Daylight & sustainability – what are the future political & regulatory drivers?

Prof. David Strong

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David Strong Consulting

The Distinctive benefits of Glazing

The social & economic contribution of glazed areas to sustainability in the built environment

Available for download from Glass for Europe website:
http://www.glassforeurope.com/images/cont/225_12633_file.pdf

A comprehensive objective review of the research evidence & data associated with daylight in buildings

- Over 80 research papers & books reviewed
- Objective evidence supported by empirical data included in study
- Evidence synthesised & collated into building type/function:
  - Healthcare
  - Education
  - Workplace (offices and industrial)
  - Retail
  - Residential

Key research findings -Healthcare

- a reduction in the average length of hospital stay
- quicker post-operative recovery
- reduced requirements for pain relief
- quicker recovery from depressive illness
  - Impacts on obesity & heart disease
- Sunlight also has disinfectant qualities

Education

- access to daylight has been shown to result in a dramatic (and demonstrable) improvement in student academic achievement:
  - behaviour,
  - calmness
  - focus.

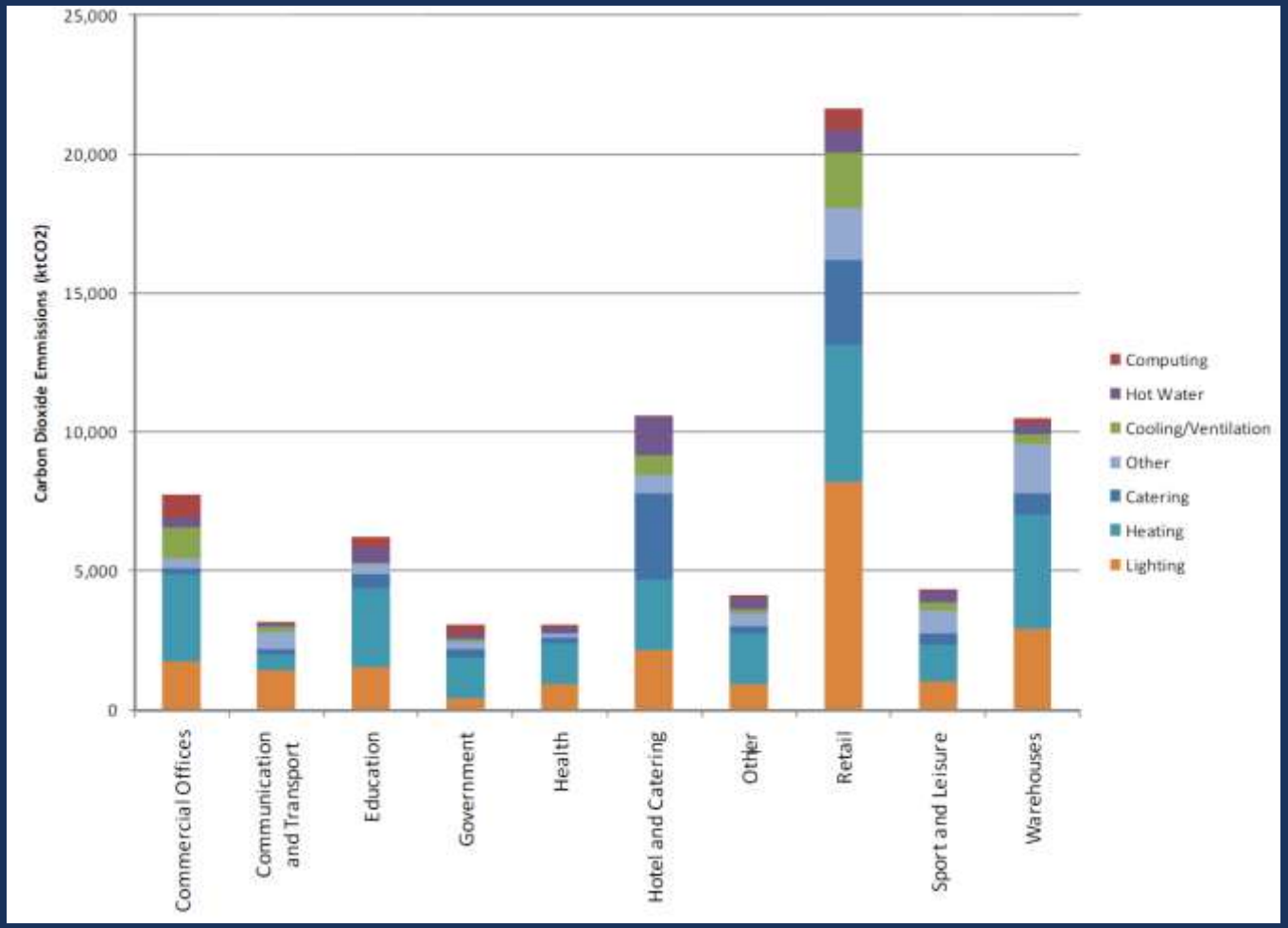
Other building types/functions

- **Workplace**
  - numerous studies have identified a preference to work near windows... An ample and pleasant view was consistently found to be associated with better office worker performance.
- **Retail establishments**
  - research shows that a substantial improvement in sales can be achieved in daylit shops. Using daylighting also has aesthetic benefits that encourage customers to enter the store, create a more pleasant shopping environment and improve colour rendering.
- **Residential**
  - many of the studied benefits associated with daylight and connections to the outside world can be equally realised, thus contributing to sensations of wellbeing.

Daylight: what are the key drivers for effective regulation?

- Human health, productivity, happiness and wellbeing
    - Daylight has a profound impact on our quality of life
- Sustainable development
  - Energy/CO2 minimisation
    - Reduction in requirement for artificial/electric lighting
    - Useful solar contribution to space heating
    - Avoidance of excessive solar gains/air-conditioning

CO_2 emissions by end use in the services sector



Lighting =19% of total UK CO_2 emissions

Given the importance of daylight regarding health & building energy requirements

- What (if any) are the national & international legal & regulatory daylight requirements?

Europe –current regulation summary

	Requirement for daylight	Requirement for direct sunlight	Minimum size of daylight openings	Maximum size of daylight openings	Performance requirements for daylight openings (DF)	Requirements to distance between buildings	Requirements for view
Denmark			+	+			
Estonia	+		+		+*		
Finland	+		+	+		+	
Germany			+				
Ireland							
Netherlands			+				
Norway	+	+			+	+	+
Sweden	+	+	+				
UK				+			

* Only for schools

Source: Daylighting standardisation in northern Europe, Tiimus P UCL London 2007

Brief international survey

- Do you have ‘Right to light’ requirements which safeguard an existing building occupants legal right to daylight?
- Do you have legislative requirements (building regulations, codes, standards or ordinances) specifically related to ensuring adequate daylight provision in new buildings?
- Are you aware of any initiatives to develop international standards associated with daylight provision in buildings?

Responses from 16 countries

Rights to Light

- Common/civil law rights in: Switzerland, Ireland, Sweden, China (residential, hospitals,& nursery schools), Australia, Belgium & UK
- Ancient Lights formally rejected by US courts in 1959 - there is no common law right to sunlight.

Photo: Taken from the Grand Priory Church of the Order of St John, St. John's Square, London by Mike Newman.

Legislative requirements ensuring adequate daylight provision in new buildings

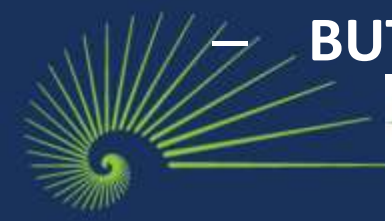
- Building Code/regulation requirements in:
  - New Zealand (habitable spaces only), Portugal, Germany, Sweden, Australia (for ventilation), France, China, Singapore, Belgium (dwellings only)
    - Requirements generally based on average Daylight Factor and/or minimum window sizes as a % of floor area (and/or wall area).
- No minimum legal requirement in:
  - Switzerland, Denmark, Ireland, UK, USA, South Africa
  - Most countries have (as a minimum) informative codes and standards requiring “sufficient” daylight or illumination
    - Mandatory levels are not defined

International daylight standards

- Existing standards:
  - ISO 8995:2002 Lighting of indoor work places
    - 4.7 Daylight
  - EN 12464-1:2002 Light and lighting –Lighting of work places –Part 1: Indoor work places
    - 4.9 Energy
    - 4.10 Daylight
  - BS 8206-2 Lighting for buildings. Part 2: code of practice for daylighting
- All existing daylighting standards are informative (i.e. **not prescriptive)**

Environmental Rating systems for buildings

- UK BREEAM (Building Research Establishment Environmental Assessment Method)
    - BREEAM "Excellent" now mandatory for all new public buildings in UK
- USA LEED (Leadership in Energy and Environmental Design)
- Equivalent schemes in many countries (e.g. Greenmark Singapore, Green Star Australia etc.)
- Increasingly being adopted as de-facto standards
- All schemes award credits for daylight
  - Often based on DF and/or window/floor area %
  - **BUT can result in highly perverse outcomes**



Major risks of perverse outcomes & unintended consequences from poorly defined regulations and environmental assessment methods

- Glare and discomfort
- Excessive solar gains leading to overheating & requirement for air-conditioning
- Excessive heat loss through large poor performance glazed areas

Other requirements, initiatives & good practice guidance

- EU Workplace (Health, Safety and Welfare) Regulations (1992) requires:
  - "Every workplace shall have suitable and sufficient lighting" and that this lighting "shall, as far as is reasonably practicable, be by natural light"
    - NB "sufficient" and "practicable" are not defined
- ASHRAE Standard 90.1
- CIBSE Lighting Guide 10: Daylighting and Window Design

Is reliance on Daylight Factor & over simplistic criteria in Building Codes/Regulations (and environmental assessment methods) the greatest obstacles to good daylight design?

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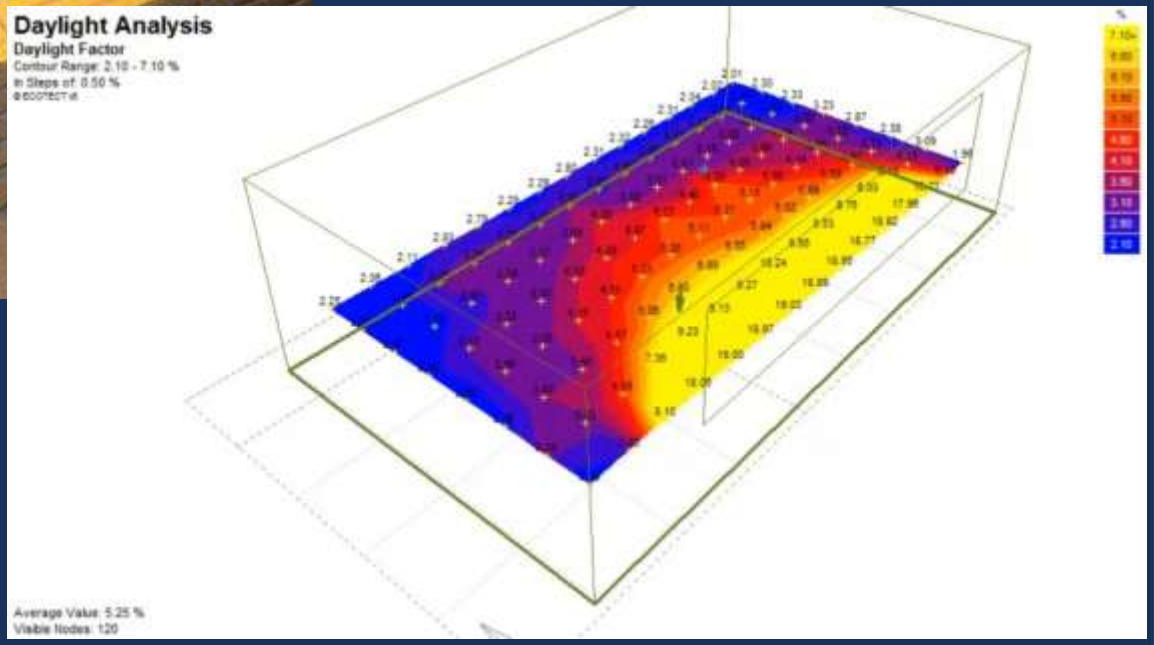
Daylight Factor: Mind the (reality) gap



The Daylight Factor reality gap

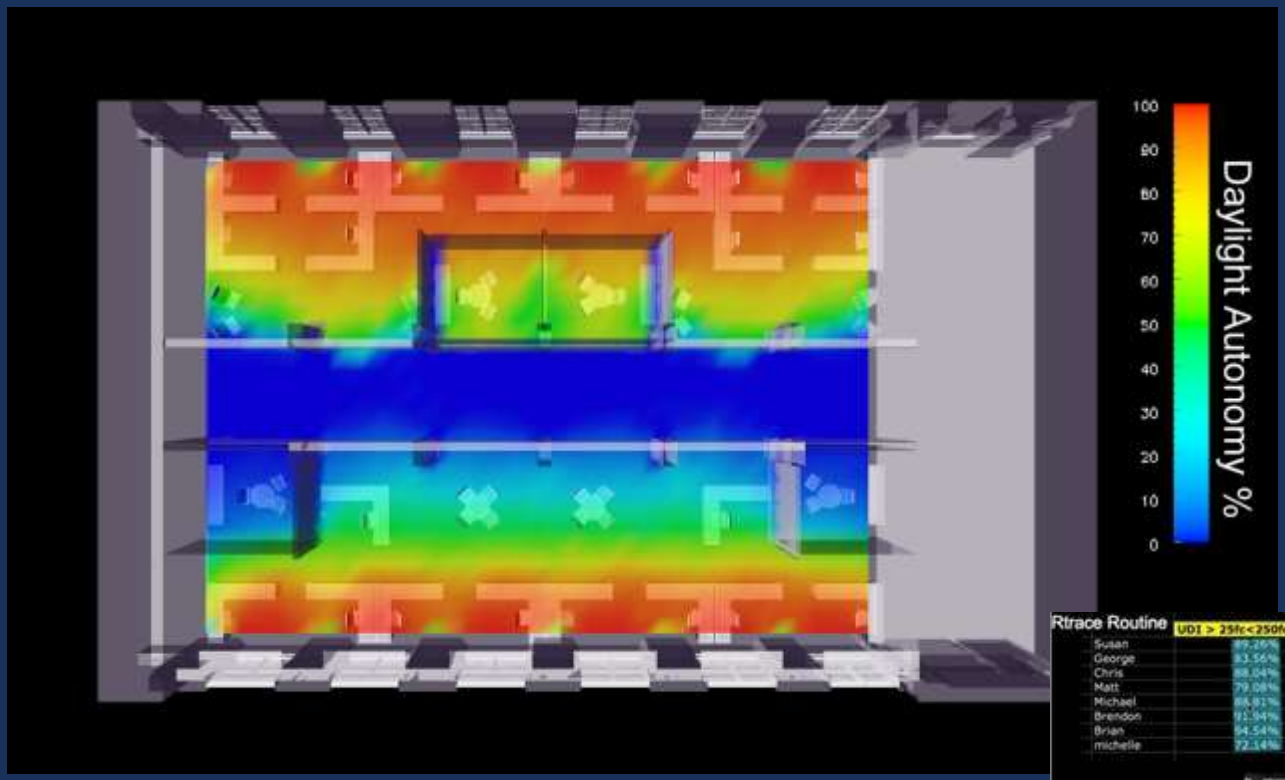
- Average Daylight Factor specification
  - open to interpretation and " game playing"
  - sometimes impossible to reconcile criteria for Daylight Factor/Solar penetration and minimisation of solar gains (to avoid air-conditioning requirements)
  - DF is a proxy for daylight & not specific to building location or orientation
- Any new international standard will require something smarter than DF

For more information see: A Roadmap for upgrading National/EU Standards for daylight Mardaljevic J CIE mid-term meeting Paris 2013

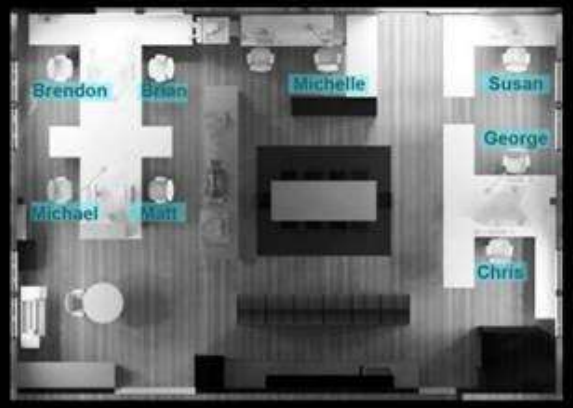
What's the way forward?

- Climate Based Daylight modelling
  - Provides a basis for considering daylight holistically based on building location & façade orientation
  - Can be integrated with thermal modelling
  - A standardised methodology requires **URGENT** international agreement regarding conventions to be adopted by software providers
    - e.g. UK National Energy Calculation Method based on CEN conventions for EU EPBD compliance
    - NB CEN conventions developed & agreed in 3 years!
      - Implemented by software providers within 3 months!!

Climate Based Daylight modelling



Rtrace Routine	UDI > 25fc<250fc (DA)	UDI <25fc	UDI > 250fc	Shade Closed	Lights On	Hours Shade Closed	Hours Lights On
Susan	89.26%	9.23%	1.51%	4.29%	10.74%	162	405
George	83.56%	16.44%	0.00%	0.00%	16.44%	0	620
Chris	88.04%	8.30%	3.66%	5.78%	11.96%	218	451
Matt	79.08%	20.89%	0.03%	1.54%	20.92%	58	789
Michael	88.81%	10.50%	0.69%	3.39%	11.19%	128	422
Brendon	91.94%	5.38%	2.68%	8.35%	8.06%	315	304
Brian	94.54%	5.30%	0.16%	5.51%	5.46%	208	206
michelle	72.14%	27.41%	0.45%	1.78%	27.86%	67	1051



Useful Daylight Illuminance (UDI) & Daylight Autonomy (DA) Images courtesy of Loisos + Ubbelohde

Could an approach based on “cumulative illuminance” be an interim step towards CBDM

- Approach suggested by Mardaljevic & Christoffersen for consideration by CEN TC 169/WG11;
  - Annual occurrence for illuminance based on the cumulative availability of diffuse illuminance from standardised climate files
  - Possible target: 300 lux across half the work-plane for half the year when sun is above the horizon
    - Allows location specific DF’s to be set as the target

Three major initiatives identified

- CEN / TC 169 WG11 Daylight

- CIE 4 D3/D6 Joint Technical Committee

- IES LM- 83 Daylight Metrics Committee

CEN / TC 169 WG11 Daylight

- In response to EU Council Directive 89/654/EEC 1989 (minimum safety and health requirements for the workplace)
- Will attempt to define:
  - *metrics used for the evaluation of daylighting conditions and methods of calculation and verification*
  - *Will apply to all spaces regularly occupied by people for extended periods*
- Convenor: Peter Raynham, The Bartlett School of Graduate Studies, University College, London

CIE 4 D3/D6 JTC
Chair Dr. Martine Knoop, TU Berlin

- To review the scientific literature in all relevant fields
  - To produce a concise document that identifies the values of windows in buildings e.g:-
    - light for visibility, ventilation, means of egress; aesthetic benefits, access to a view, light for physiological functioning, circadian rhythm regulation
  - based on this literature, the committee will propose preliminary criteria for daylight metrics
    - metrics are under development by CIE TC 3-47

IES LM -83 Daylight Metrics Committee

- Mission to develop a “suite” of daylight metrics
  - Using annual, climate-based simulation
    - To meet visual needs of occupants (not energy performance) initially for 3 types of workplace building
- IES formally adopted/published two metrics
  - Spatial Daylight Autonomy
  - Annual Sunlight Exposure
- Extra LEED credits if LM-83 metrics/modelling is used (NB provides a stimulus/incentive for building designers & software providers)

Summary

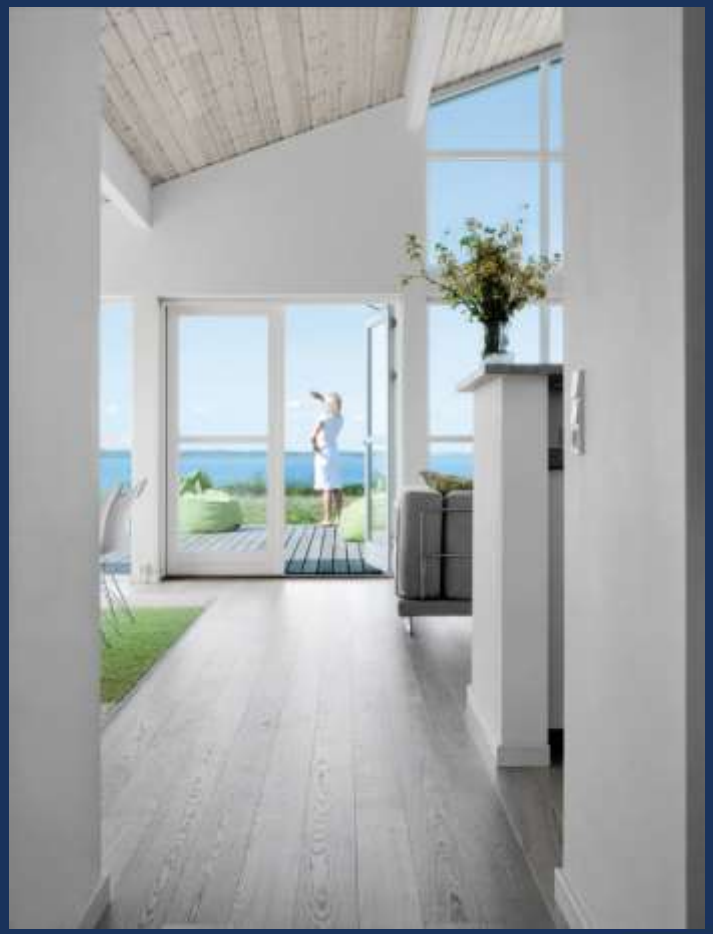
- Legal requirements and regulations regarding daylight are internationally very diverse
  - in most cases regulations are only advisory
- Daylight is becoming an increasingly important health & sustainability issue
- An urgent need exists to develop robust international conventions & methodologies
  - The next generation of building Codes and Regulations (and Environmental Assessment Methods) will require:
    - daylight to be considered holistically, including:
      - Building location and orientation
      - Comfort & glare considerations
      - Energy related implications

Dr David Strong

David Strong Consulting Ltd

To download a copy of the international survey visit:

www.davidstrong.co.uk



Slide 1, 4, 5, 6 & 25 images courtesy of Glass for Europe

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