



glasstec
conference
20 - 23 SEPT 2022

WELCOME
WILLKOMMEN

Daylight needs of humans and daylight in the planning practice

– today and in the future

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Ås, Norway**

With support of
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University of Life Sciences, NMBU



Daylight in the planning

Daylight needs of humans

Man is made for the outdoors(, near equator)





Photo: Tor Even Mathisen



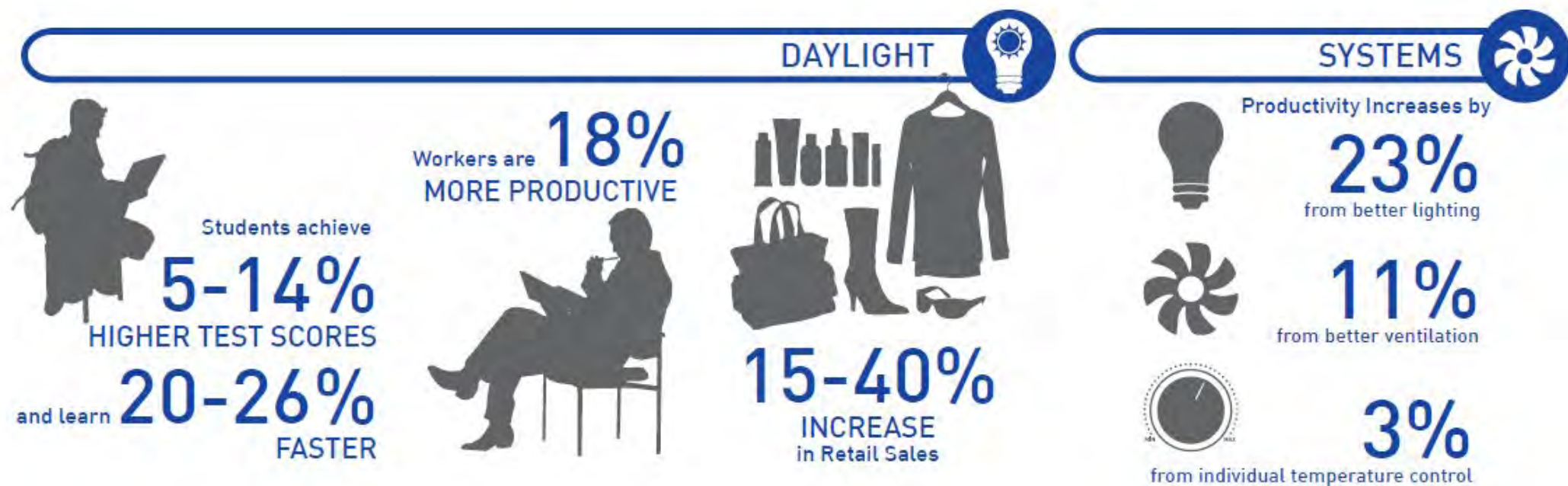
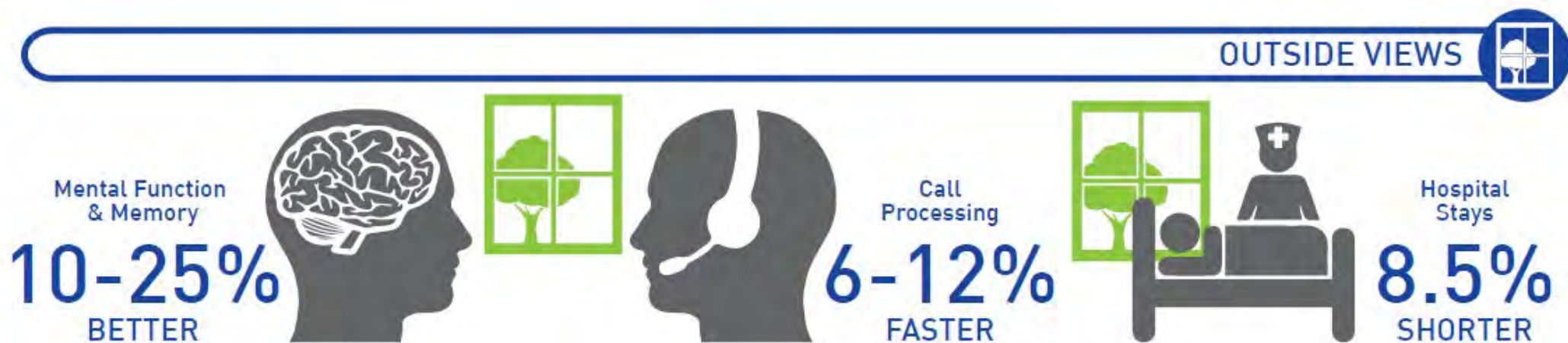
Huseby Schule, Trondheim, SPINN architects + Filter
Mesterfjellet Schule, SPINN architects + Cebra
Tyven fjellstue, Hammerfest, SPINN architects
Flesberg Schule, SPINN architects



SPINN Architects

Photo: Tor Even Mathisen

The stats



Reserach example

2003: Windows and Offices: A Study of Office Worker Performance and the Indoor *Heschong*

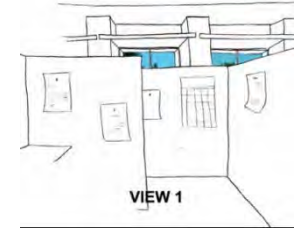
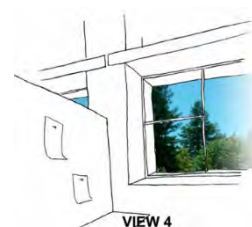


Mahone Group, Inc.

Lisa Heschong, Project Director

http://h-m-g.com/downloads/Daylighting/order_daylighting.htm

- Improved break view: 6-7% faster
- Improved prime view: Additional 6% faster
- Workers behind high dividing walls 11-18% slower than workers behind lower dividing walls



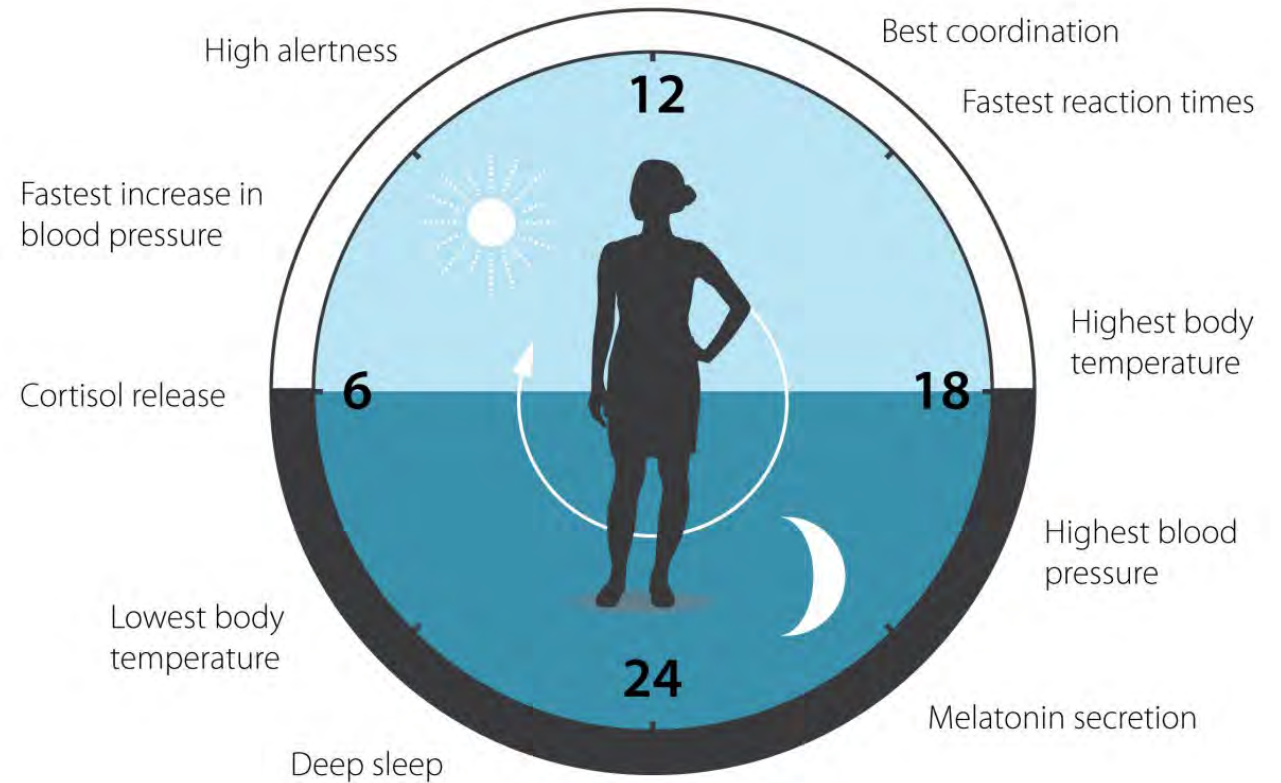
The circadian rhythm

- Melatonin and serotonin.
- Daylight driven
- The biological effects
- Daylight levels in building codes and certifications systems



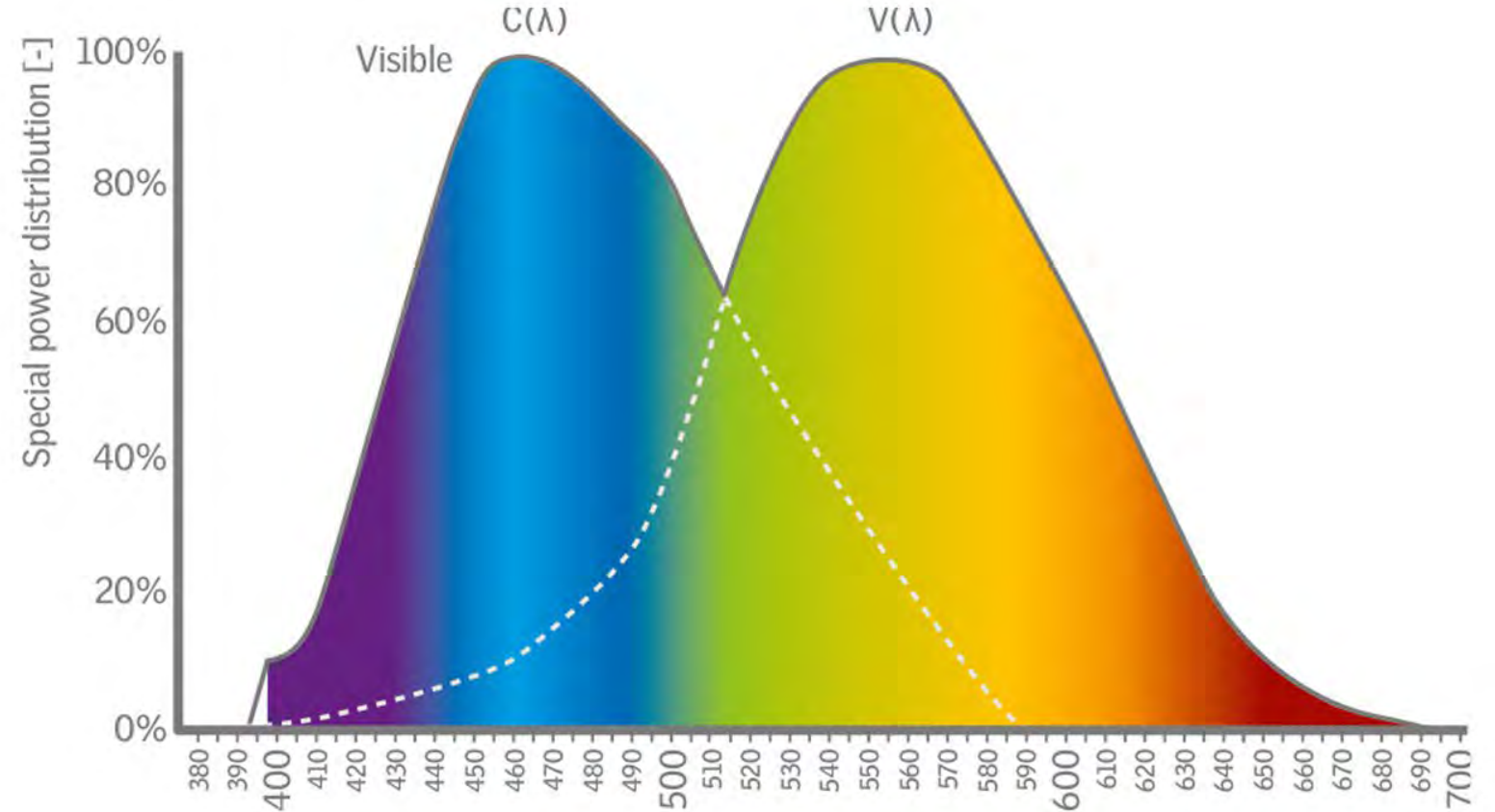
Melatonin as a driver for the circadian rhythm

- Melatonin (sleep hormone)
- Mood regulation and appetite

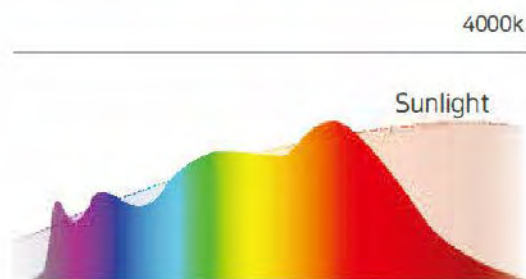
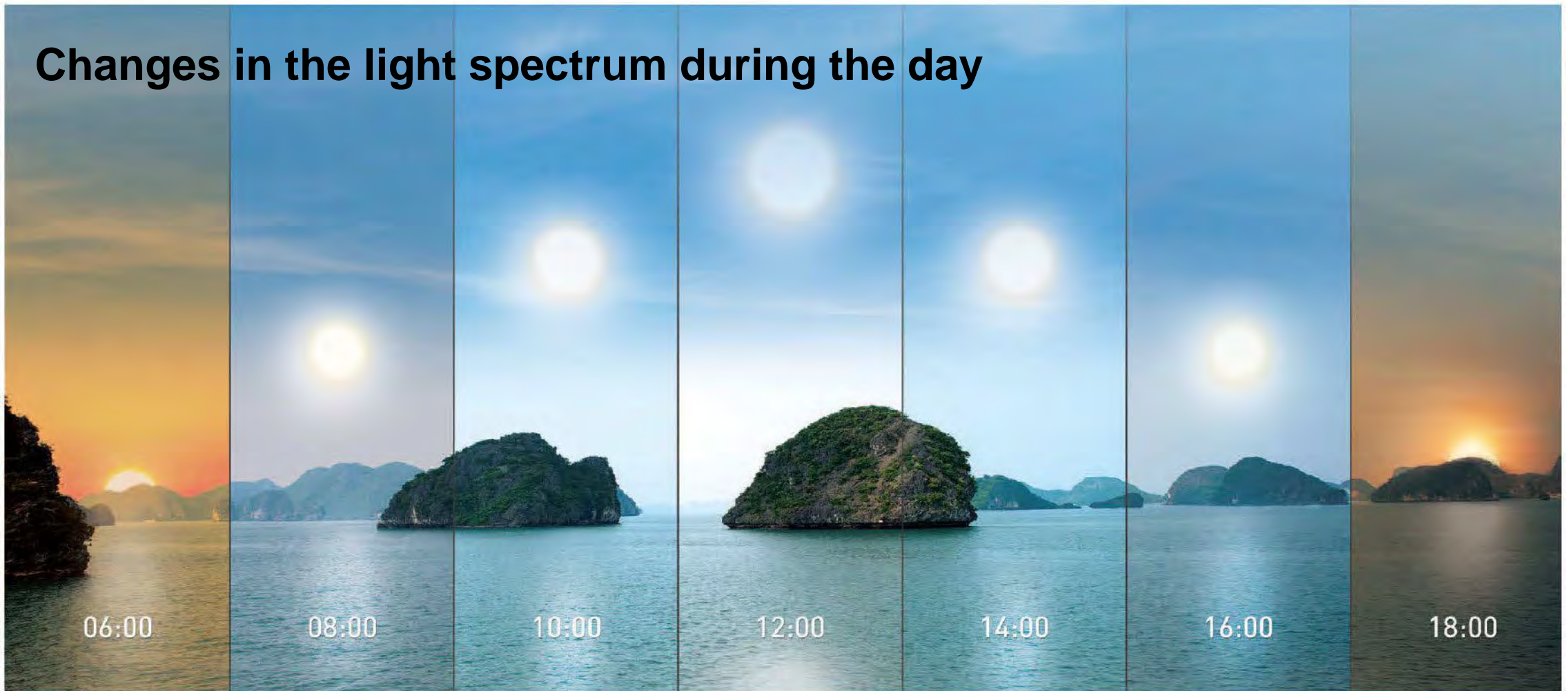


The importance of the spectral composition

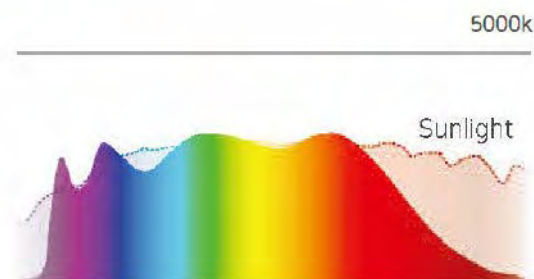
- Melanoptic (biological) sensitivity
- Photopic sensitivity



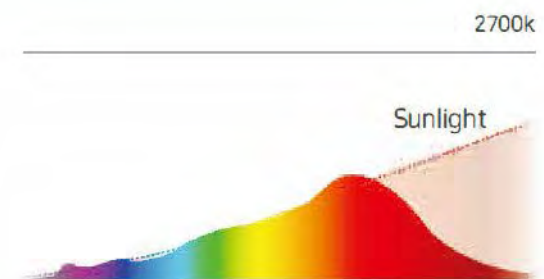
Changes in the light spectrum during the day



Morning Color



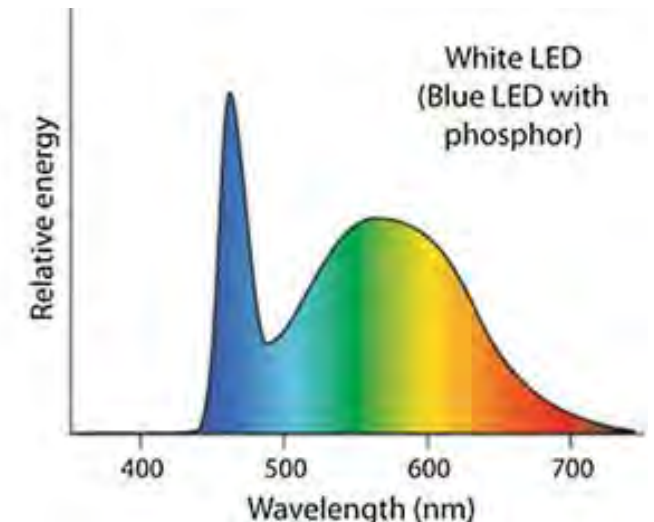
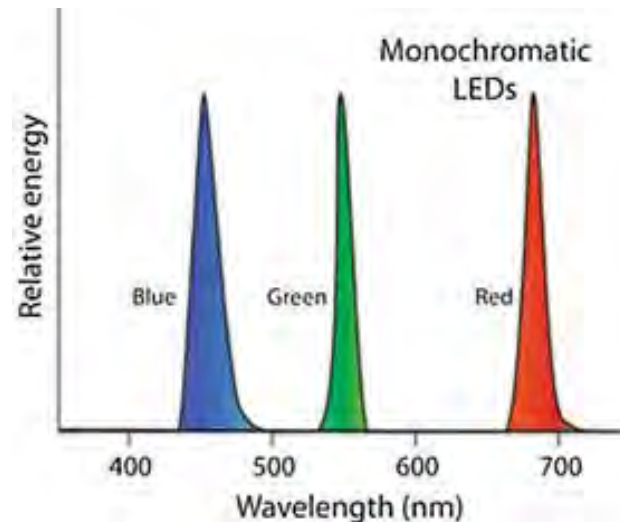
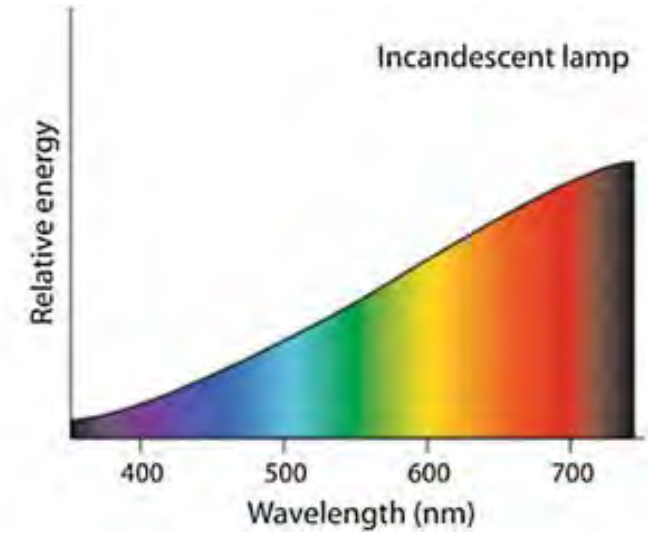
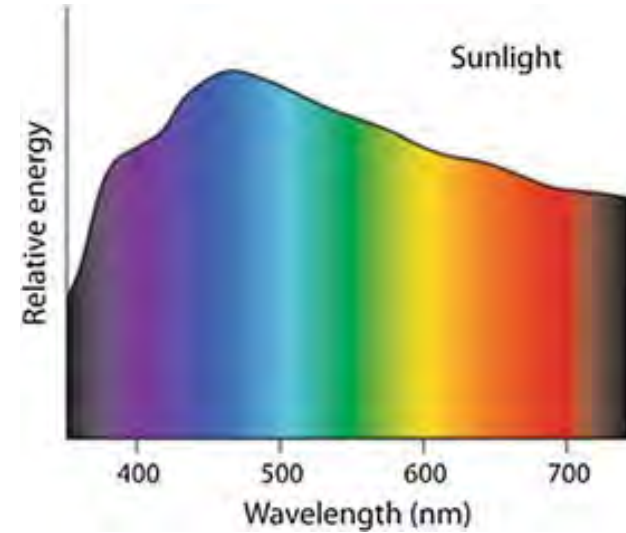
Noon Color



Evening Color

Daylight vs. Electrical lighting

- The visual spectrum of daylight is between 380 nm and 780 nm
- Spectral composition varies from light source to light source



Daylight and human behavior

■ Fernanda Nissen School



Photo: L. D. Houck

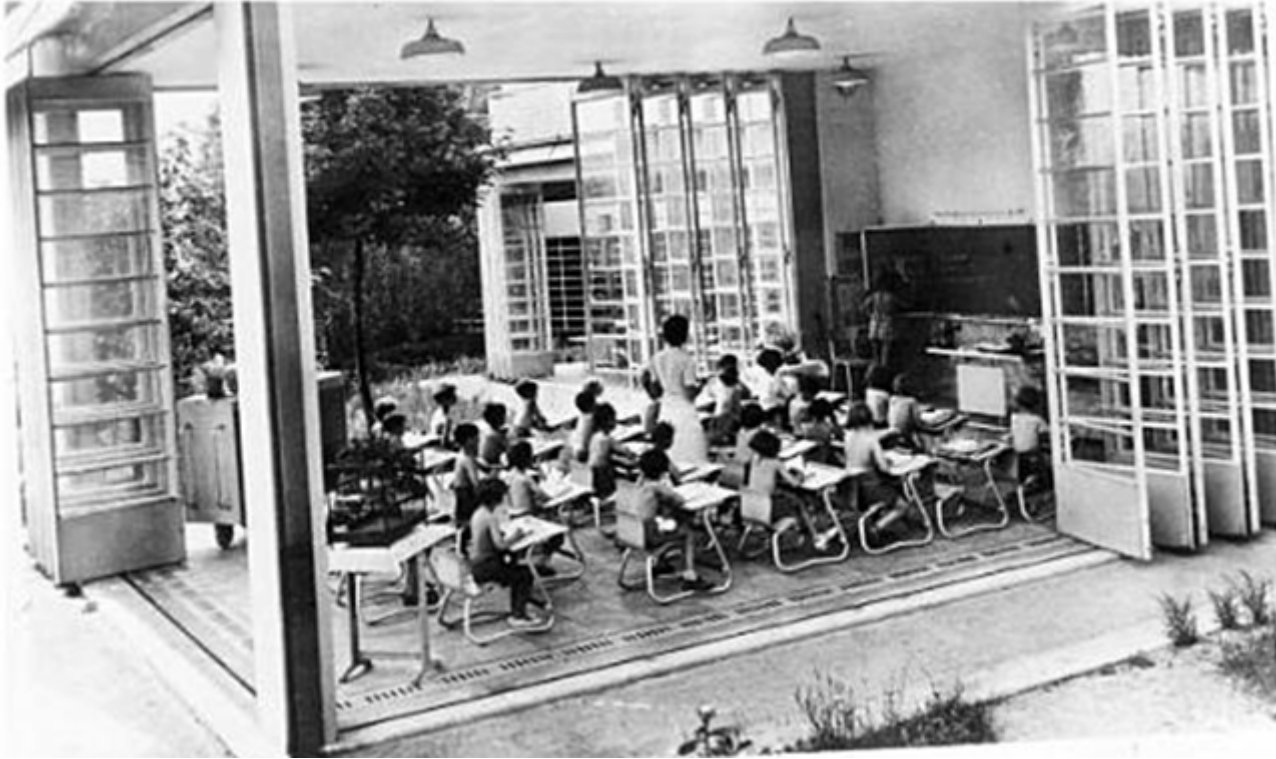
Daylight and human behavior

- Fernanda Nissen School



Photo: L. D. Houck

Daylight - and air



The Suresnes Open-Air School (1931-1935)

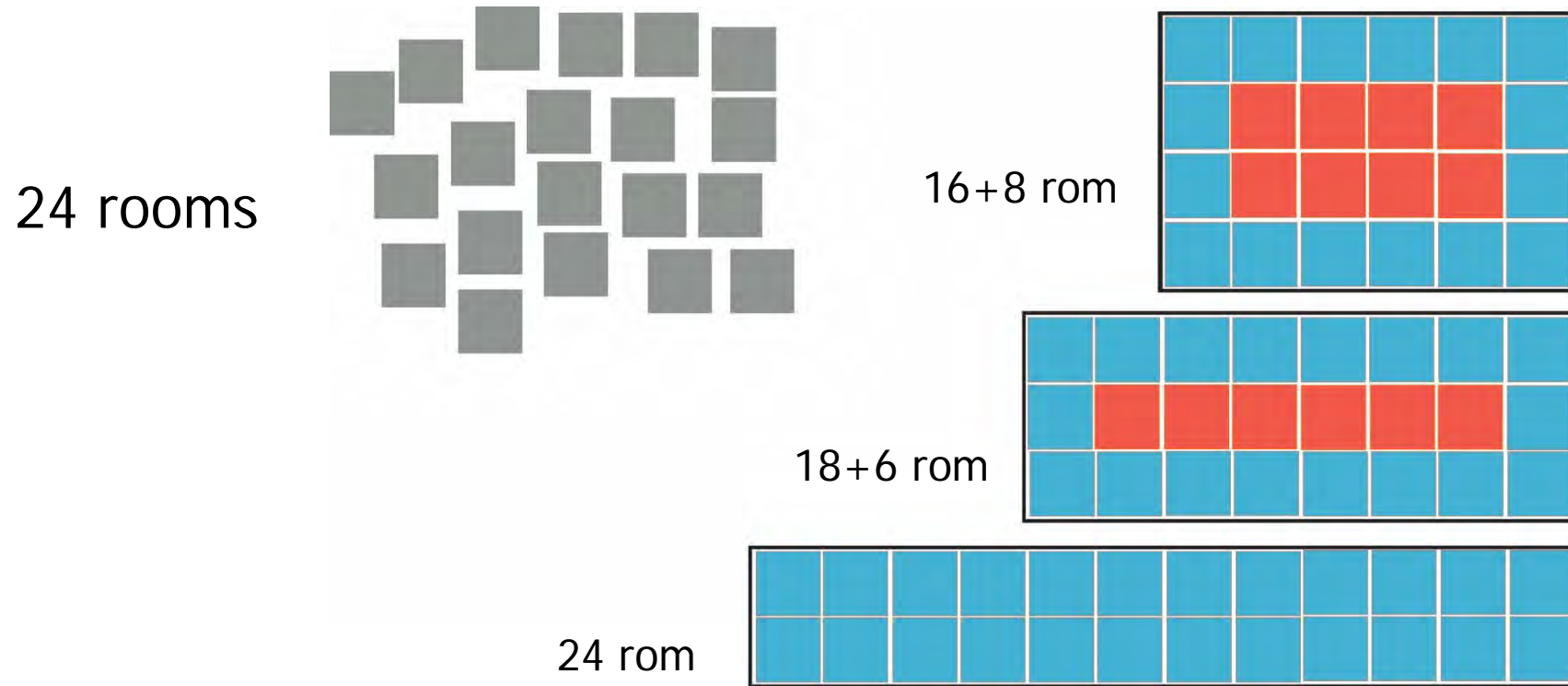


Cliostraat Openluchtschool, Ark Jan Duiker (1927-1930)

Planning of daylight

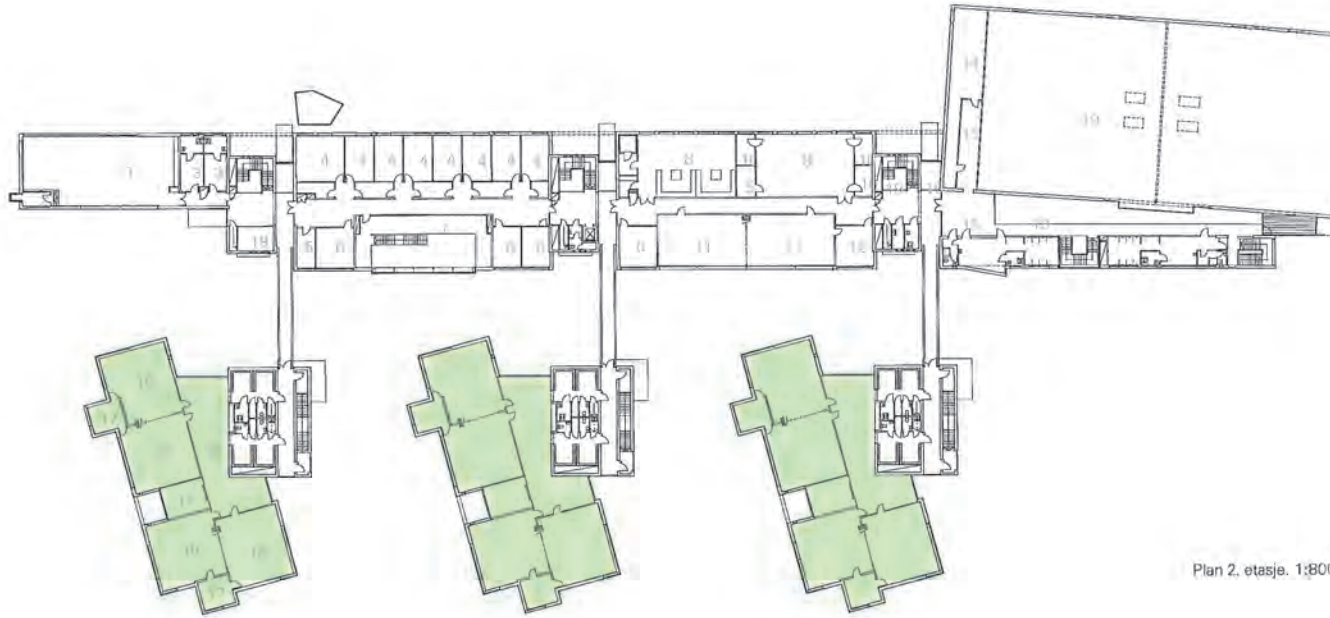
Conceptual level - buildings

Sustainability: Toward compact buildings?

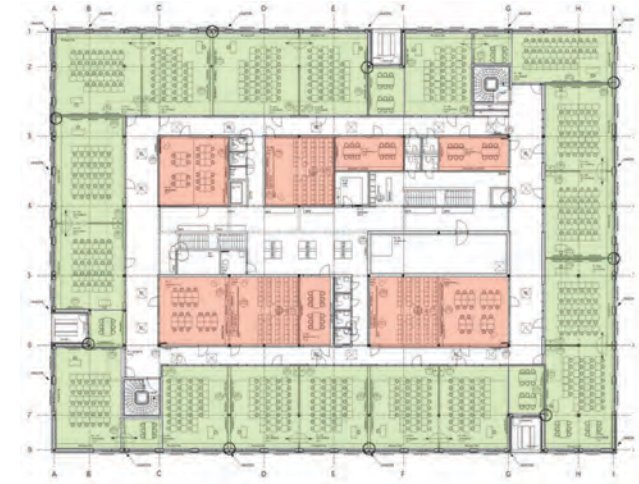


Which building is more sustainable?

Sustainability: Toward compact buildings?

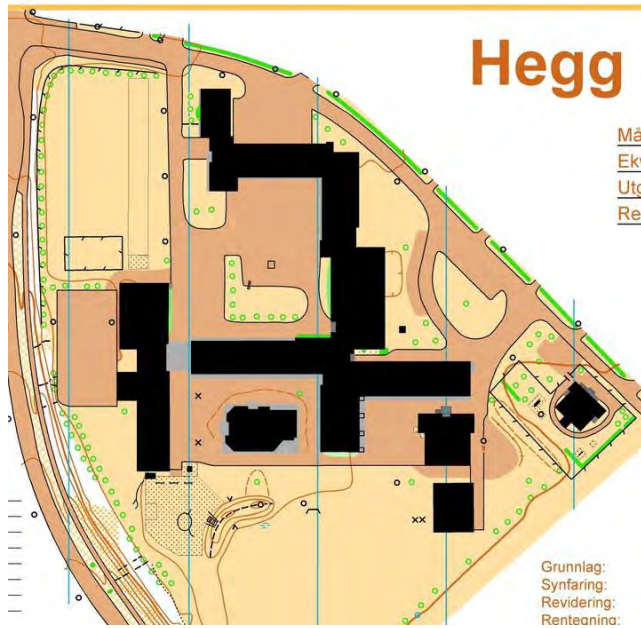


Gulskogen School 1999-2001
Client: Drammen Municipality
14 meters of facade per class



Marienlyst school 2007-2009
Norway's first passive house school
Client: Drammen Municipality
9,4 meters of facade per class

Sustainability: Toward compact buildings?



Hegg School – old school



Hegg School 2015 – new
Passiv House
Breeam Very Good
11.300 m²
6,2 meter facade per class

Photo: L. D. Houck



Daylight versus heating

Refurbishment 2010, Risør School



Photo: Ecobox



Photo: Ecobox

Veivangen school, 2012



Photo: L. D. Houck

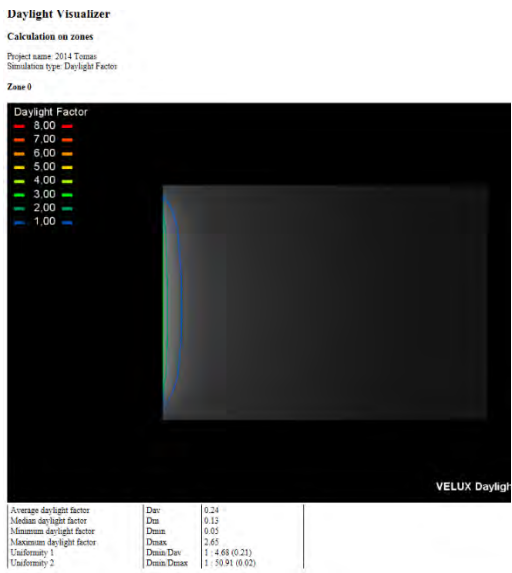


Figure: L. D. Houck

Calculated $DF_{av}=0,24$

Requirement
Norwegian building code: 2% DF

A novel approach on assessing daylight in schools

Leif D. Houck, *Procedia Economics and Finance* 21(2015)

Meters of facade per class	
5,5 6,5	Only daylight for classrooms. No daylight for any Group study rooms or other common teaching areas. Deep and narrow classrooms. Hardly room for future change of plan layout
7 – 9,5	Daylight in classrooms and up to half of the group study rooms. For lower values: either deep and narrow classrooms, or no group study rooms with daylight
10 – 12,5	Daylight in classrooms. Daylight in at least half of the group study rooms. Daylight in some other common teaching areas
13 -	High degree of freedom with concern to daylight distribution into most, or all classrooms, group study rooms and common teaching areas

Schematic relationship between a school project's meters of facade and the project's daylight capacity

A novel approach on assessing daylight in schools

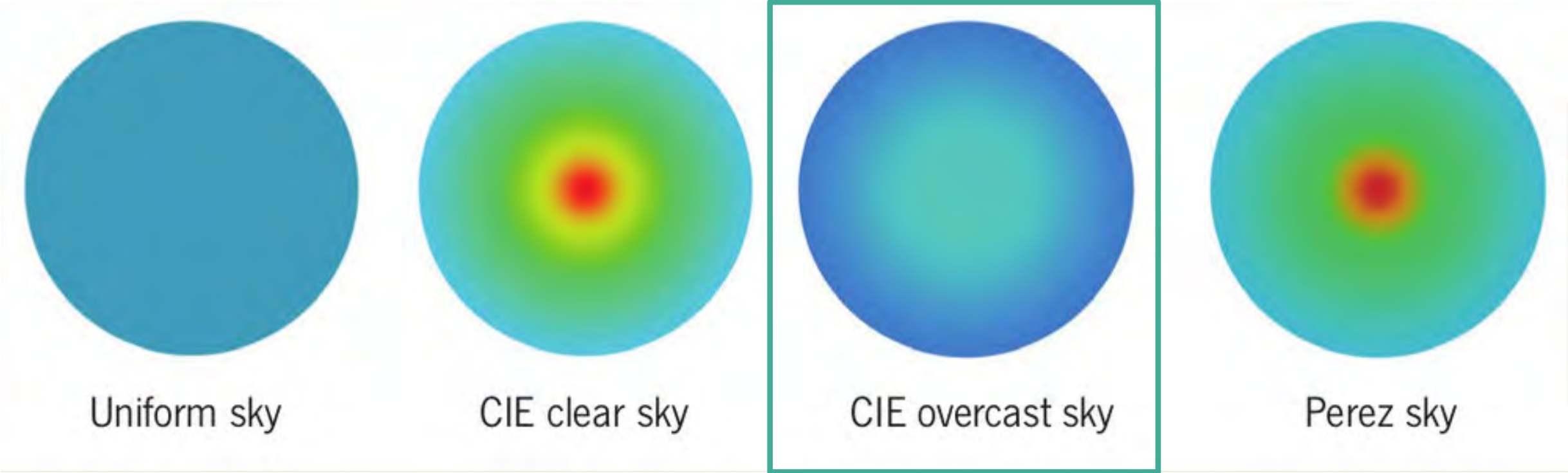
Leif D. Houck, Procedia Economics and Finance 21(2015)

Results from a school competition with minimum 12 meters of facade per class as a requirement

Competitor	Meters of façade per class FMC	Energy Consumption NS3031	Fulfills NS 3701 (Passive house standard)
1	13.4	62 kWh/m ² /a	Yes
2	12.3	65.8 kWh/m ² /a	Yes
3 (winner, see fig. 2 c)	12.0	68.4 kWh/m ² /a	Not documented
4	12.9	67.8 kWh/m ² /a	Yes

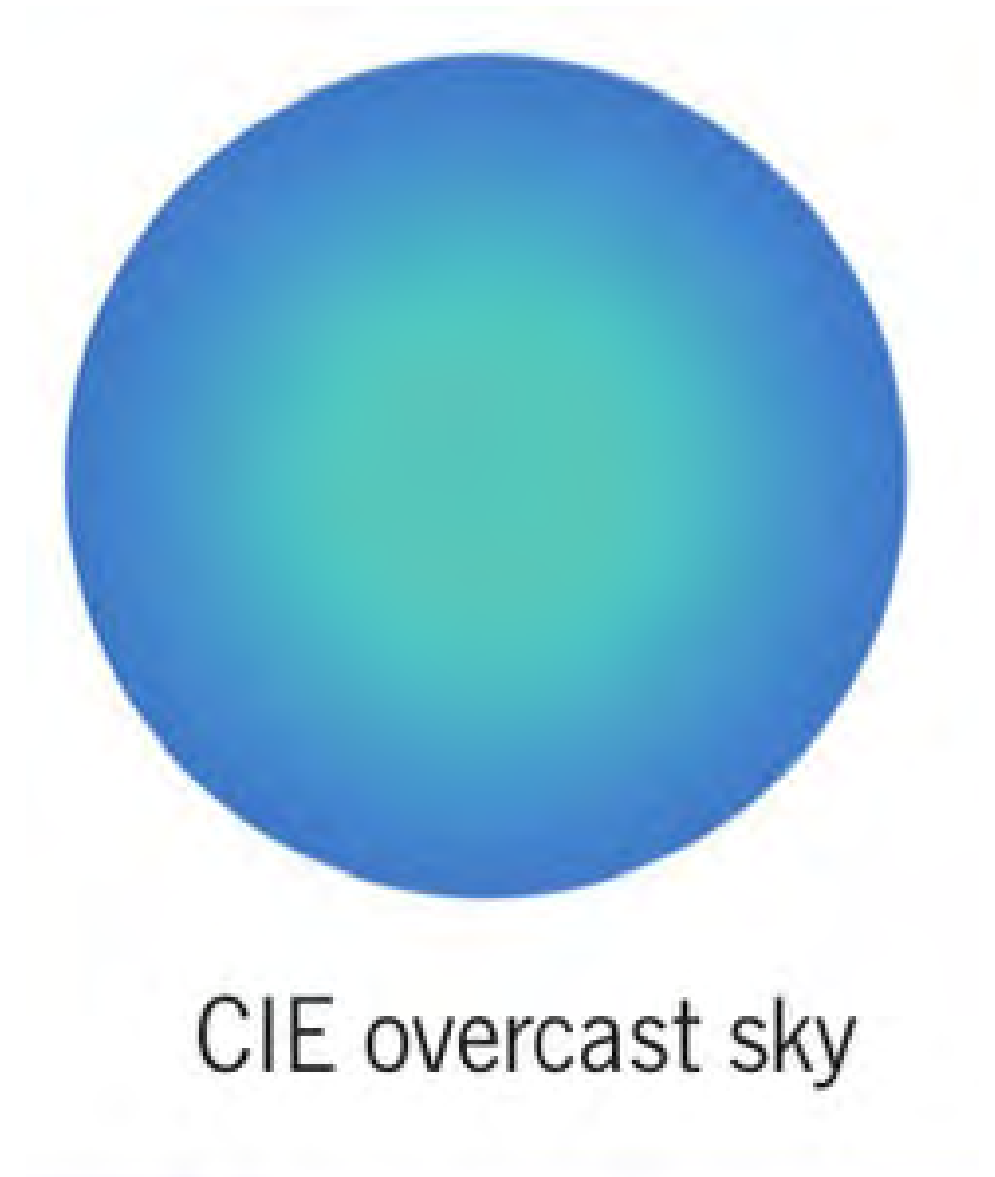
Calculation of Daylight

Different sky models

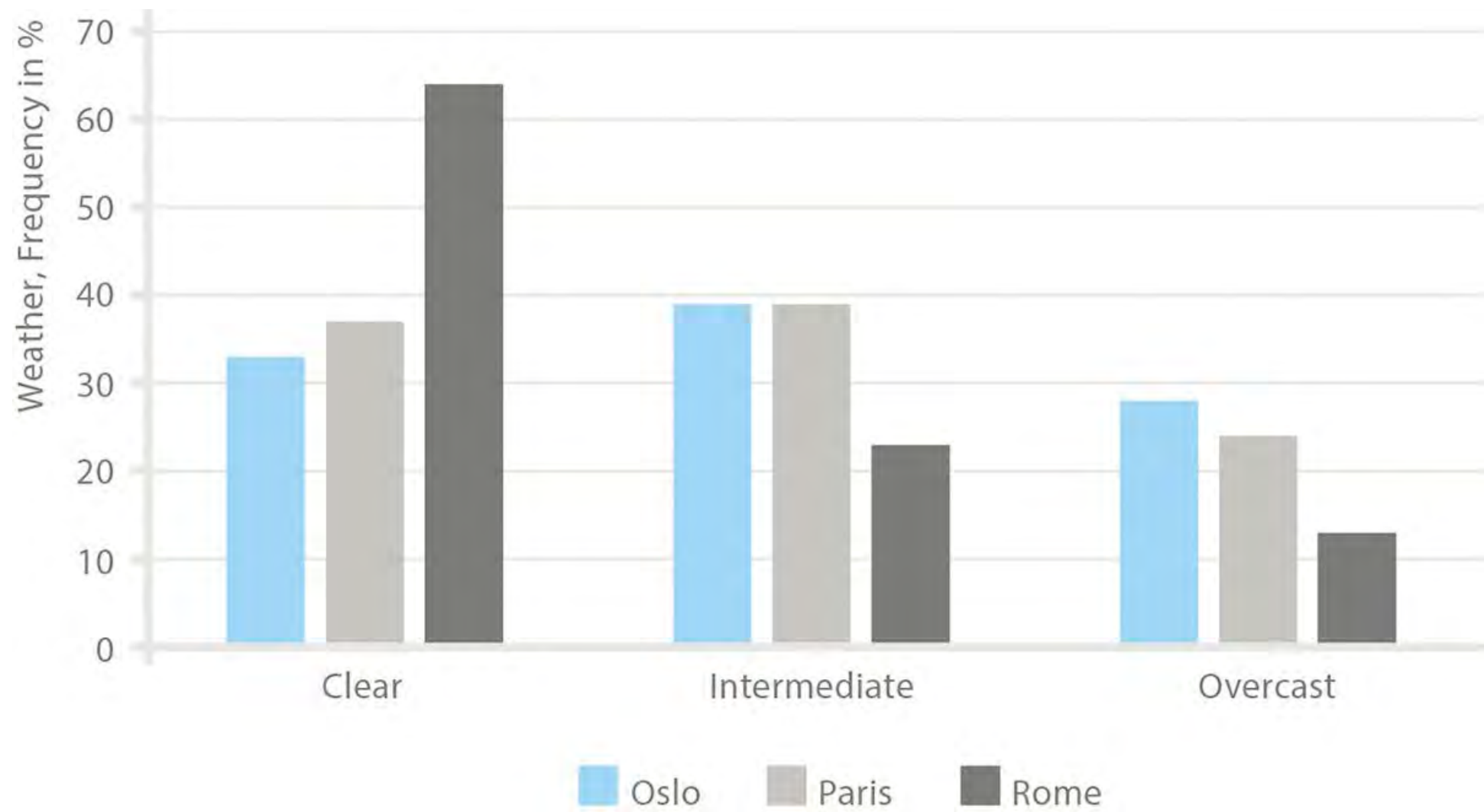


Daylight factor calculations

- A static sky model
 - CIE overcast sky
- The result is not affected by:
 - geographical location
 - local climate
 - orientation
- An imperfect metric that gives an indication of daylight quality
- Firmly rooted in our code



Frequency of weather in %



The argument for climate based metrics, DF

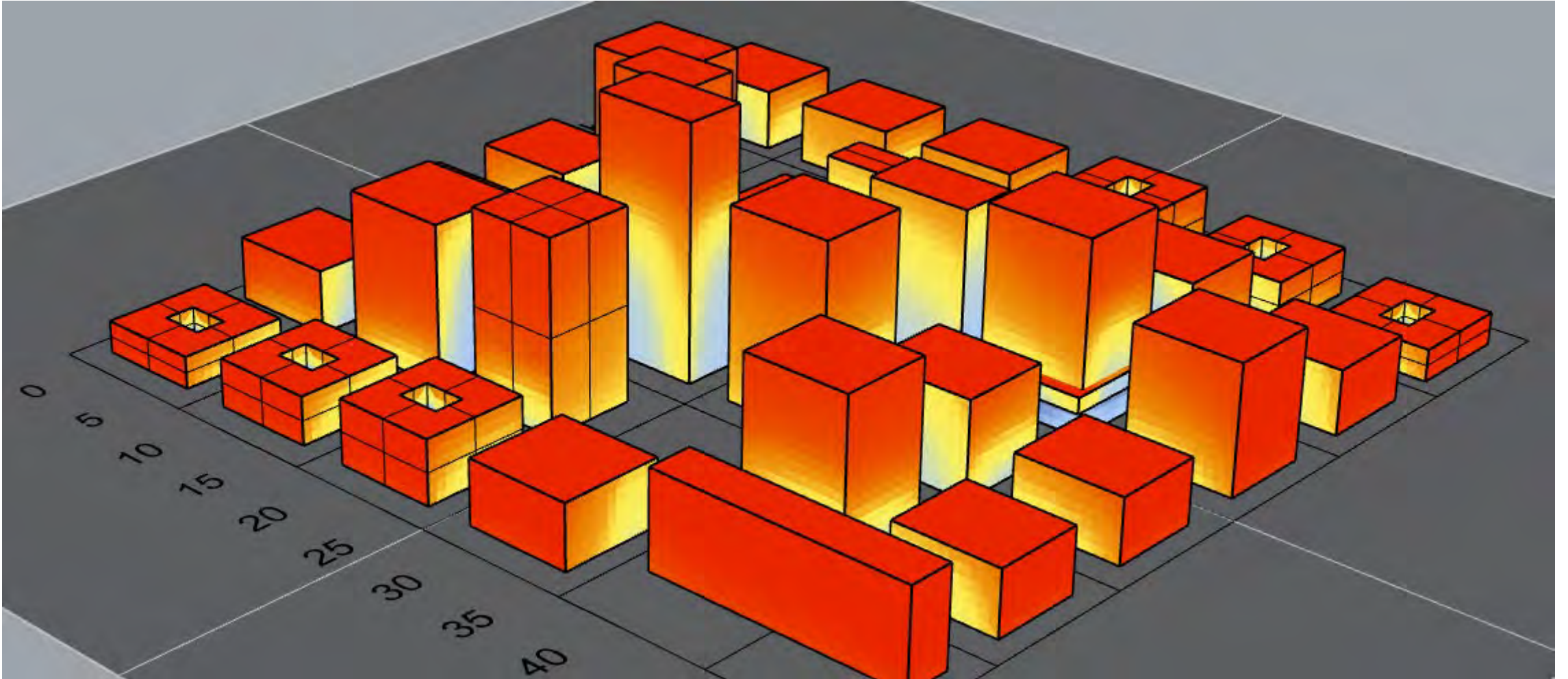


Figure: Arnkell Petersen

The argument for climate based metrics, DA

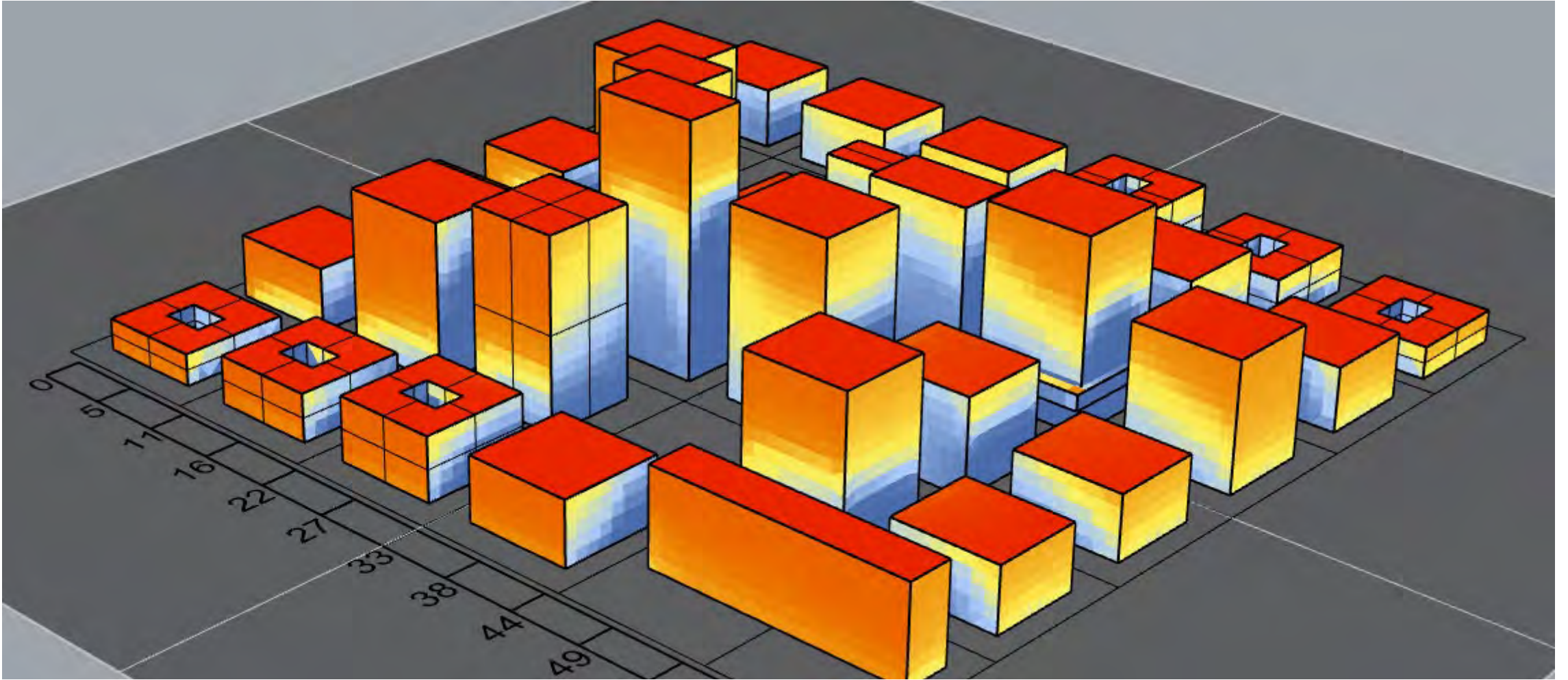


Figure: Arnkell Petersen

Different climate based metrics

- **Daylight autonomy (DA)** corresponds to the percentage of the occupied time when the target illuminance at a point in a space is met by sufficient daylight
- **Useful daylight illuminance (UDI)** corresponds to the percentage of the occupied time when a target range of illuminances at a point in a space is met by useful (or better) daylight.
- **Daylight Glare Probability (DGP)** predicts the likelihood that an observer at a given view position and orientation will experience discomfort glare. The metric is usually calculated using a fisheye rendering



Imperceptible glare	Perceptible glare	Disturbing glare	Intolerable glare
$DGP \leq 34\%$	$34\% < DGP \leq 38\%$	$38\% < DGP \leq 45\%$	$45\% < DGP$

The argument for climate based daylight metrics

- Daylight is not static, but dynamic
- Daylight varies with:
 - Time
 - Climate
 - Place
 - Orientation
 - can provide info on glare
- Climate based metrics give good indications of real daylight conditions
- Code of the future



If this is the resource...

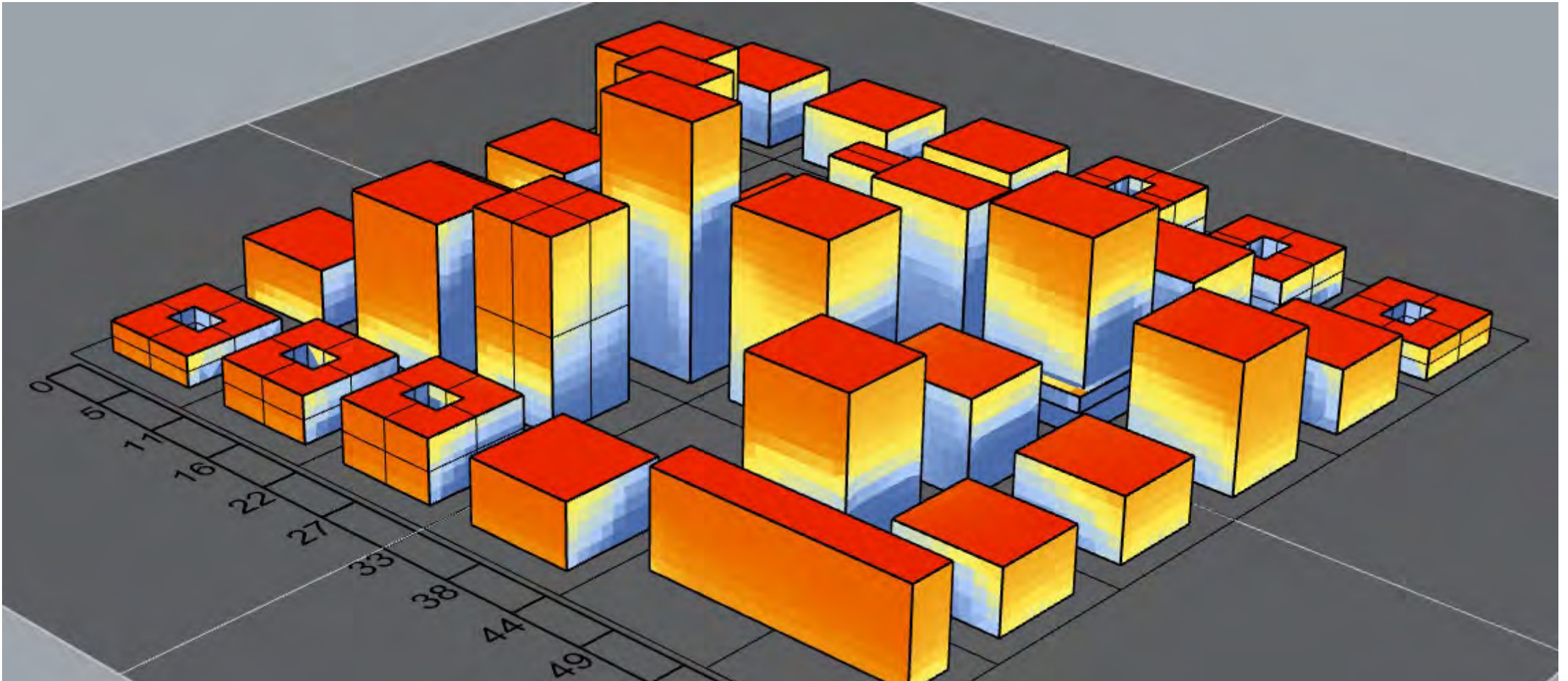


Figure: Arnkell Petersen

This is maybe not the proper response





Conclusions

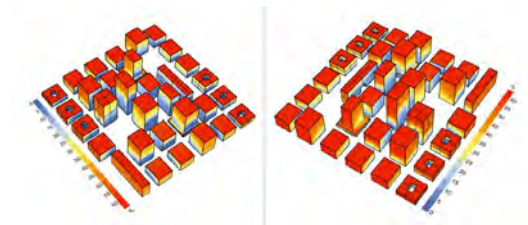


Photo: Bamble Schule. SPINN Architects

We need daylight!

Two paths:

- More simple**
- More complex**



Thankyou!