

PHILIPS

sense and simplicity

Paybacks on lighting adjustments

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Thinking about the title...

payback /'peɪbæk/ *n.* **1** a financial return; a reward. **2** the profit from an investment etc., esp. one equal to the initial outlay.

adjust /ə'dʒʌst/ *v.* **1 tr. a** arrange; put in the correct order or position. **b** regulate, esp. by a small amount. **2 tr.** (usu. foll. by *to*) make suitable. **3 tr.** harmonize (discrepancies). **4 tr.** assess (loss or damages). **5 intr.** (usu. foll. by *to*) make oneself suited to; become familiar with (*adjust to one's surroundings*). □□
adjustable *adj.* **adjustability** /-'bɪlɪtɪ/ *n.* **adjuster** *n.* **adjustment** *n.* [F *adjuster* f. OF *ajoster* ult. f. L *juxta* near]

Considering 'paybacks'

- Reducing the cost of ownership
 - The usual 'payback' based on reduced energy use and less maintenance.
- Making use of daylight
 - When roof-lights offer lower costs than insulation.
- Improving productivity – and 'health and well being'
 - Appreciating that light can pay for itself many times over in other ways.

Considering 'adjustments'

- Lighting can be 'adjusted' in many ways, we can change:

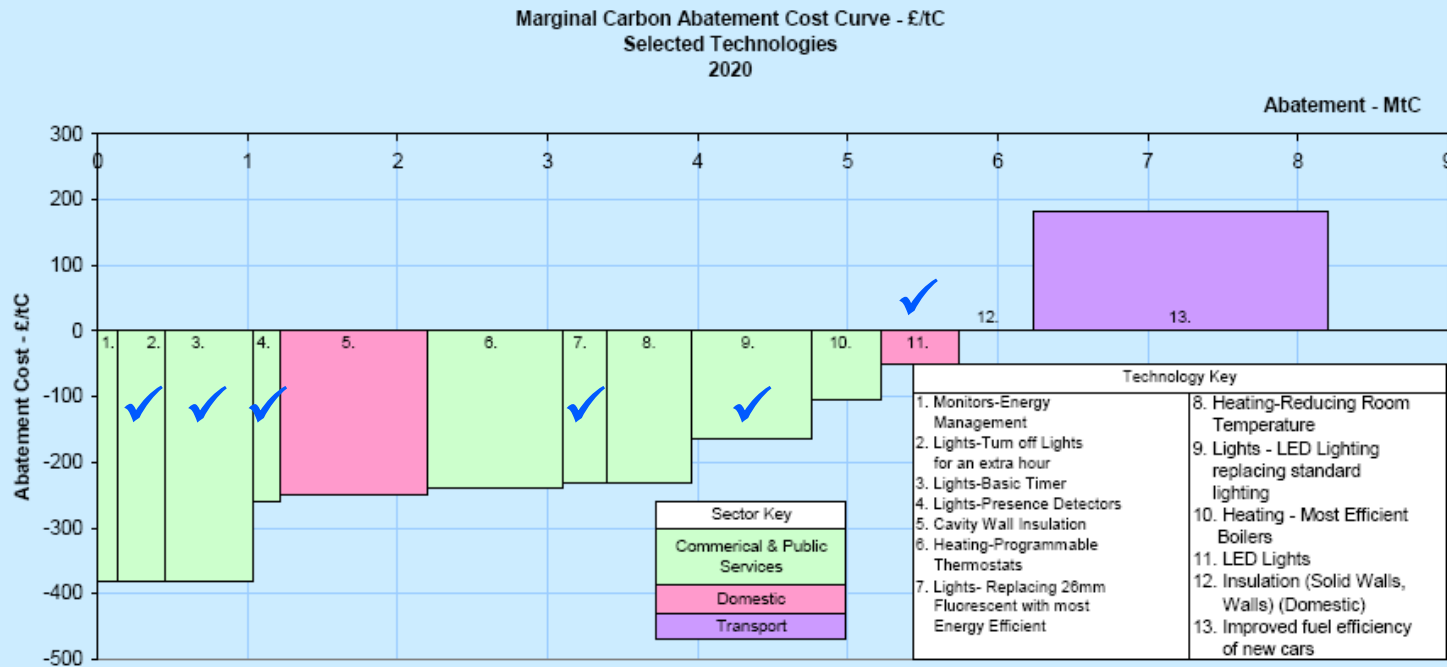
- Illumination levels
- Colour rendering index
- Colour appearance
- Colour
- Source
- Location
- Intensity
- Balance
- Precision



The usual paybacks

Lighting and CO₂ reduction – Stern Review

Figure 9.2 Aggregate carbon abatement cost curve for the UK – annual carbon savings by 2020²⁸

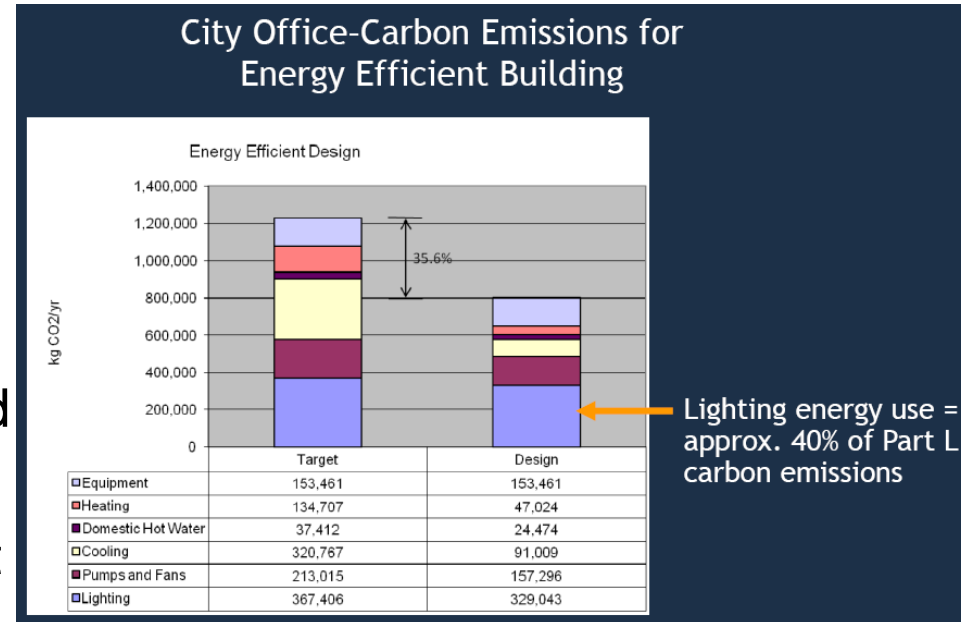


Lighting measures total: 2.55 MtC

More important – the measures are a net cost benefit!

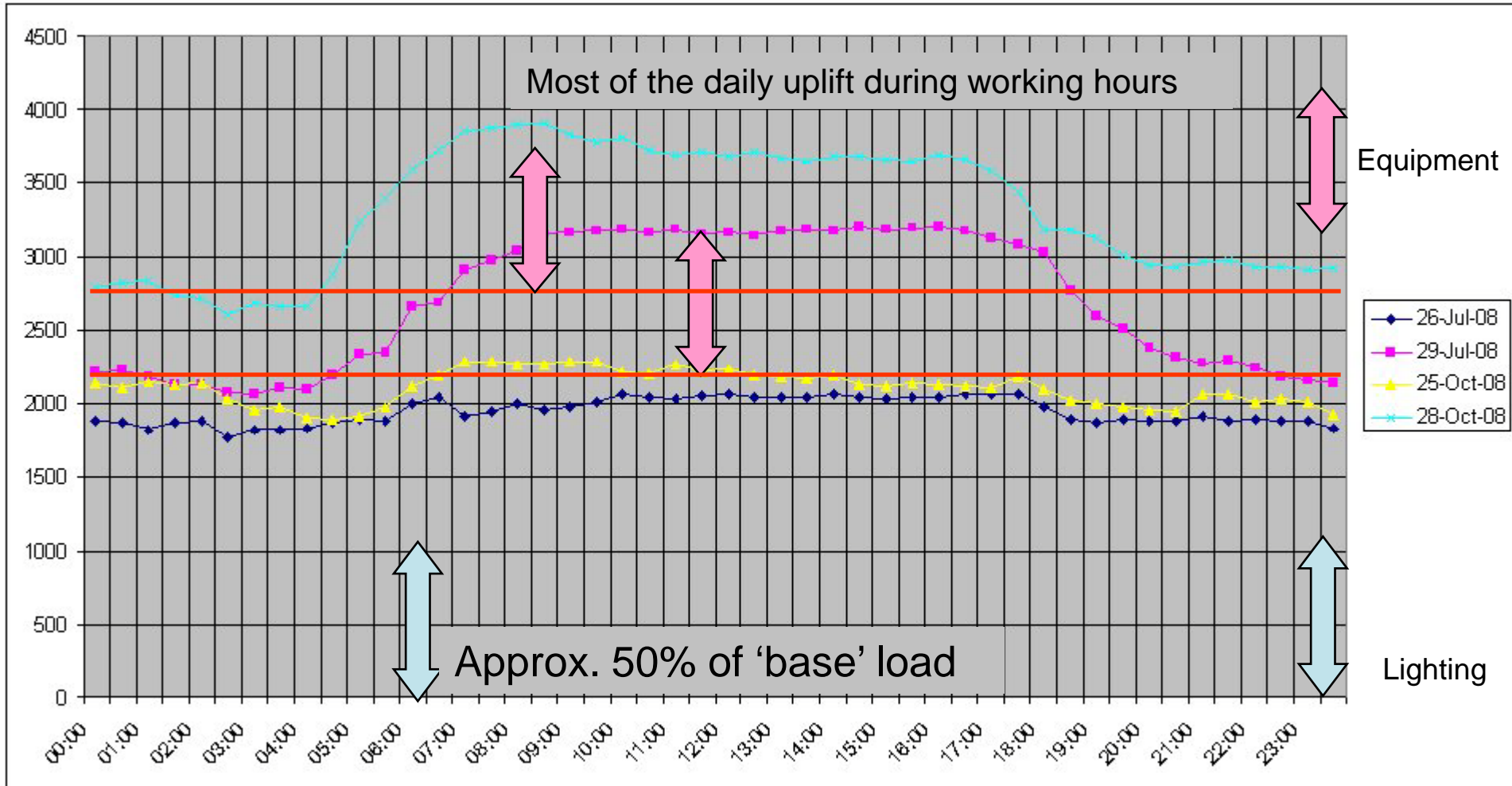
Reducing the cost of ownership

- Two primary costs that lighting adjustments can address:
 - Reduced energy use
 - Lower maintenance costs
- Establishing what can be achieved is not straightforward:
 - Do we really know the amount of energy our lights use?
 - Are the ‘maintenance costs’ visible?



When we can identify the savings they go straight to ‘profit’!

Sometimes analysis is required....



...but realised 'paybacks' can be very good.

National Theatre foyer

Relamping of projectors used for general illumination in the main foyer, saves 130,434 kWhs per annum.

Savings = 81.3% or over £9,100.00

Cost to NT ≈ £7,700.00

PAYBACK = 10 months 5 days



National Theatre: Conversion of ETC Source 4 projectors to use CDM-T Elite 70W lamps.

Application / area	Qty.	Original Lamp	Hours run per annum	Circuit Watts	kWhs used per annum	New lamp	Circuit Watts	kWhs used per annum
Maintained emergency	20	575W tungsten	8736	575	100464	70W CDM-T Elite	74.5	13017
Concert pitch	16	575W tungsten	2496	575	22963	70W CDM-T Elite	74.5	2975
Sponsors	4	150W metal halide	4368	168	2935	70W CDM-T Elite	74.5	1302
Achitectural	72	150W metal halide	2184	168	26418	70W CDM-T Elite	74.5	11715
Cathedral window	16	575W tungsten	832	575	7654	70W CDM-T Elite	74.5	992
Total					160435	Total		30000
					Total electricity use reduction:			130434

Notes:

- Hours of use figures provided by the National Theatre.
- 150W circuit watts based on typical value for EM gear.

Hi-bay lighting in a manufacturing plant

Observations

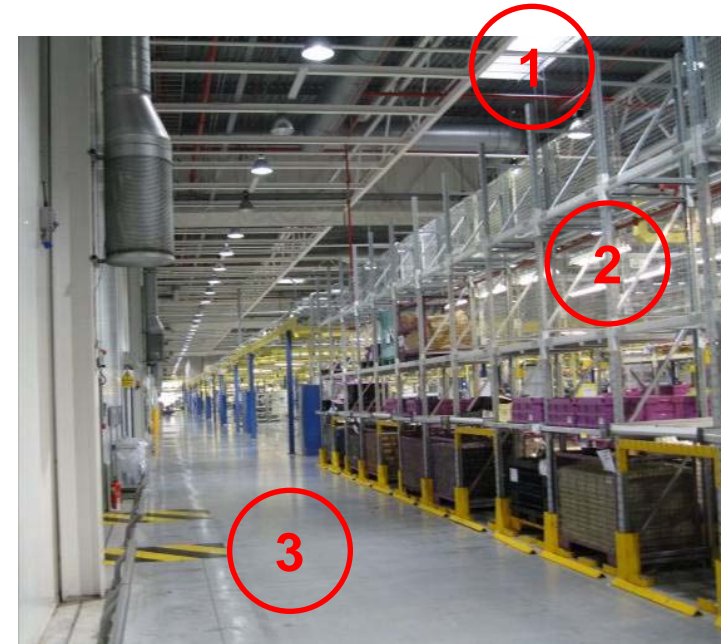
The plant is highly automated, with few people present. In most cases they are at workstations with local lighting.

There are roof lights and some vertical glazing

The 400W metal halide hi-bay lighting is producing 'design' illumination of between 380 and 570 lux – at floor level!

Much of this illumination falls on corridors or the top of large automated machines.

If the hi-bay lighting was replaced by dimmable fluorescent luminaires then **an effective control system could be applied**. And the installed load would drop from **561kW to 446 kW – a saving of some 20% in itself**.



Example area

1. Roof-lights
2. 'Task' lighting
3. Corridor

Hi-bay lighting in a manufacturing plant

Calculated **annual** energy savings using dimming fluorescent fittings

Production and Assembly Areas - Hi-bay Lighting

	Load	Annual cost (calculated from existing hours)
Existing 400W HID	561 kW	£233,641.50
Proposed 4x80W T5 HFR	446 kW	£185,851.19

Assembly area - possible dimming zones

	No. lights	Percent 'P'	Level 'L'	Level 'P'	Power used
Low level lighting available	125	31.25%	30.00%	45.00%	19.69
Corridor	70	17.50%	35.00%	50.00%	12.25
Machinery area A	130	32.50%	60.00%	70.00%	31.85
Machinery area B	75	18.75%	70.00%	79.00%	20.74

Total 'P' in kW = 140
Reduced 'P' in kW = 84.53

Overall % of power used **60.38%**

Extrapolated over both Production and Assembly:

Total power in kW **443** (New T5 lighting) Power used while dimming: **267**

Savings generated solely through 1:1 luminaire change: **£47,790.31**

Further value of power saved (using crude overall 40% saving through dimming): **£73,643.54**

TOTAL SAVING: £121,433.84

Key:

'P' = Power (in sample area)

'L' = Light output

ROI (material only): exceeds 50%

Adjusting the lighting in large supermarkets

The local lighting makes contributes to the illumination of the aisle. This allows a reduction in the main overhead lighting.

The main lighting scheme is, therefore, based on dimmable fluorescent luminaires. These are controlled in zones to match the aisle layout.

Result: In a **supermarket containing 123kW of dimming fluorescents** the control system **delivers £11,500.00** of annual savings by adjusting the main lighting. The control system typically costs **£5,000.00 - £7,000.00** per store.



Localised lighting in a supermarket



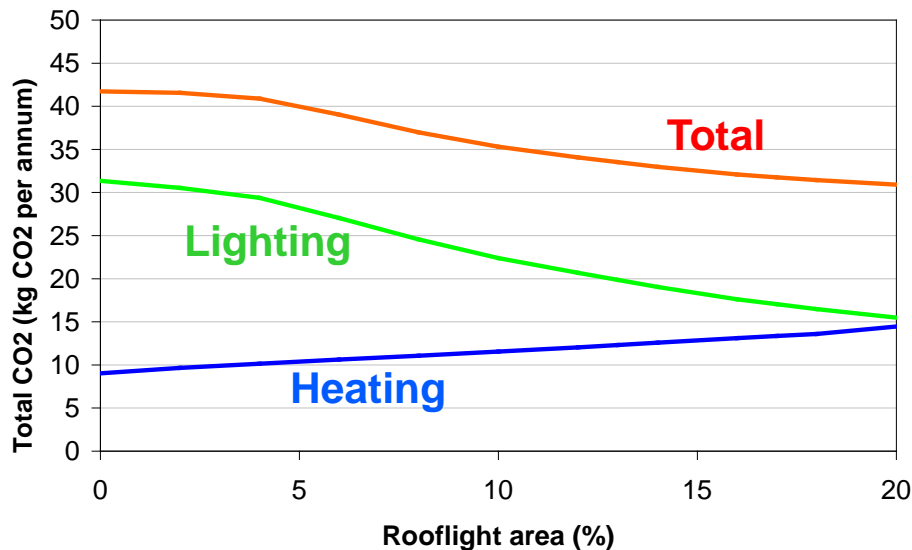
Making use of daylight



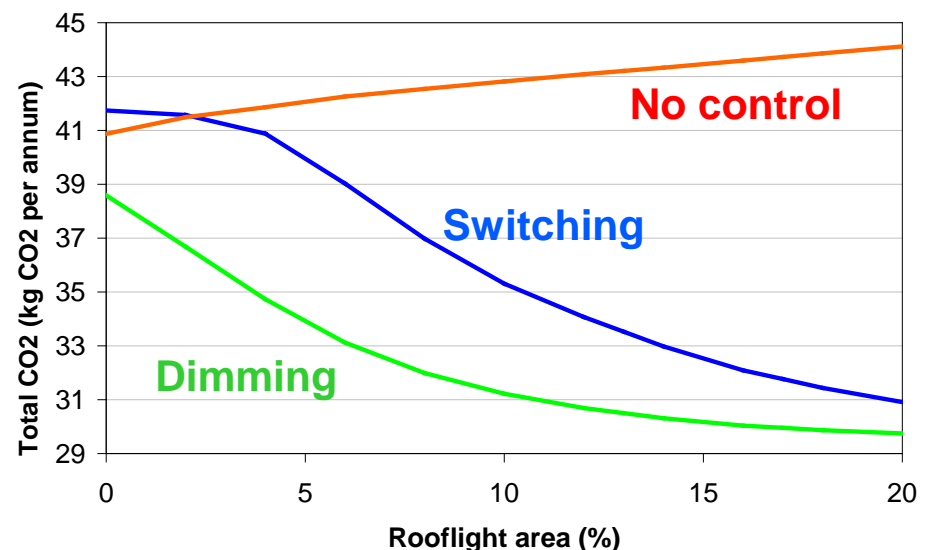
Resisting the temptation to insulate 100%

- Roof-lights can genuinely reduce carbon emissions – by reducing the use of electricity.
- But – this can only be done with ‘lighting controls’.
- Roof-lighting between 5% and 20% can be readily justified

Using roof-lights with lighting controls

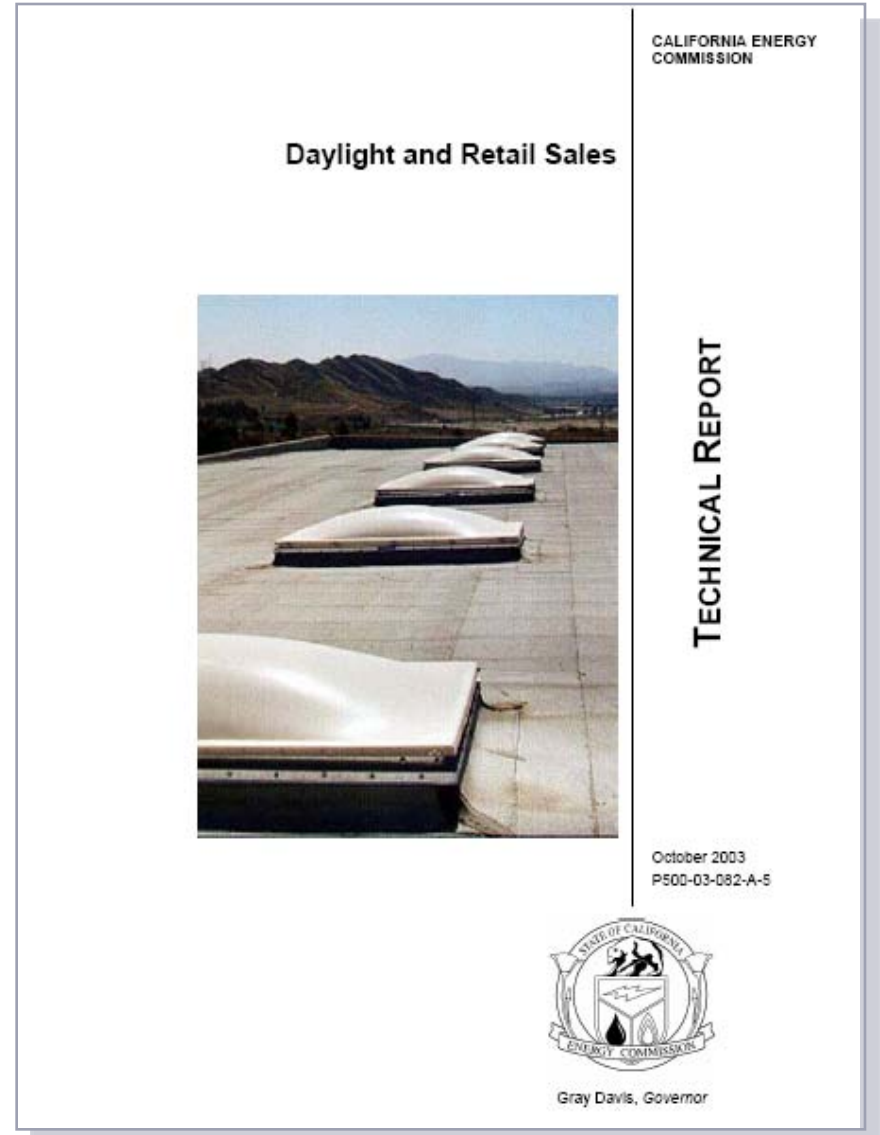


Effect of lighting control



Added benefits of daylight

- California Energy Commission report on 'Daylight and Retail Sales' from October 2003.
- Examined 73 stores.
- Demonstrated that those stores that benefited from daylight had higher sales.
- Many other studies have identified the benefit of daylight at work, at school and in hospitals.



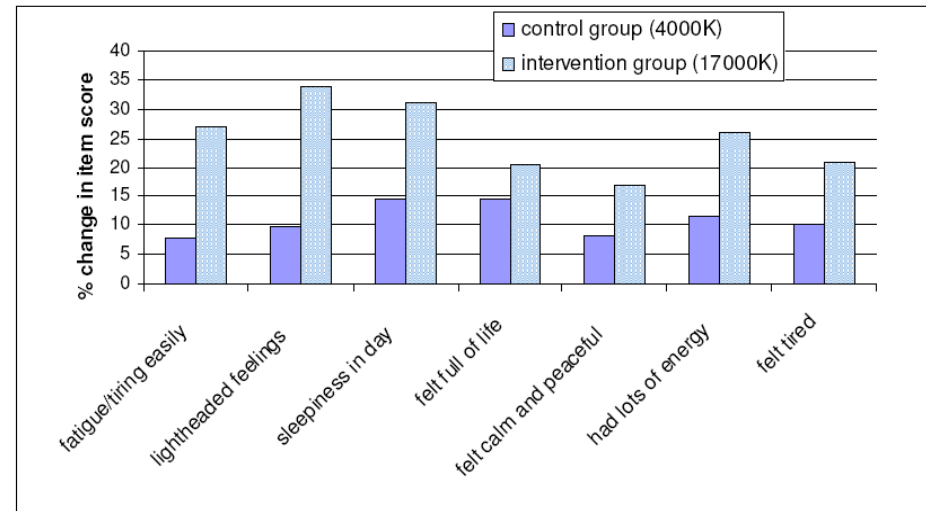
Improving productivity – ‘health and well being’

'Blue-sky' lighting

- Early research
 - Call centre – 17000 K lighting

 - Highly significant change in two key performance indicators vs control group
 - Work Performance – increased 19.4% ($p < 0.001$)
 - Concentration Problems – decreased 36.9% ($p < 0.001$)

- New research confirms effect.



Original article

Scand J Work Environ Health—online first

Blue-enriched white light in the workplace improves self-reported alertness, performance and sleep quality

by Antoine U Viola, PhD,¹ Lynette M James,¹ Luc JM Schlangen, PhD,² Derk-Jan Dijk, PhD¹

Viola AU, James LM, Schlangen LJM, Dijk DJ. Blue-enriched white light in the workplace improves self-reported alertness, performance and sleep quality. *Scand J Work Environ Health*—online first.

Objectives Specifications and standards for lighting installations in occupational settings are based on the spectral sensitivity of the classical visual system and do not take into account the recently discovered sensitivity of workers to blue light. The authors investigated the effects of exposure to blue-enriched white light during daytime work hours in an office setting.

Methods The experiment was conducted on 104 white-collar workers on two office floors. After baseline assessments under existing lighting conditions, every participant was exposed to two new lighting conditions, each lasting 4 weeks. One consisted of blue-enriched white light (17 000 K) and the other of white light (4000 K). The order was balanced between the floors. Questionnaire and rating scales were used to assess alertness, mood, sleep quality, performance, mental effort, headache and eye strain, and mood throughout the 8-week intervention.

Results Altogether 94 participants (mean age 36.4 (SD 10.2) years) were included in the analysis. Compared with white light (4000 K), blue-enriched white light (17 000 K) improved the subjective measures of alertness ($P<0.0001$), positive mood ($P=0.0001$), performance ($P<0.00001$), evening fatigue ($P=0.0001$), irritability ($P=0.004$), concentration ($P<0.0001$), and eye discomfort ($P=0.002$). Daytime sleepiness was reduced ($P=0.0001$) and the quality of subjective nocturnal sleep ($P=0.016$) was improved under blue-enriched white light. When the participants' expectation about the effect of the light treatments was entered into the analysis as a covariate, significant effects persisted for performance, alertness, evening fatigue, irritability, difficulty focusing, concentrating, and blurred vision.

Conclusions Exposure to blue-enriched white light during daytime work hours improves subjective alertness, performance, and evening fatigue.

Key terms mood; office lighting.

Specifications for lighting in occupational settings are based on the well-established visual effects of light, with aspects such as illuminance, glare restriction, and the color-rendering index being taken into account (1). However, during the past two decades evidence has accumulated in support of the claim that, in addition to facilitating vision, exposure to polychromatic white light has many "nonvisual" effects. These nonvisual effects include physiological responses such as the suppression of melatonin (2), circadian phase shifting (3), the elevation of core body temperature (4), and heart rate (5). Furthermore, exposure to polychromatic white light elicits behavioral responses, which include enhancing alertness and performance (6–9) and brain responses to cognitive tasks, as detected by photon emission tomog-

raphy (10) and functional magnetic resonance imaging (fMRI) (11).

Nonvisual effects of light have been shown to be mediated, at least in part, by a recently discovered melanopsin-dependent photoreceptive system (12). Melanopsin is a photopigment found in intrinsically photosensitive retinal ganglion cells of the eye (13) and is the most sensitive to wavelengths of approximately 480 nm (14). As a consequence, the nonvisual effects produced through exposure to light are greater when the wavelengths are shorter than when the light is geared towards vision (15, 16). Exposure to blue light at night has been shown to have a greater effect on various physiological measures, such as melatonin suppression, alertness, thermoregulation, heart rate, cognitive performance and electroen-

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Performance improvements confirmed

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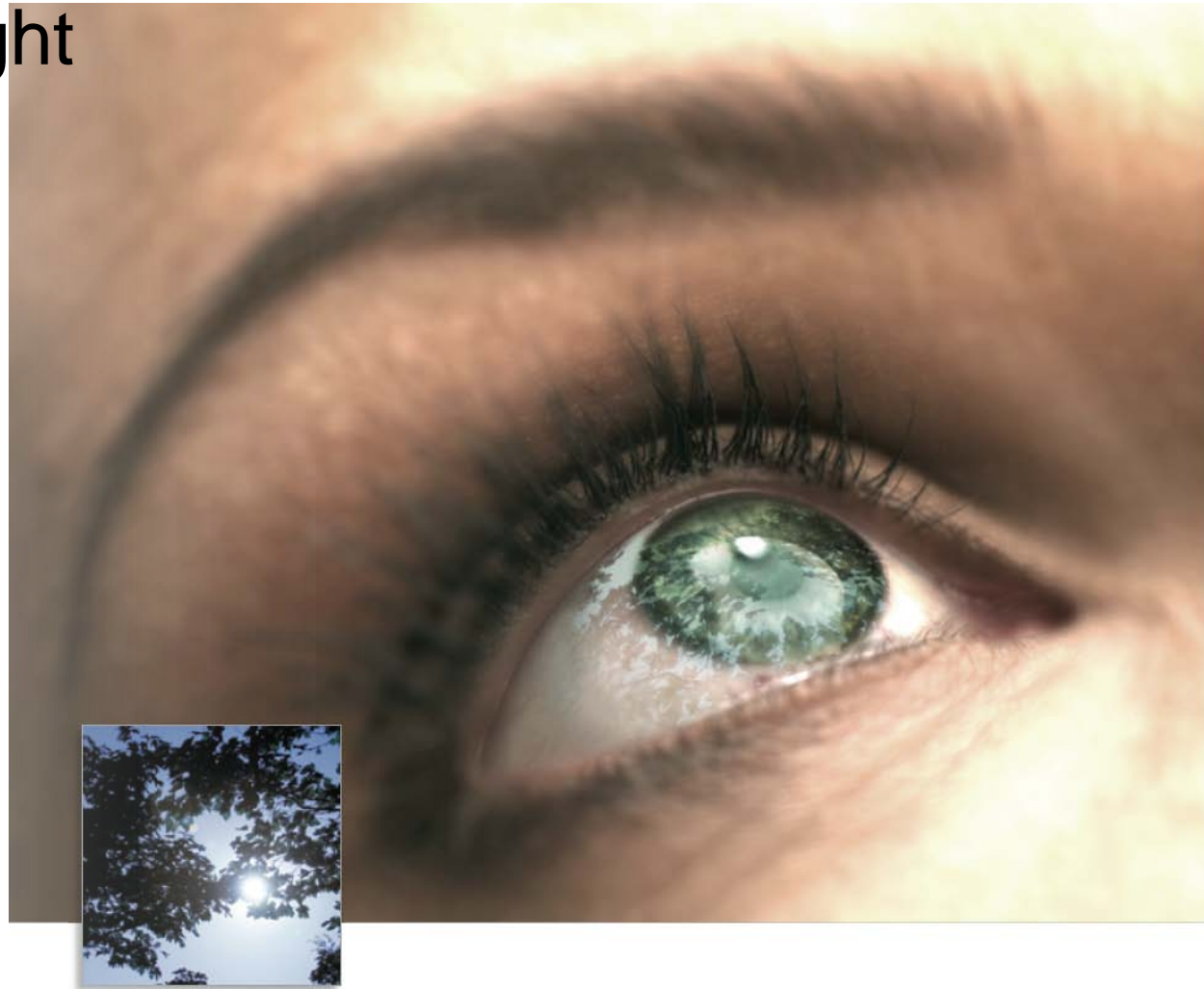


Summary

- Reducing the cost of ownership
 - The usual ‘payback’ based on reduced energy use and less maintenance.
 - Sometimes it takes LESS than a year
- Making use of daylight
 - When roof-lights offer lower costs than insulation.
 - Making more of a difference than you think
- Improving productivity – and ‘health and well being’
 - Appreciating that light can pay for itself many times over in other ways.
 - Demonstrating that only the RIGHT light is sustainable

Importance of light

- 80% of sensory input at work is received through the eye
- 19% of the World's electricity is used by lighting
- **The right lighting pays for itself!**



Make your lighting adjustments now....



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