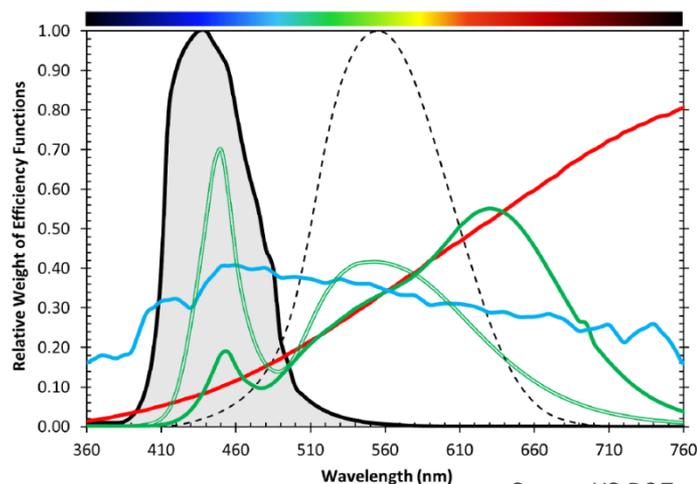
Artificial light at night

- ipRGC most sensitive to blue light
- Ongoing research on minimum light level resulting in changes in melatonin level
- Threshold for suppressing melatonin varies with spectral irradiance: peak at 446-477nm
- Blue wavelengths (400-500nm) appear to affect alertness, body temperature and heart rate
- Common cool white light sources produce significant light output in the 460-500nm range
- Night-time exposure to cool white light can be disruptive



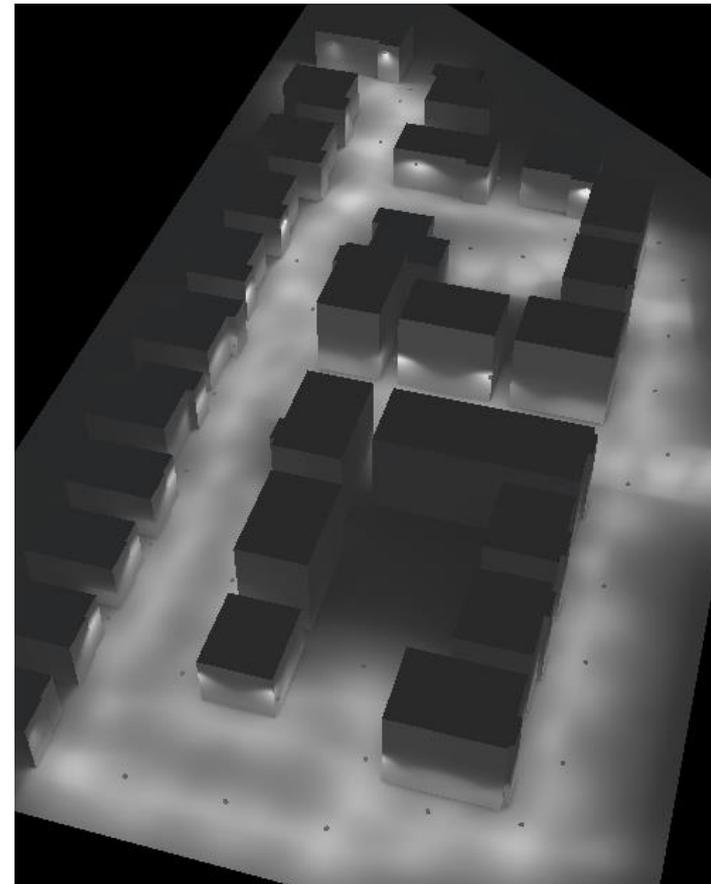
Circadian lux

- WELL Building Standard
 - Equivalent Melanopic Lux (EML), a proposed alternative metric weighted to the ipRGCs instead of to the cones, which is the case with traditional lux
 - At least 250 EML at 75% or more of workstations vertically facing forward at 1.2m above floor level for at least 4 hrs/day for every day of the year
- DIN SPEC 67600
 - Biologically effective lighting design: illuminance; spatial distribution of light; light colour; right light for the time of day
 - At least 250 lux at 8000 K
 - Illuminance adjustments at other CCT as per DIN SPEC 5031-100



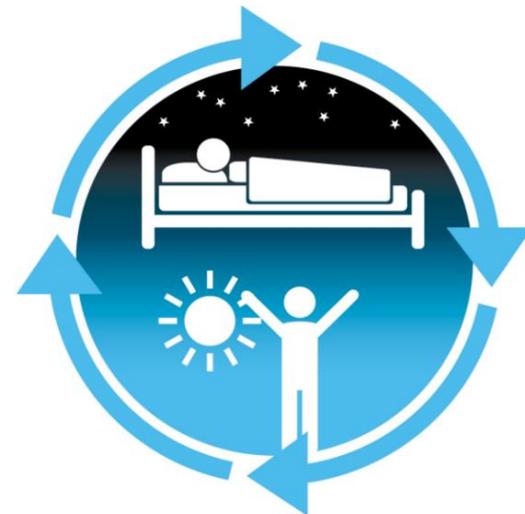
Obtrusive light study

- Impact of night-time spill light from external artificial lighting
- Light spillage into surrounding residential areas; potential glare to sensitive receptors; potential increases in sky glow
- BRE study:
 - In situ measurements of baseline conditions (vertical illuminance on windows from existing street lighting)
 - Computer modelling of proposed development (ULOR; vertical illuminance on windows of nearby dwellings; luminous intensity)
- Mitigation measures unnecessary
- Good practice: lighting controls based on presence detection and/or timing



Circadian lighting

- Research project funded by BRE Trust (pending approval) and CIBSE
- Partners: Oxford University, Cambridge University, Photonstar, Zumtobel
- Objectives:
 - Investigate links between circadian lighting control schedules and effects of circadian lighting on occupants' health & wellbeing
 - Identify optimal circadian lighting control strategies that maximise health & wellbeing benefits
 - Develop light spectra and intensities recommendations for different times of day
- Proposed outcomes (within 30 months):
 - Inform CIBSE SLL publications
 - Published paper; BRE Information Paper; trade journal article(s)



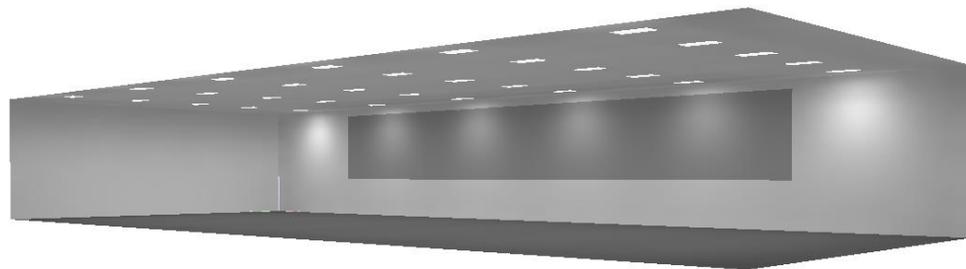
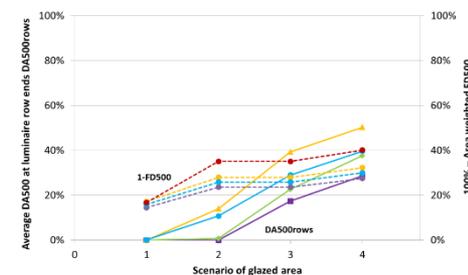
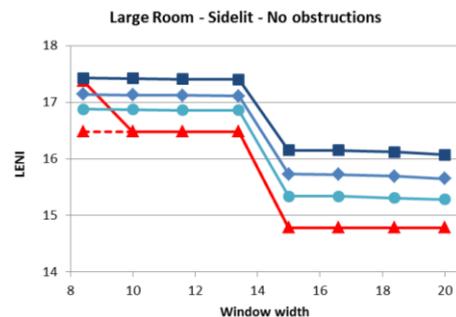
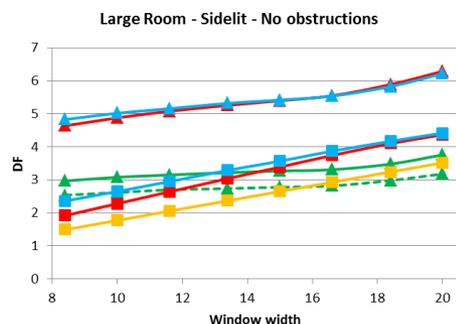
Daylight

- Daylight gives high levels of blue enriched light which are ideal for modulating circadian rhythms
- Daylit provision also allows for contact with the outside, which has additional benefits for health and mood
- Outdoors exposure to sunlight allows synthesis of Vitamin D, essential for healthy bones, and probably beneficial to the cardiovascular system and mood
- Studies indicate exposure to daylight helps prevent myopia (short sightedness) in children



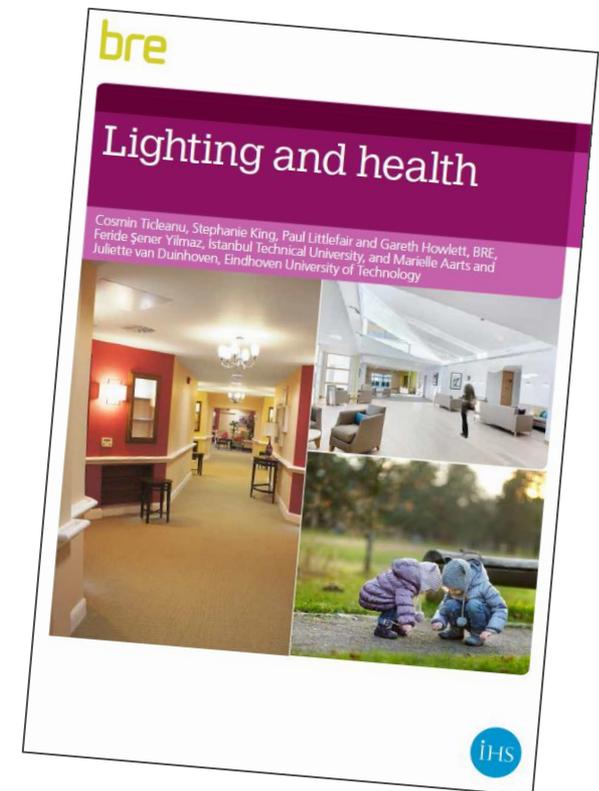
Assessing metrics for daylight calculation

- Review daylight metrics based on LENI and CBDM approaches
- Funded by BRE Trust and CIBSE
- Daylight modelling using Dialux, Radiance/Daysim (Ecotect) and Excel (ADF and EN15193)
- Side-lit and top-lit rooms; realistic obstructions; range of glazed areas
- Stepped/narrow variation of LENI with glazing area – not reflecting DF/DA/UDI progressive variation
- Current and newly proposed EN15193 overestimates daylight penetration and underestimates energy used for electric lighting



Conclusions

- Provide well-designed lighting, controlling glare and avoiding flicker
- Provide daylight and sunlight to interior spaces, and access to outdoor amenity areas
- Provide right level and spectrum of artificial light in the evening
- Avoid stray night-time artificial light in bedrooms
- Simulation can be used to design / assess electric lighting and daylight provision
- Circadian lux not yet available in commonly used simulation tools
- Simulation needs to be combined with correct performance specification to avoid negative impacts on health & wellbeing



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Thank you for your attention!

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