DAYLIGHT IN OFFICES

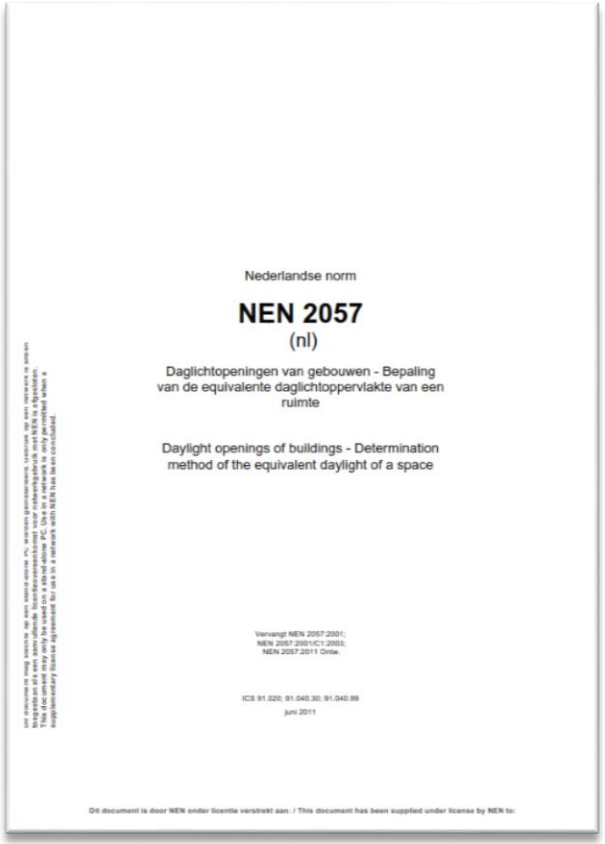
A COMPARISON BETWEEN THE DUTCH AND EUROPEAN STANDARDS FOR DAYLIGHT IN BUILDINGS

P5 PRESENTATION

LIANNE ZOUTENDIJK – 4218663

APRIL 20, 2018

No guarantee for daylight quality



Nederlandse norm

NEN 2057

(nl)

Daglichtopeningen van gebouwen - Bepaling van de equivalente daglichtoppervlakte van een ruimte

Daylight openings of buildings - Determination method of the equivalent daylight of a space

Vervangt NEN 2057:2001;
NEN 2057:2001/C1:2003;
NEN 2057:2011 Ontw.

ICS 91.020; 91.040.30; 91.040.99

juni 2011

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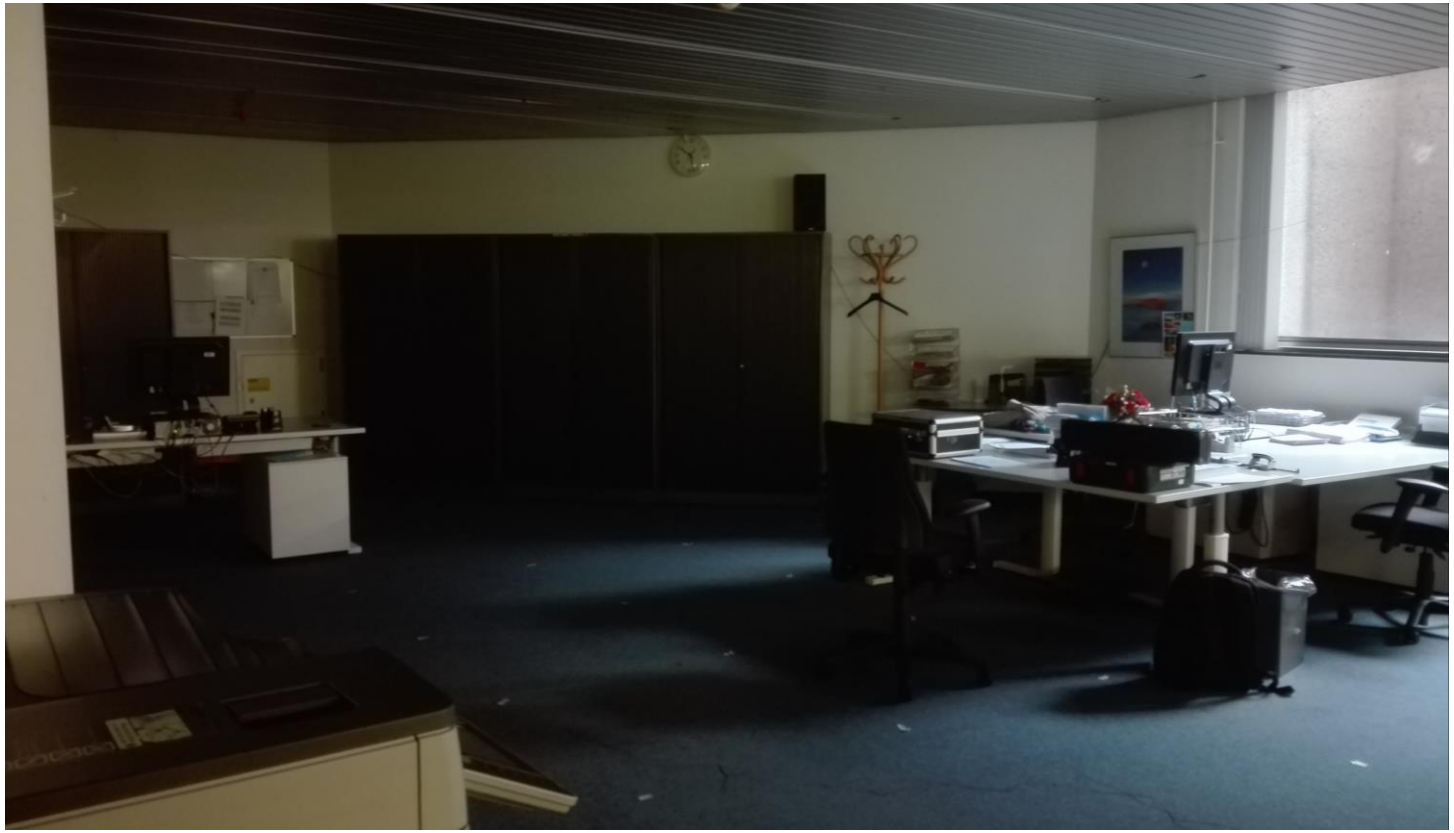
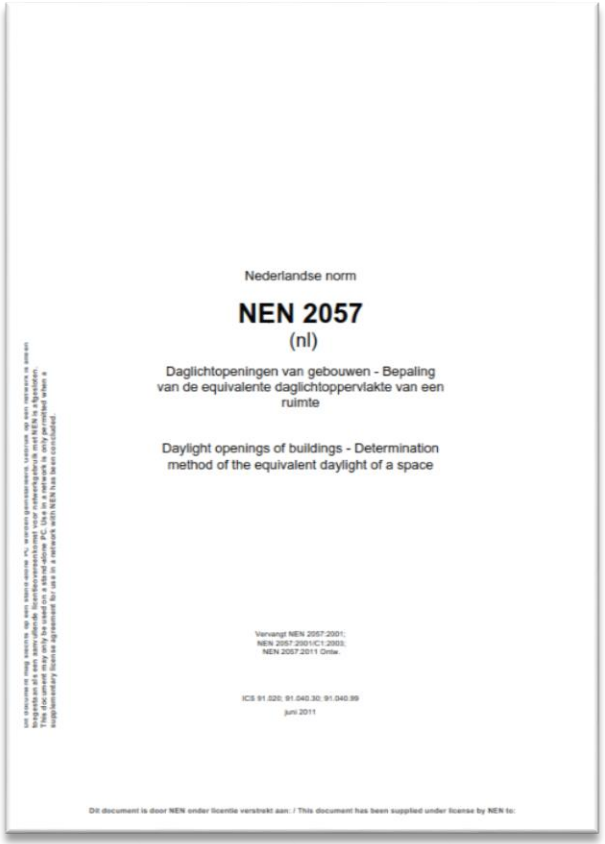


Standards for daylight in buildings



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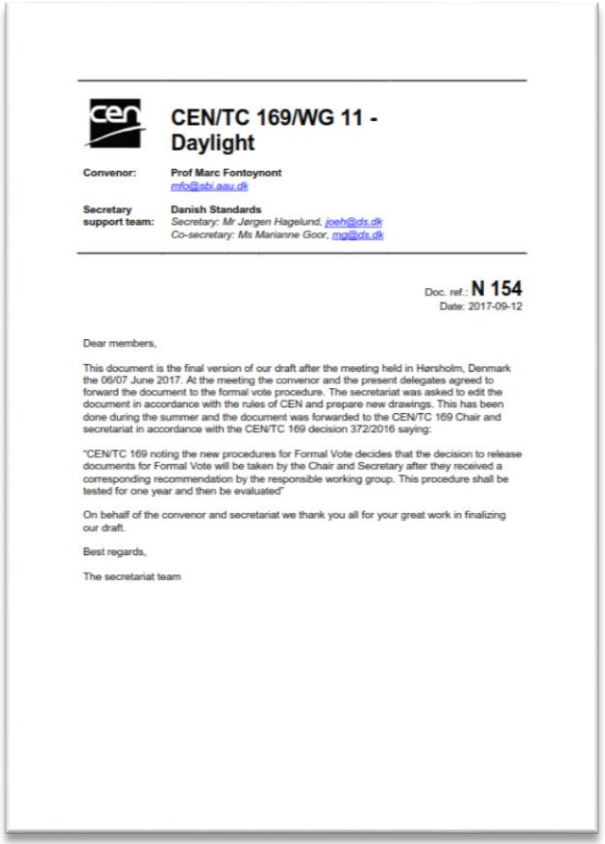

CEN/TC 169/WG 11 - Daylight

Convenor: **Prof Marc Fontoynont**
mfo@sbi.aau.dk

Secretary support team: **Danish Standards**
Secretary: Mr Jørgen Hagelund, joeh@ds.dk
Co-secretary: Ms Marianne Goor, mg@ds.dk

Doc. ref.: **N 154**
Date: 2017-09-12

Dear members,

This document is the final version of our draft after the meeting held in Hørsholm, Denmark the 06/07 June 2017. At the meeting the convenor and the present delegates agreed to forward the document to the formal vote procedure. The secretariat was asked to edit the document in accordance with the rules of CEN and prepare new drawings. This has been done during the summer and the document was forwarded to the CEN/TC 169 Chair and secretariat in accordance with the CEN/TC 169 decision 372/2016 saying:

"CEN/TC 169 noting the new procedures for Formal Vote decides that the decision to release documents for Formal Vote will be taken by the Chair and Secretary after they received a corresponding recommendation by the responsible working group. This procedure shall be tested for one year and then be evaluated"

On behalf of the convenor and secretariat we thank you all for your great work in finalizing our draft.

Best regards,

The secretariat team

Content

- Research framework
  - Goals
  - Research question
  - Approach
- Literature review
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- Case studies
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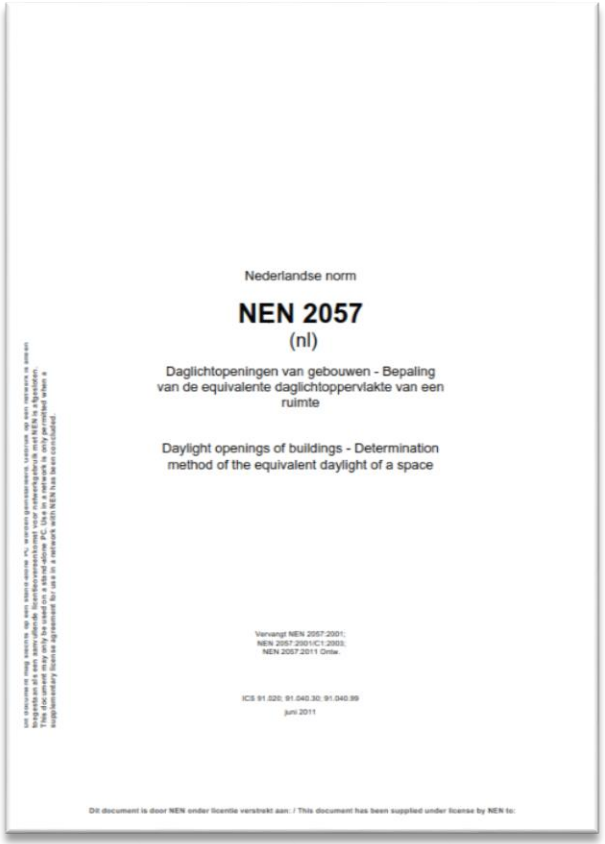
  - Case 2 – Office DGMR Casuariestraat The Hague
  - Results
- Systematic study
  - Methodology
  - Variants
  - Results
- Conclusions
- Recommendations
- Discussion

Goal



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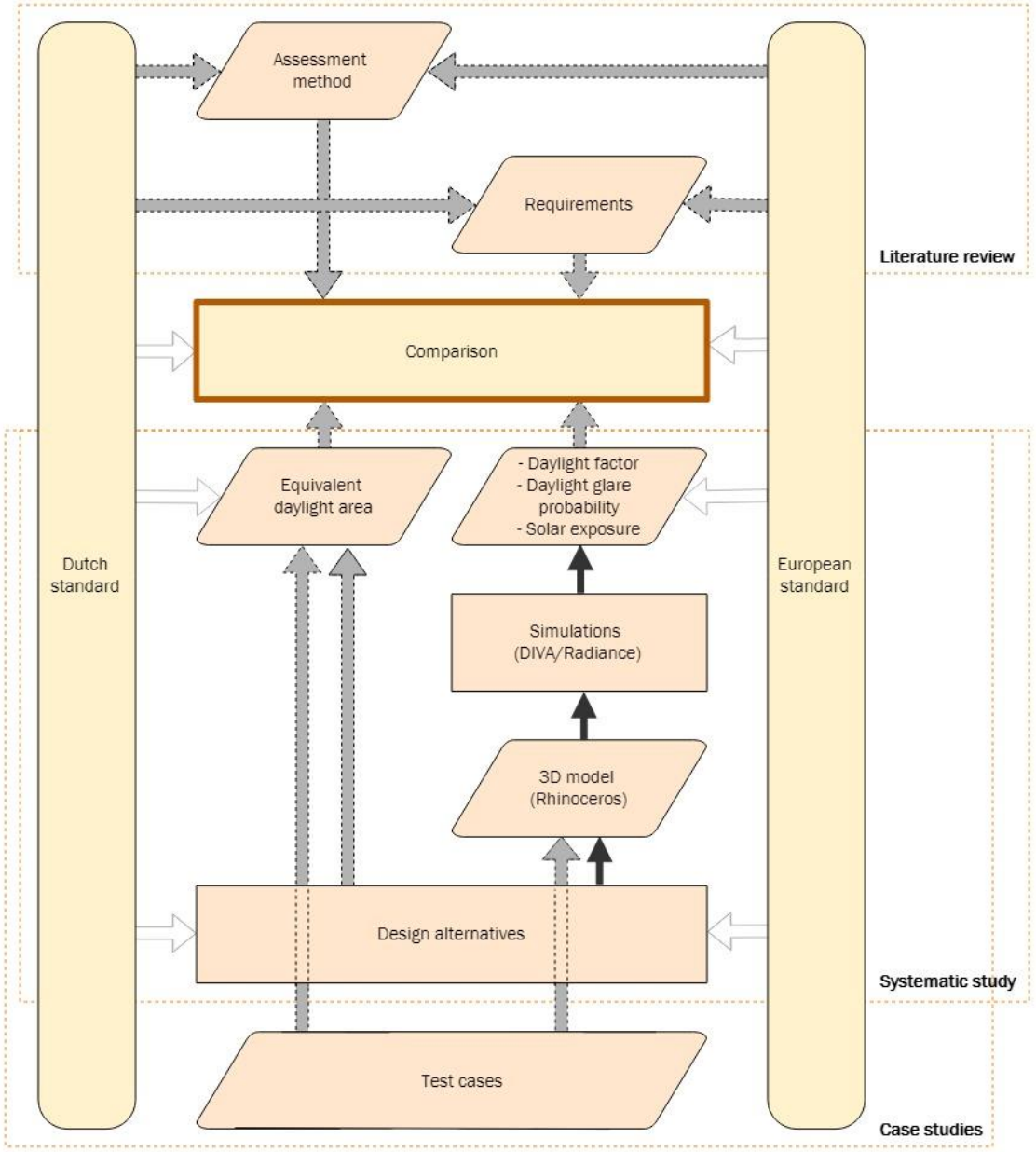
Set of recommendations

Research question

- What are the main differences between the Dutch and the European standards for daylight in buildings?
  - Assessment methods
  - Requirements
  - Effects on daylight quality

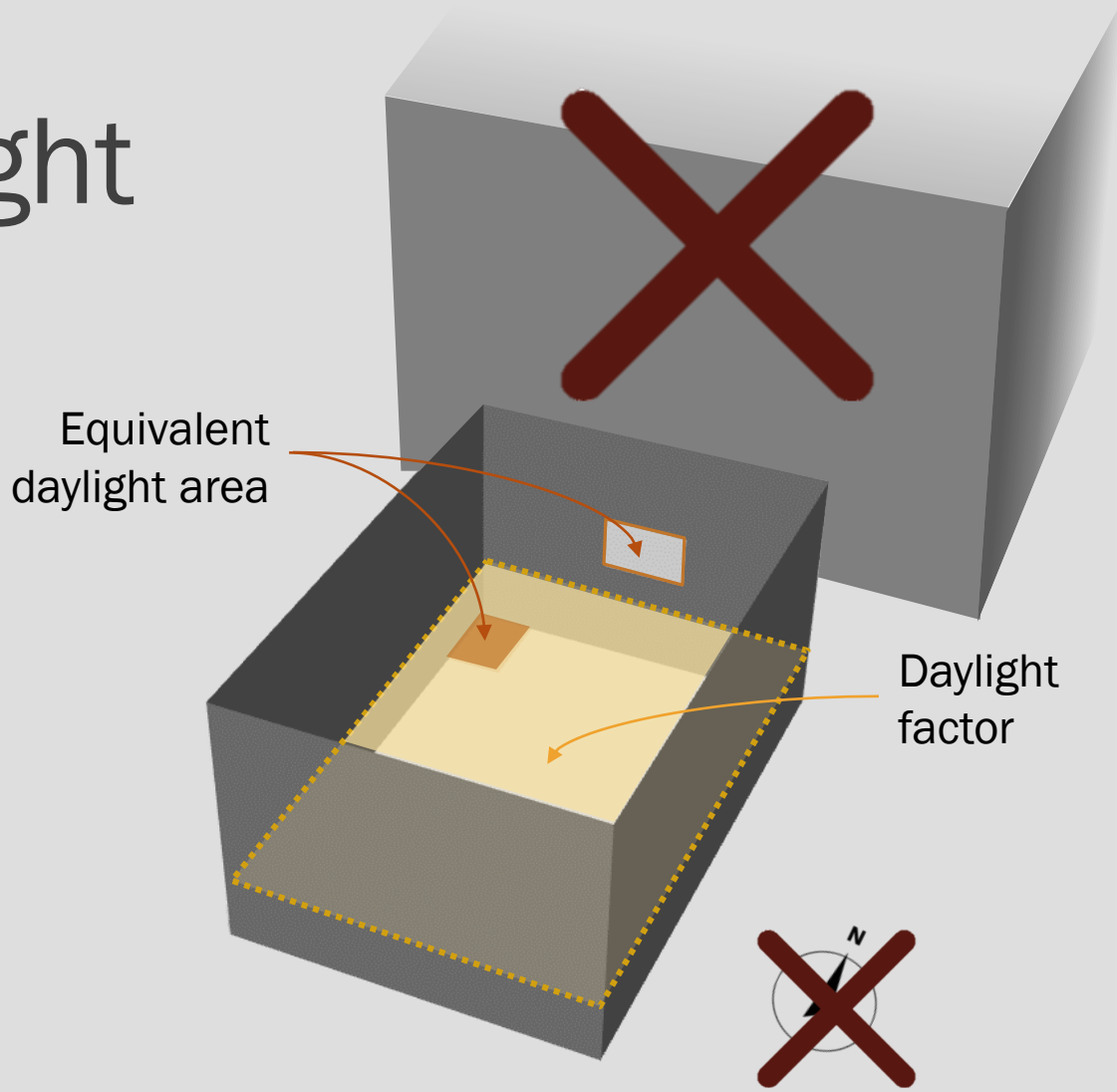
Approach

- Literature review
- Case studies
- Systematic study



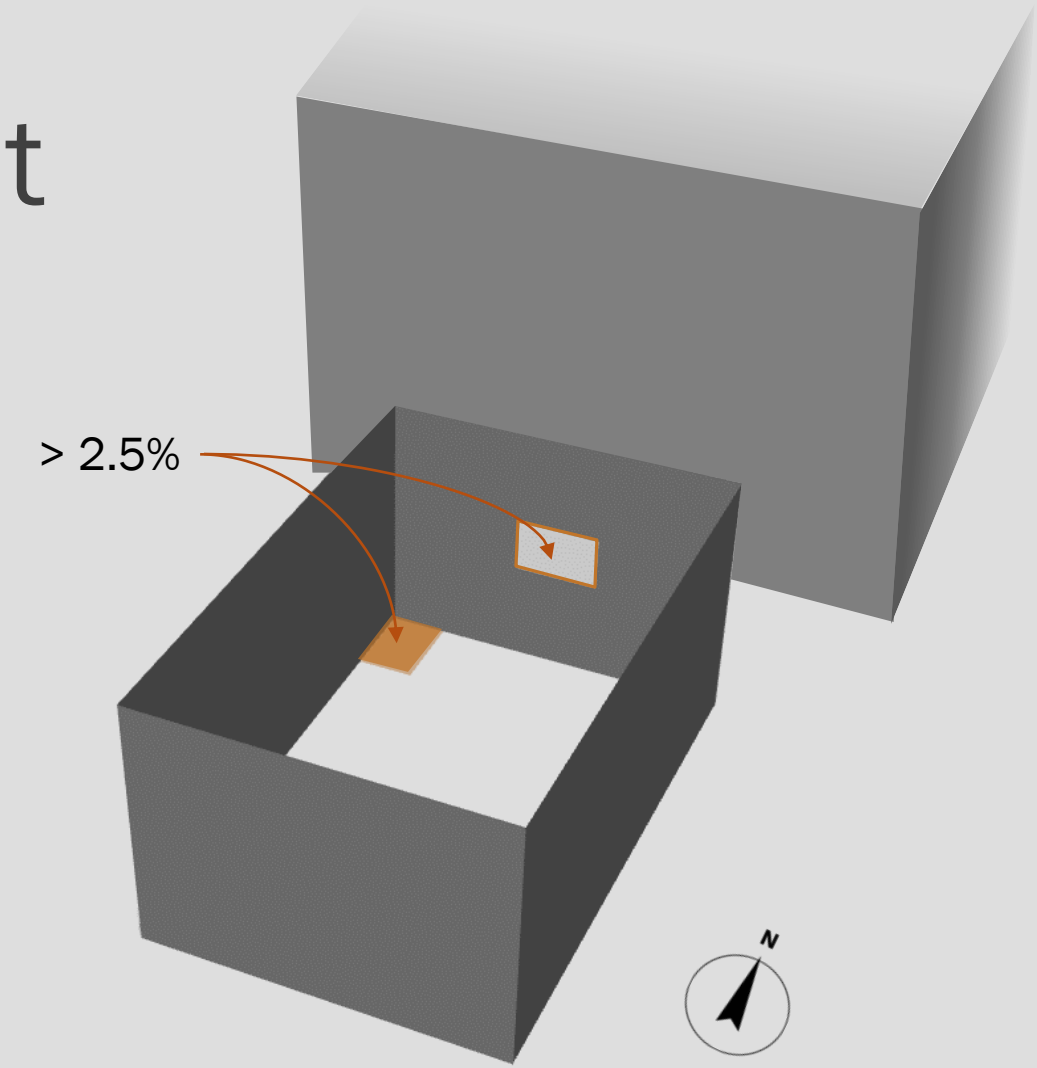
Standards for daylight

- Dutch standard - NEN 2057
- European standard - EN 17037



Standards for daylight

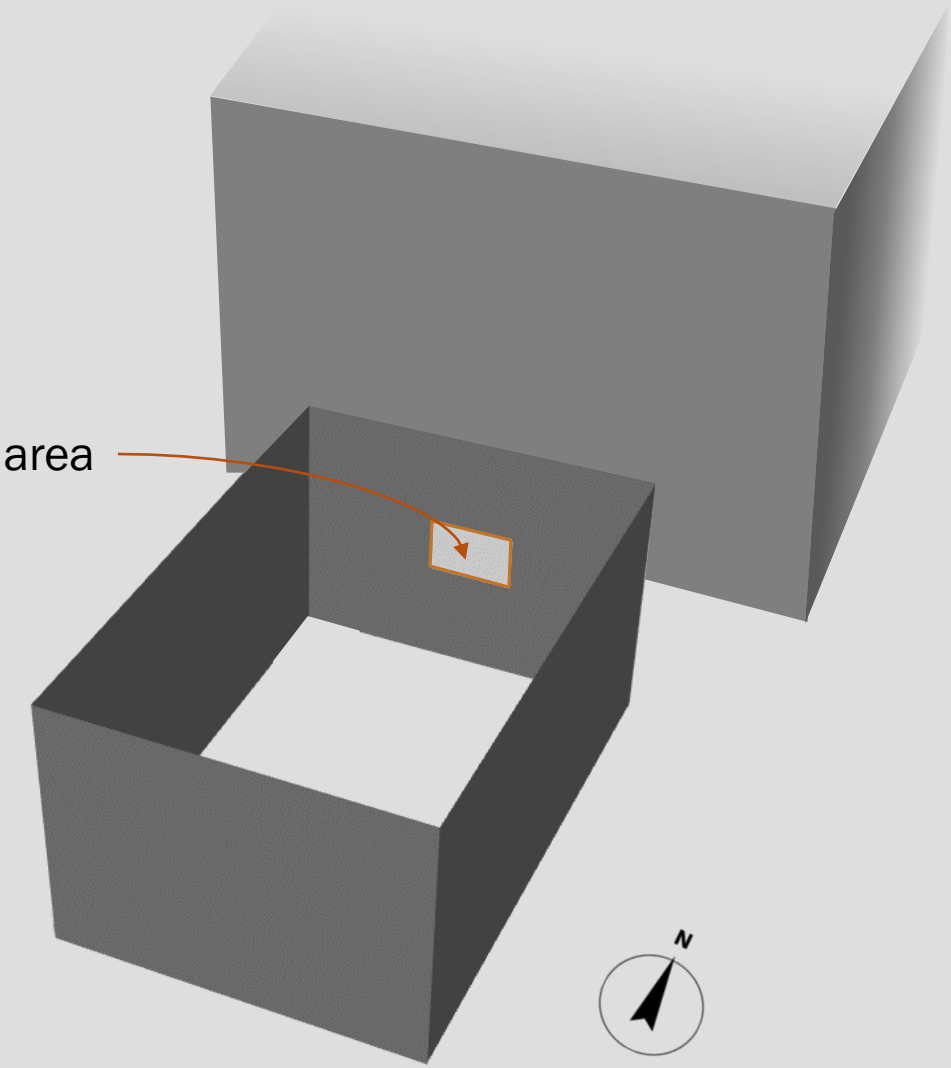
- Dutch standard – NEN 2057
- Equivalent daylight area $A_{e,i}$
  - At least 2.5% of the floor area
  - At least 0.5m^2



Standards for daylight

- $A_{e,i} = A_{d,i} \cdot C_{b,i} \cdot C_{u,i}$

- $A_{d,i}$ is the daylight area [m^2]
- $C_{b,i}$ is the obstruction factor [-]
- $C_{u,i}$ is the reduction factor [-]



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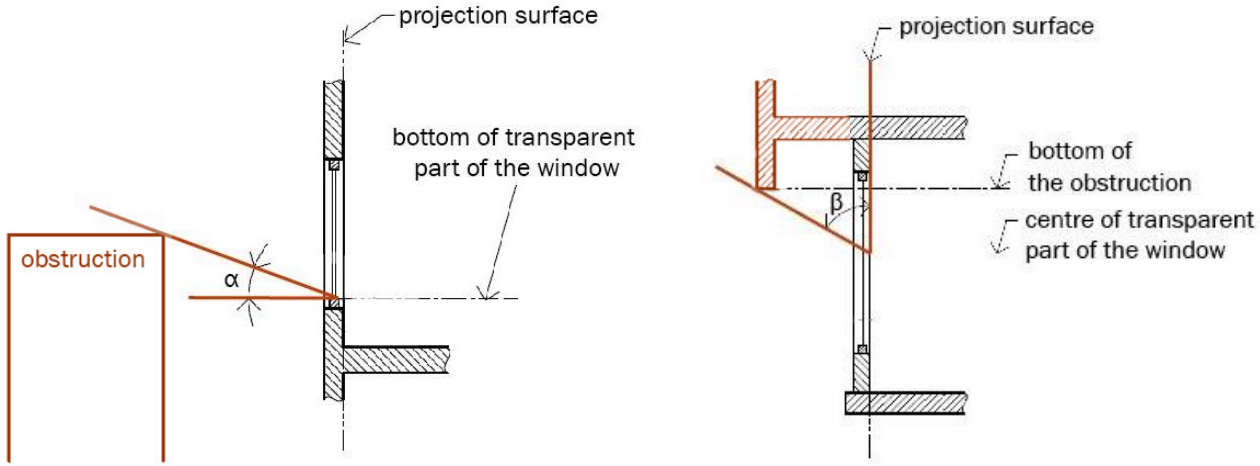

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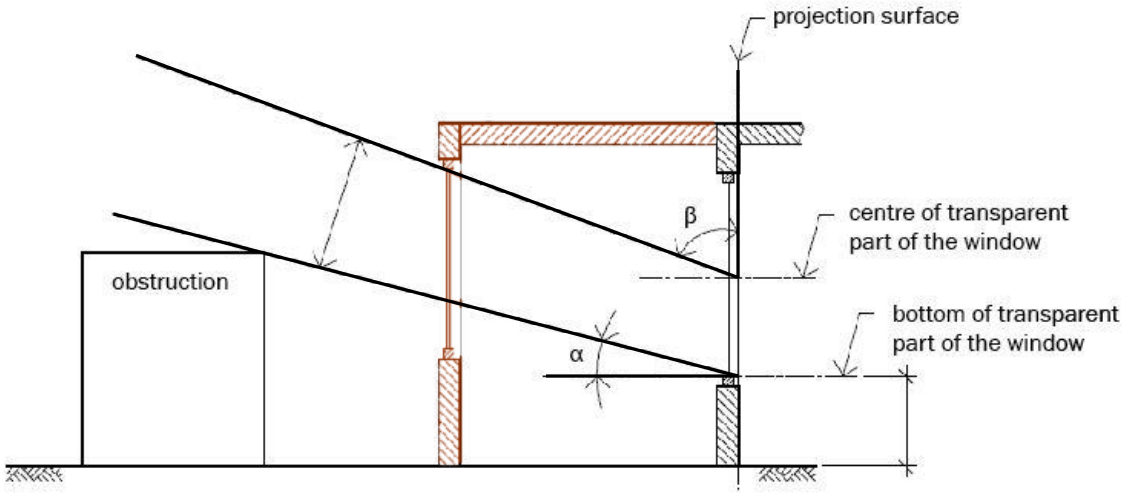
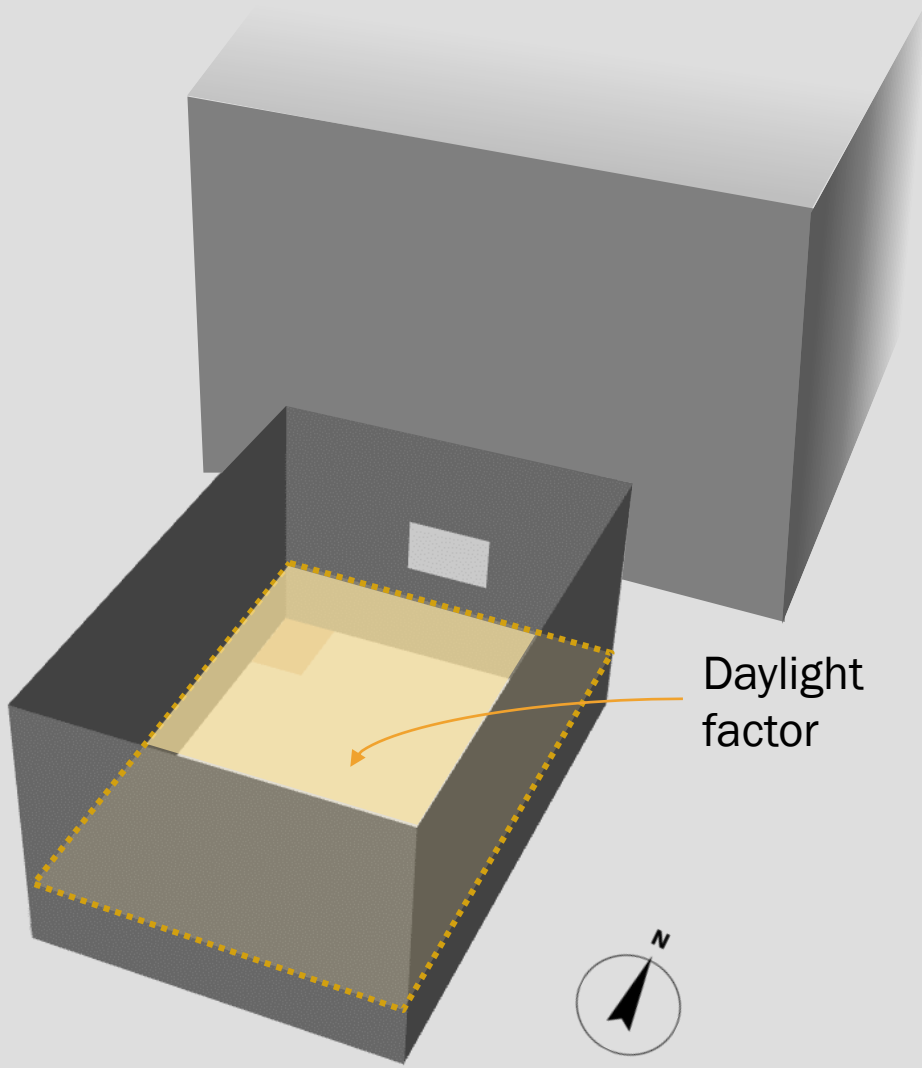


Standards for daylight

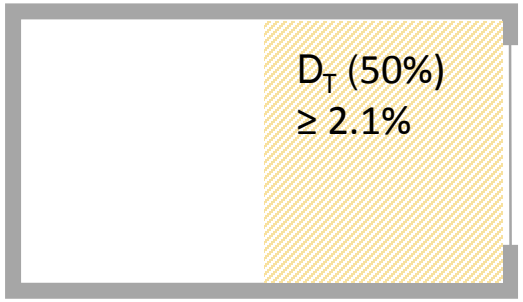
- European standard - EN 17037
  - Daylight
  - Sunlight
  - Glare
  - View
- Levels of recommendation



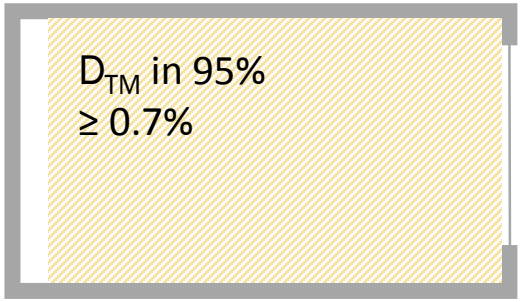
Standards for daylight

Daylight

- $D = \frac{\text{internal illuminance}}{\text{illuminance of the unobstructed sky}} \cdot 100\%$



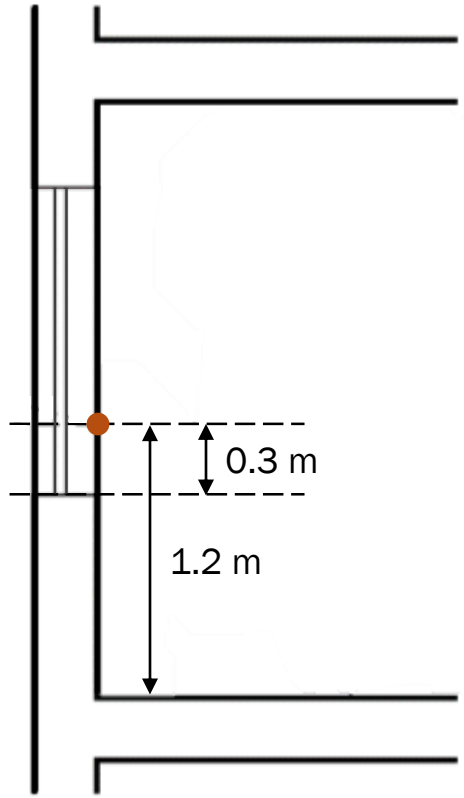
- Target daylight factor D_T ≥ 2.1%
- Minimum target daylight factor D_{TM} ≥ 0.7%



Standards for daylight

Daylight

- 1,5 hours
- One day between February 1 and March 21



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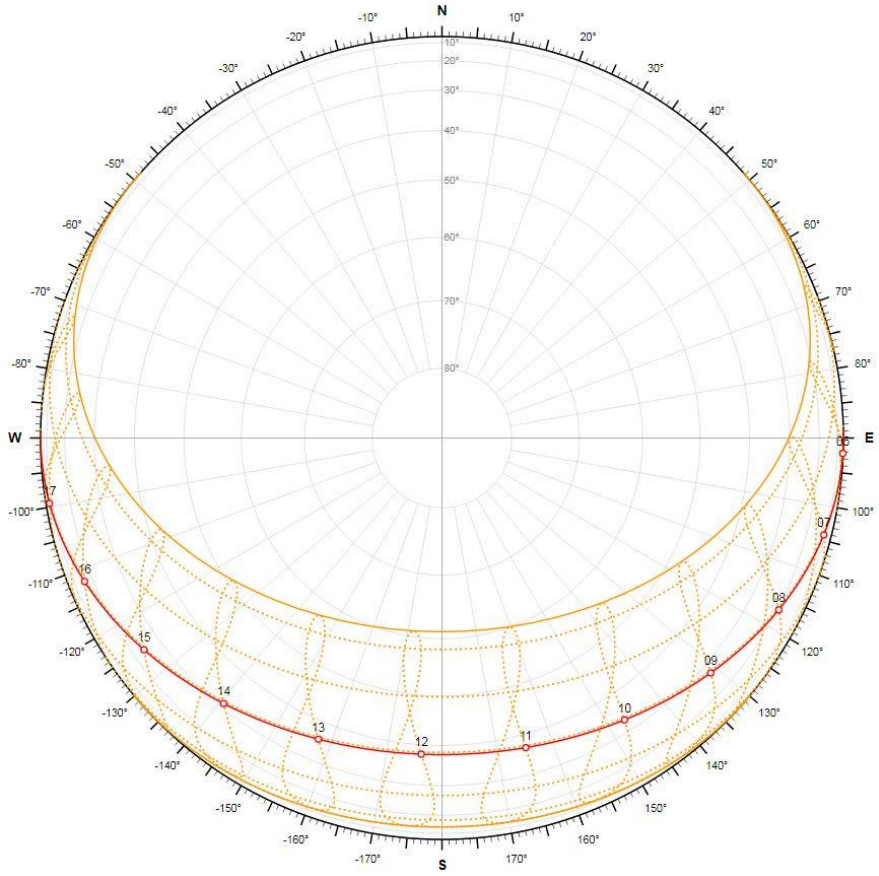

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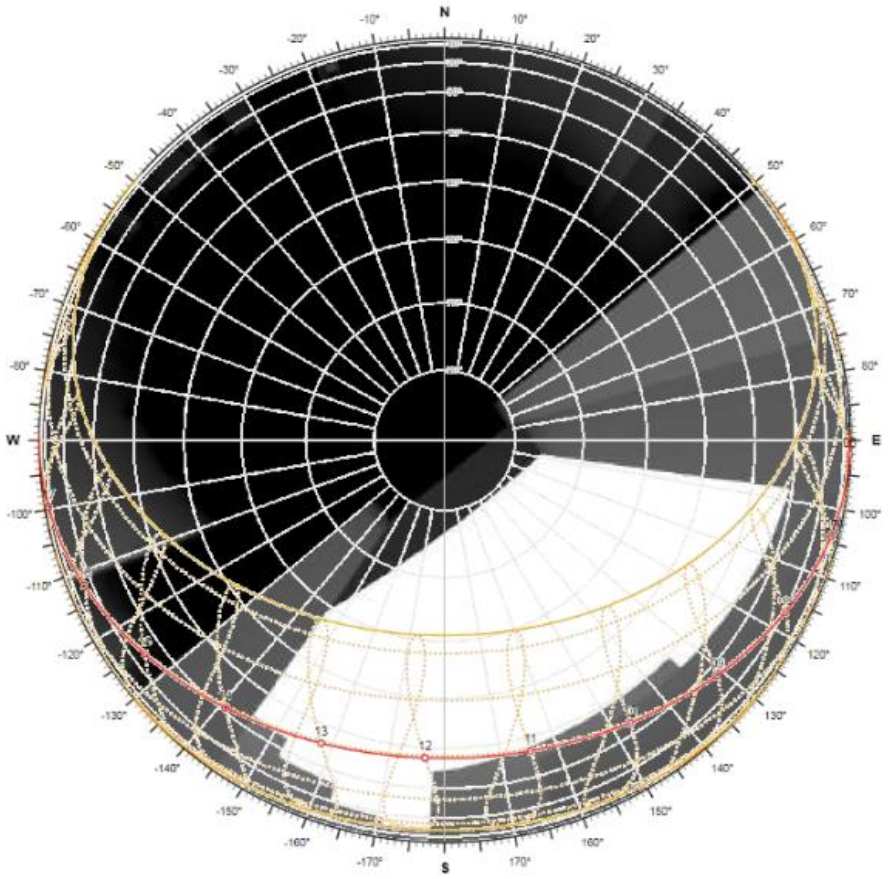


Standards for daylight

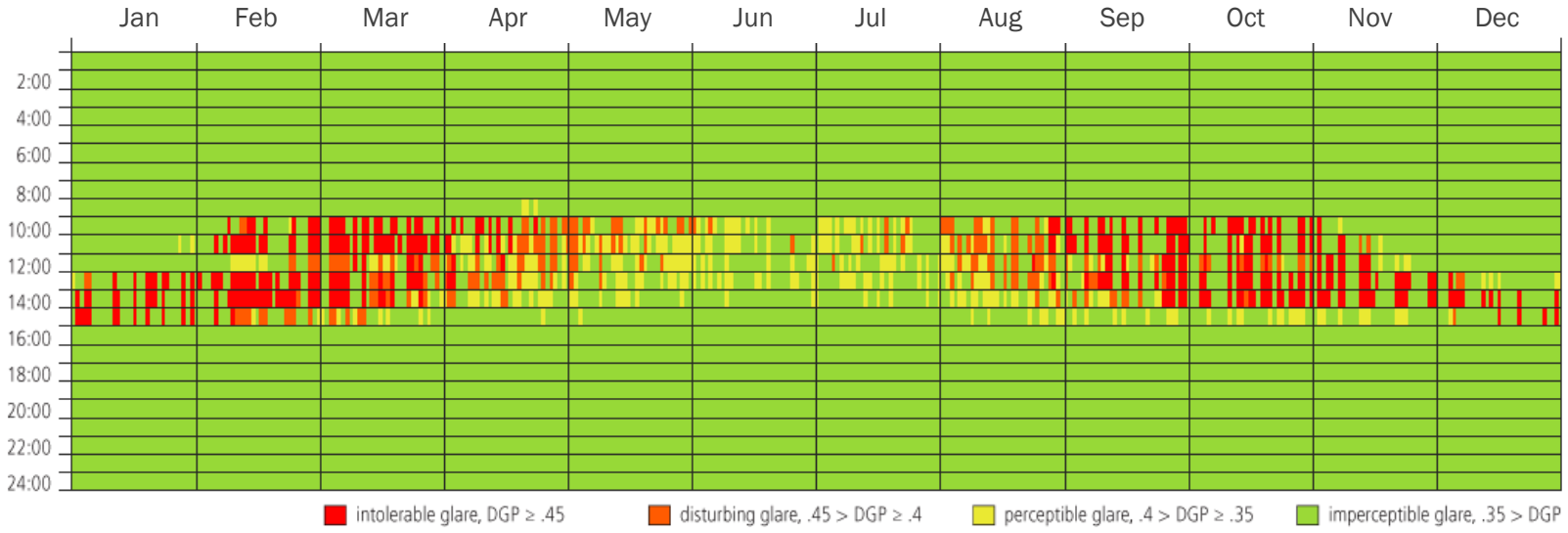
Glare

- Daylight Glare Probability (DGP)
- DGP $\not\geq$ 0.45, during more than 5% of the occupation time.

Standards for daylight

Glare

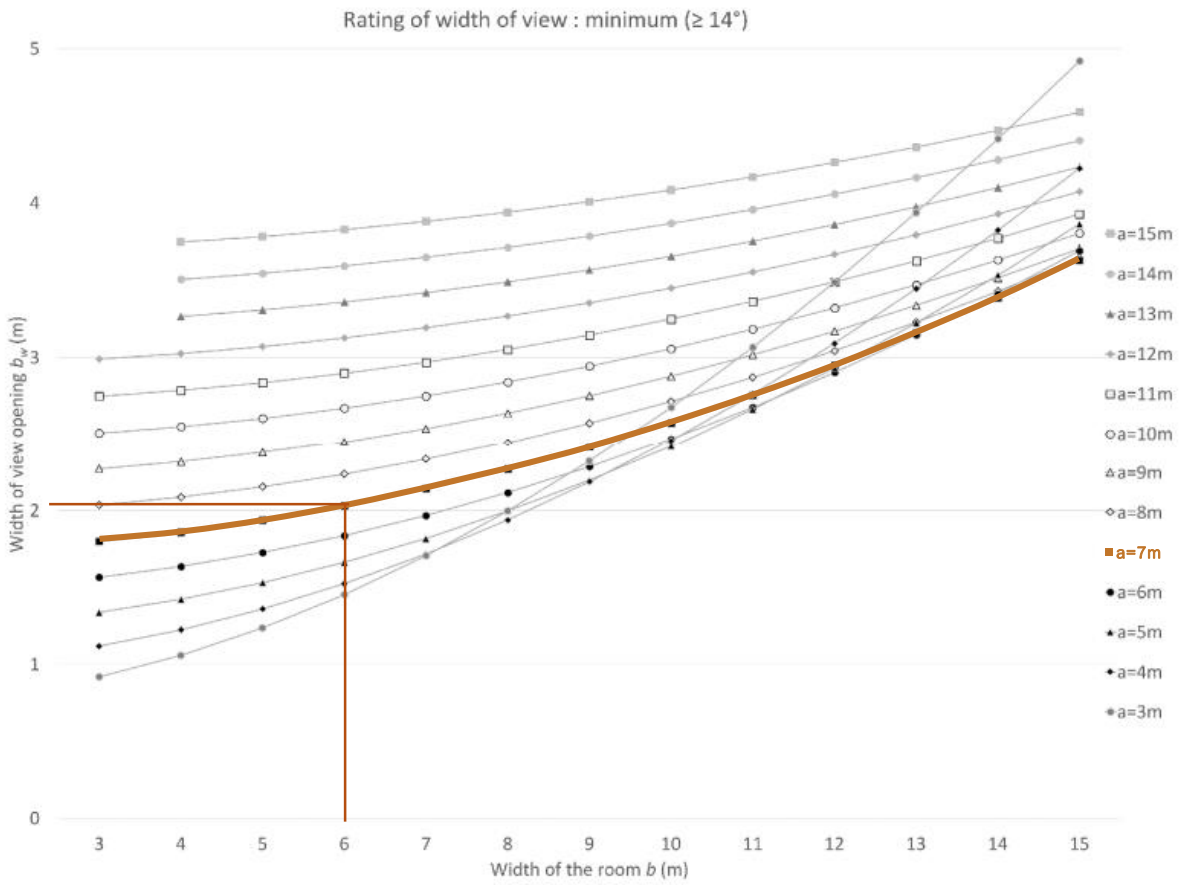
- Daylight Glare Probability (DGP)
- DGP ≯ 0.45, during more than 5% of the occupation time.



Standards for daylight

View

- View distance ≥ 6m
- Landscape layer visible from 75% of the utilised area
- Window dimensions → view angle ≥ 1



Standards for daylight

Dutch standard

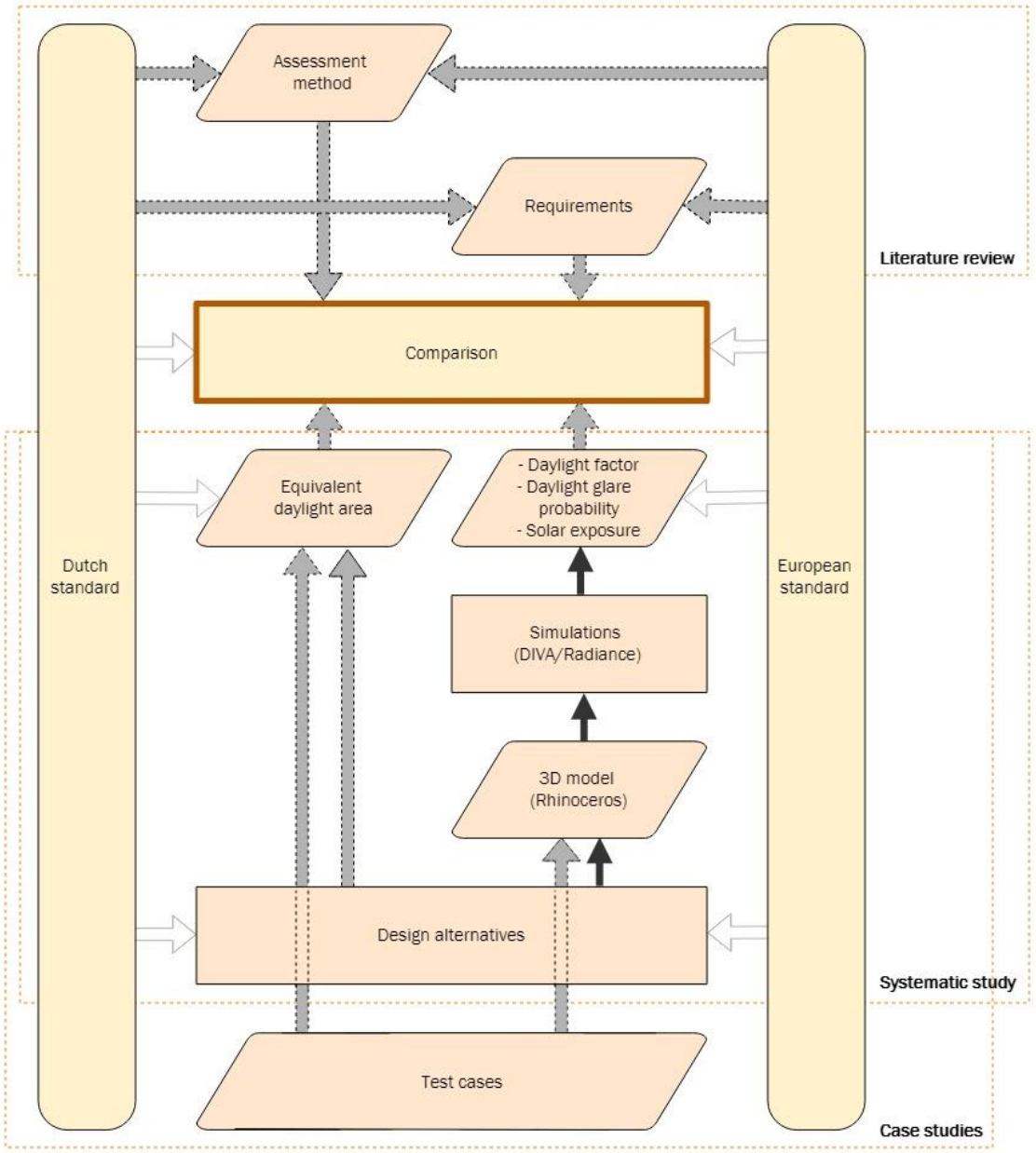
- Requirements
- Normative
- Equivalent daylight area

European standard

- Recommendations
- Descriptive
- Daylight factor
  - Duration of solar exposure
  - Daylight glare probability
  - View

- Obstructions
- Reflection factors
- Light transmittance of the glass

Case studies



1. Basement Basisweg Amsterdam

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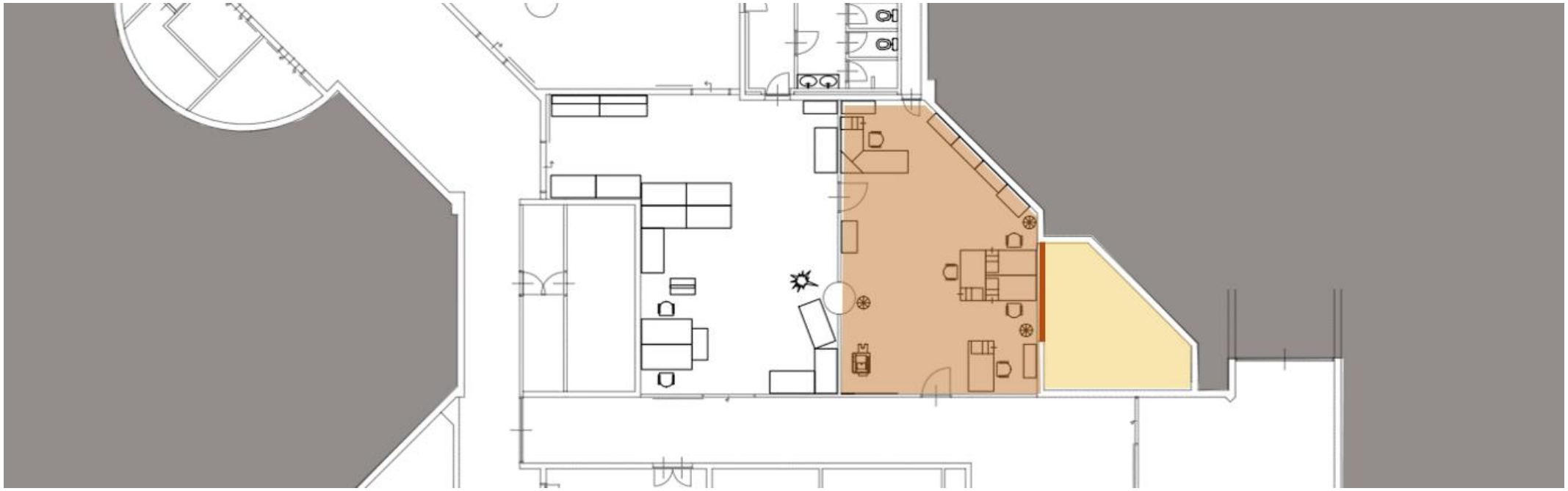
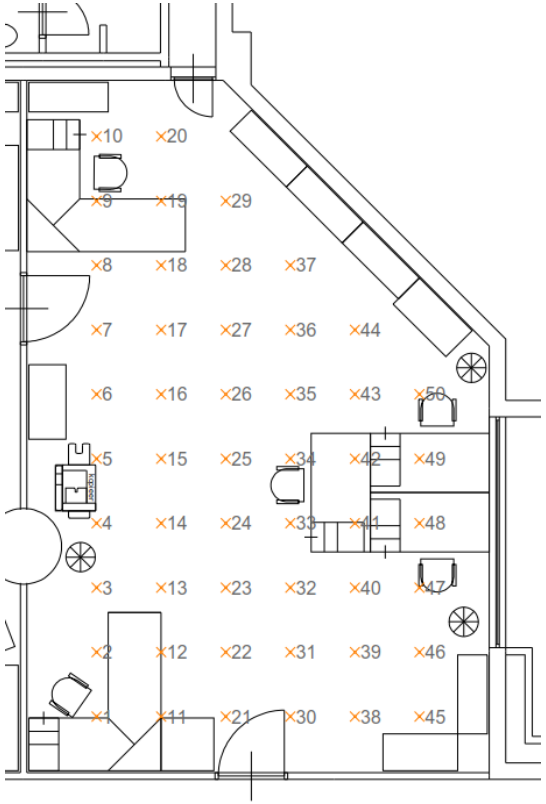


1. Basement Basisweg Amsterdam

- Equivalent daylight area $A_{e,i} = A_{d,i} \bullet C_{b,i} \bullet C_{u,i} = 5.25 \bullet 0.52 \bullet 1 =$ **2.73 m²**
  = **4.2%** of the floor area of 65.5m²

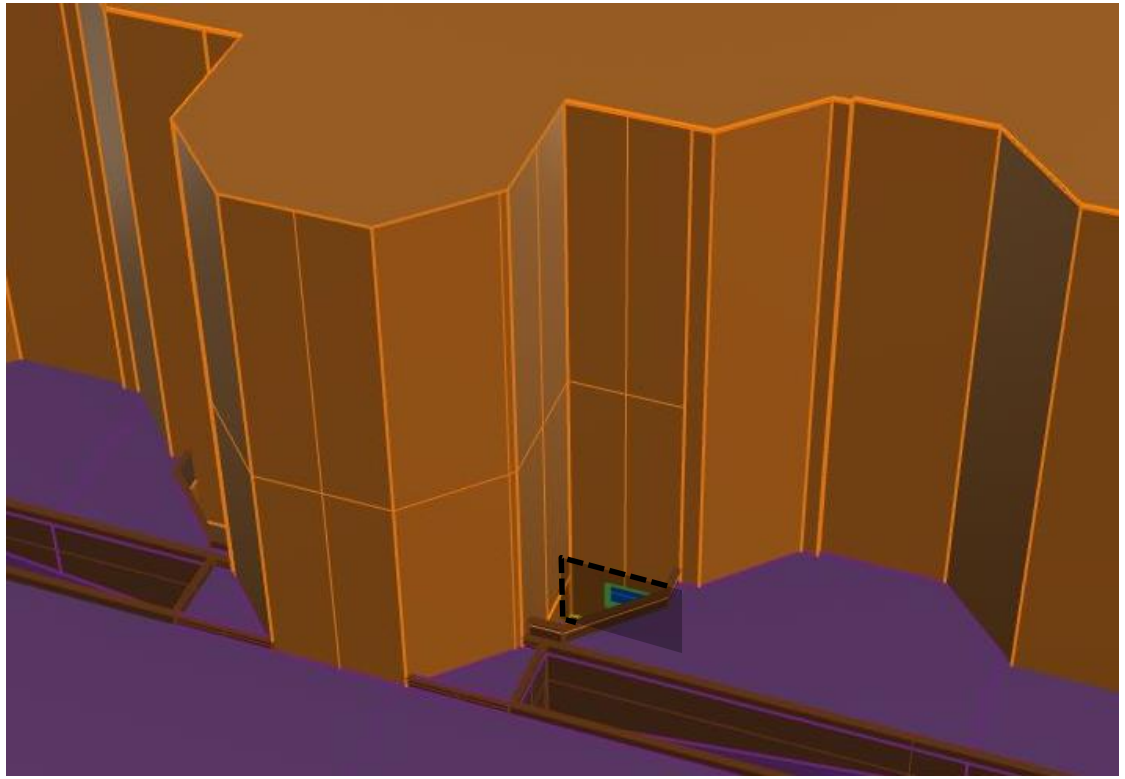
1. Basement Basisweg Amsterdam

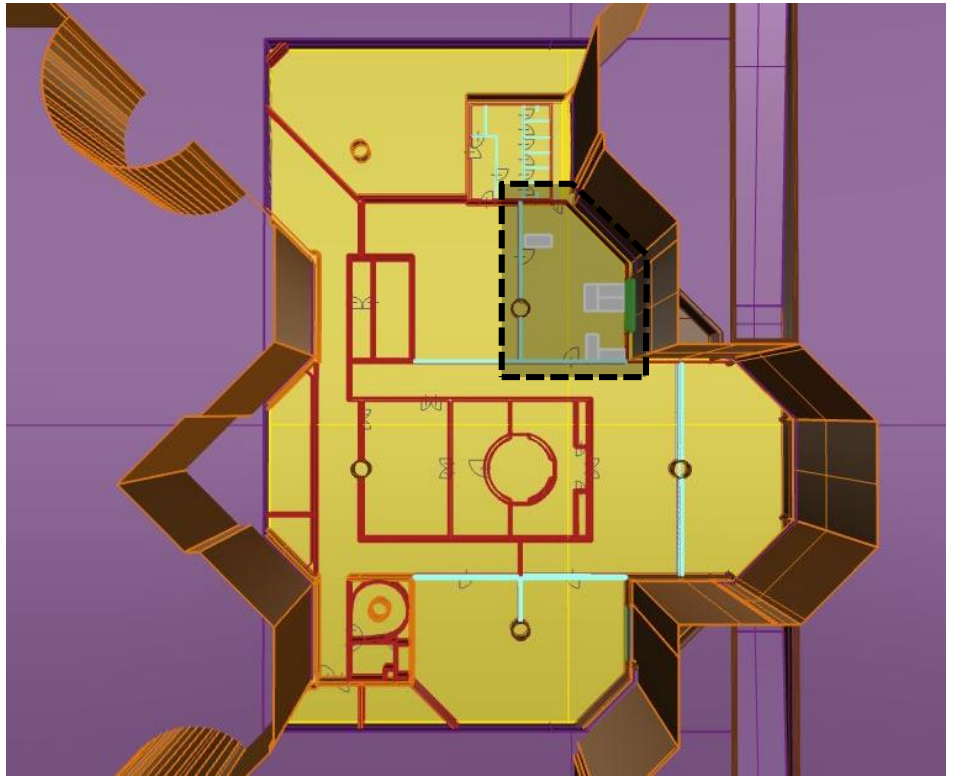
- Measurements



1. Basement Basisweg Amsterdam

- Simulations





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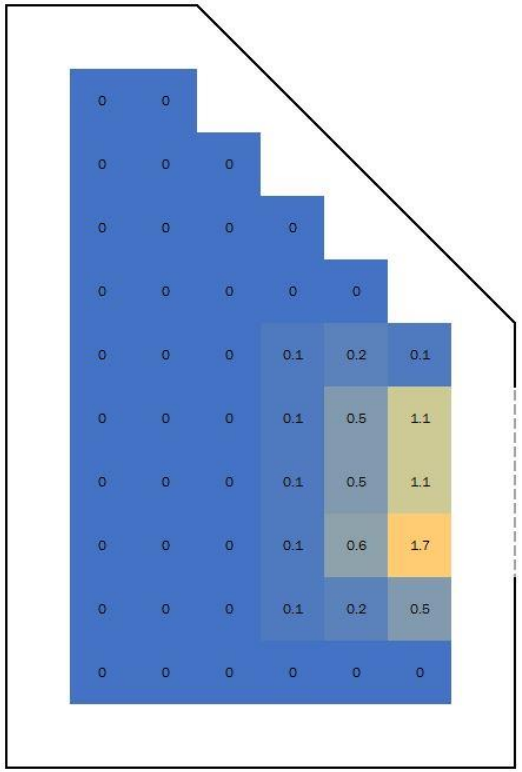
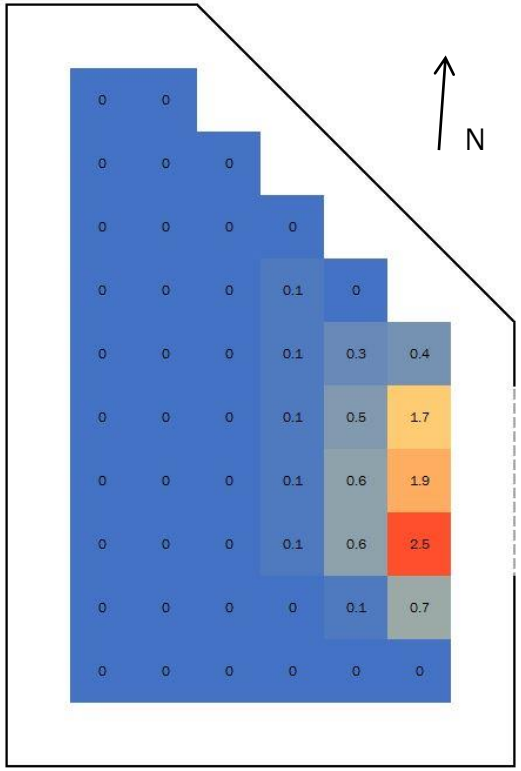
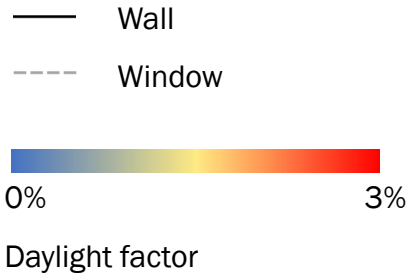


Measured daylight factor



Simulated daylight factor



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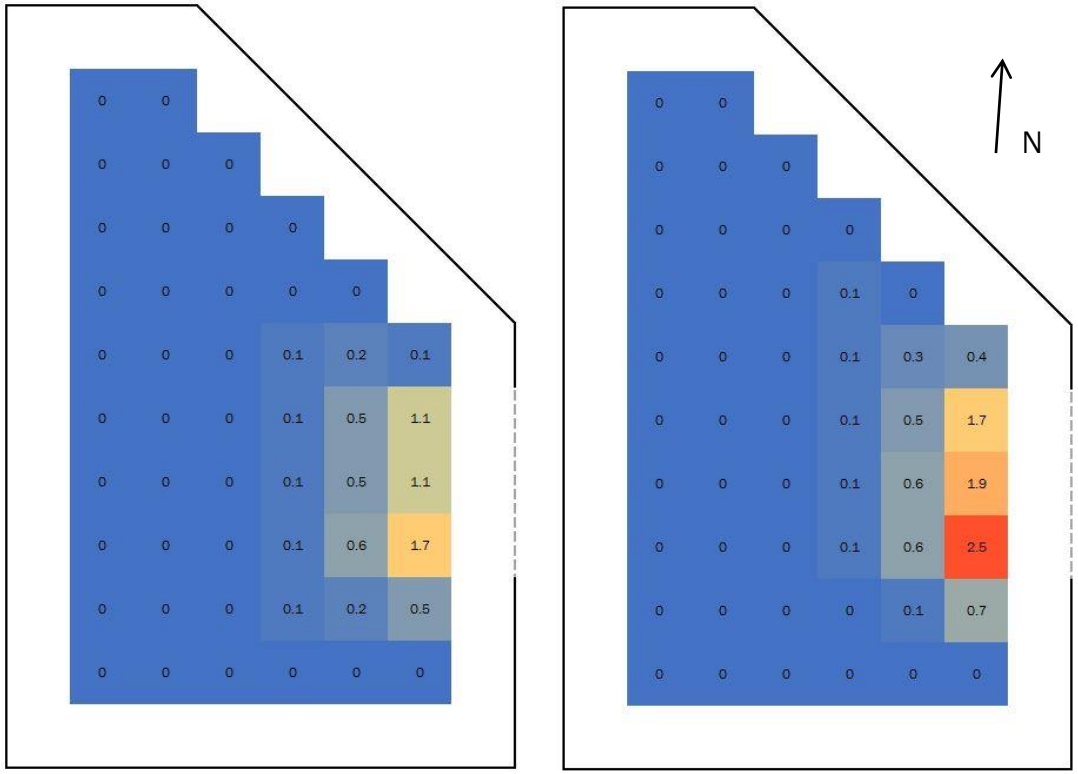
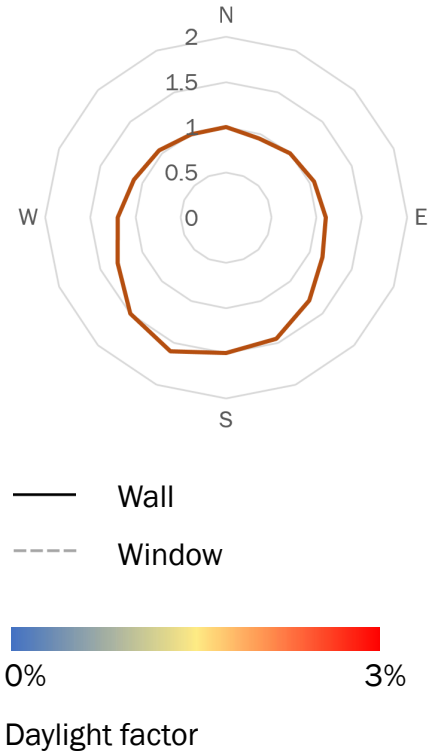


Measured daylight factor

Simulated daylight factor



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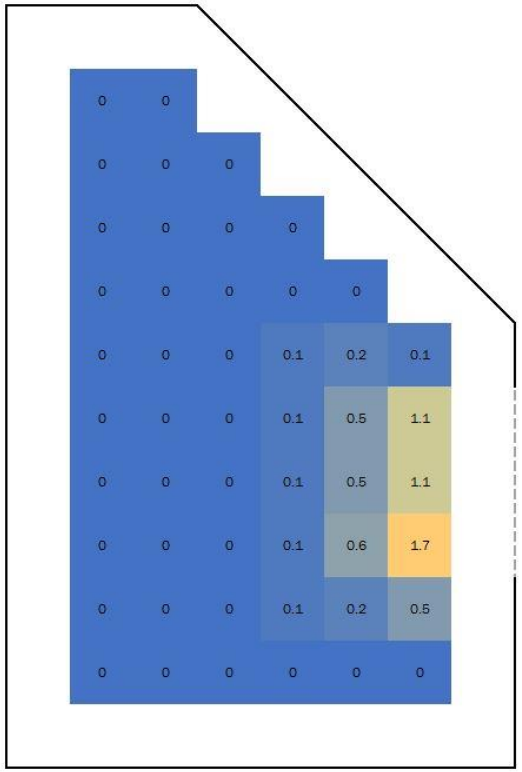

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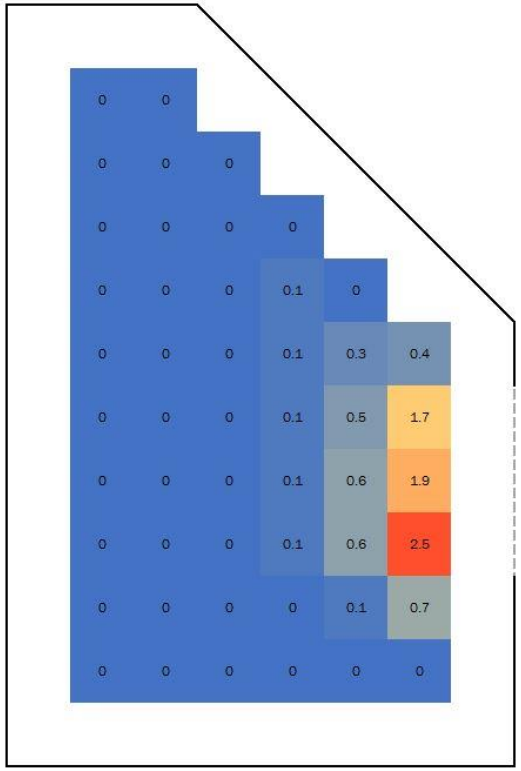
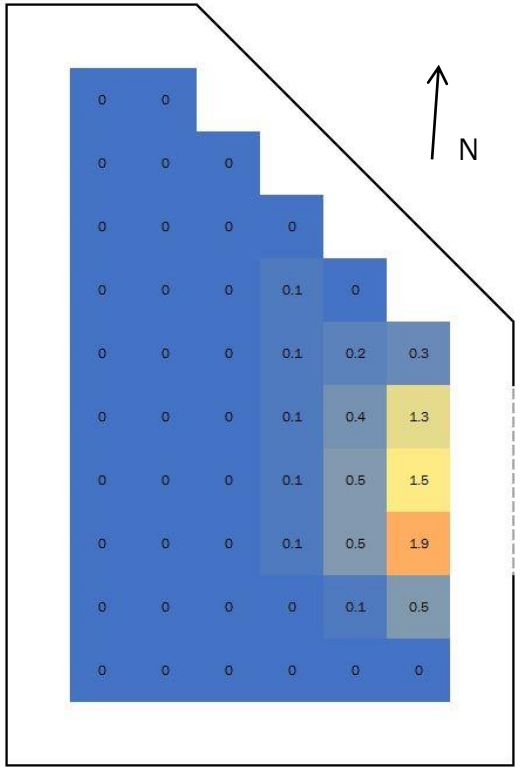
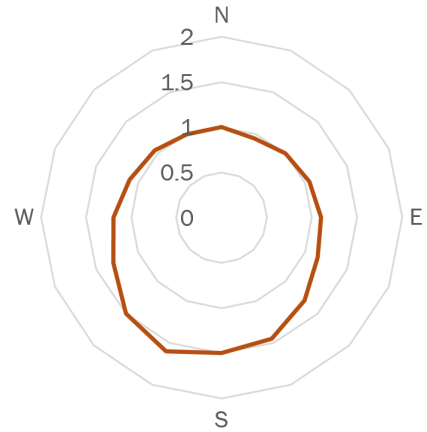


Simulated daylight factor



Simulated daylight factor converted with orientation factor



Wall

Window

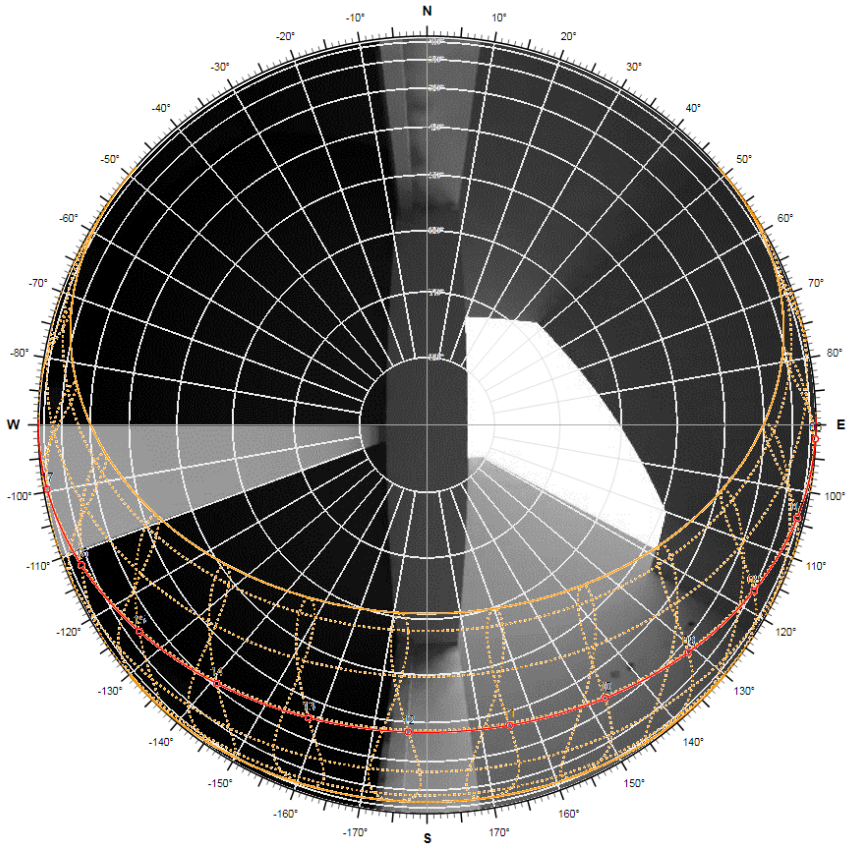
0% 3%

Daylight factor

1. Basement Basisweg Amsterdam

Sunlight

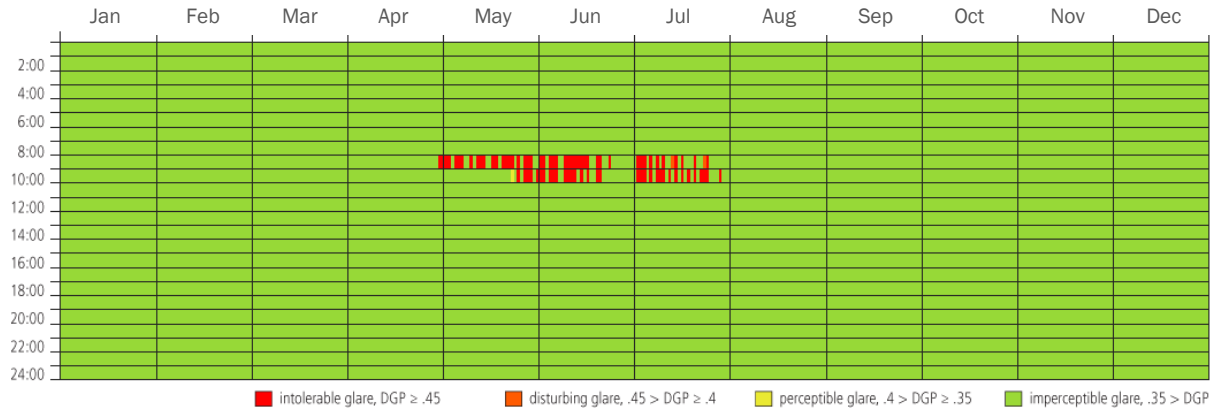
- No direct sunlight enters the room on a day between February 1 and March 21

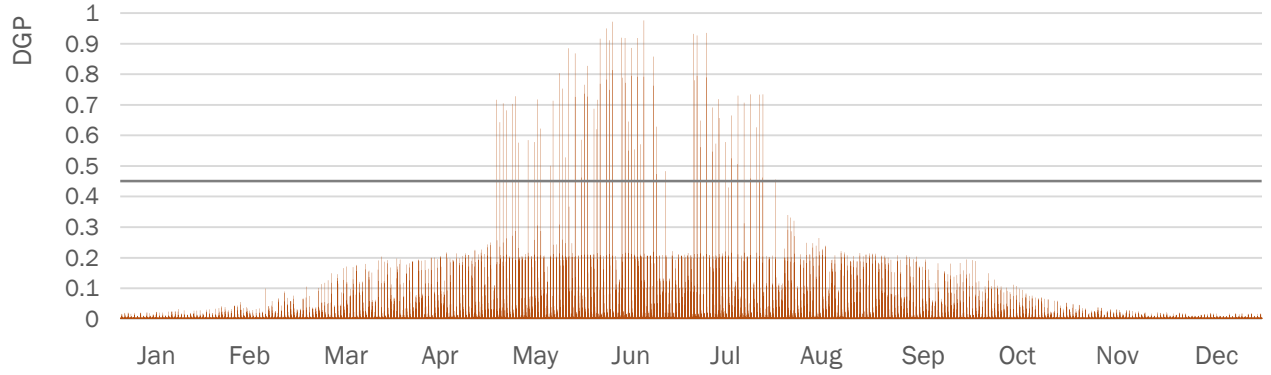


1. Basement Basisweg Amsterdam

Glare

- Daylight glare probability
  - ≥ 0.45 during 2.2% of the occupation time





1. Basement Basisweg Amsterdam

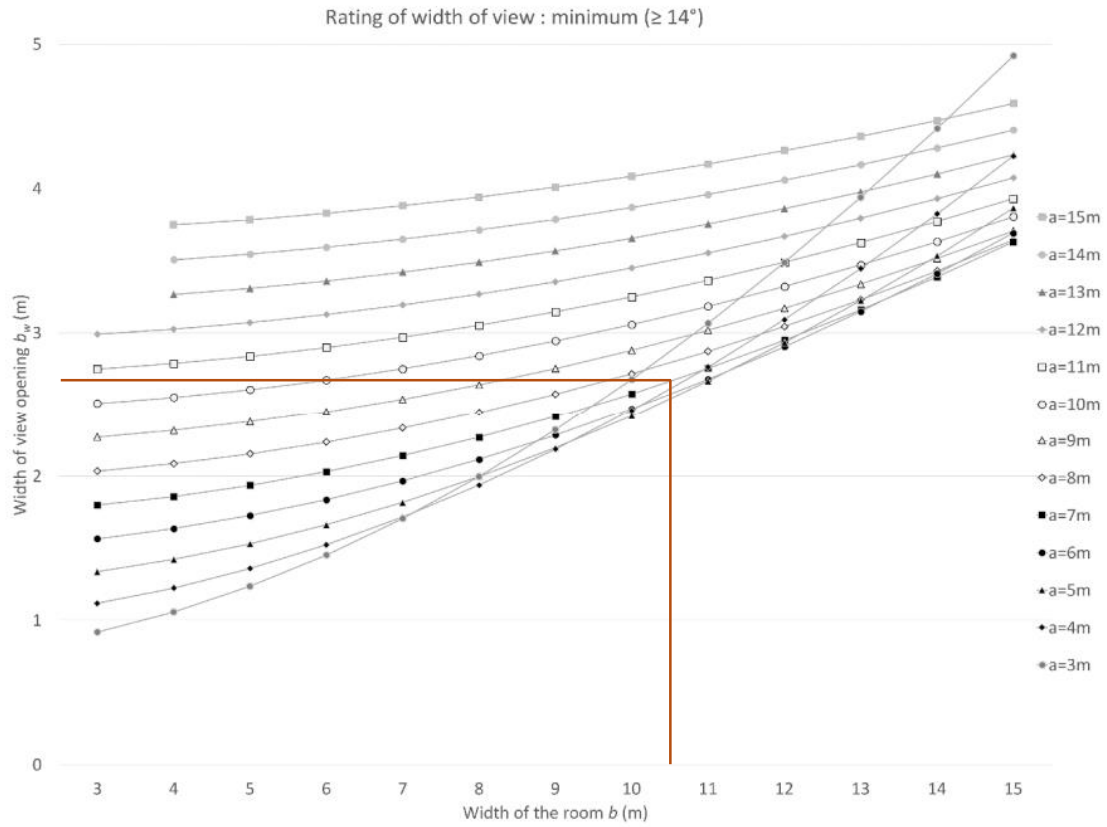
View

- Landscape layer is visible
- View distance < 6m
- View angle ≥ 14°
  - Window width = 3.5m

1. Basement Basisweg Amsterdam

View

- Landscape layer is visible
- View distance < 6m
- View angle ≥ 14°
  - Window width = 3.5m > 2.7m



1. Basement Basisweg Amsterdam

- This badly daylit space complies to the Dutch standard
- The uncomfortable view almost complies with the European standard
- An orientation factor is necessary to match measurements and simulations
  - In reality daylight factors are influenced by the orientation

2. DGMR office The Hague

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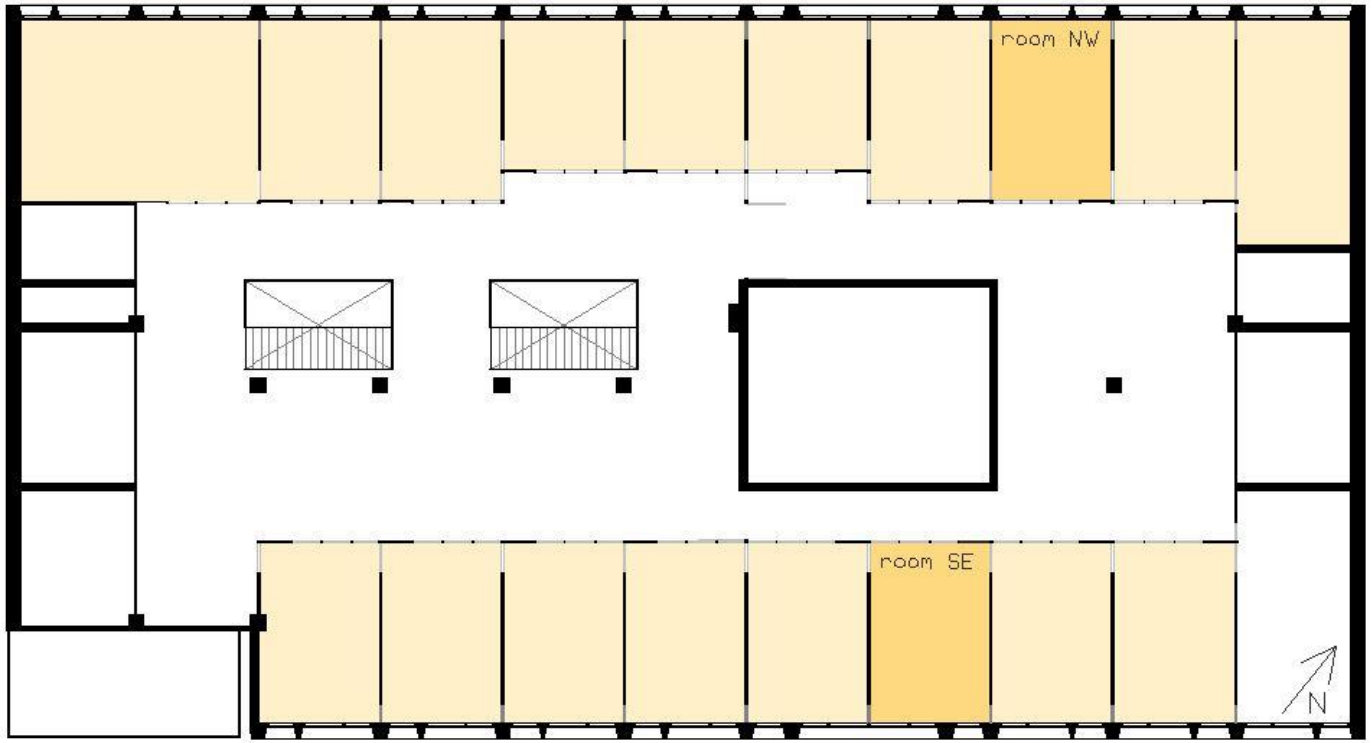
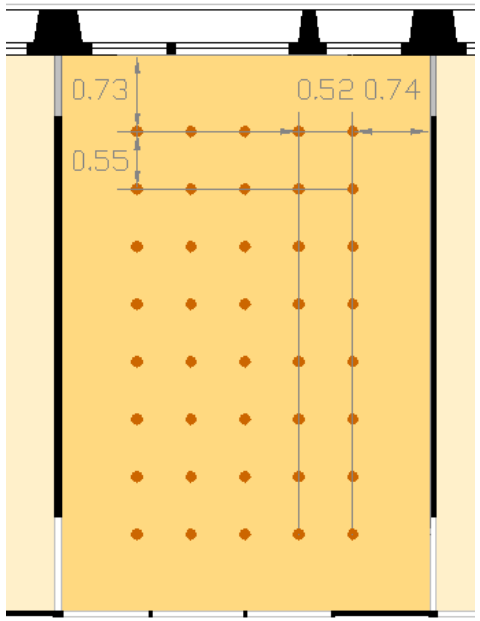
- Room NW
  $A_{e,i}$ = **1.88 m²**
  = **9.7%** of the floor area of 19.44m²

- Room SE
  $A_{e,i}$ = **2.93 m²**
  = **15.1%** of the floor area of 19.44m²

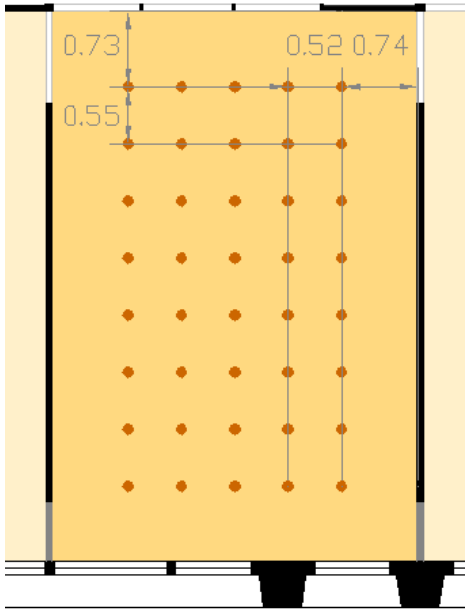


2. DGMR office The Hague

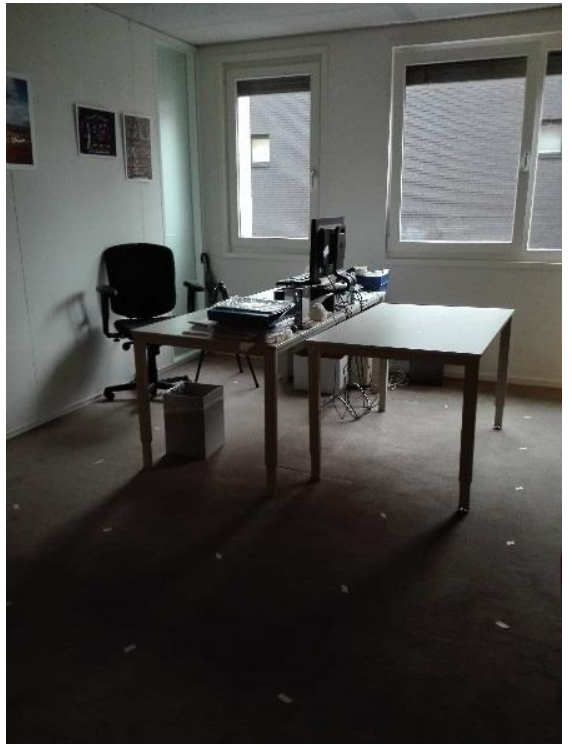
Measurements



Room NW

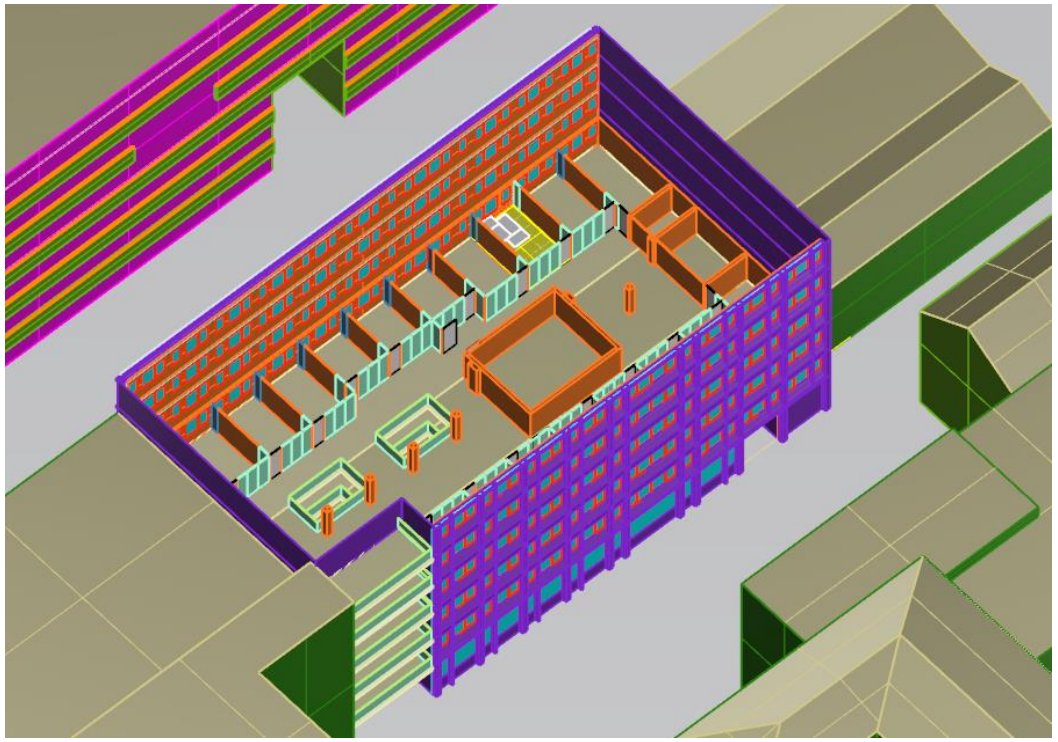


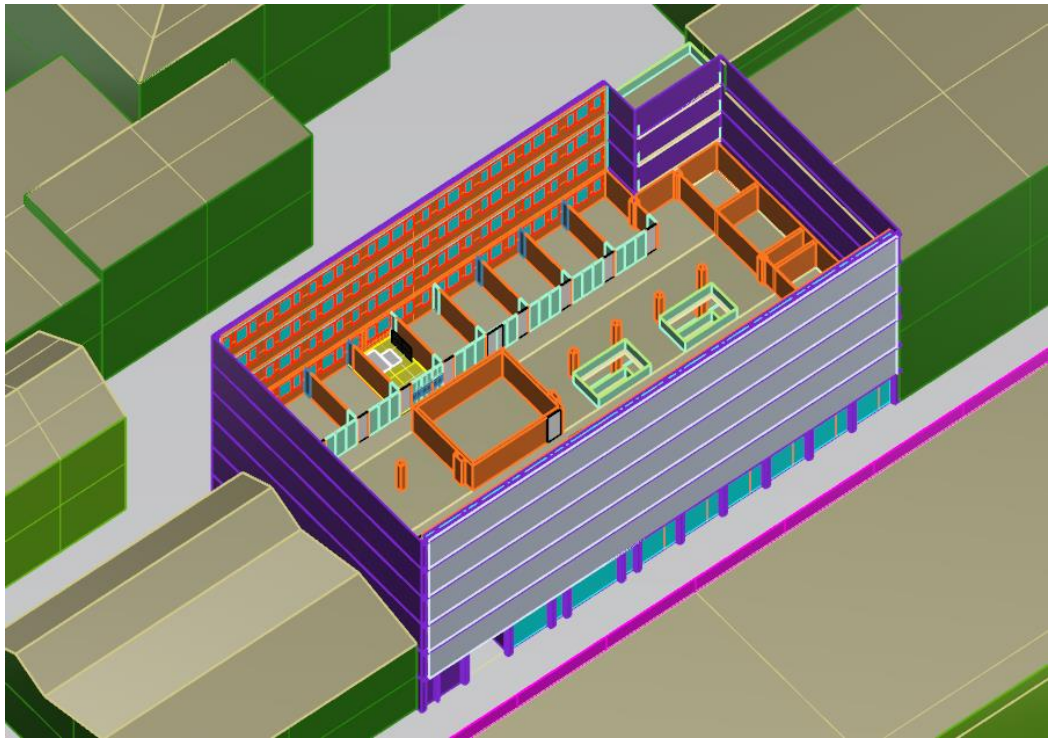
Room SE



2. DGMR office The Hague

Simulations

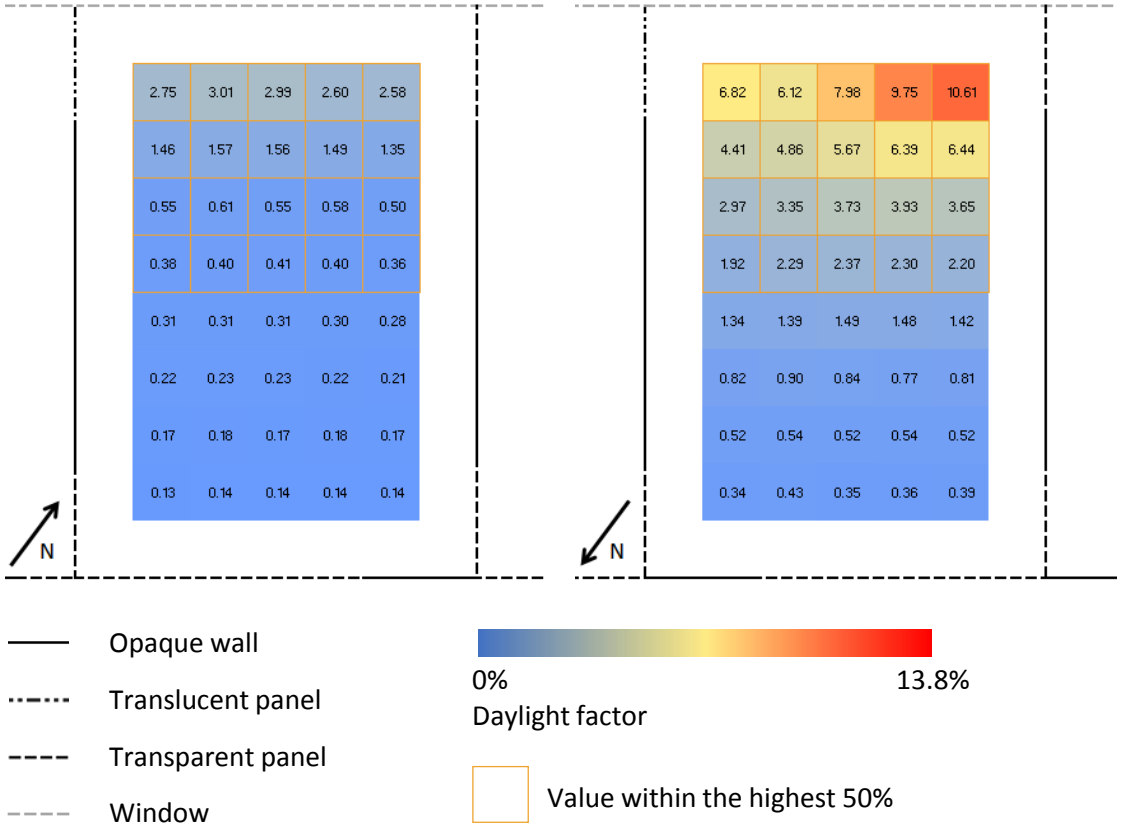




2. DGMR office The Hague

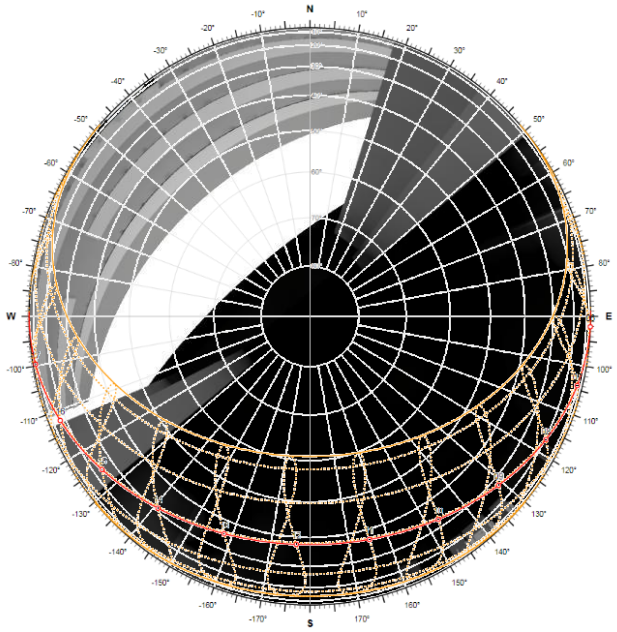
Daylight

- Room NW
  - D_{TM} = 0.14% < 0.7%
  - D_T = 0.36% < 2.1%
- Room SE
  - D_{TM} = 0.36% < 0.7%
  - D_T = 1.92% < 2.1%

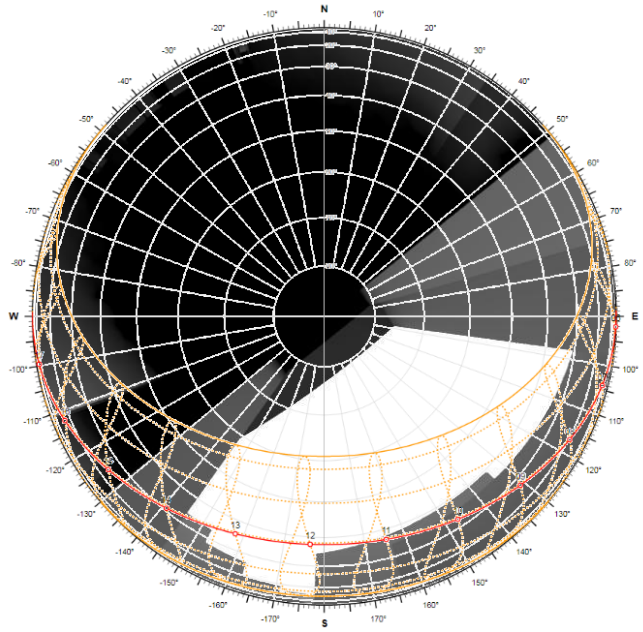


2. DGMR office The Hague

Sunlight



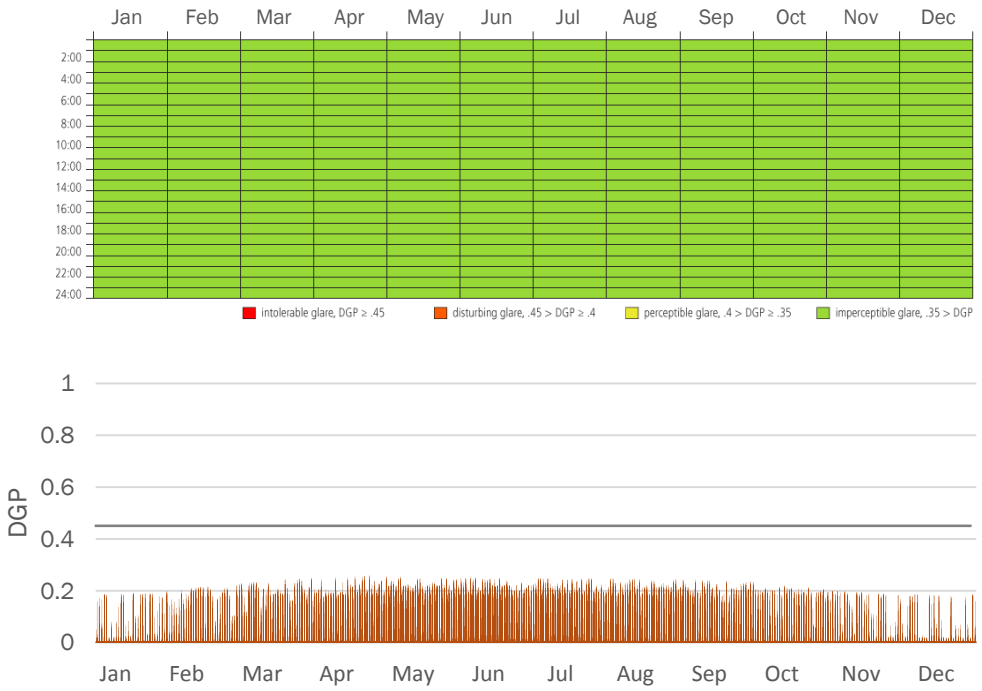
- Room NW
  - 0.2 hours on March 21



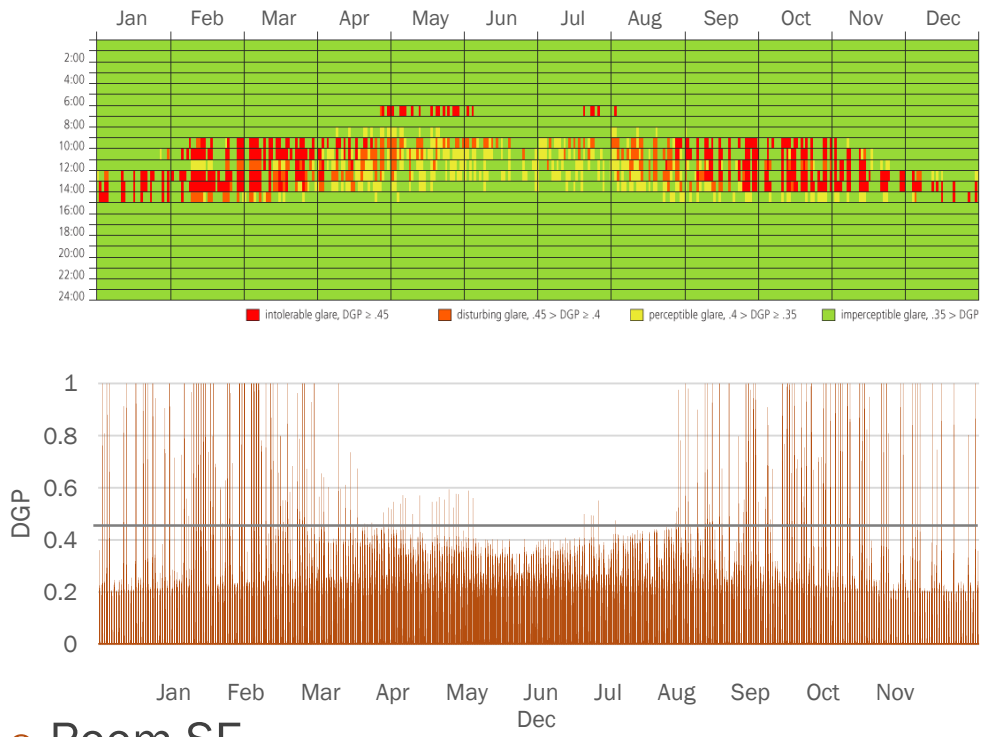
- Room SE
  - 2.7 hours on March 21

2. DGMR office The Hague

Glare



- Room NW
  - DGP ≥ 0.45 during 0% of the occupation time



- Room SE
  - DGP ≥ 0.45 during 9.89% of the occupation time

2. DGMR office The Hague

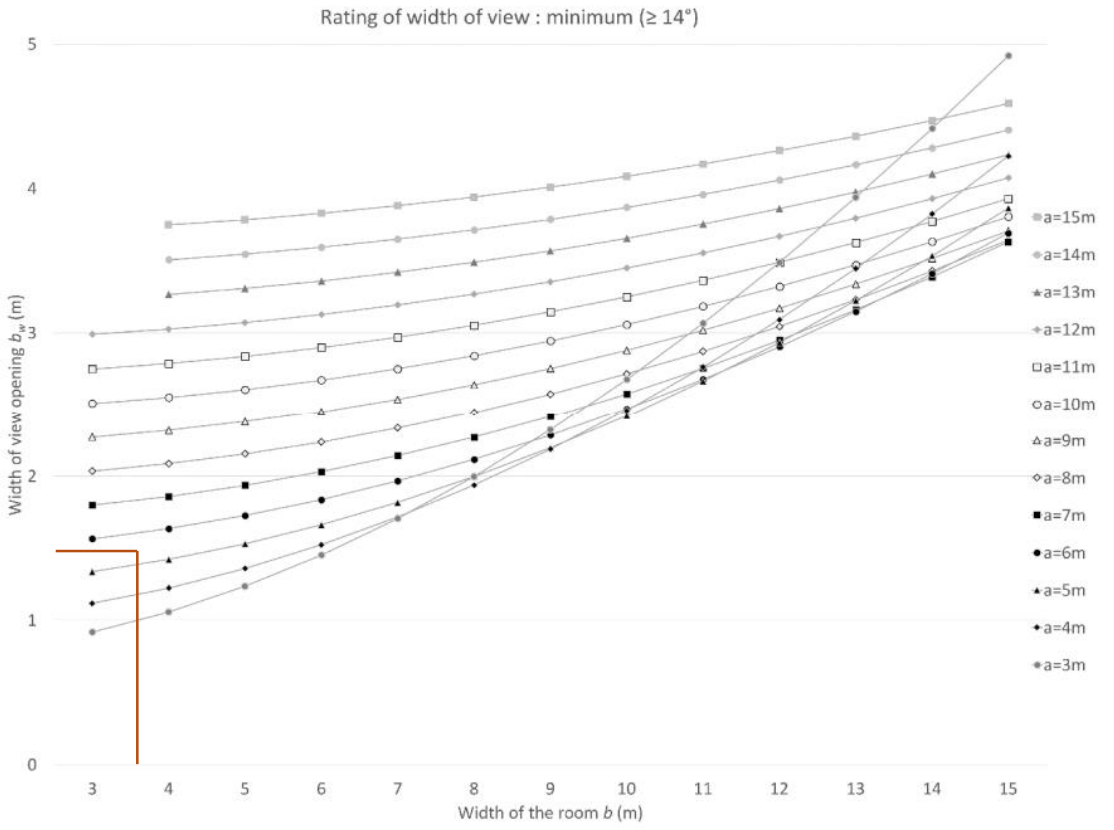
View

- Landscape layer is visible
- View distance > 6m
- View angle ≥ 14°
  - Window width = 3.25m

2. DGMR office The Hague

View

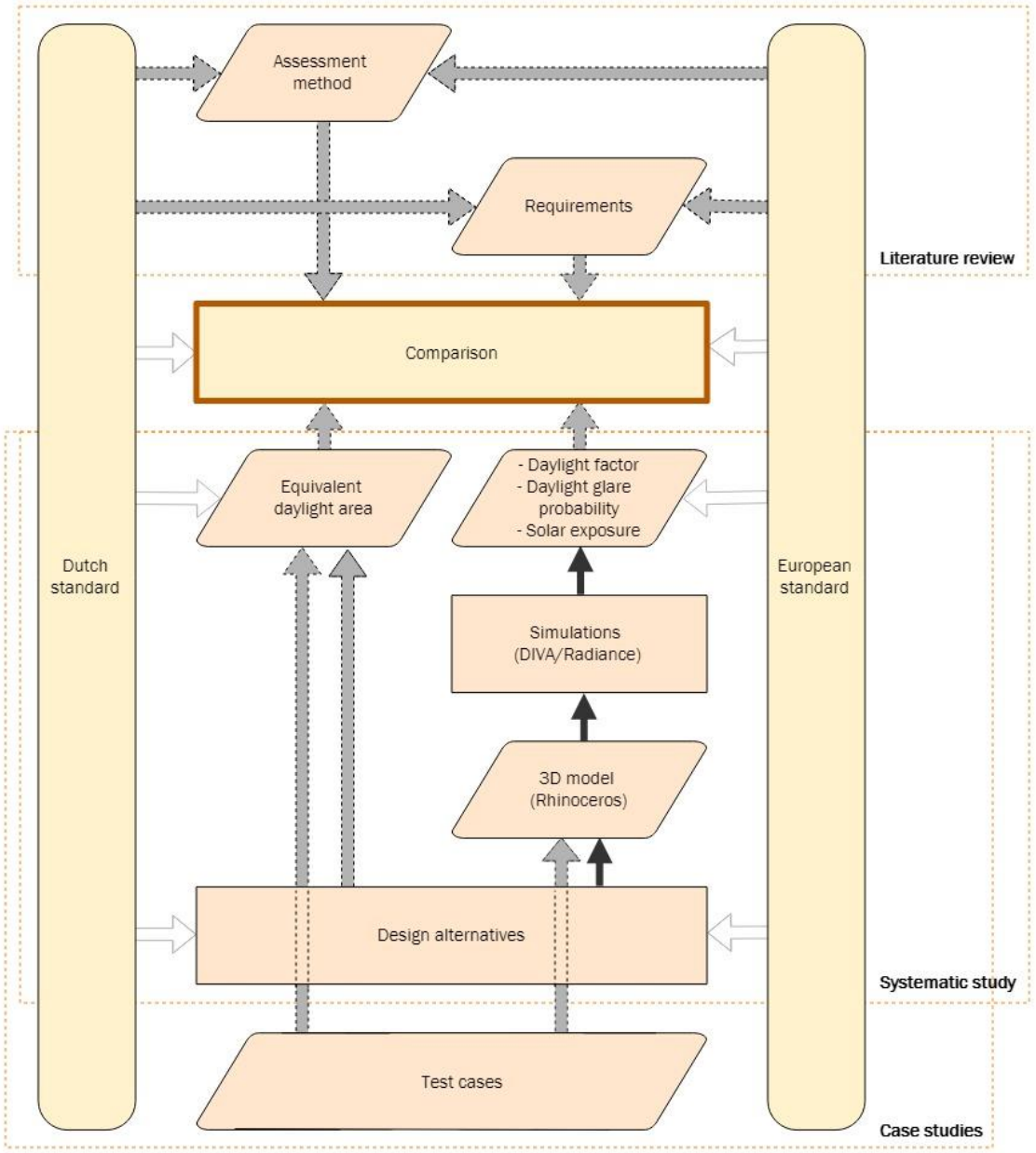
- Landscape layer is visible
- View distance > 6m
- View angle ≥ 14°
  - Window width = 3.25m > 1.5m



2. DGMR office The Hague

- This visually comfortable office does not comply with the European standard
- Glare and exposure to sunlight highly depend on the orientation and surroundings

Systematic study

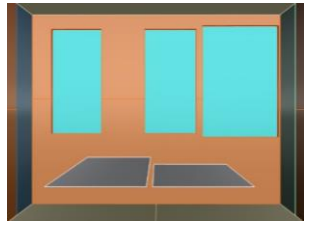
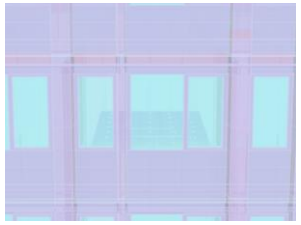


Systematic study

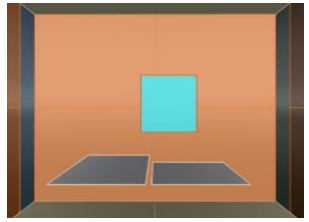
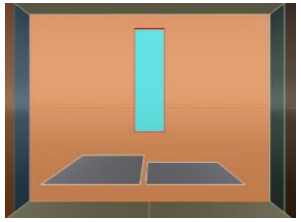
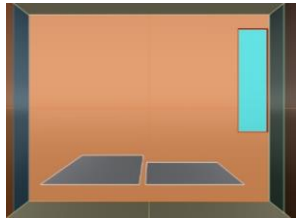
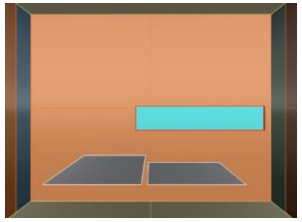
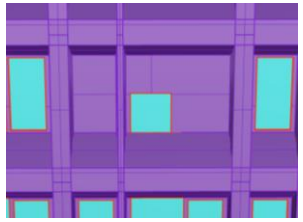
- Three categories
  - 0. Original design
  - 1. Minimal window area according to the Dutch standard
  - 2. Minimal daylight factors according to the European standard

Systematic study

- Original design

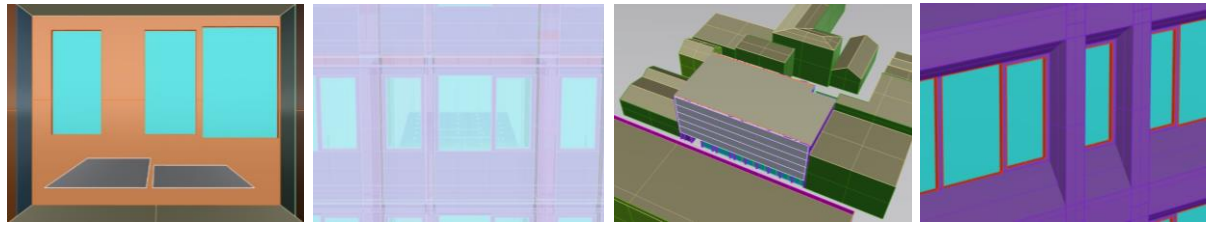
- Category 1, minimal window area

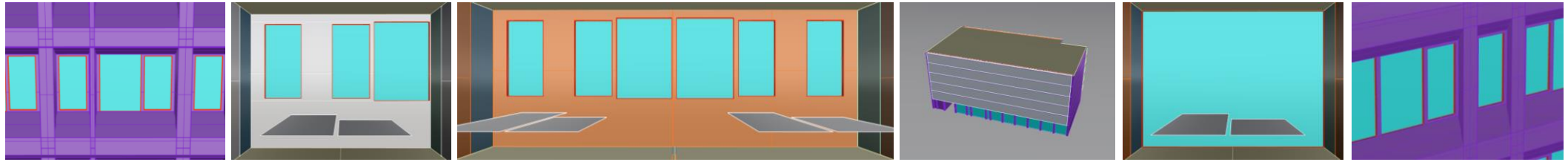
1.1 1.2 1.3 1.4 1.5

Systematic study

- Original design



- Category 2, maximum daylight factor

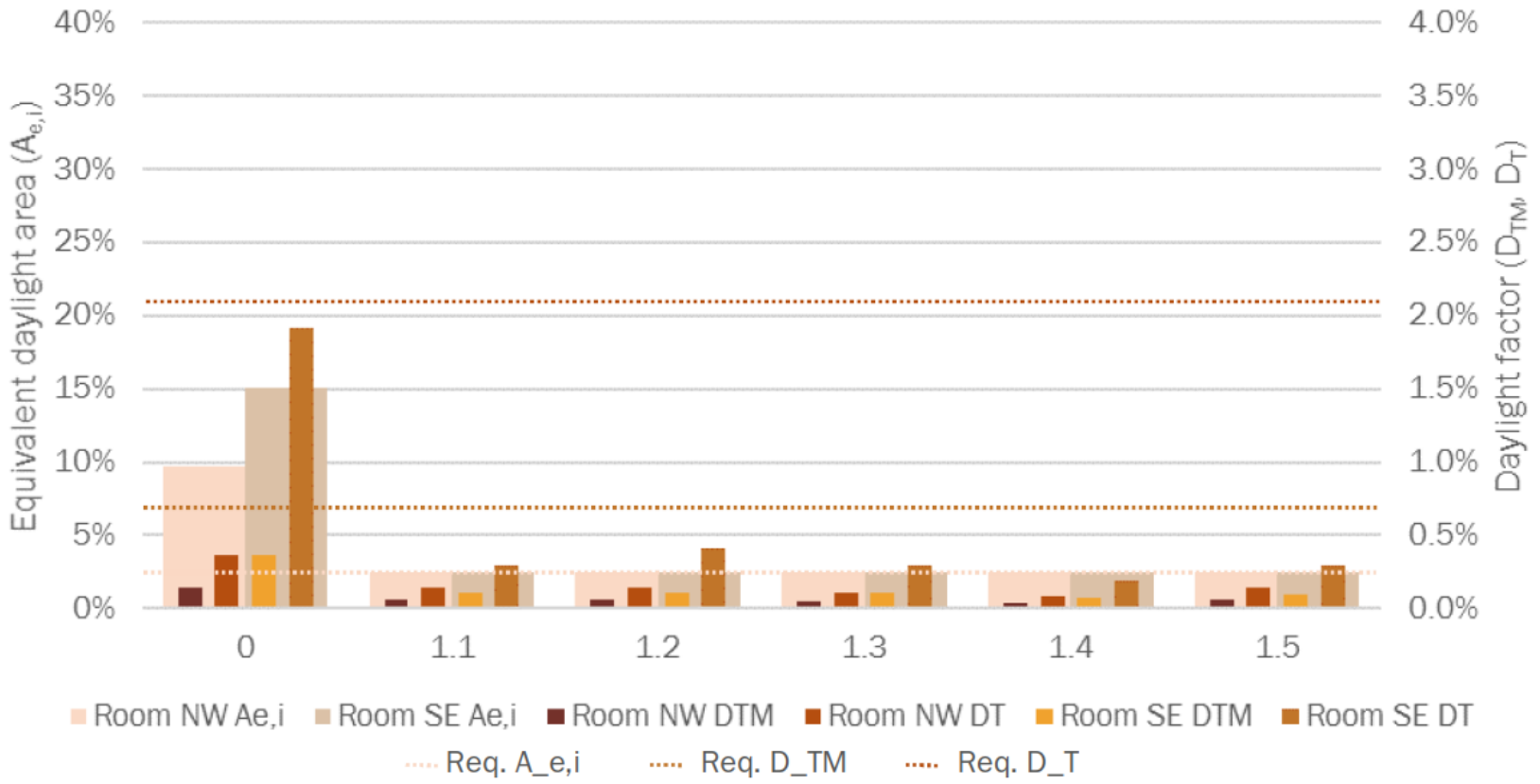


2.1 2.2 2.3 2.4 2.5 2.6

Systematic study

Daylight

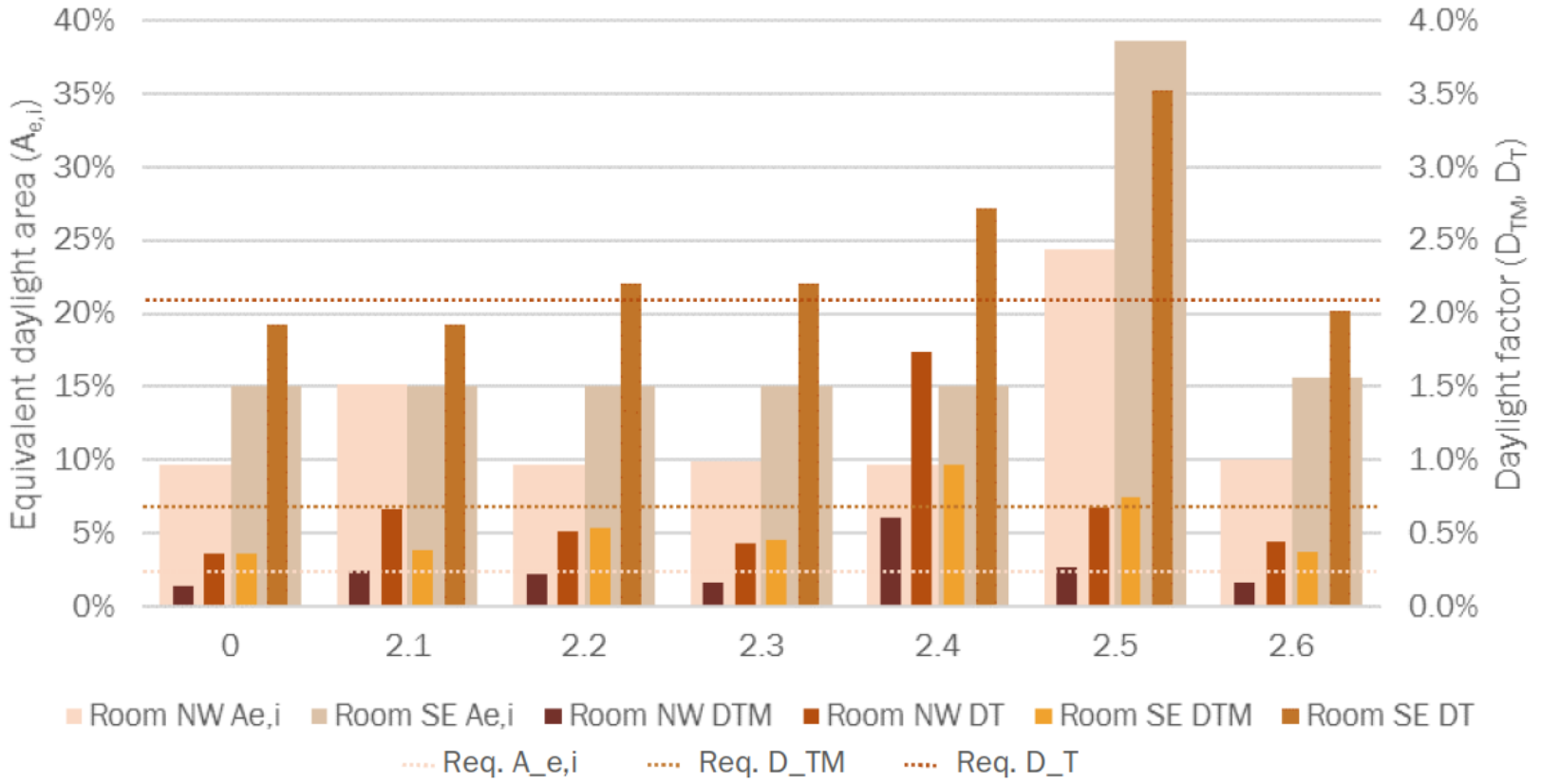
- Category 1



Systematic study

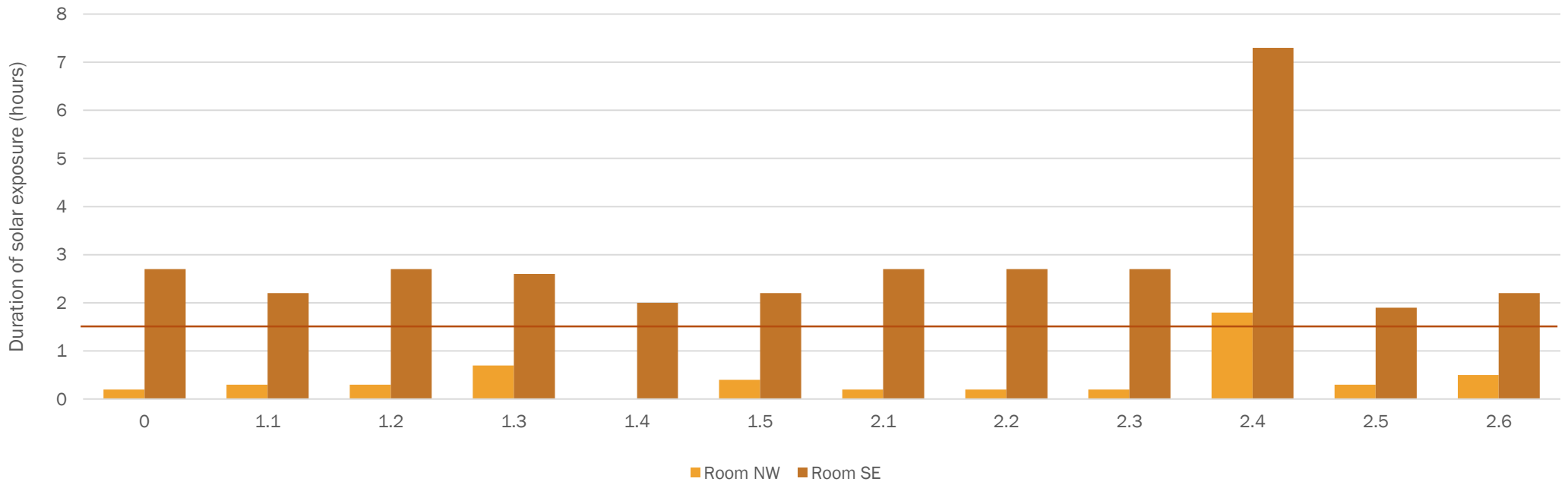
Daylight

- Category 2



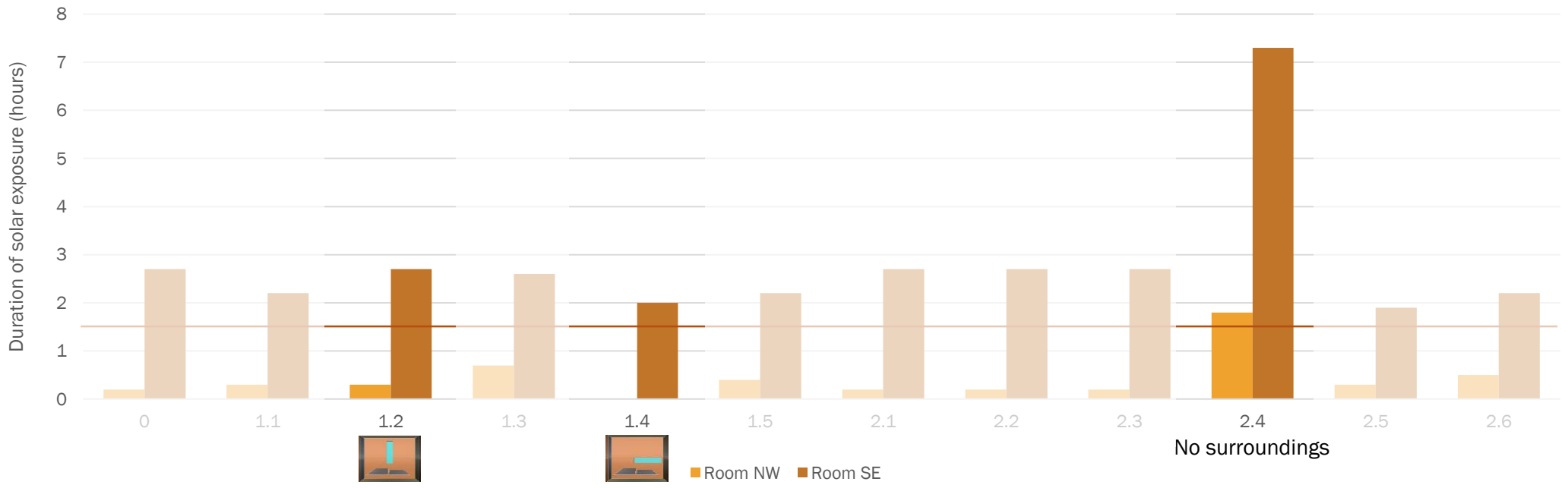
Systematic study

Sunlight



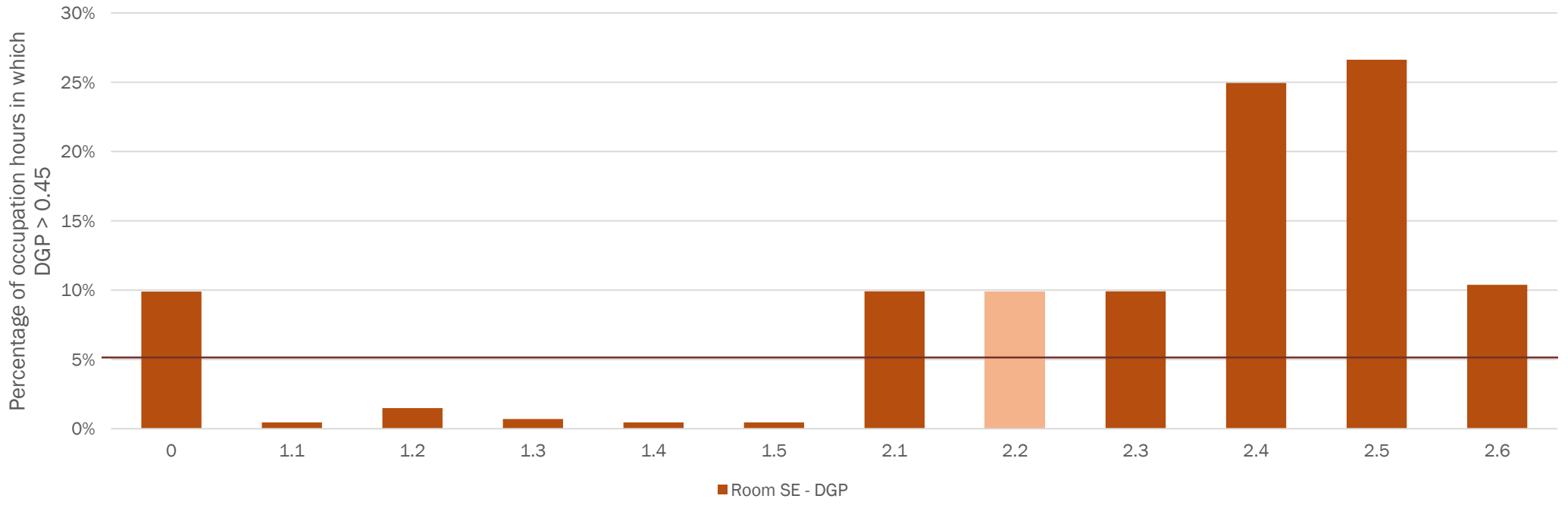
Systematic study

Sunlight



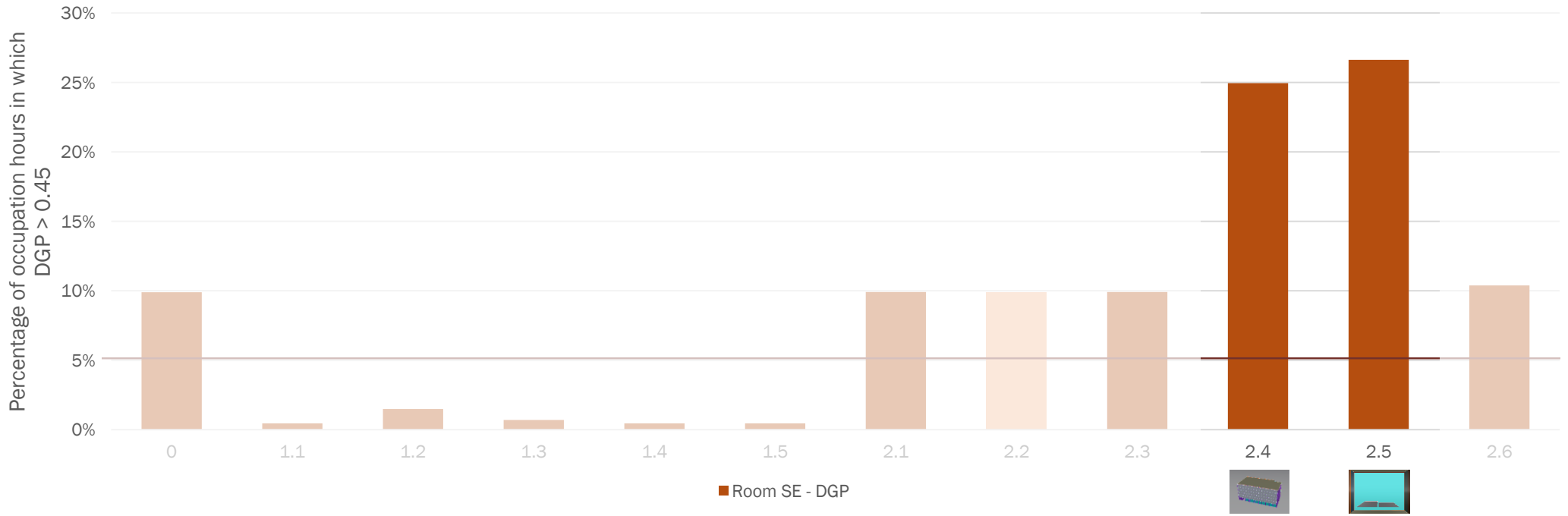
Systematic study

Glare



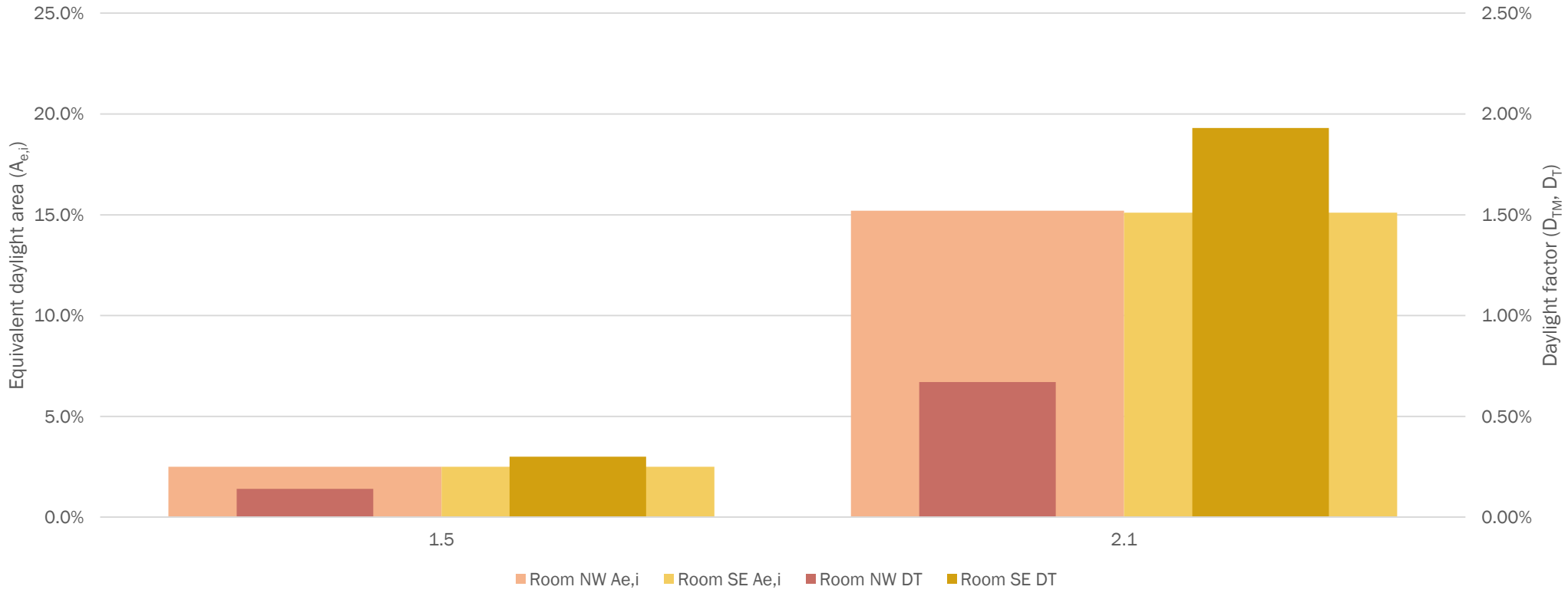
Systematic study

Glare



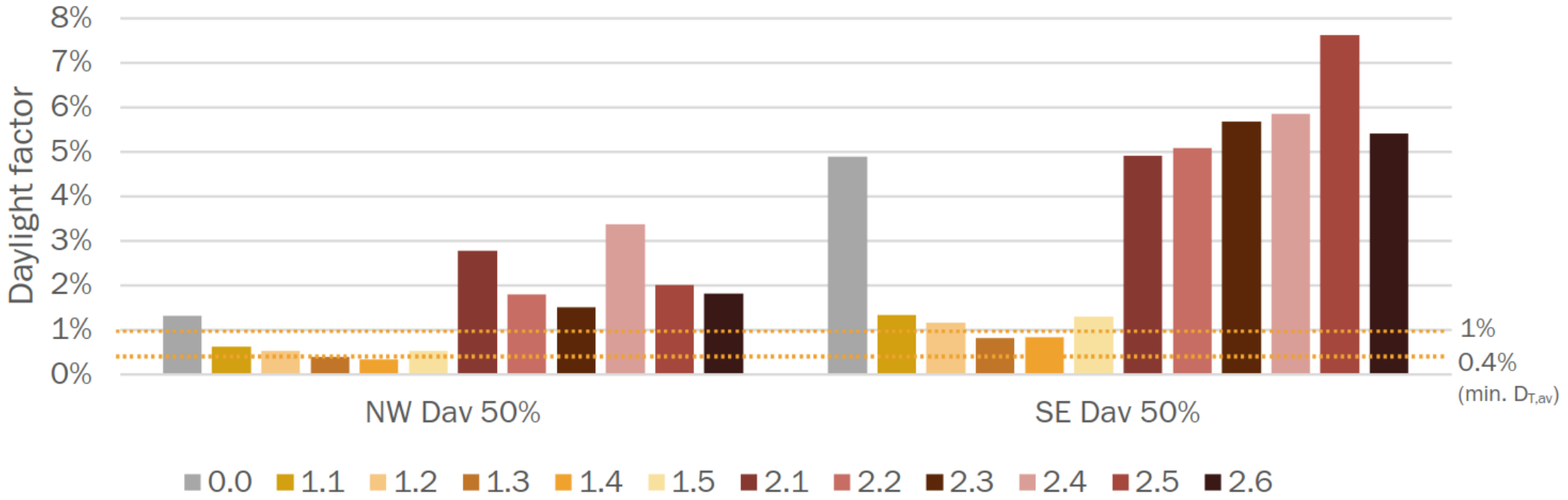
Systematic study

Orientation



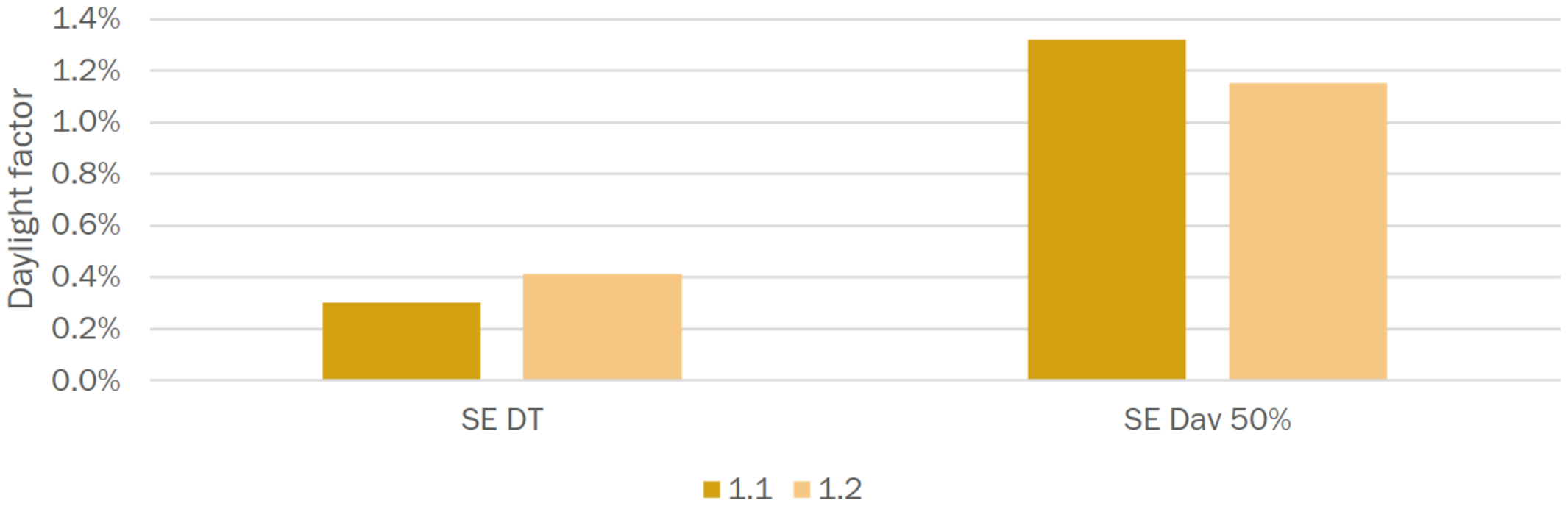
Systematic study

Average daylight factors



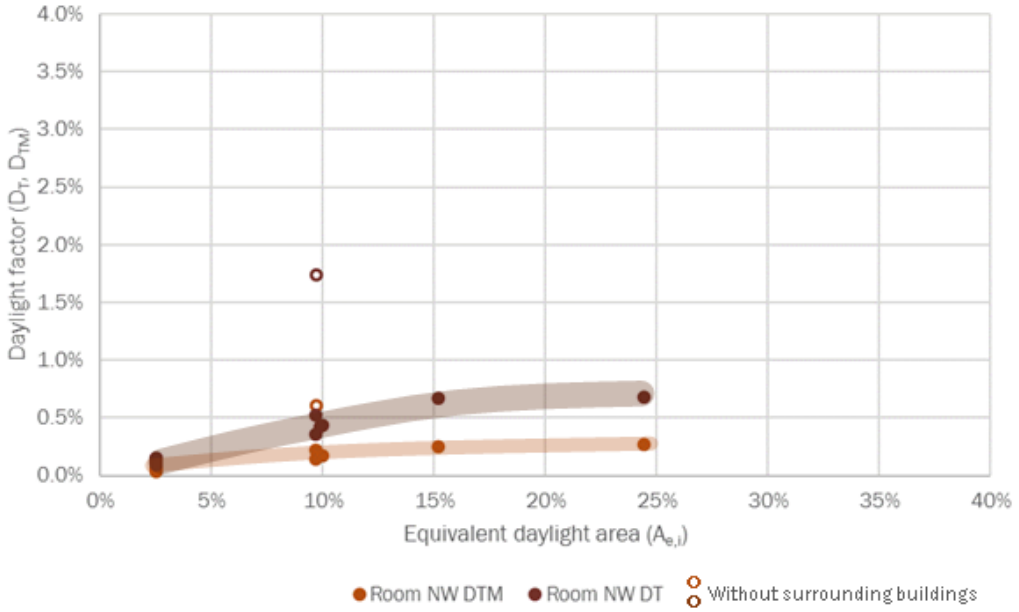
Systematic study

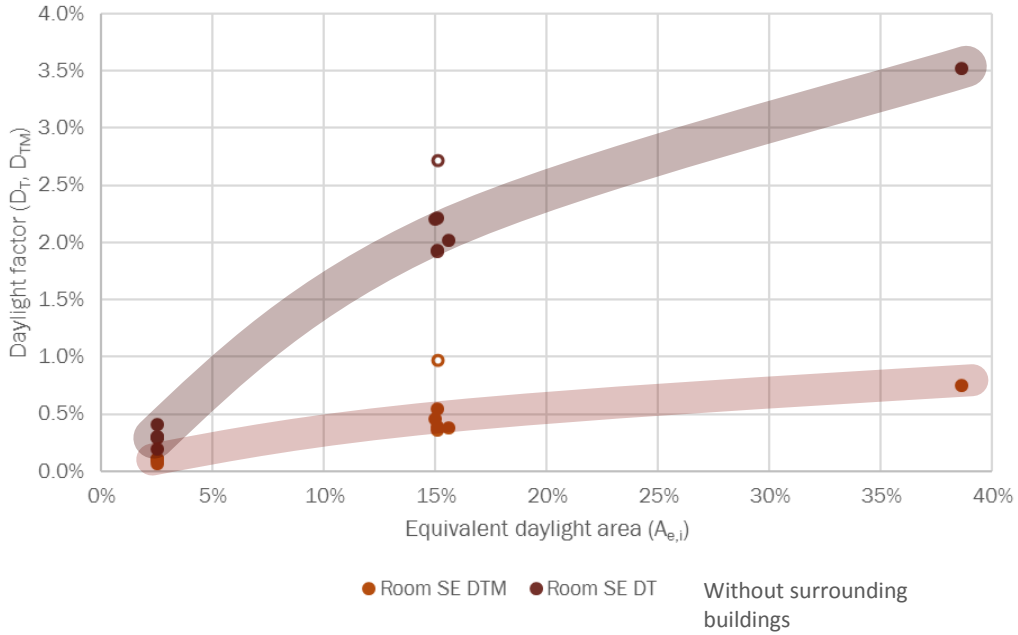
Average daylight factors



Systematic study

The relation between quivalent daylight area and daylight factor



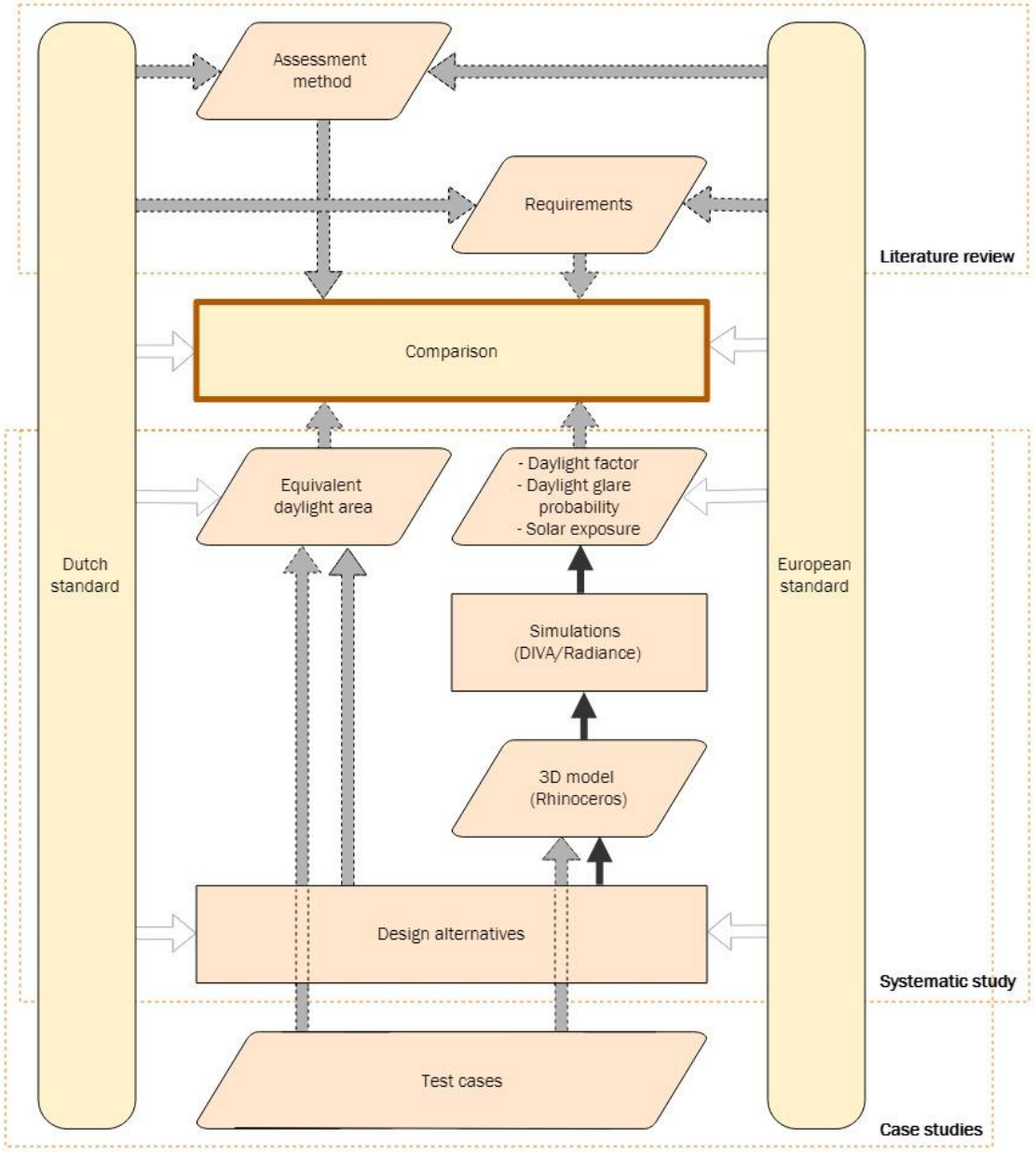


Systematic study

- With the minimum equivalent daylight area, the target daylight factor is not reached.
- It is almost impossible to meet the European standard.
- Multiple influencing factors
  - Surroundings
  - Orientation
  - Window shape

Conclusions

- What are the main differences between the Dutch and the European standards for daylight in buildings?
  - Assessment methods
  - Requirements
  - Visual effects



Assessment methods & requirements

Dutch standard

- Requirements
- Normative
- Equivalent daylight area
- Mandatory minimum obstructions and light transmittance

European standard

- Recommendations
- Descriptive
- Daylight factor
  - Duration of solar exposure
  - Daylight glare probability
  - View
- No limits regarding obstructions, light transmittance and reflection factors

Effects on daylight quality

Dutch standard

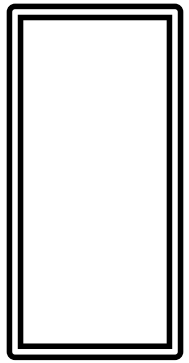
- Easily achievable
- Requirements are too low
- Equivalent daylight area = 2.5%

European standard

- Hardly achievable
- Recommendations are too high
- Target daylight factor = 0.2%

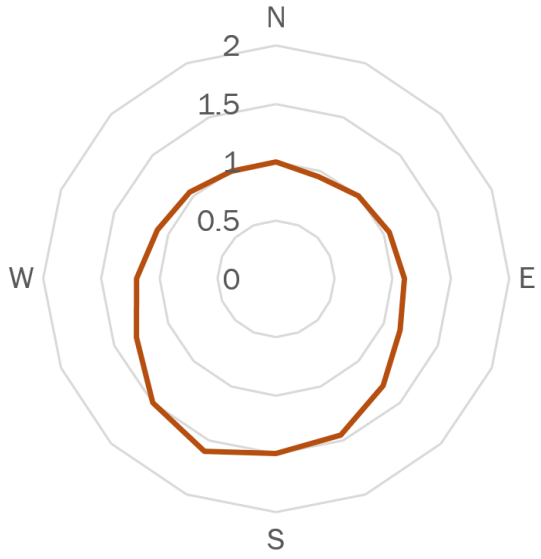
Recommendations

- Consider surroundings and orientation
- Convert simulated daylight factors with an orientation factor
- Use standard reflection factors and at least minimum obstructions
- Use the right window shape



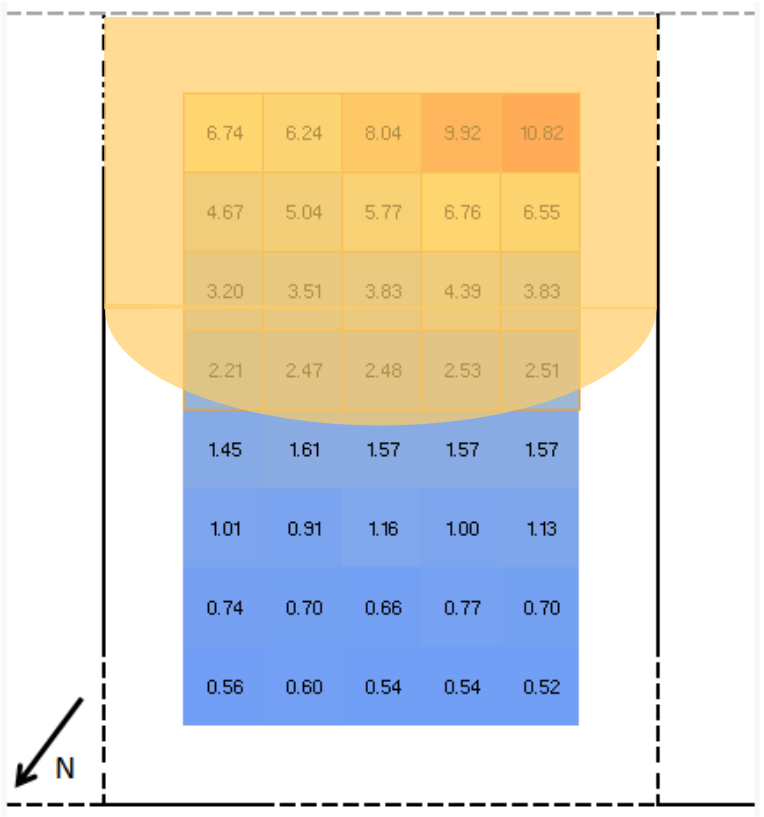
More light

More view



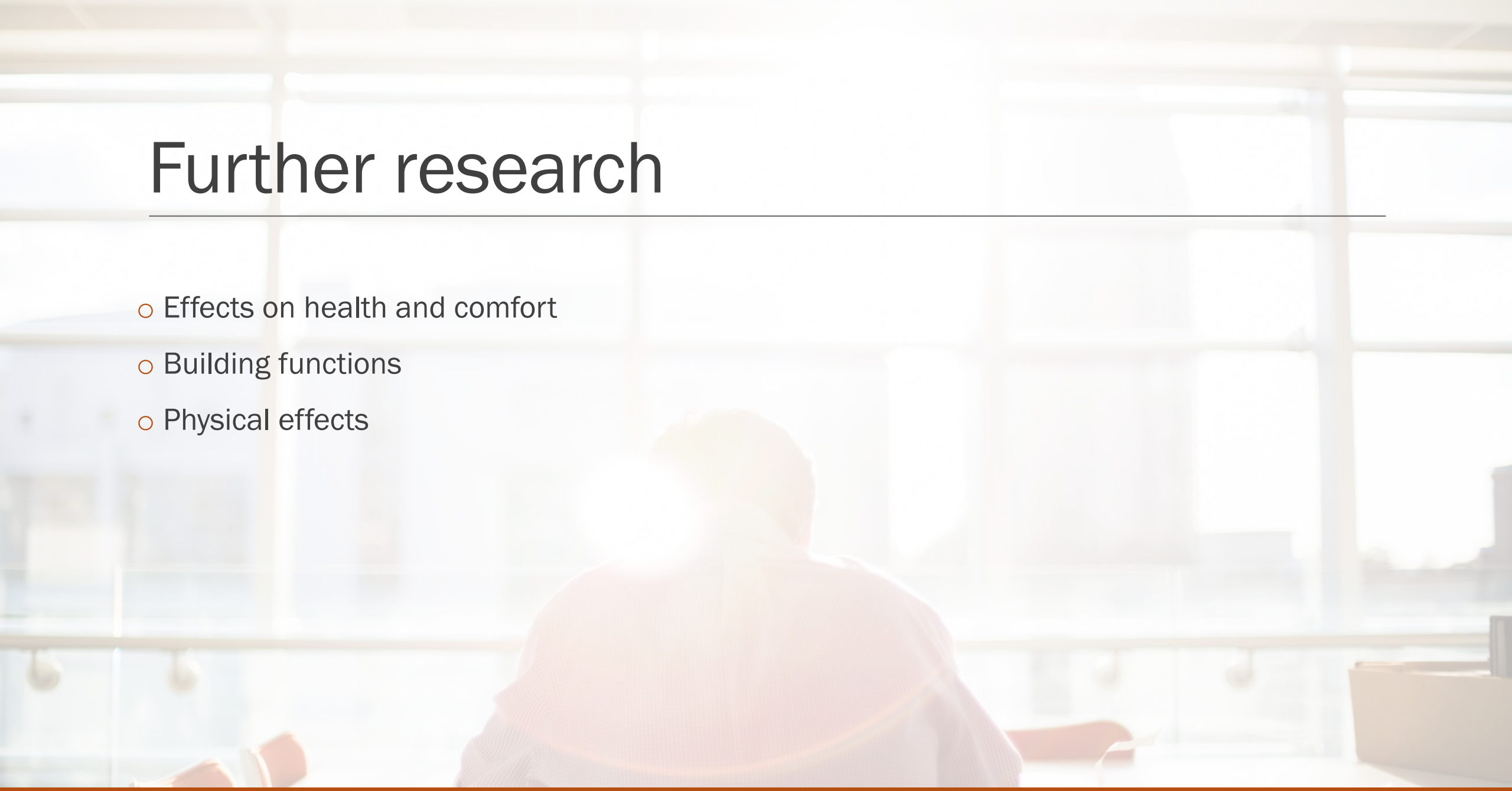
Recommendations

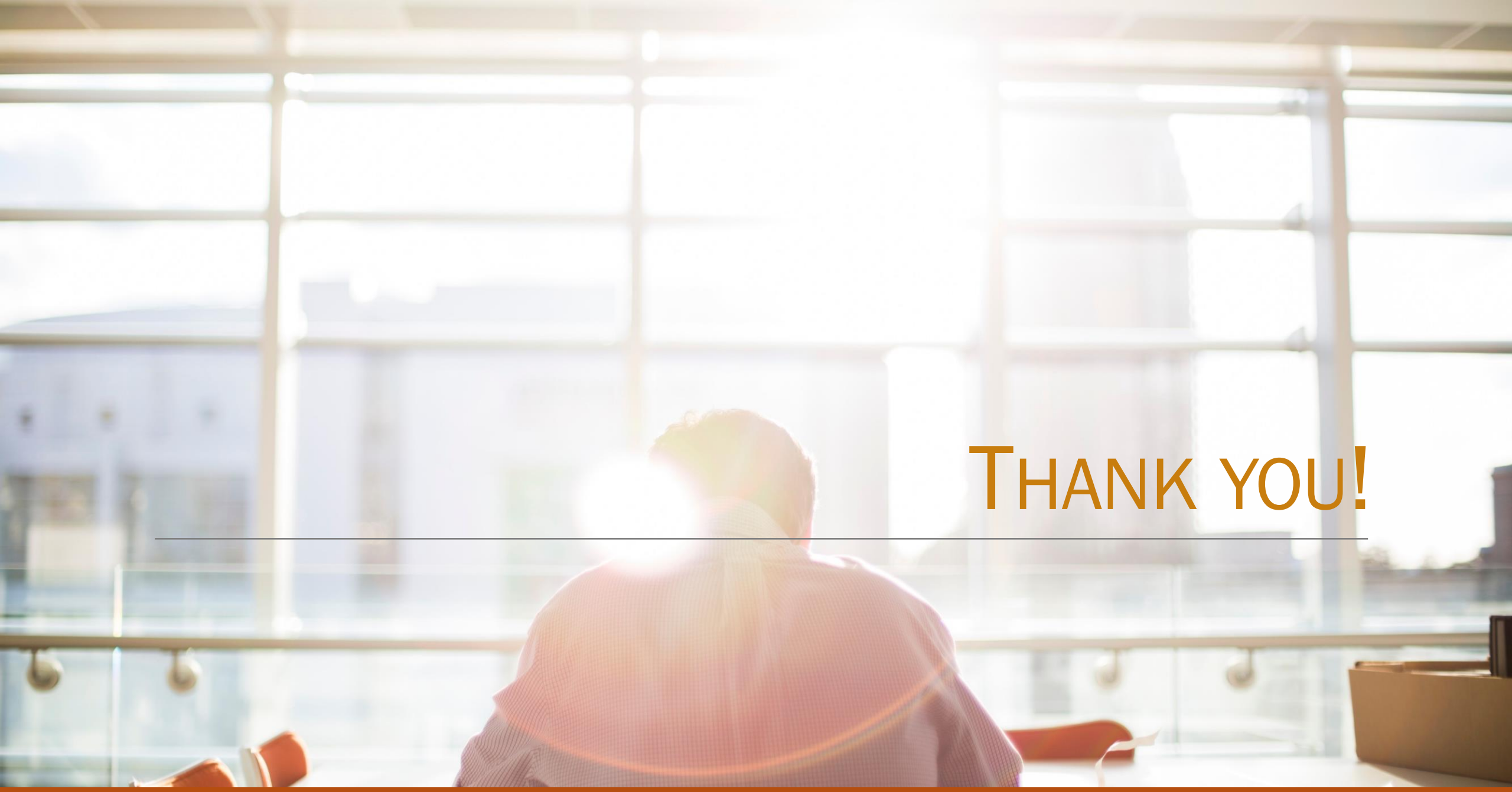
- Consider the average daylight factor
- Target daylight factor of 0.8%
- Average daylight factor of 1.5%
- Consider sunlight, glare and view
- Use simulations to gain insight in the daylight quality



Further research

- Effects on health and comfort
- Building functions
- Physical effects





THANK YOU!