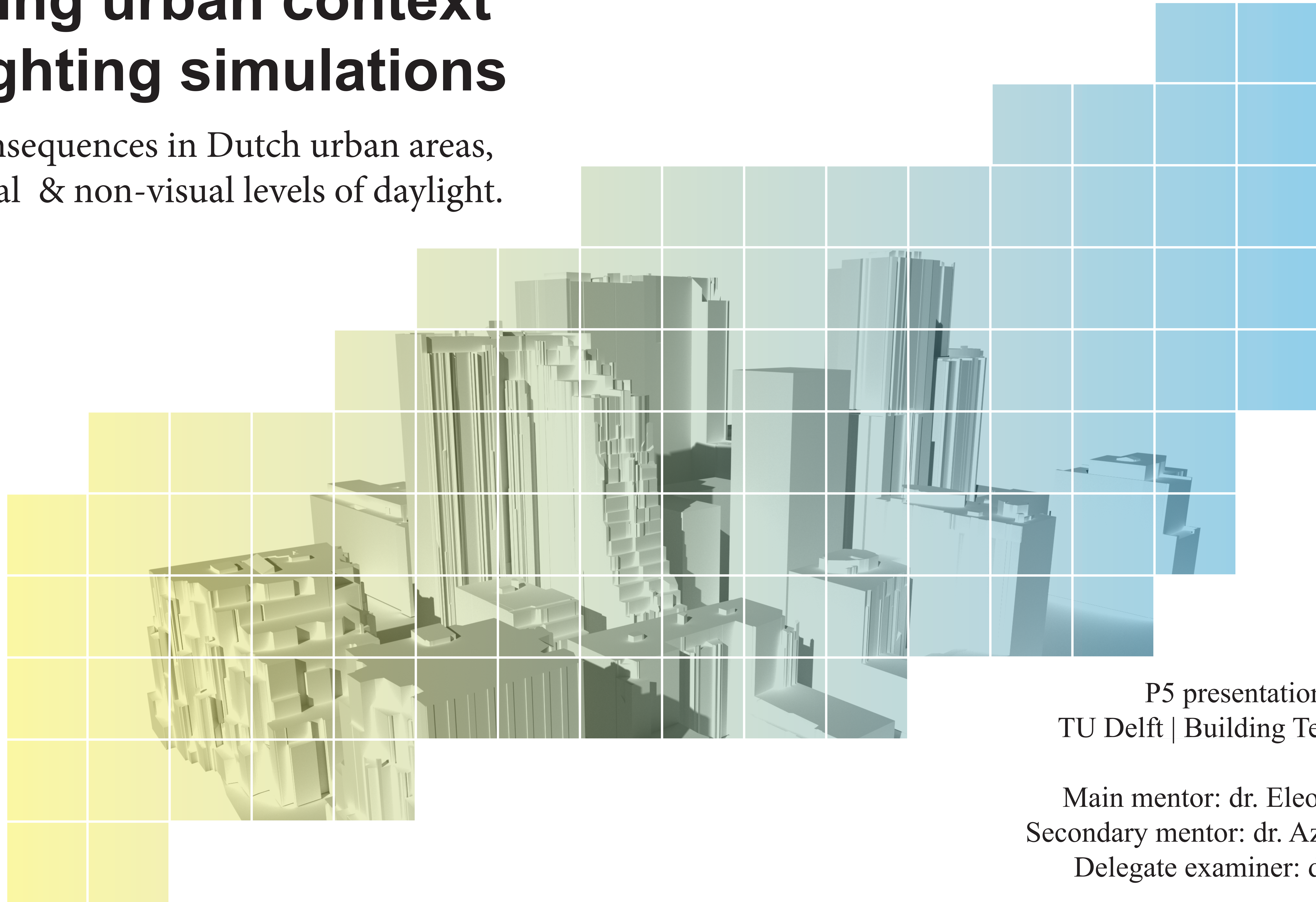


Integrating urban context in daylighting simulations

The design consequences in Dutch urban areas,
regarding visual & non-visual levels of daylight.



26-06-2023

P5 presentation Daniël Koster
TU Delft | Building Technology track

Main mentor: dr. Eleonora Brembilla
Secondary mentor: dr. Azarakhsh Rafiee
Delegate examiner: dr. Ir. Ad Straub



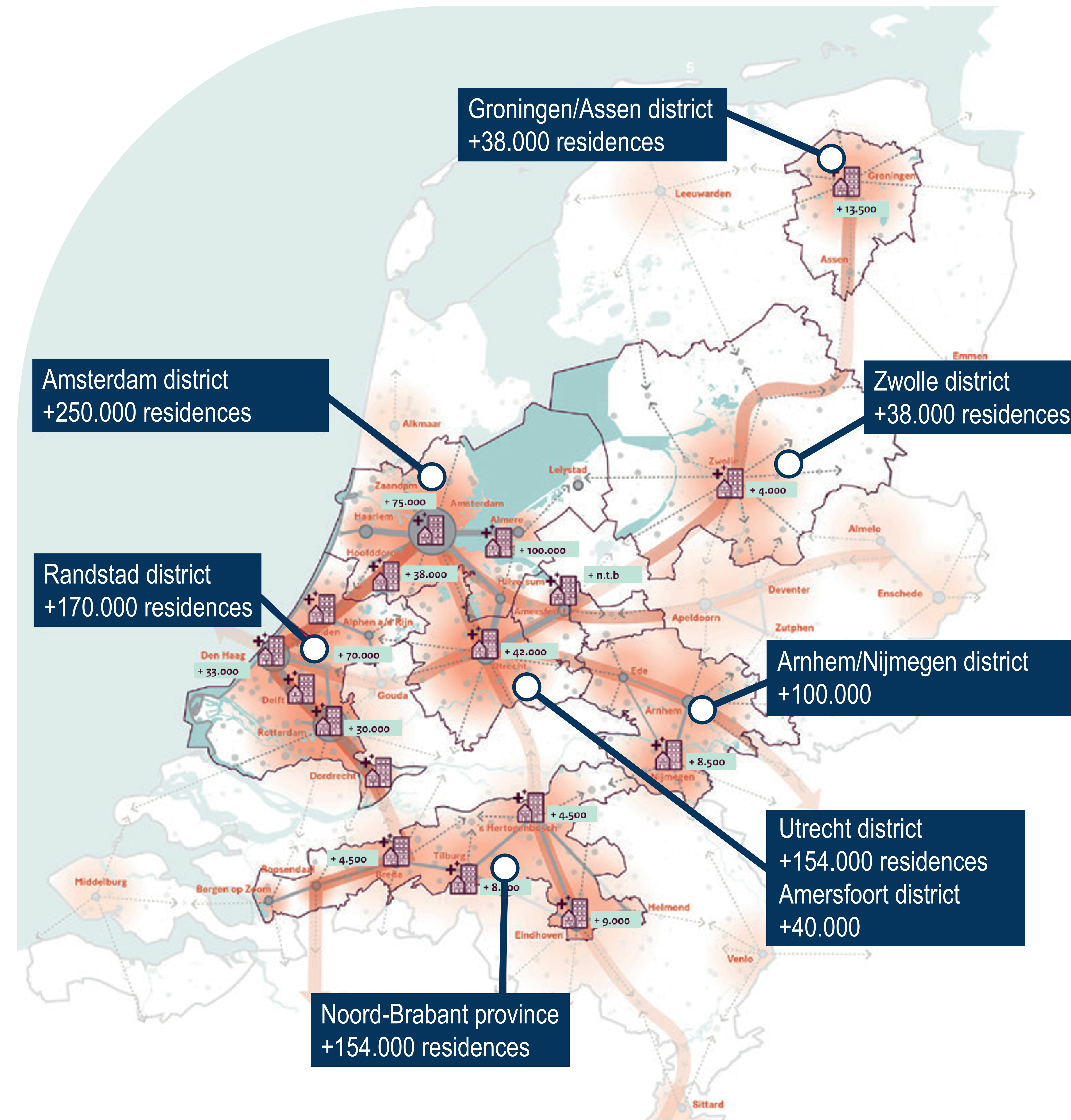
Little C, Rotterdam - CULD & INBO (2021)

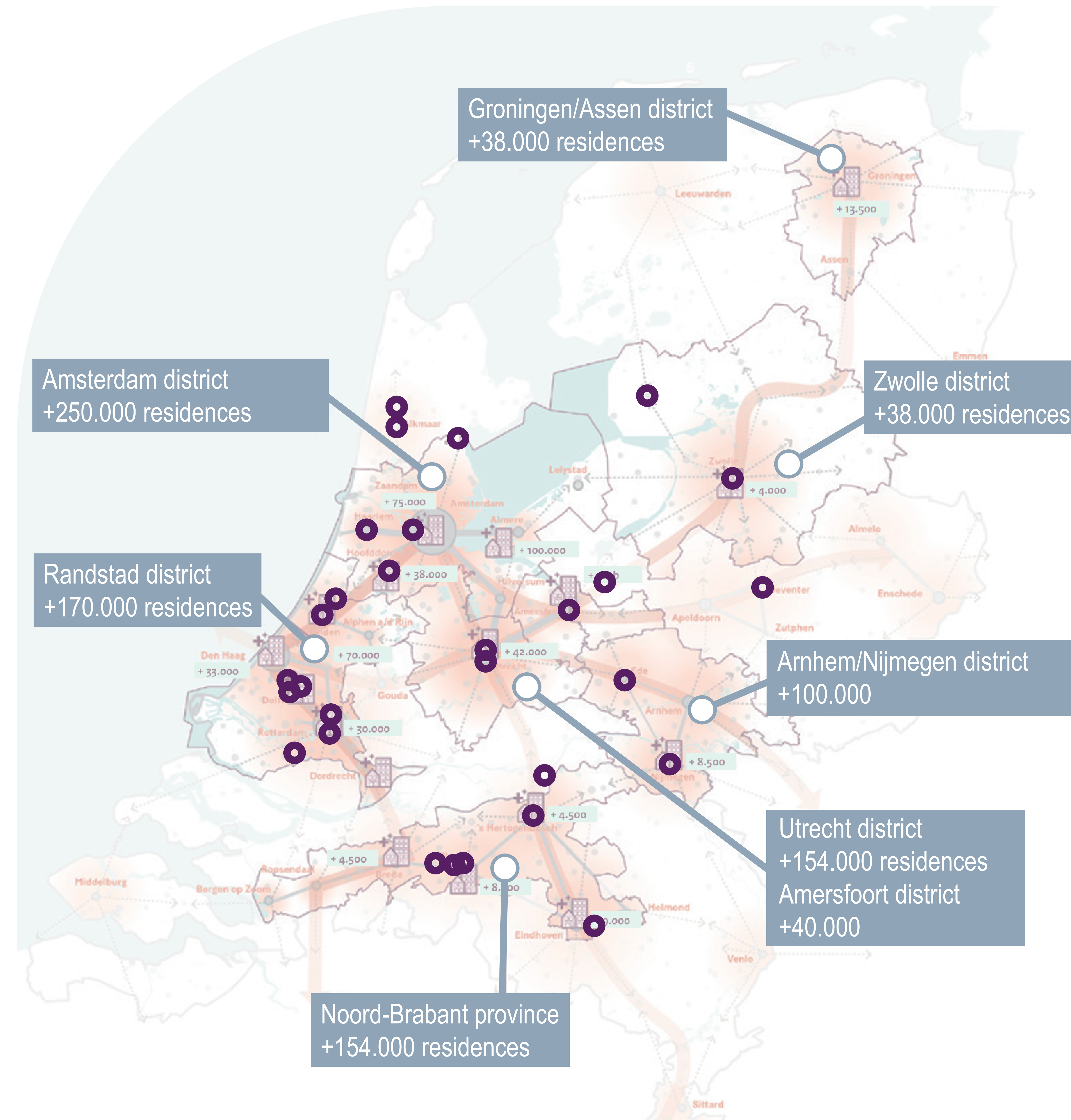


De bankier, Tilburg - Diederendirrix (2023)



De Syp en de Styn, Utrecht - OZ (2023)





Ministry of Housing & Spatial order (2022)

320 / 170.000

x 531



Little C, Rotterdam - CULD & INBO (2021)

118 / 154.000

x 1305



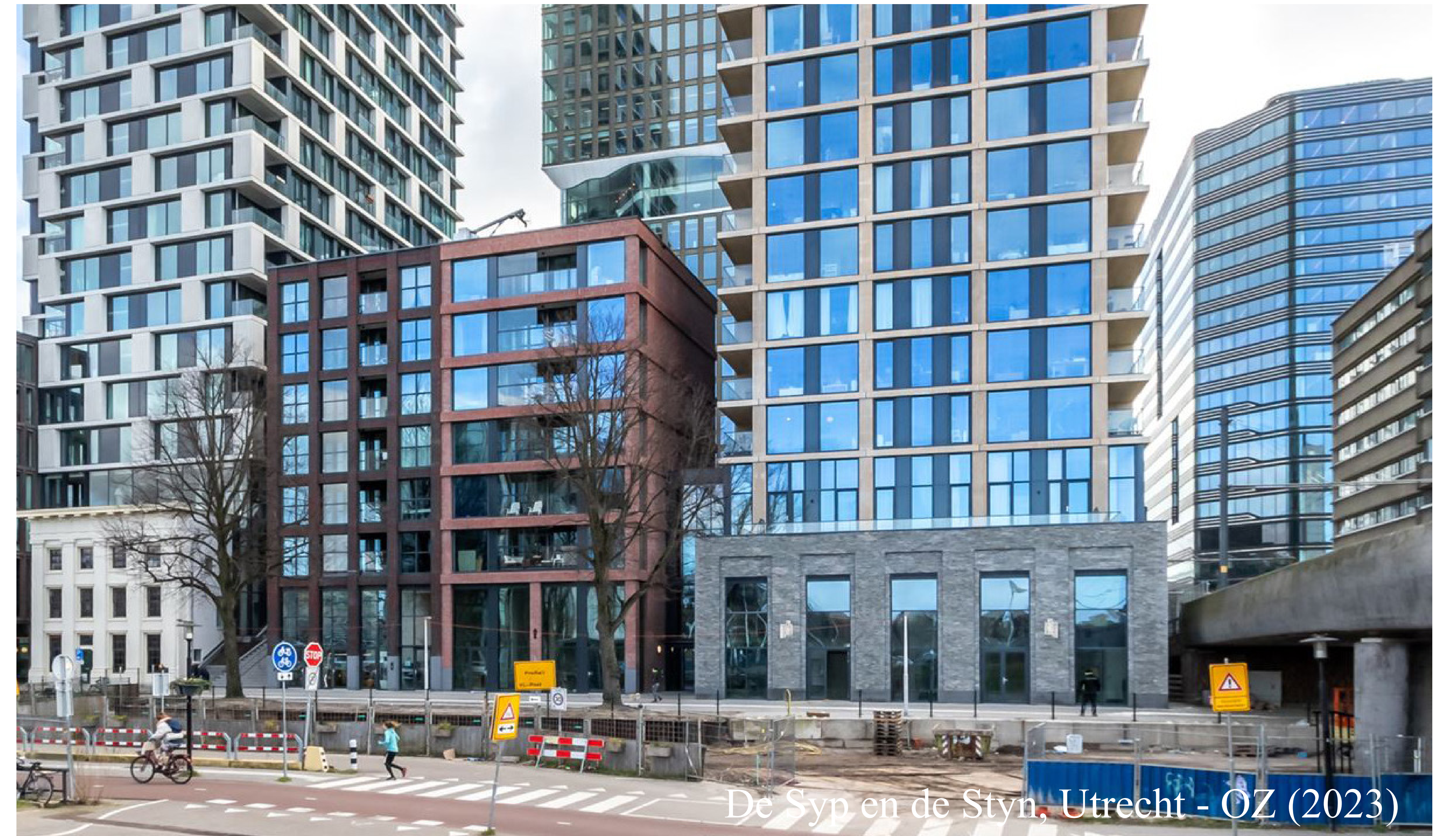
De bankier, Tilburg - Diederendirrix (2023)

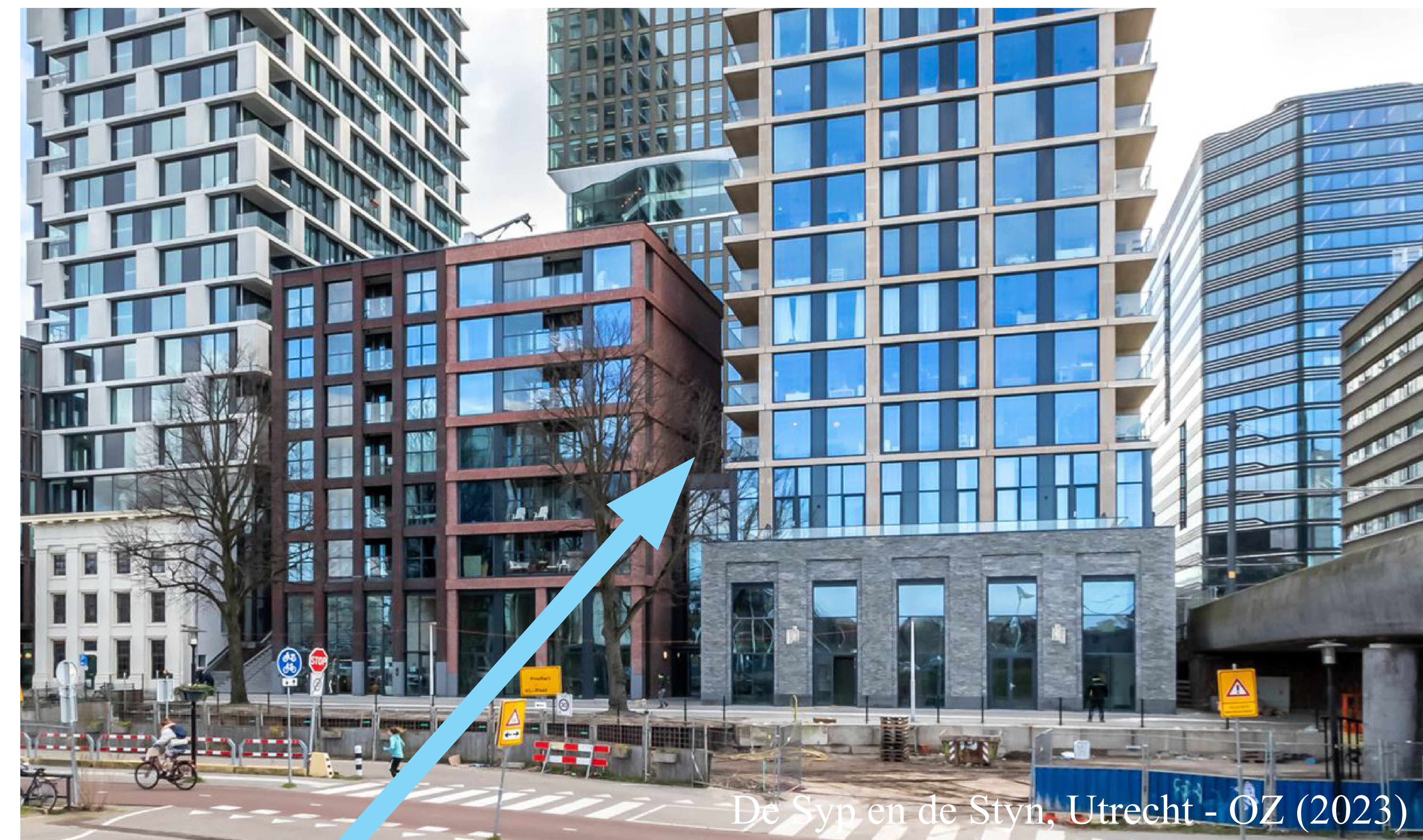
386 / 154.000

x 398



De Syp en de Styn, Utrecht - OZ (2023)





Enough daylight?

Research

Simulation

Analysis

Design

Sufficient &
healthy daylight

Daylighting in
urban areas

Results &
analysis

Mitigation
strategies

Sufficient &
healthy daylight

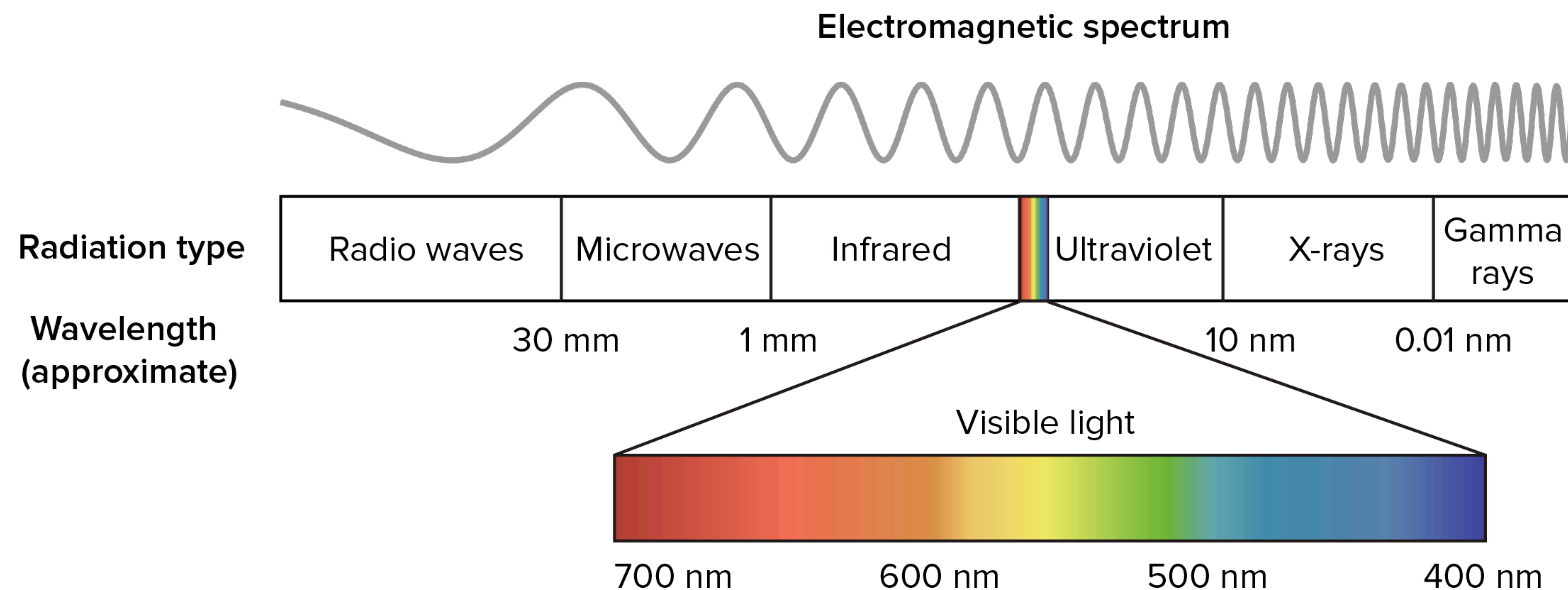
Daylighting in
urban areas

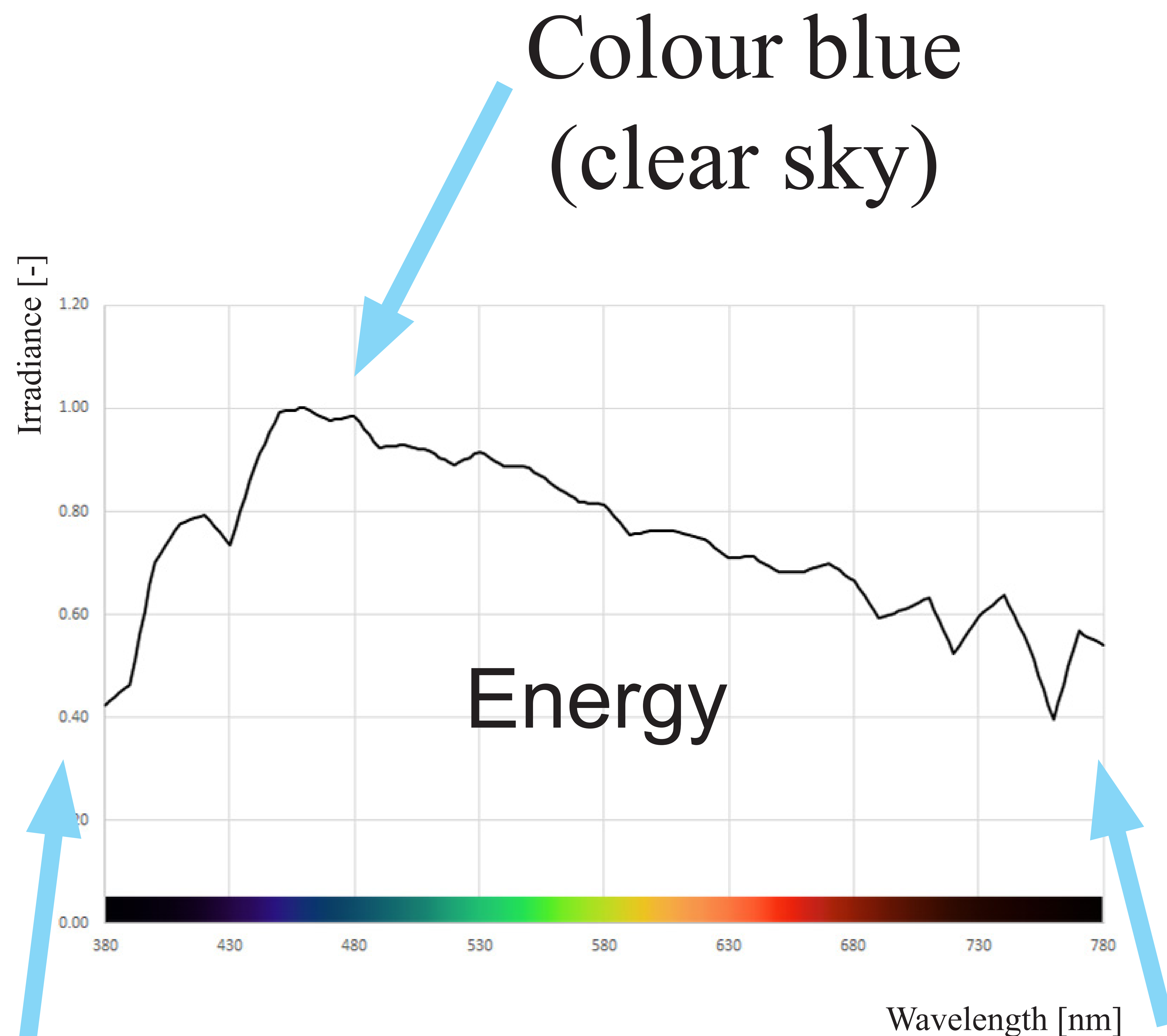
Results &
analysis

Mitigation
strategies

daylight

electromagnetic waves from the sun
that can be perceived by the human eye

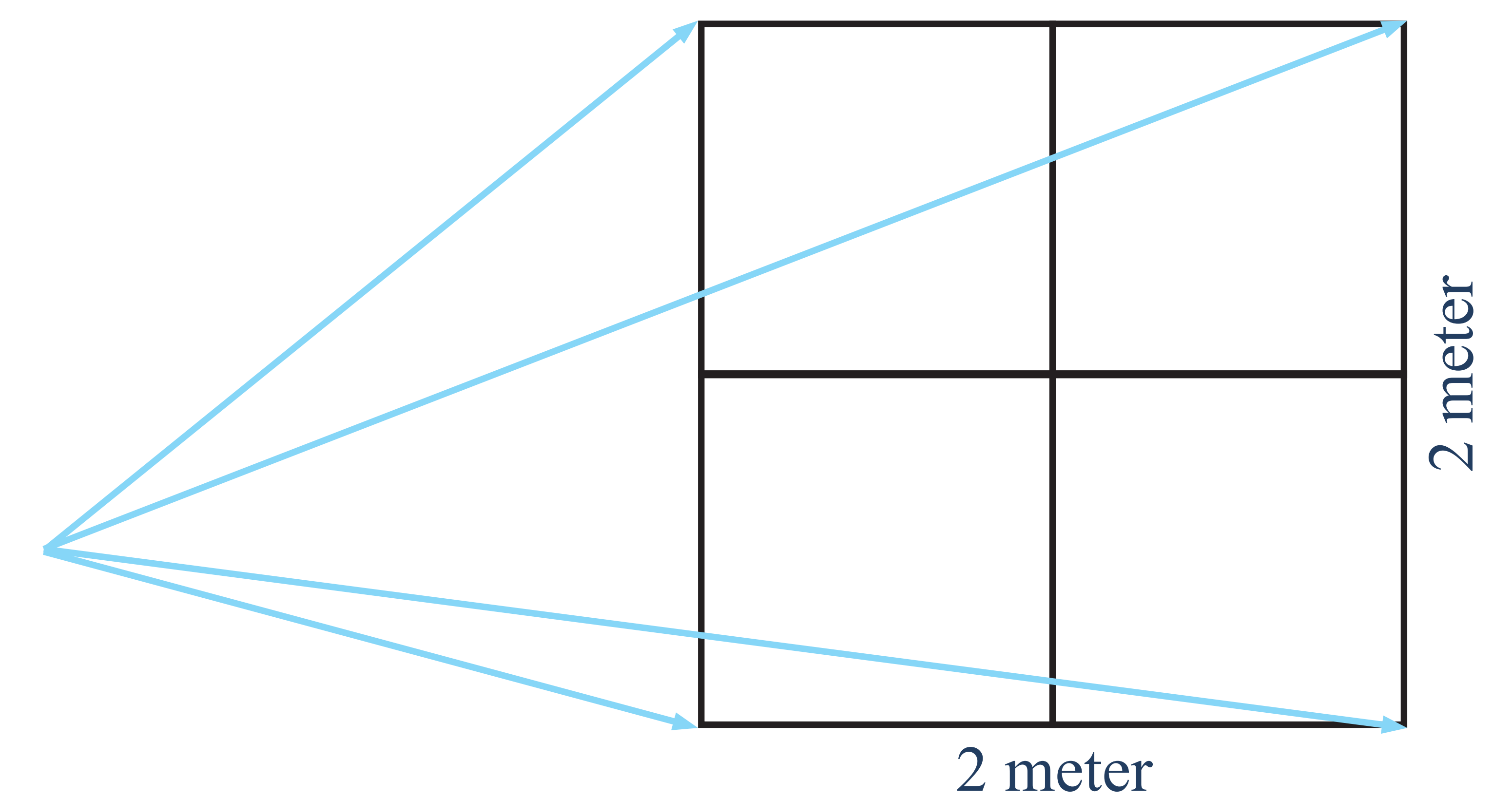




Ultra-violet
(sunburn)

Infrared
(heat)

Light source
1000 lumen



measured
250 lux

(WaveformLighting, n.d.)

What is sufficient visual daylight?

Dutch building code 144 lx

Recommended 300 lx

What is sufficient visual daylight?

Dutch building code 144 lx

Recommended 300 lx

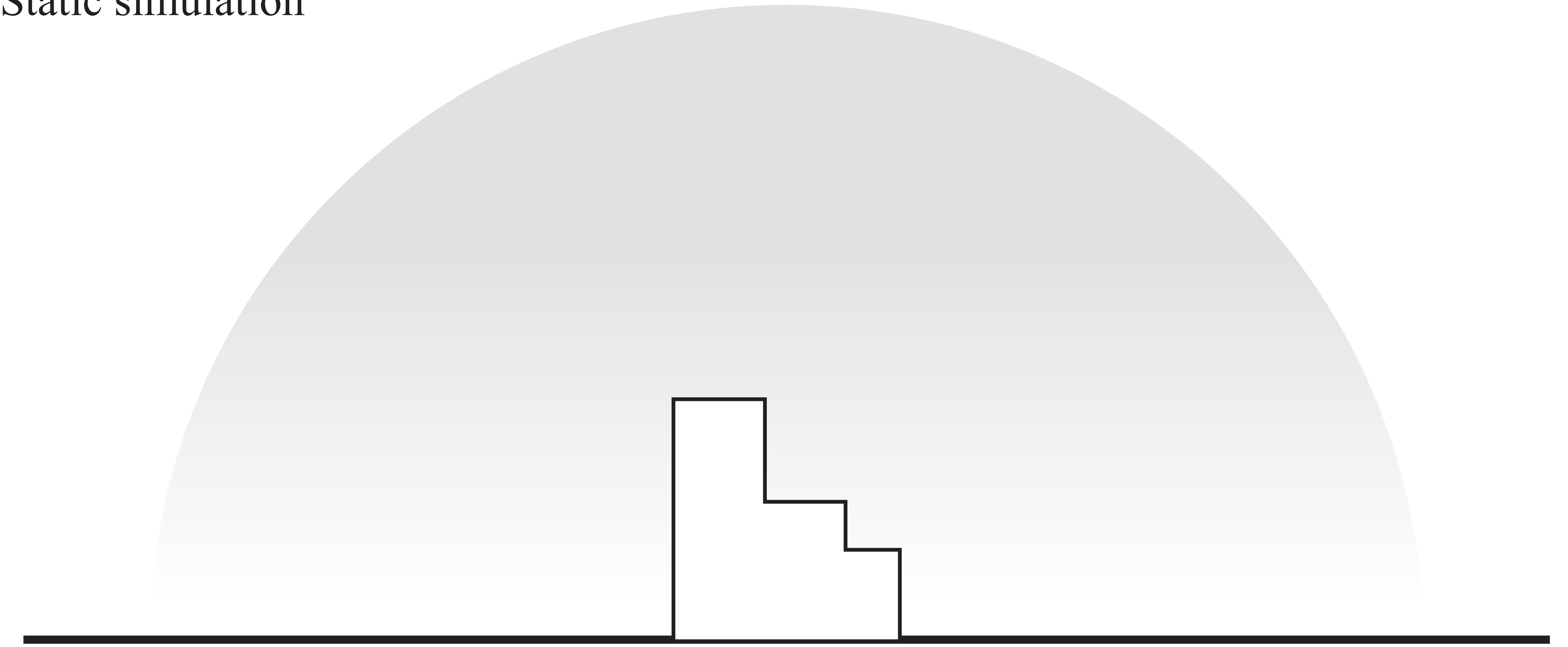
Does this result in a
healthy residence?

Can we achieve
this in urban areas?

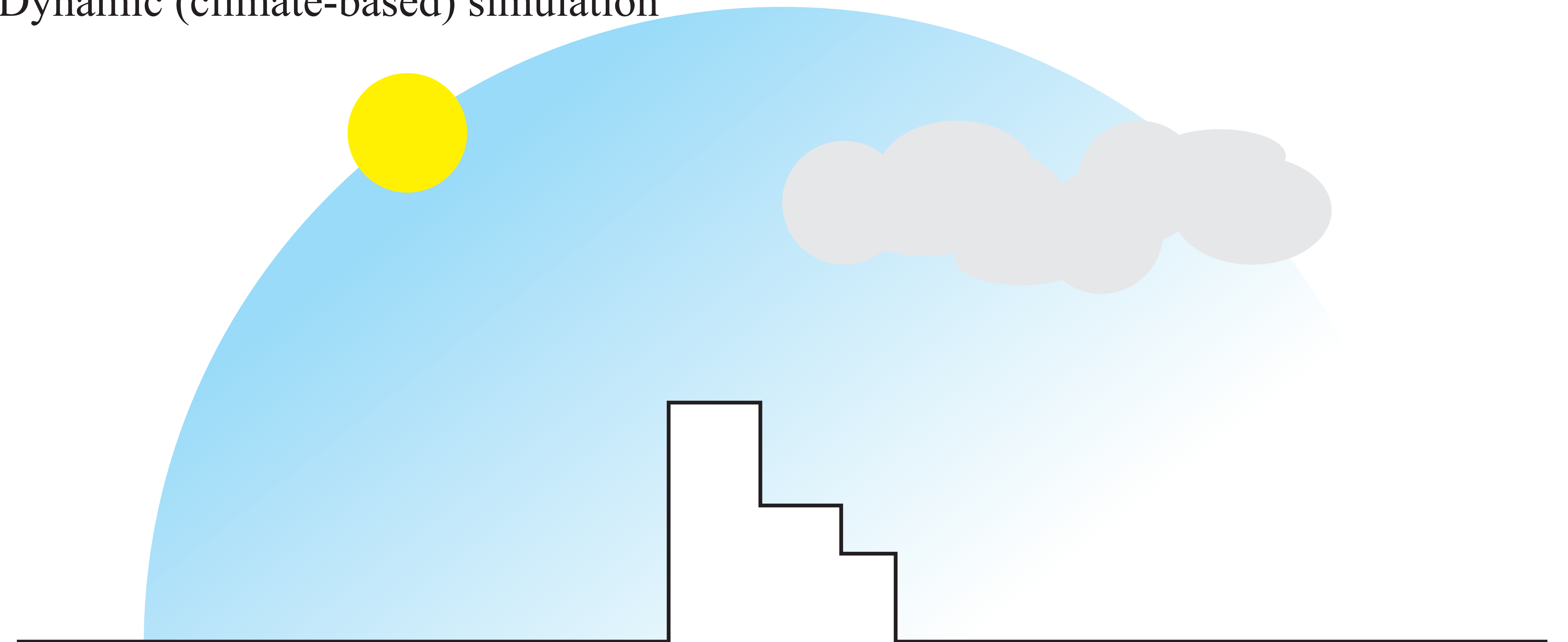
Daylight assessment: the EN 17037

- Introduced in NL 2024
- Static simulation: stress test
- Dynamic simulation: climate-based
- More realism, more accurate

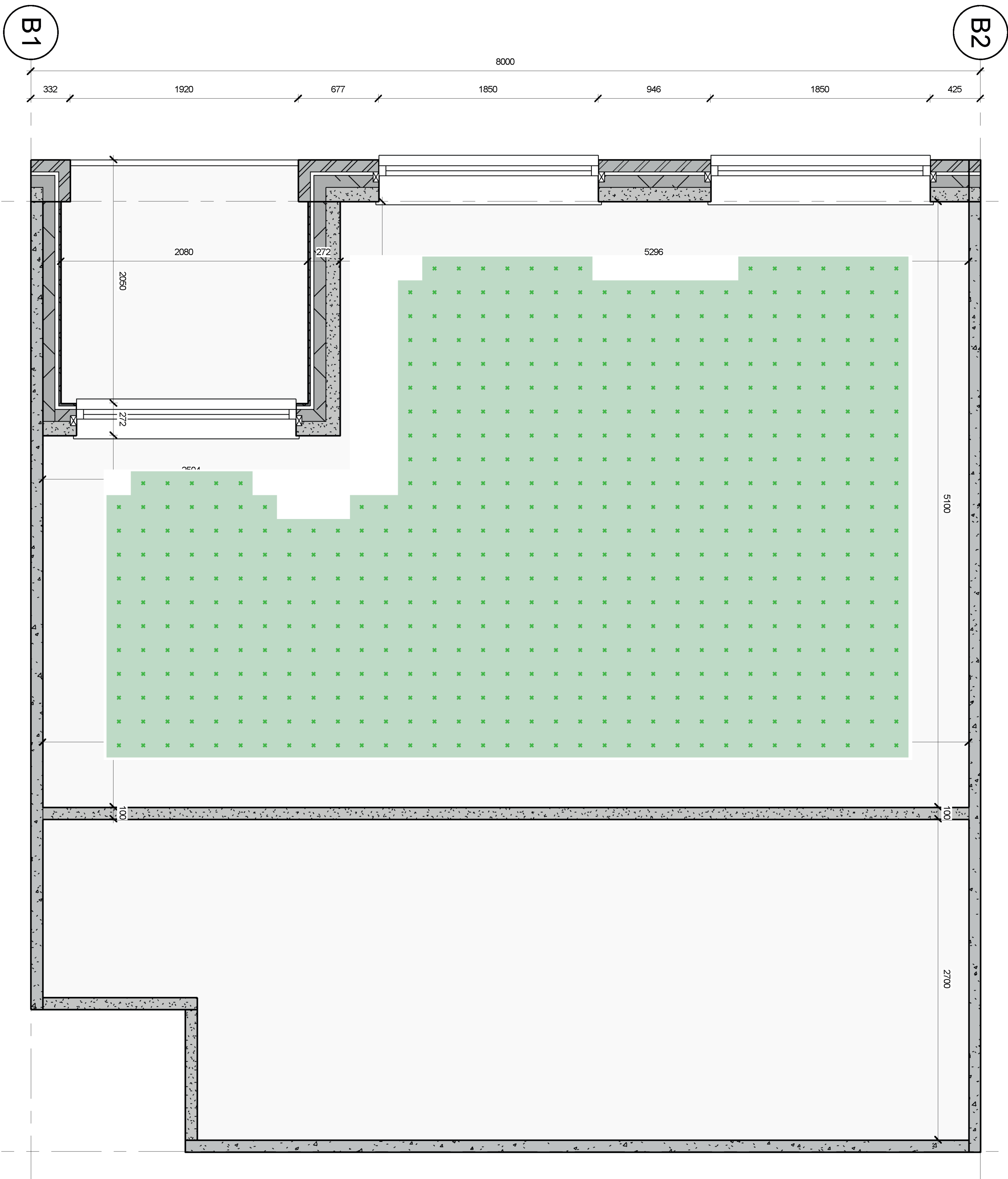
Static simulation



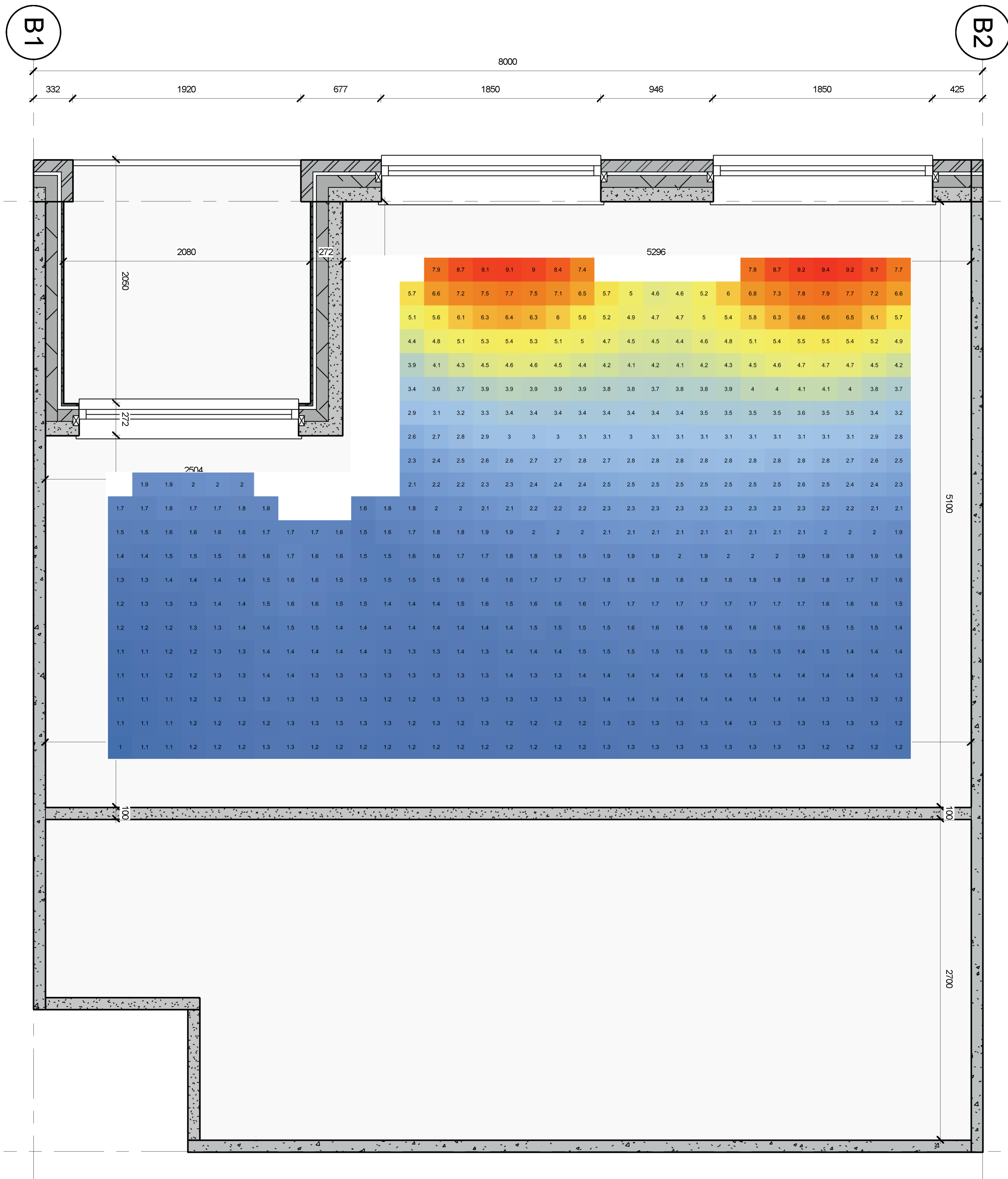
Dynamic (climate-based) simulation



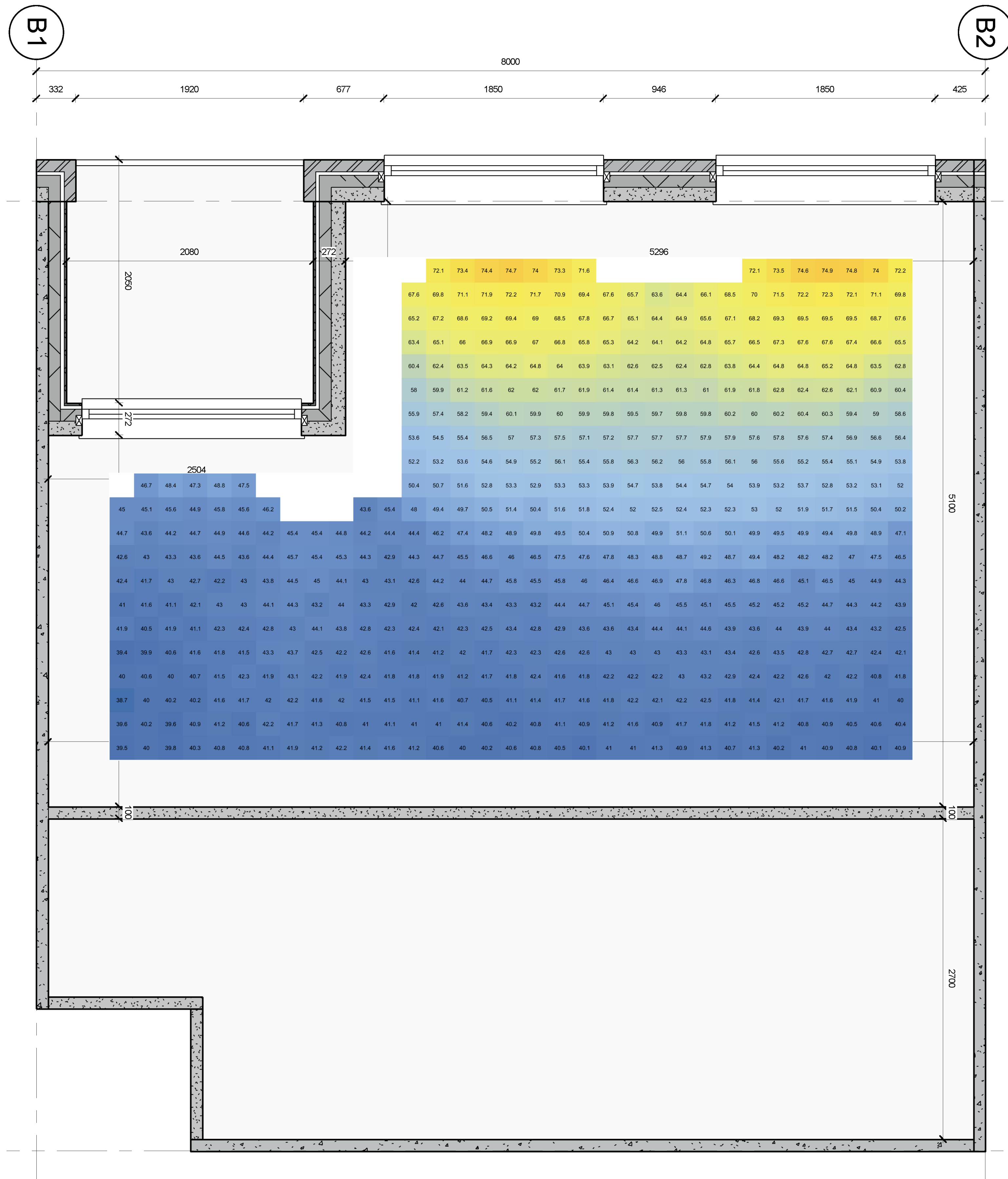
sensor grid



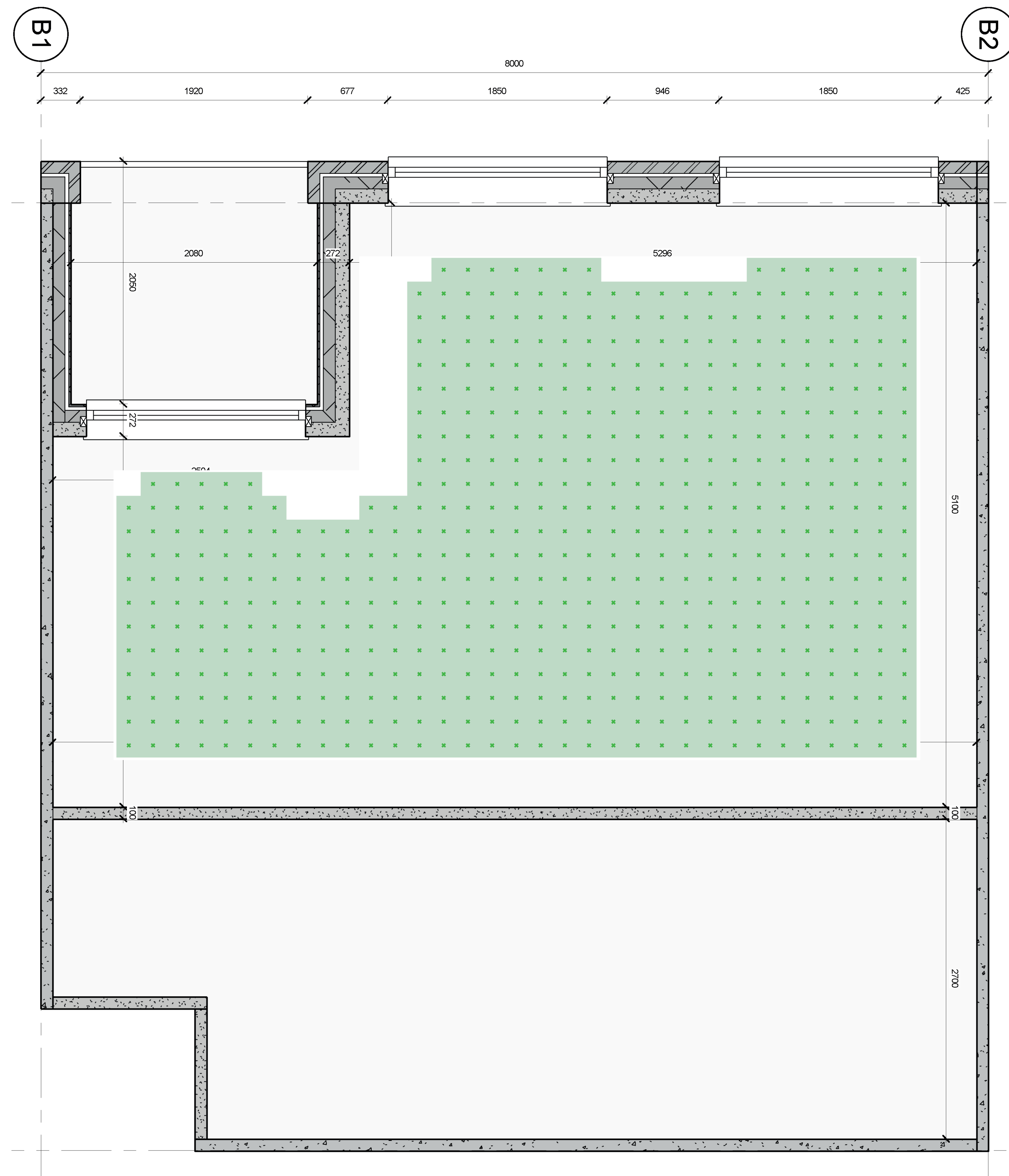
static



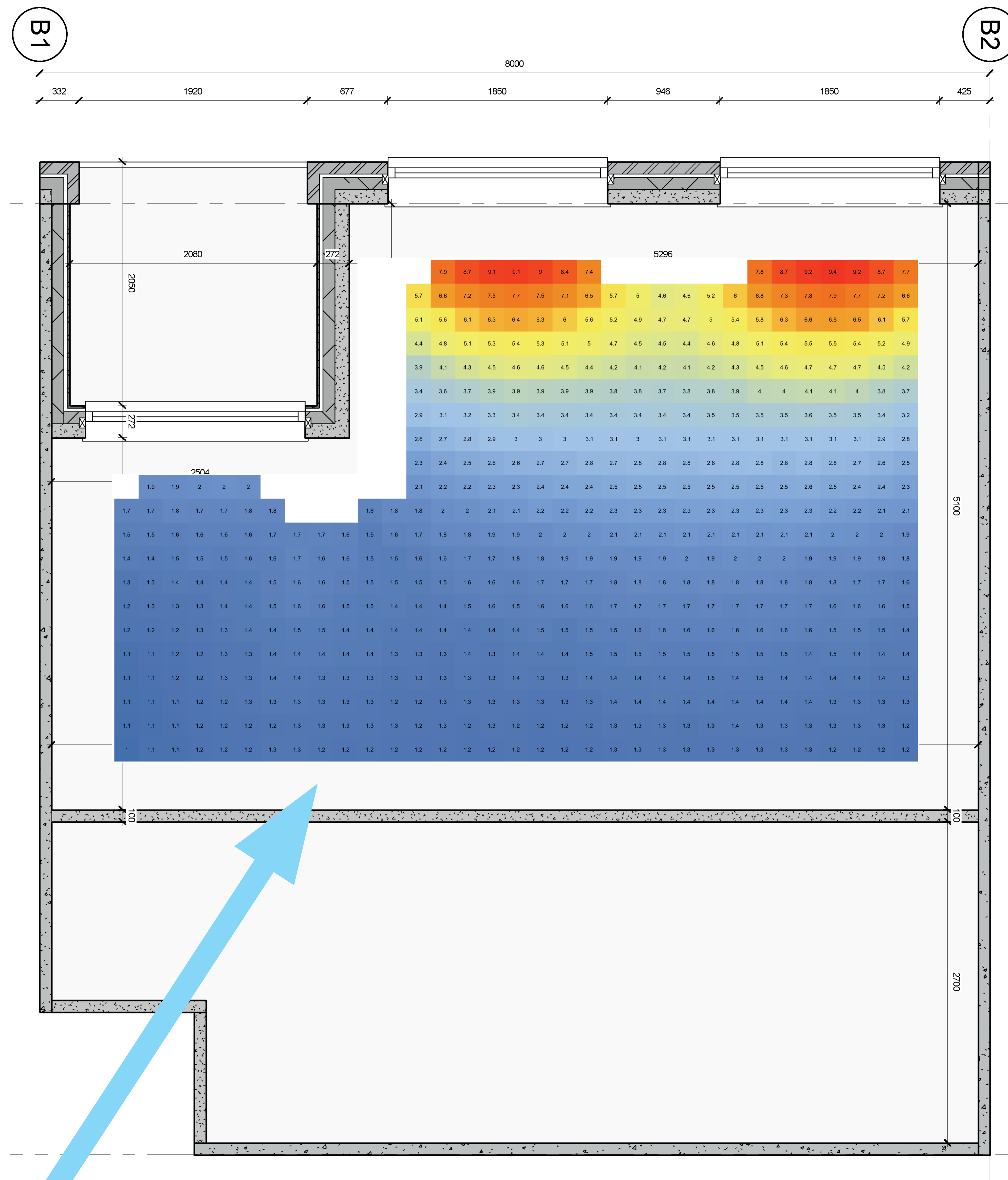
dynamic



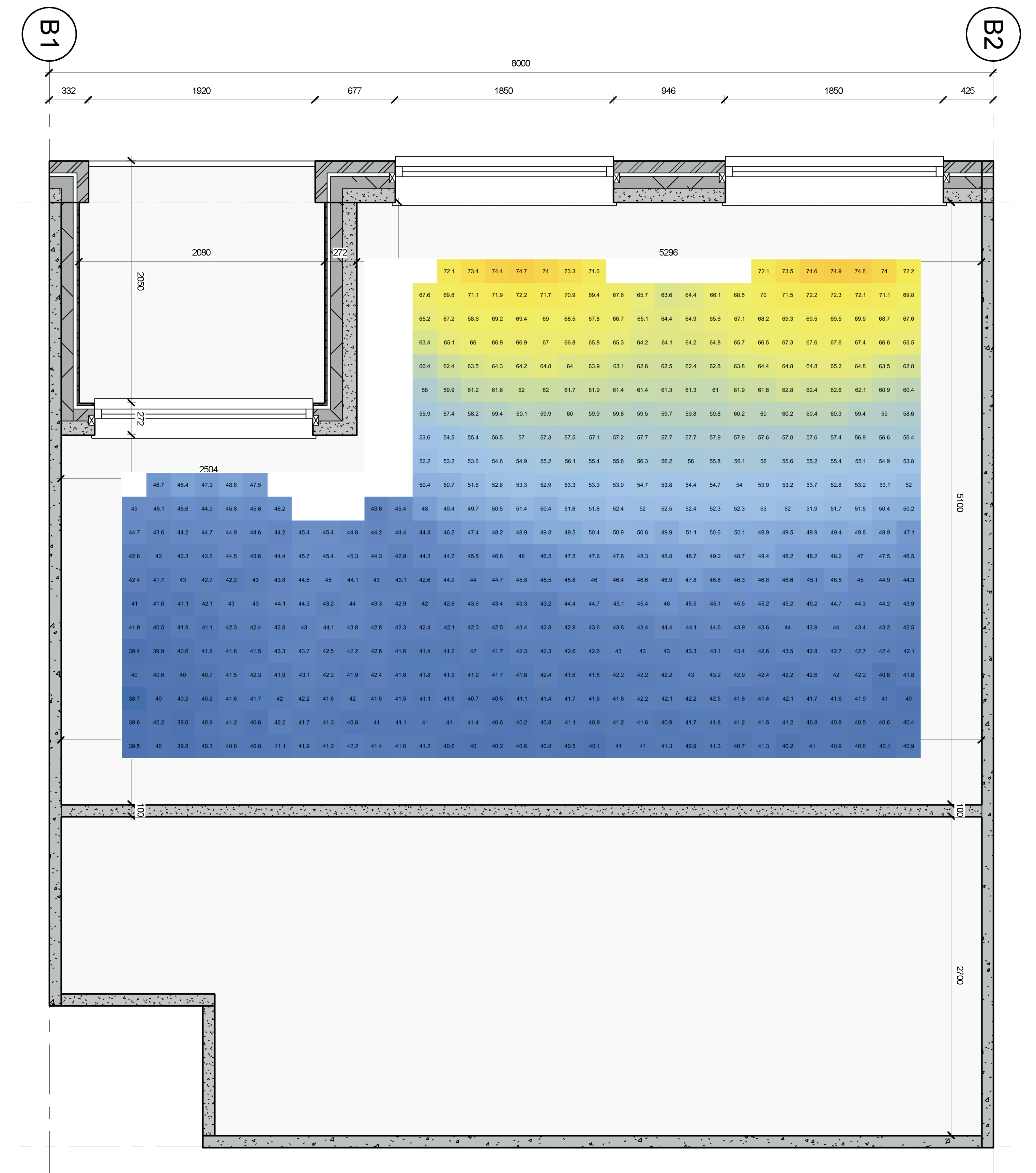
sensor grid



static

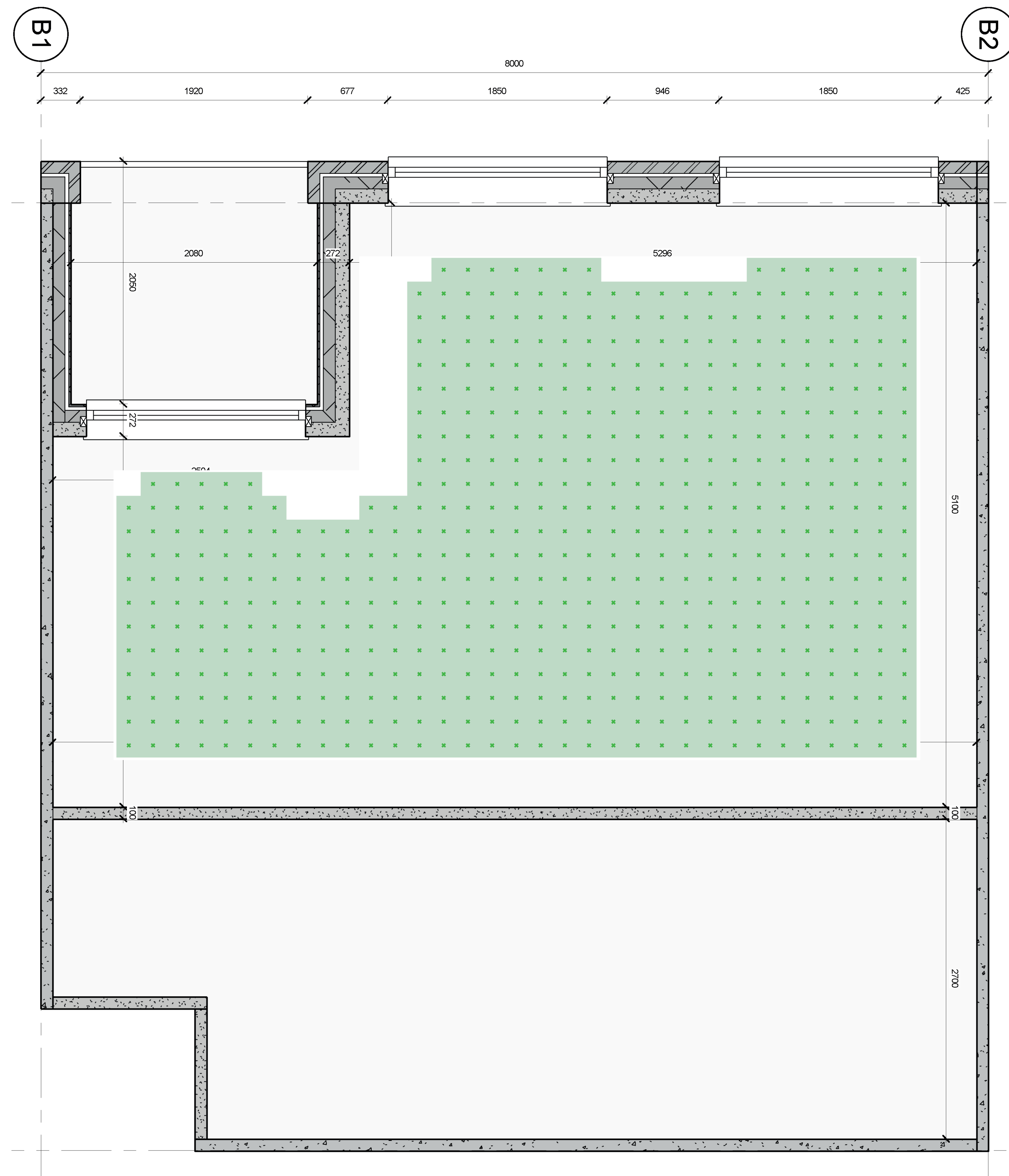


dynamic

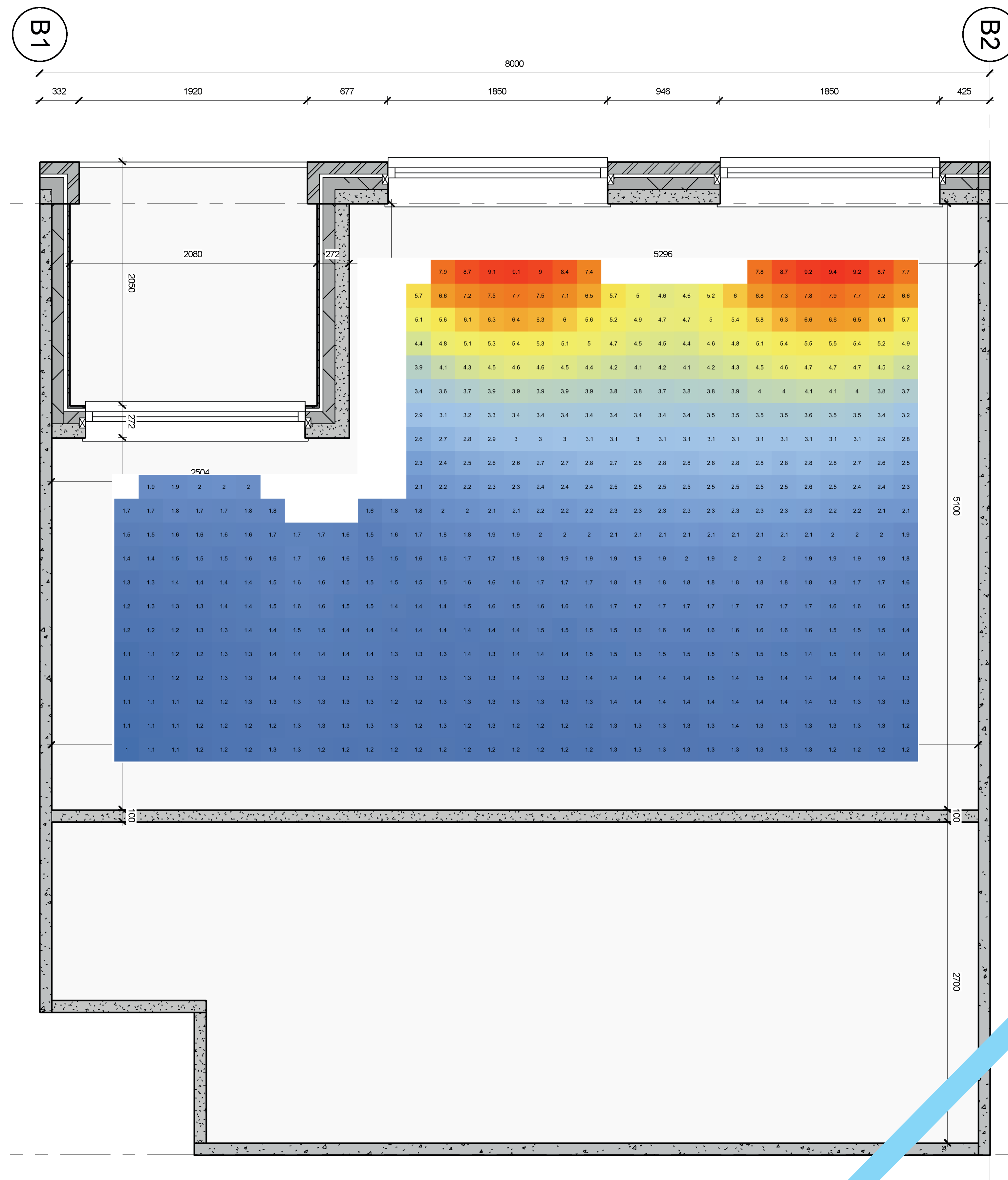


daylight factor (DF)
% of illuminance compared to outside

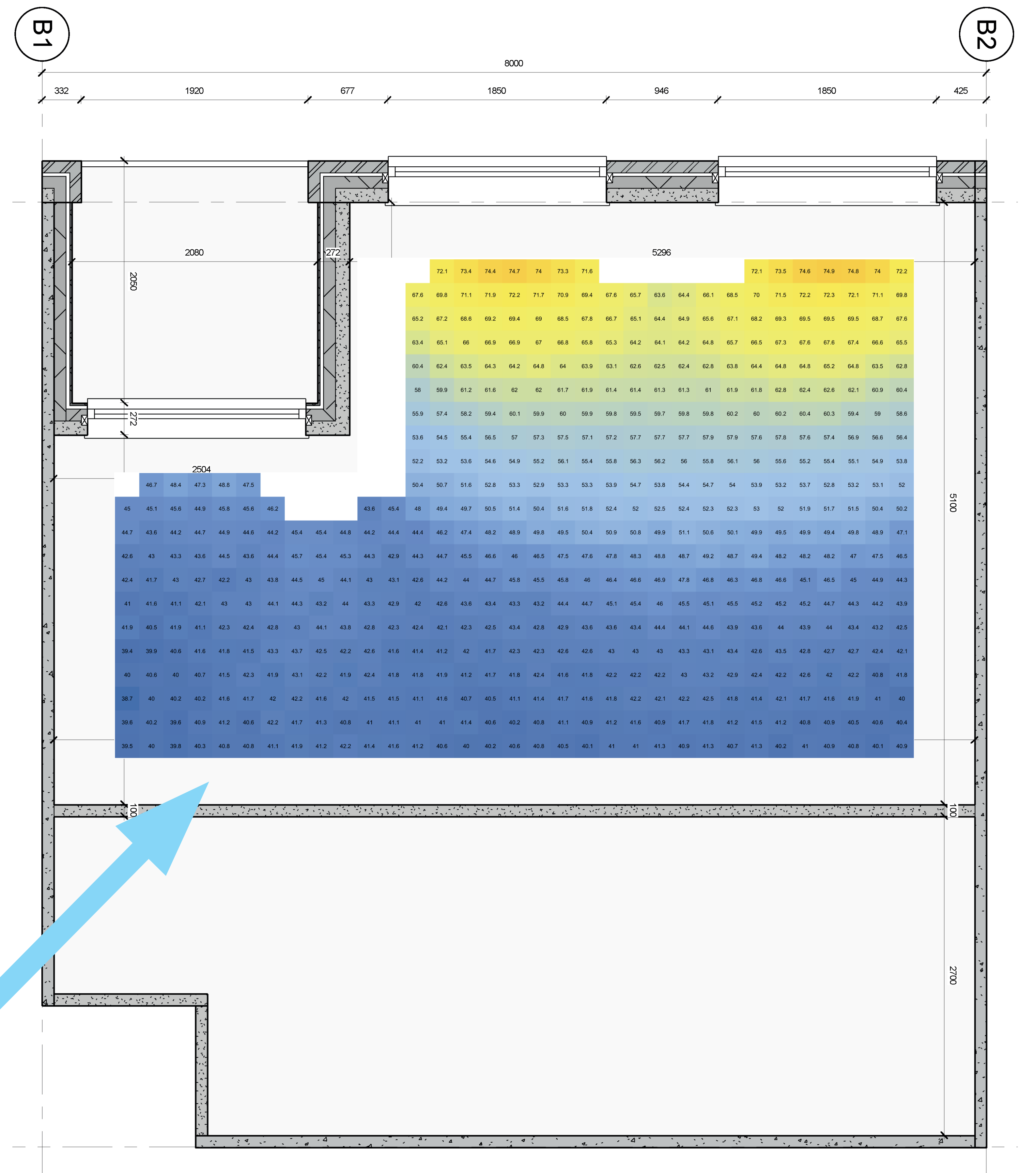
sensor grid



static

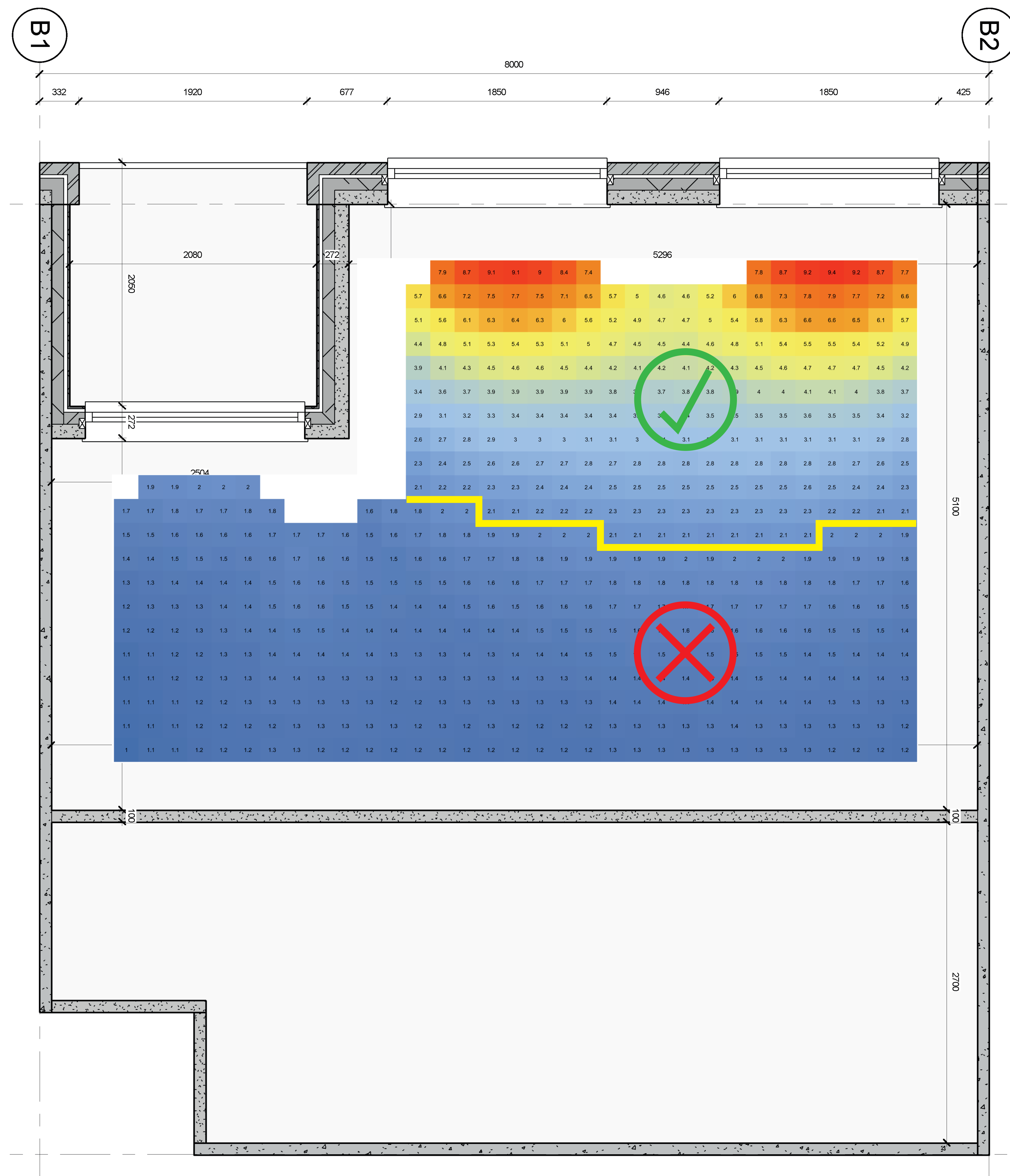


dynamic



daylight autonomy (DA)
% of time a sensor point exceeds an illuminance value

static



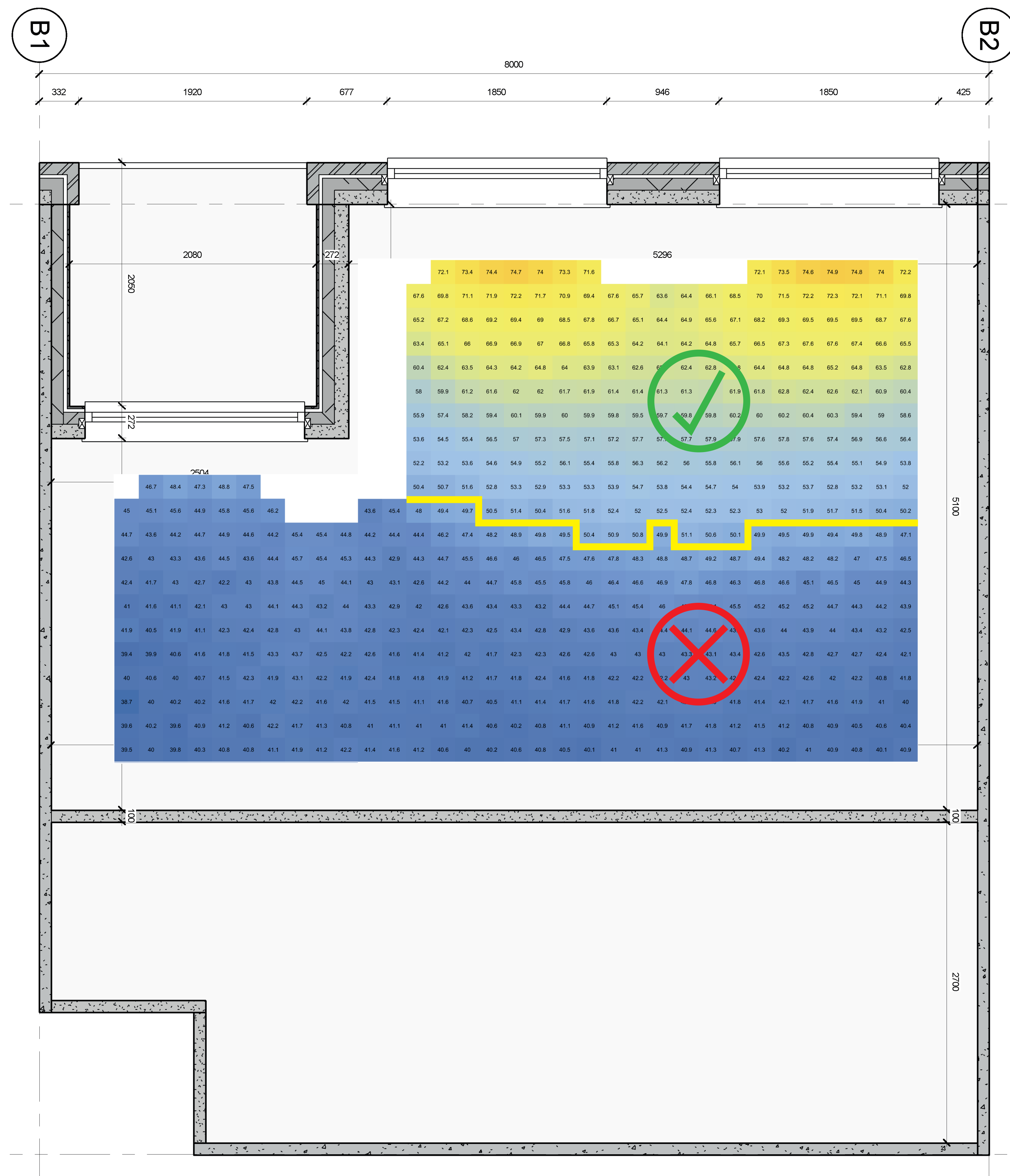
daylight factor (DF)
% of illuminance
compared to outside

$$\frac{E_{\text{indoor}}}{E_{\text{outdoor}}} = \frac{300}{14400} = 2.1$$

for half of the room so:

$$DF_{2.1} \geq 50\%$$

dynamic



daylight autonomy (DA)
% of time a sensor point
exceeds an illuminance value

$$\frac{h_{E>300lx}}{h_{\text{daylit hours}}} = \text{daylight autonomy}$$

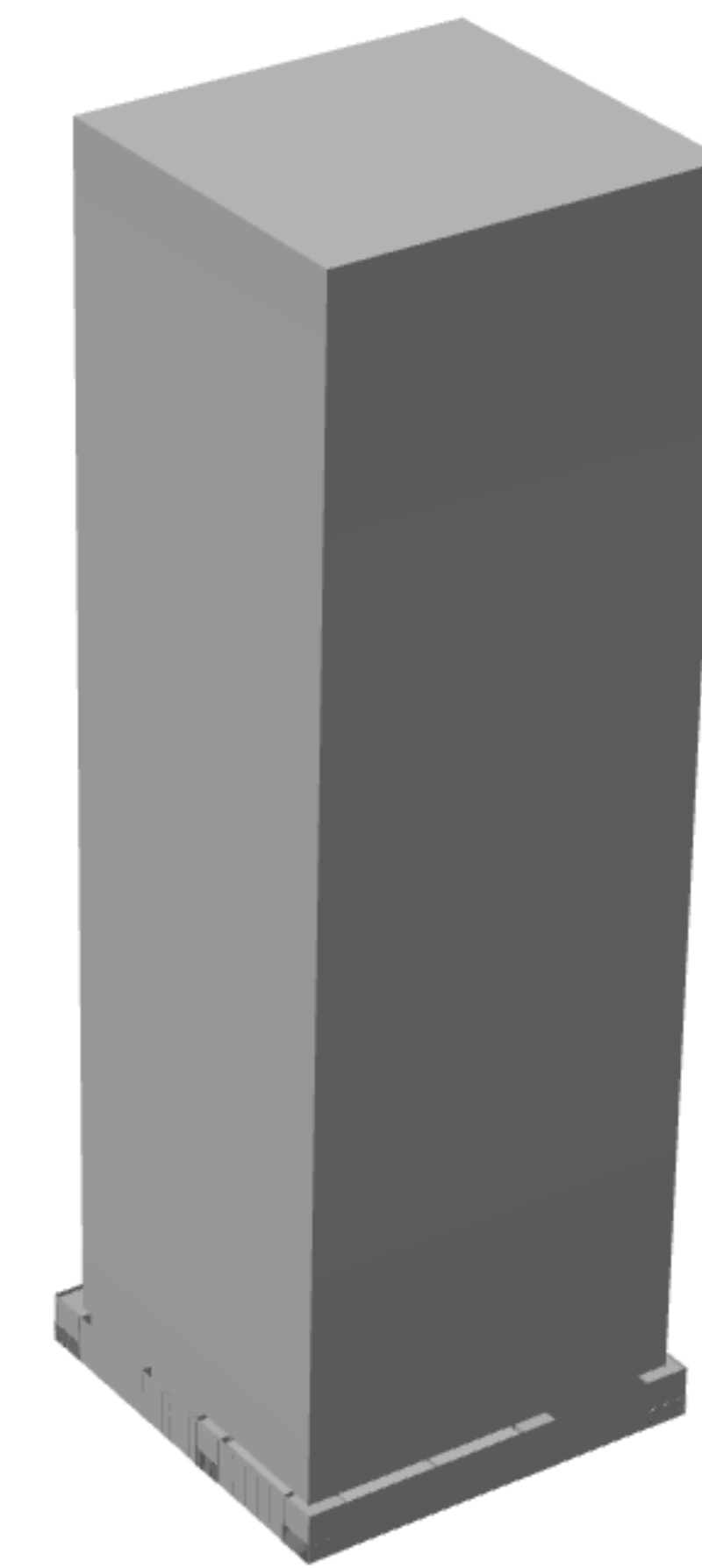
for half of the room so:

$$DA_{300} \geq 50\%$$

	Static	Dynamic
Dutch building code	$DF_1 \geq 50$	$DA_{144} \geq 50$
Recommended	$DF_{2.1} \geq 50$	$DA_{300} \geq 50$

Daylight assessment: the EN 17037

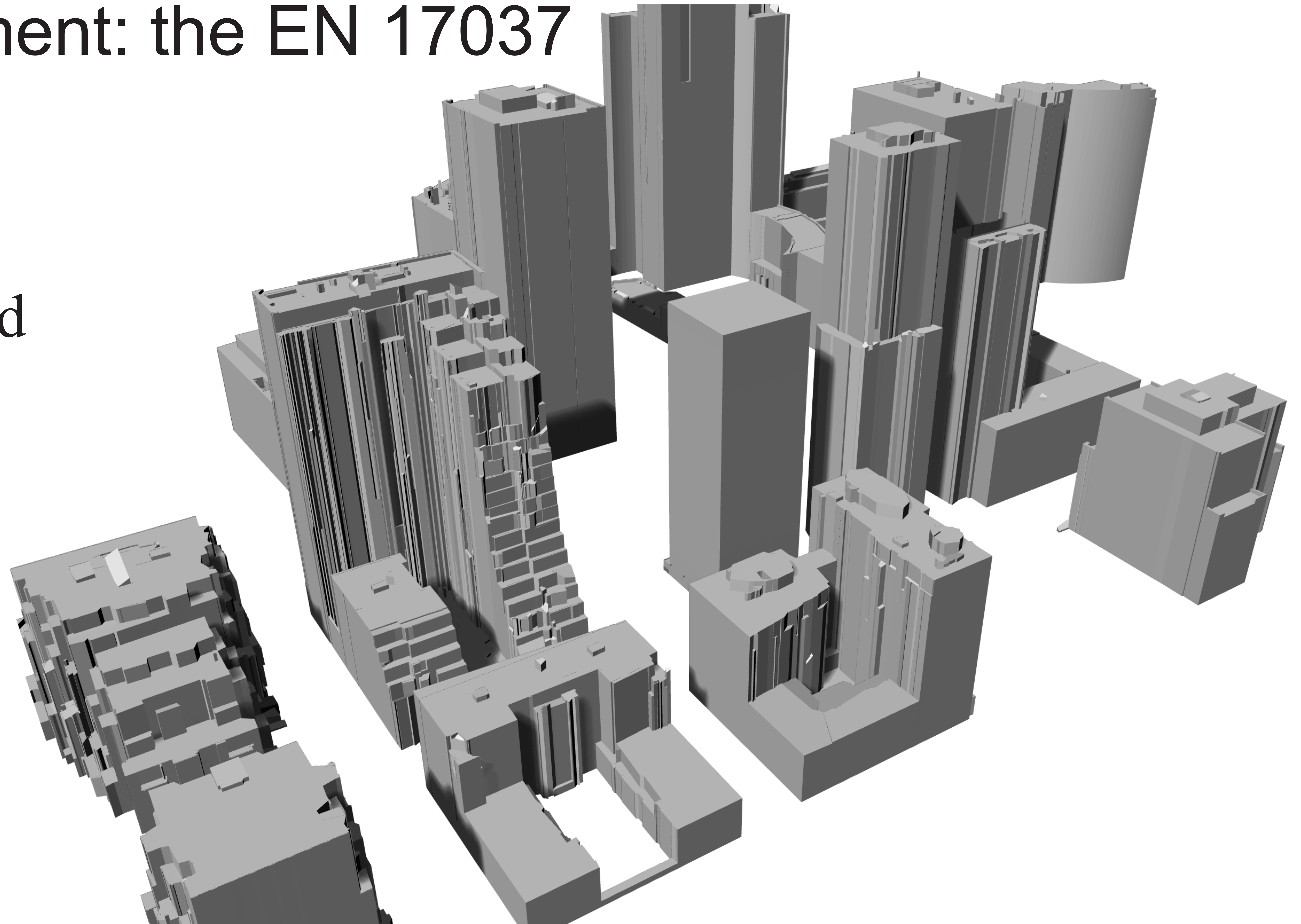
- DF & DA metrics



Daylight assessment: the EN 17037

- DF & DA metrics
- Context not included

How much is
daylighting
decreased due to
urban context?



main research question

What are the **design consequences** in Dutch urban areas when **context is integrated** in current daylighting evaluation methods, regarding visual and non-visual **levels of daylight**?

Sufficient &
healthy daylight

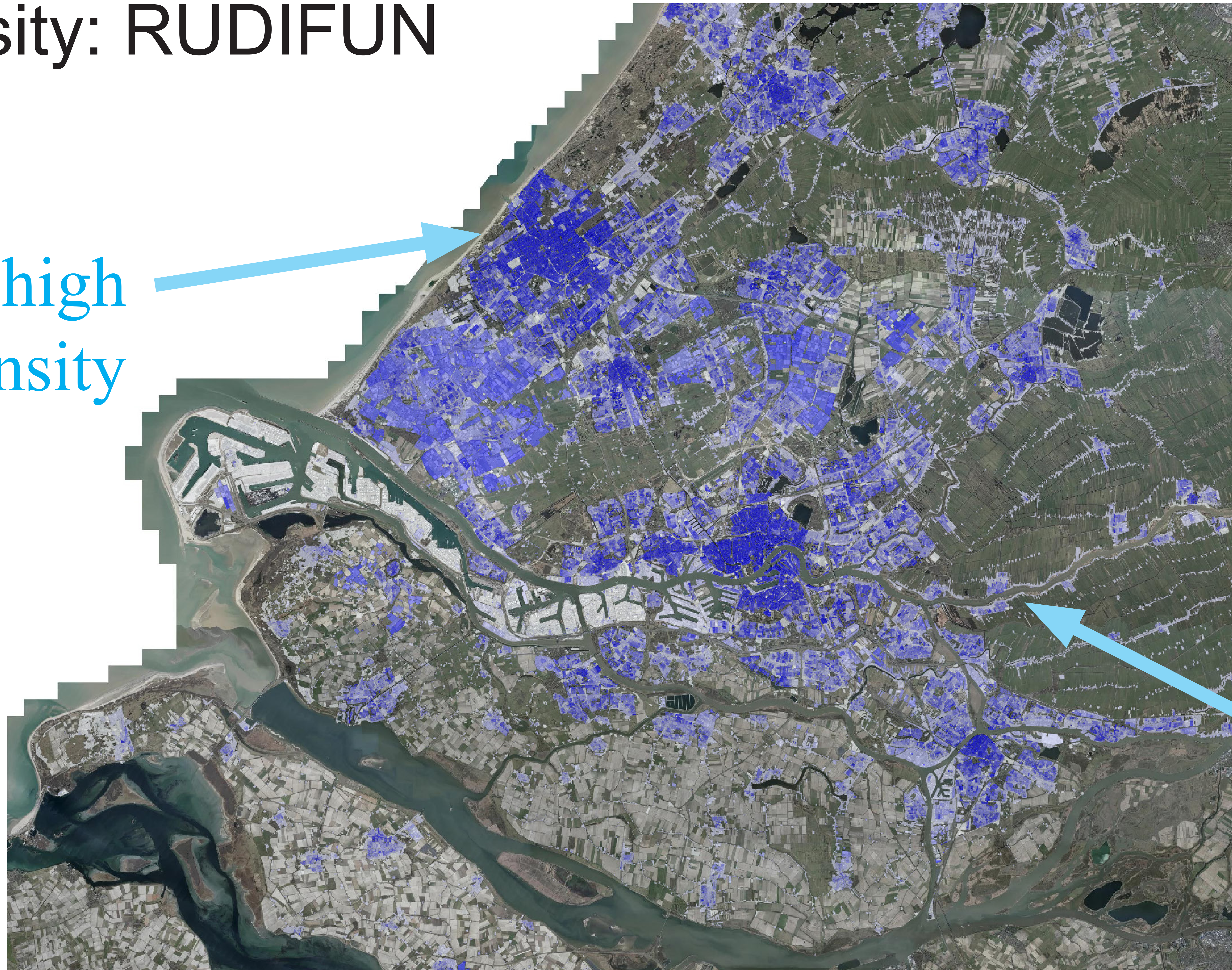
Daylighting in
urban areas

Results &
analysis

Mitigation
strategies

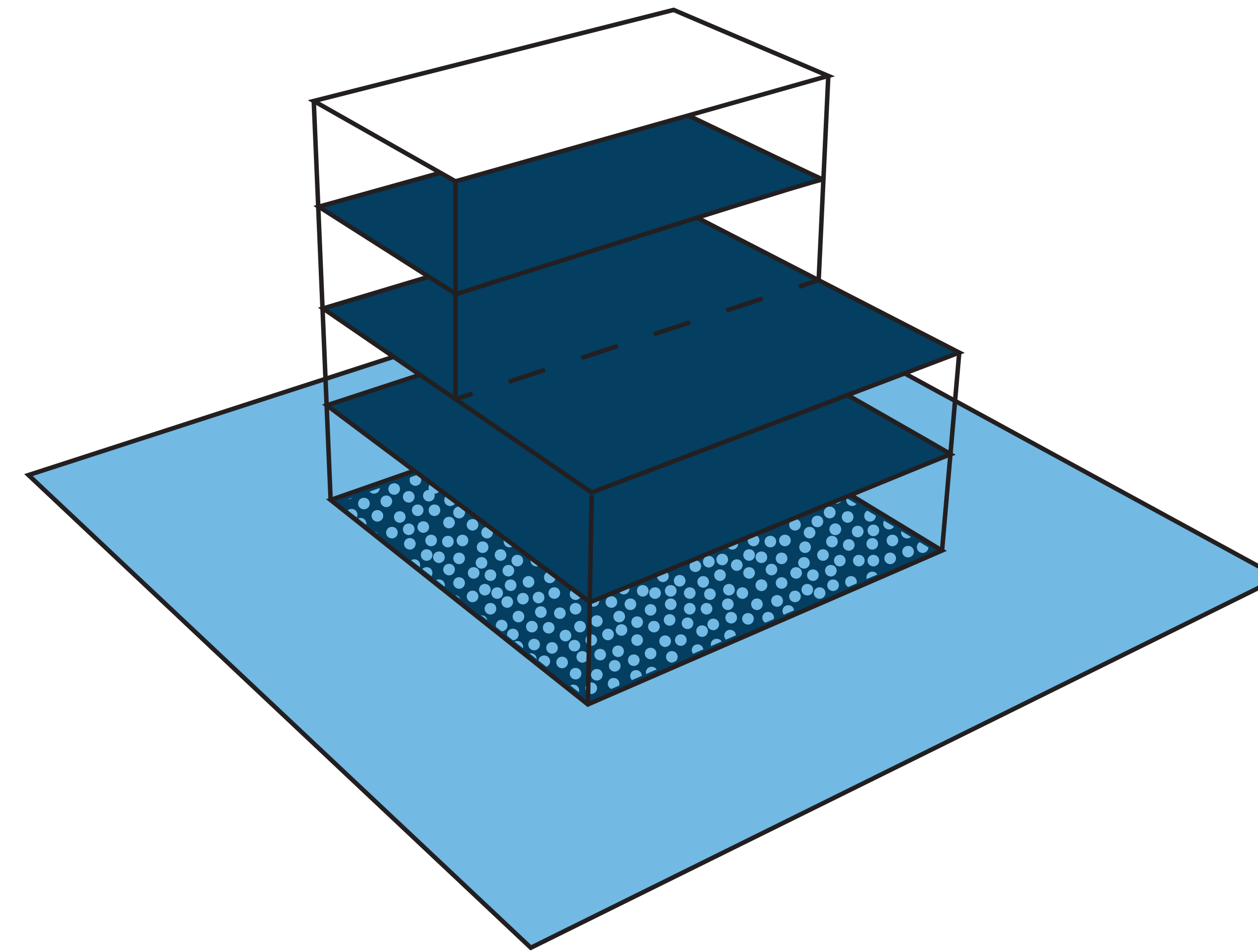
Urban density: RUDIFUN

Very high
urban density

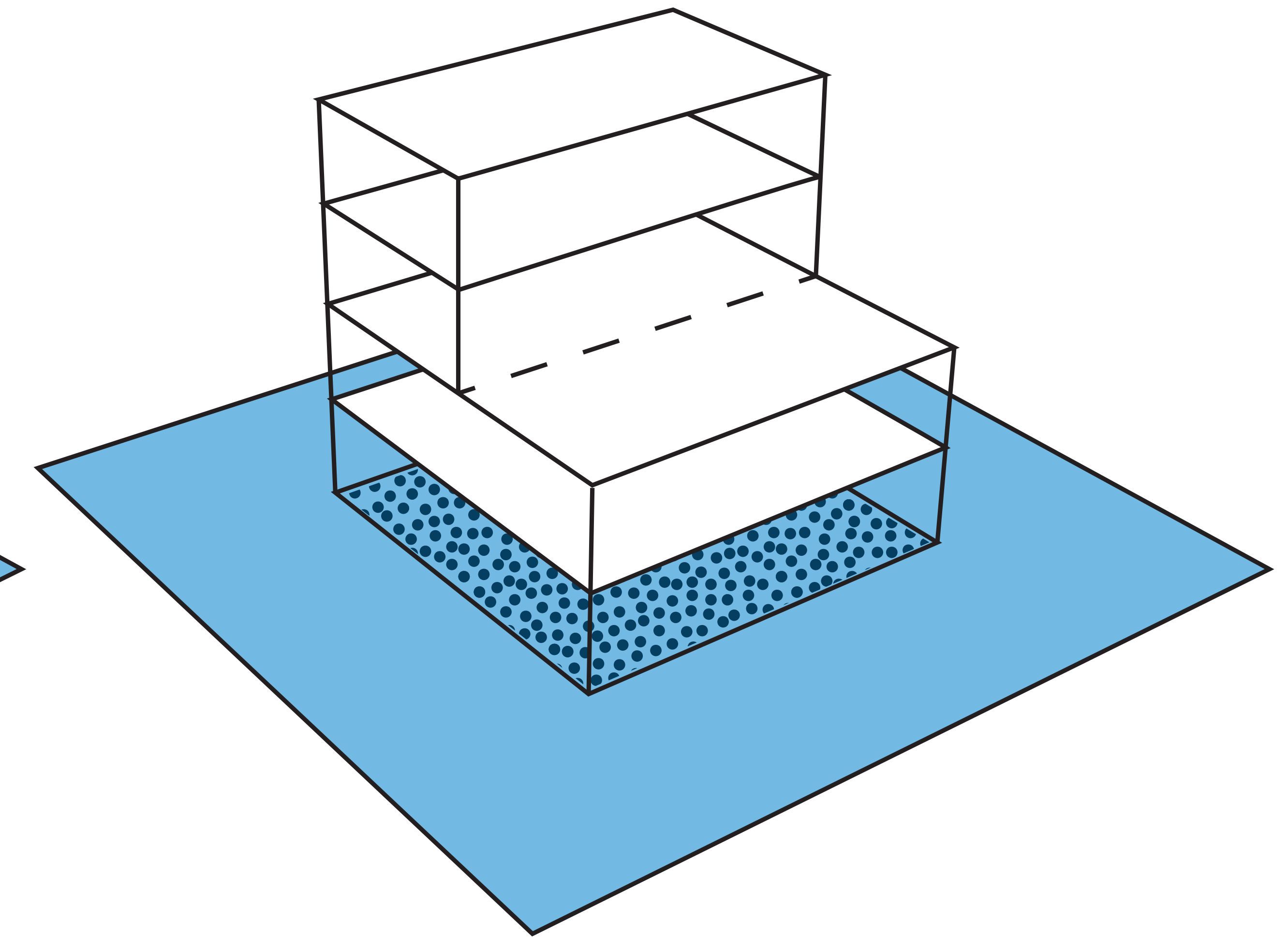


Low
urban
density

Floor-space index (FSI)
How large are the buildings?

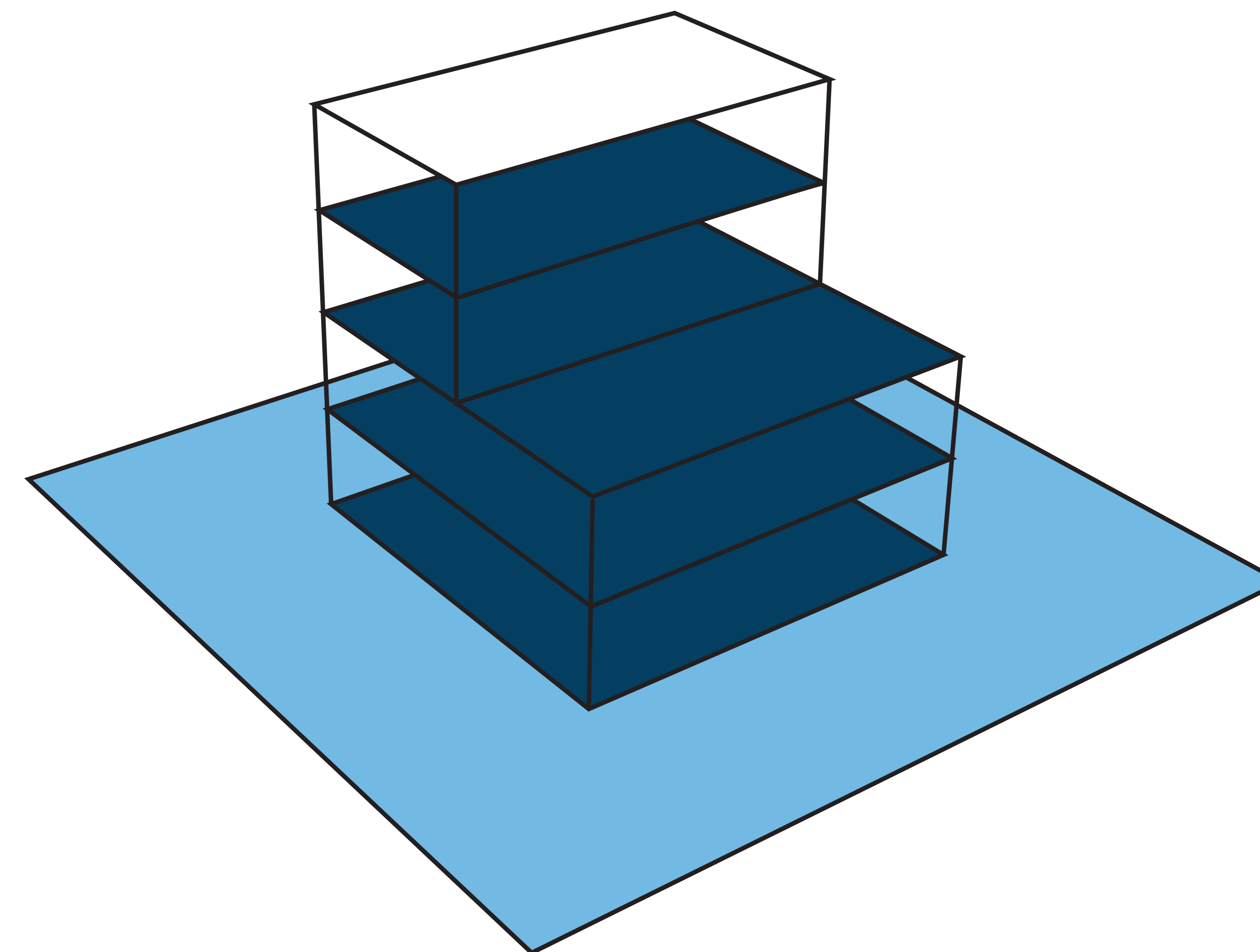


$$\text{FSI} = \text{total floor area} / \text{total surface area}$$

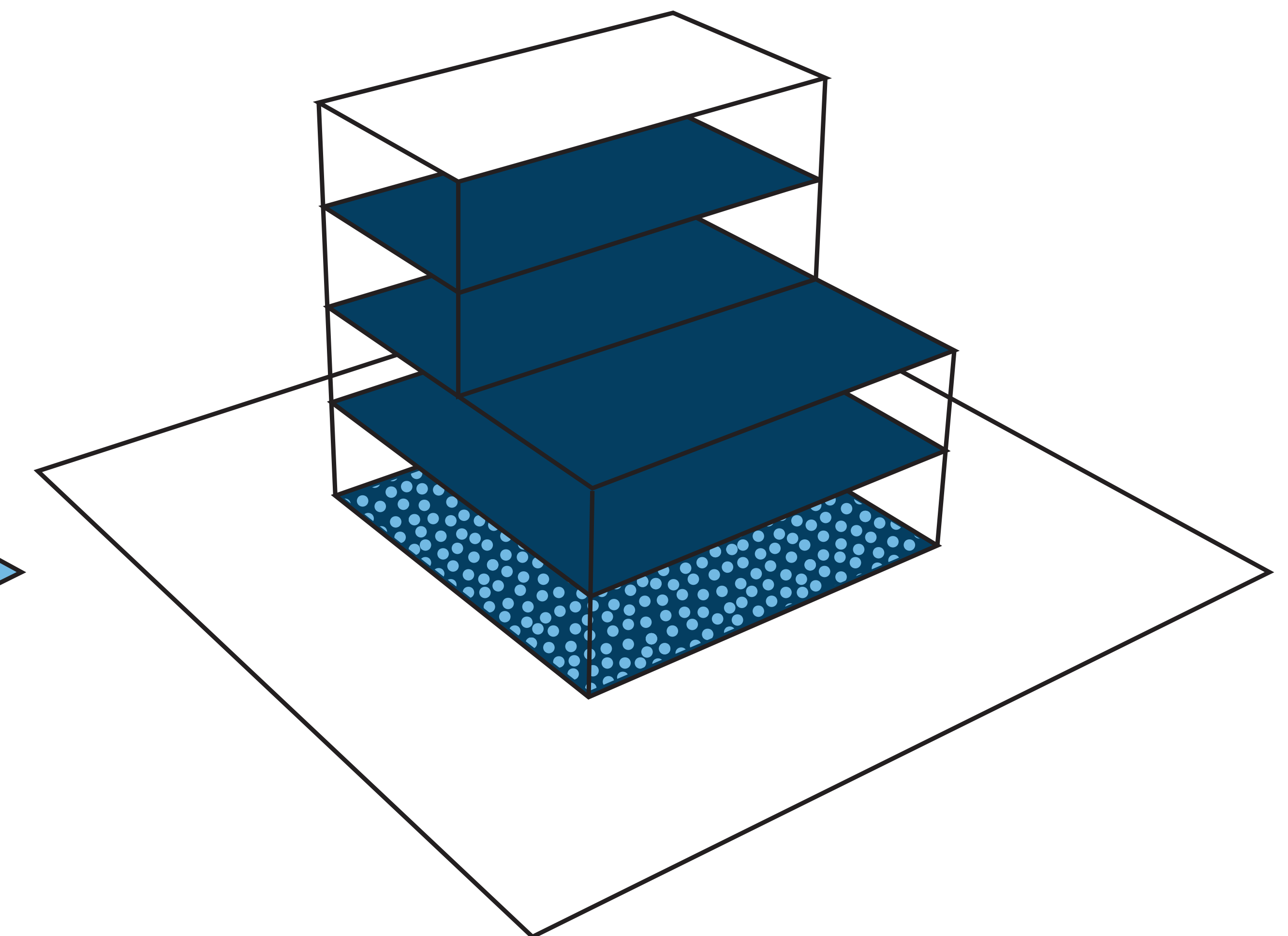


$$\text{GSI} = \text{footprint area} / \text{total surface area}$$

Ground-space index (GSI)
How much ground is built on?



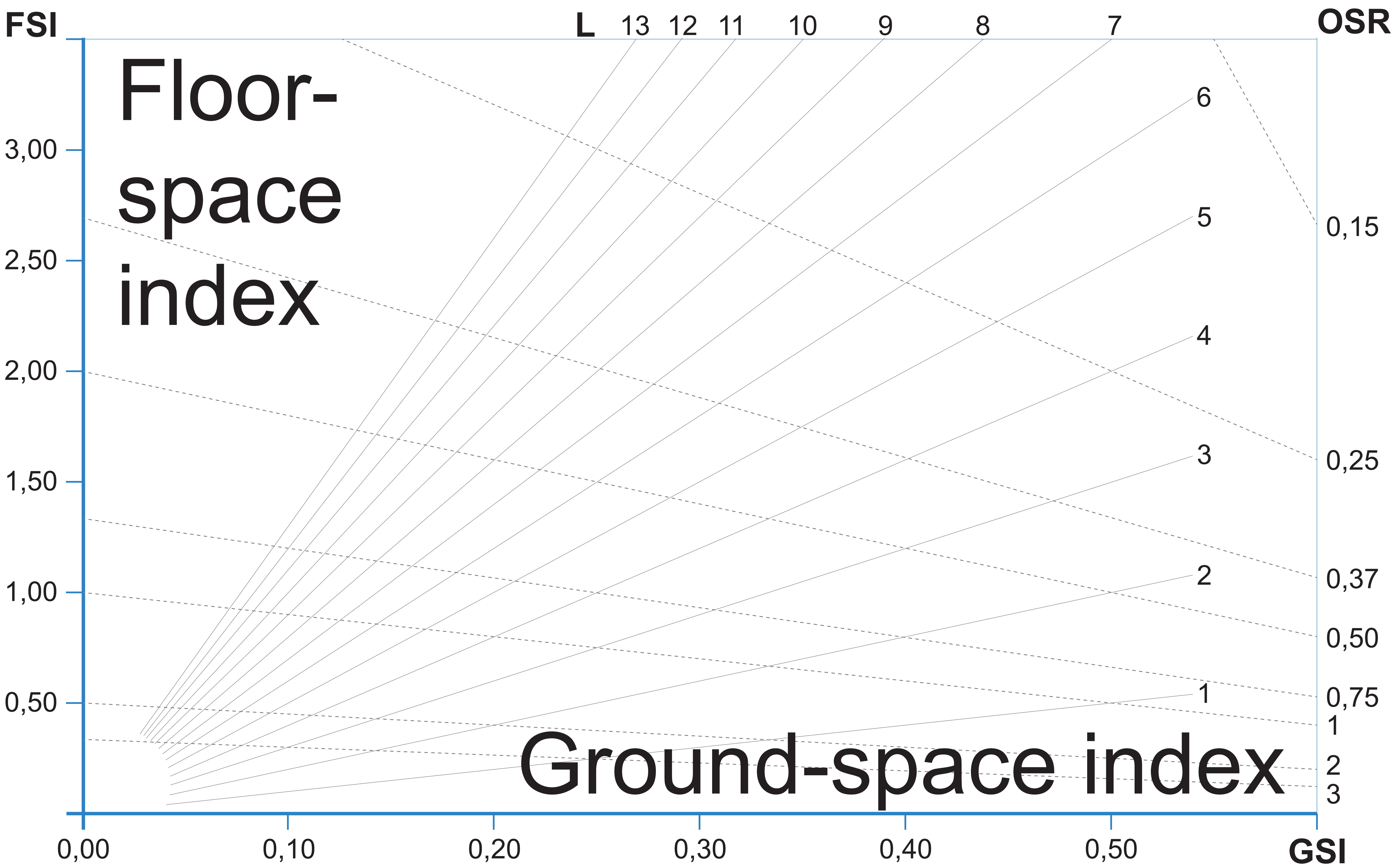
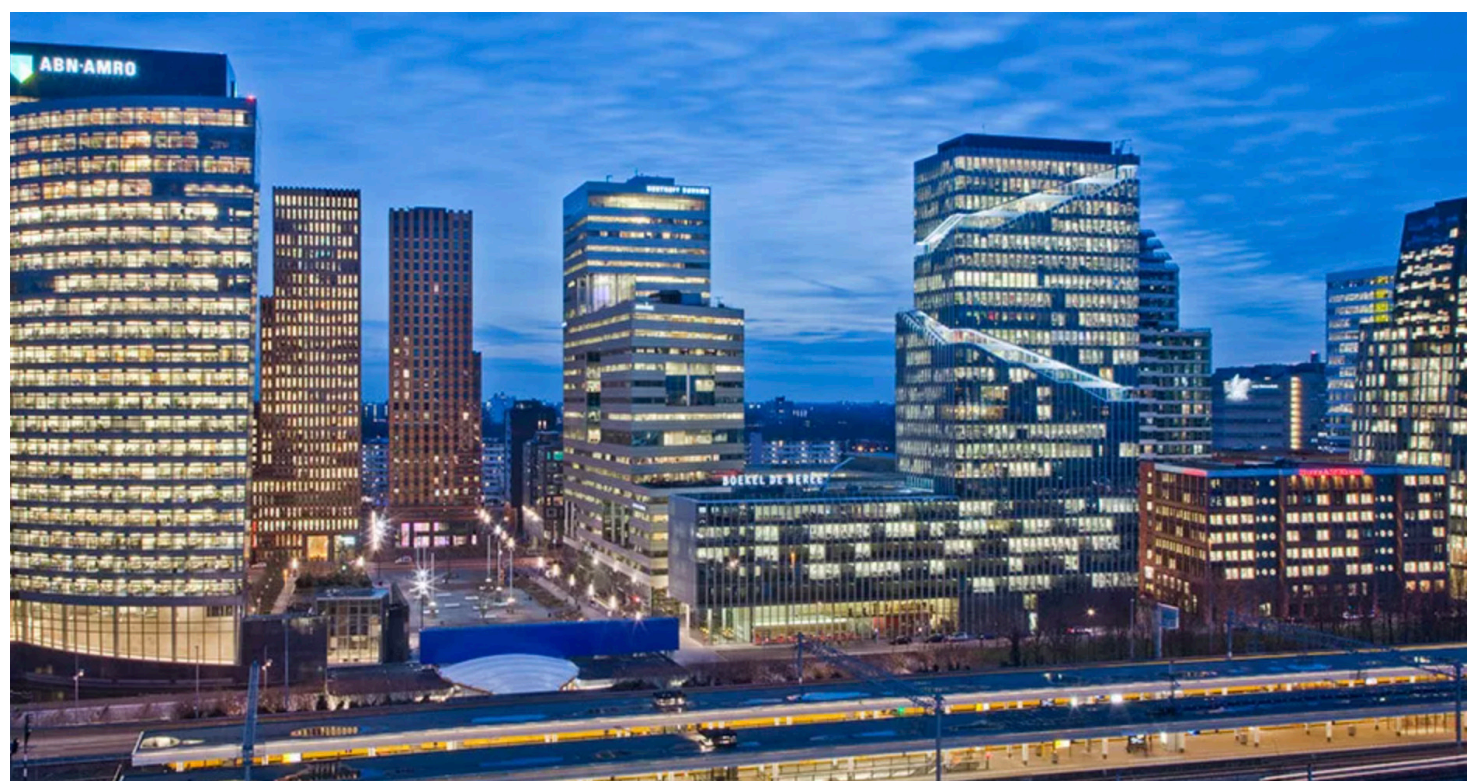
$$\text{OSR} = \text{total unbuilt area} / \text{total floor area}$$



$$L = \text{footprint area} / \text{total floor area}$$

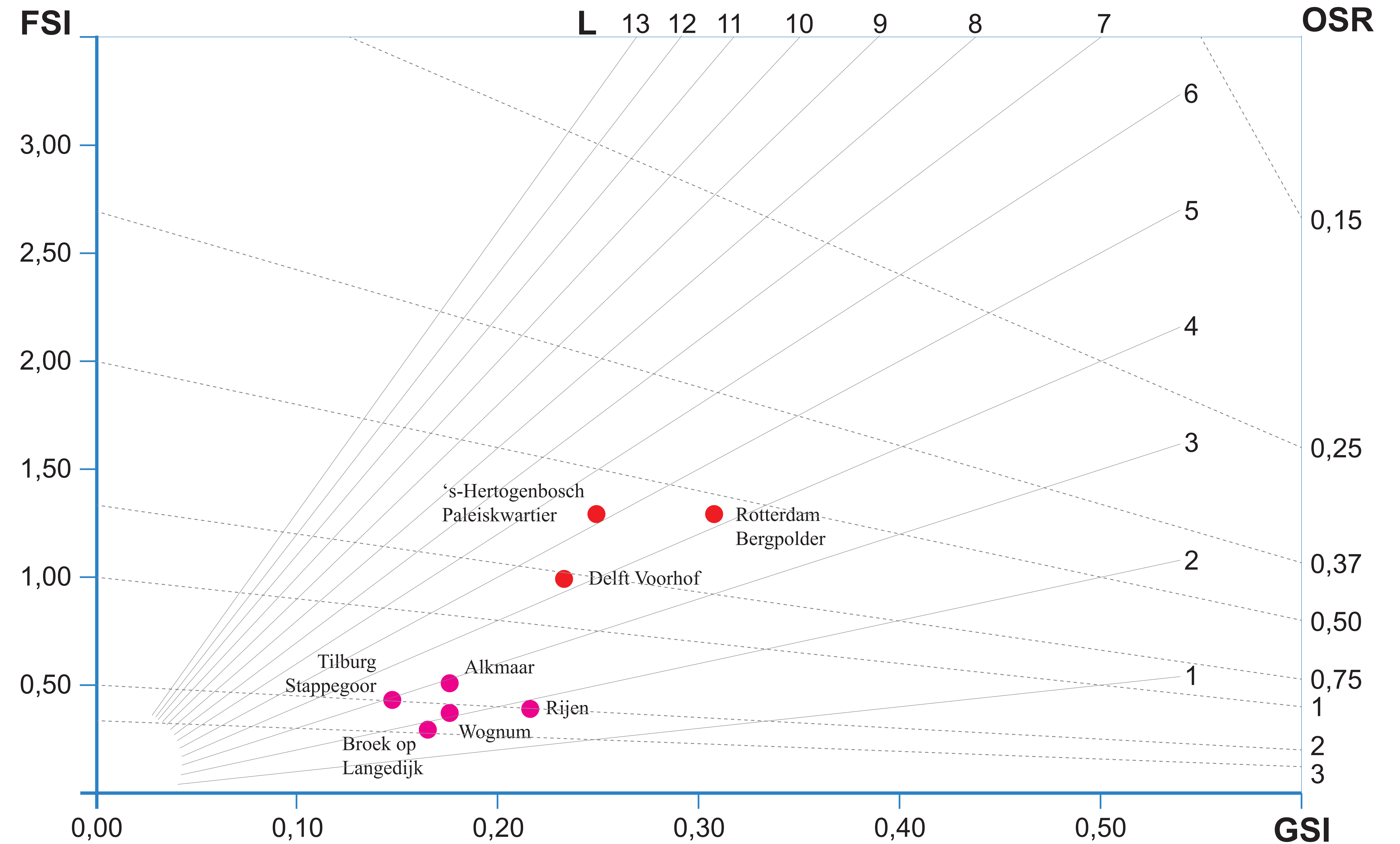
Open-space ratio (OSR)
How much space is left?

the Spacemate



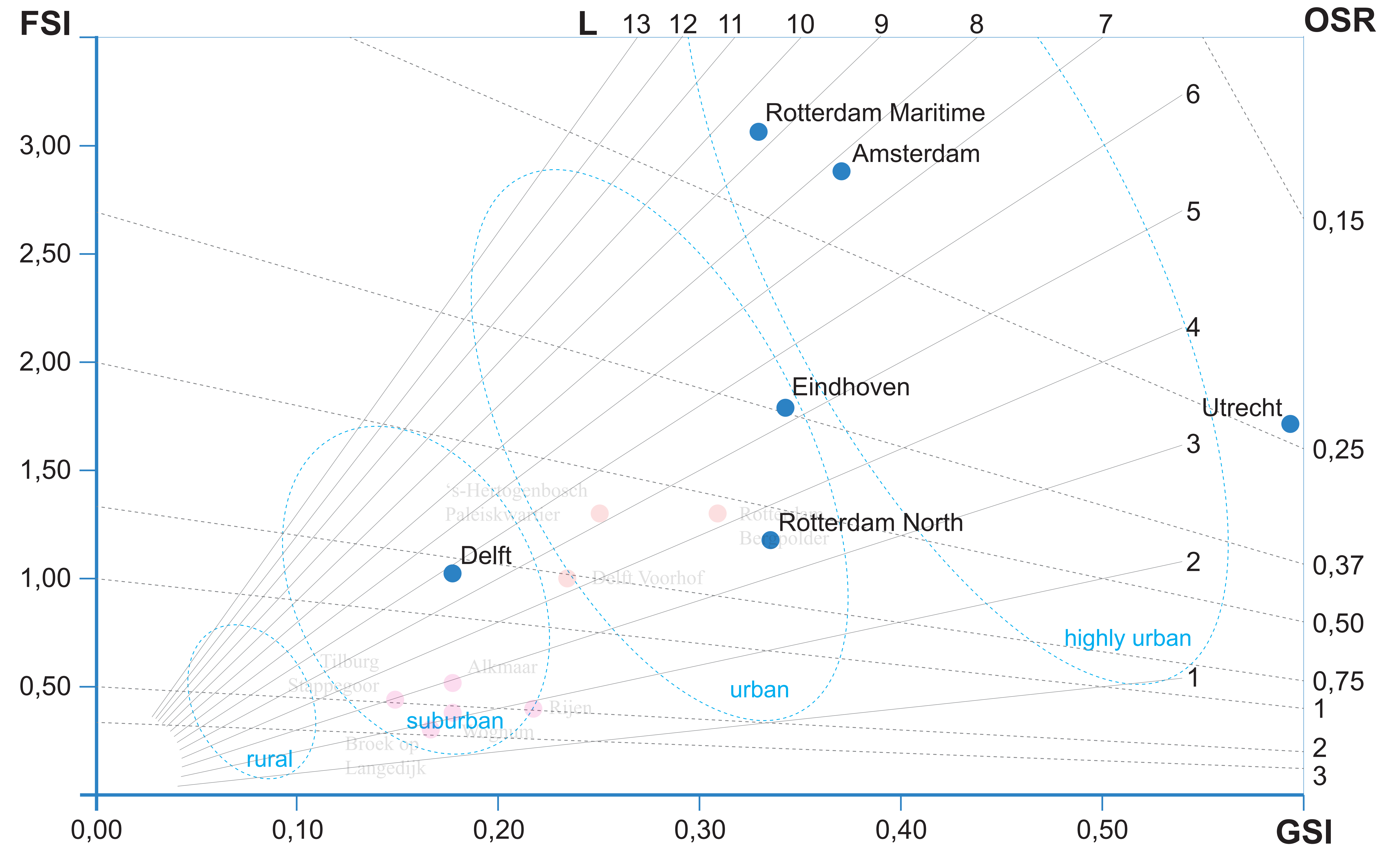
the Spacemate

- Suburban: low density
- Urban: medium density



the Spacemate

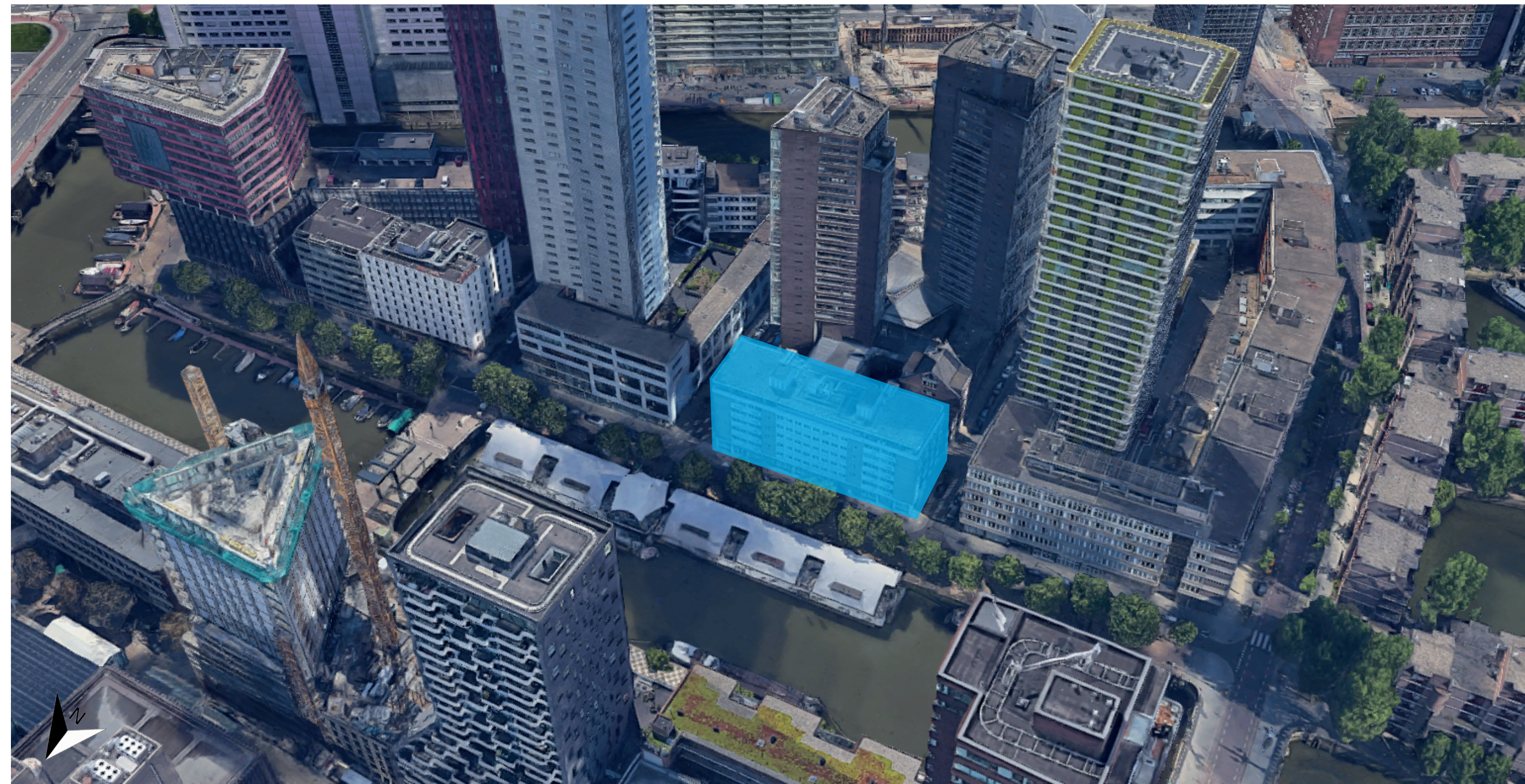
- Six locations
- Higher density, lower daylighting performance



Rotterdam Maritime

Lat. 51.9171

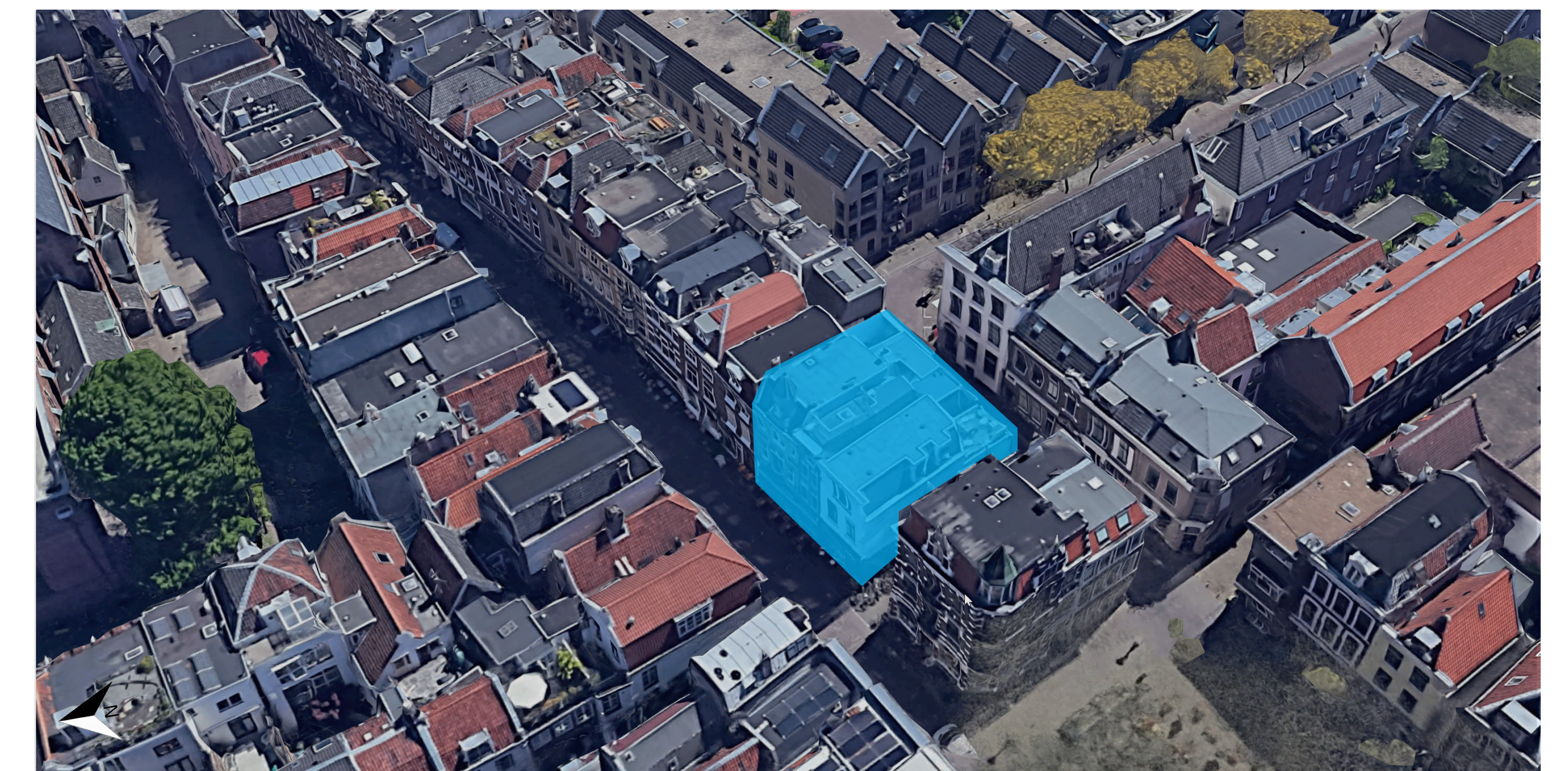
Long. 4.4868



Utrecht

Lat. 52.0898

Long. 5.1188



Amsterdam

Lat 52.3361

Long. 4.8730



Rotterdam North

Lat. 51.9326

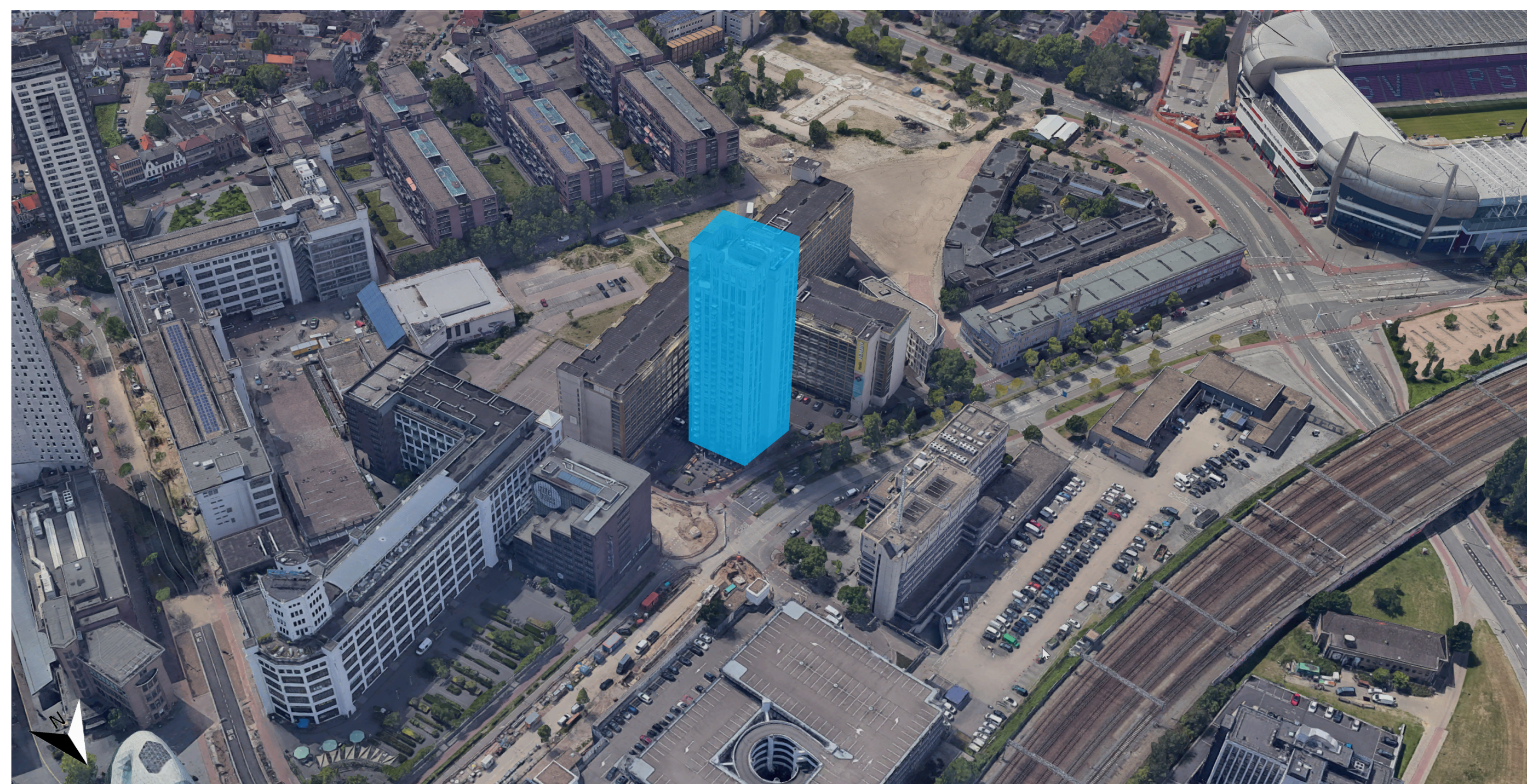
Long 4.4758



Eindhoven

Lat. 51.4408

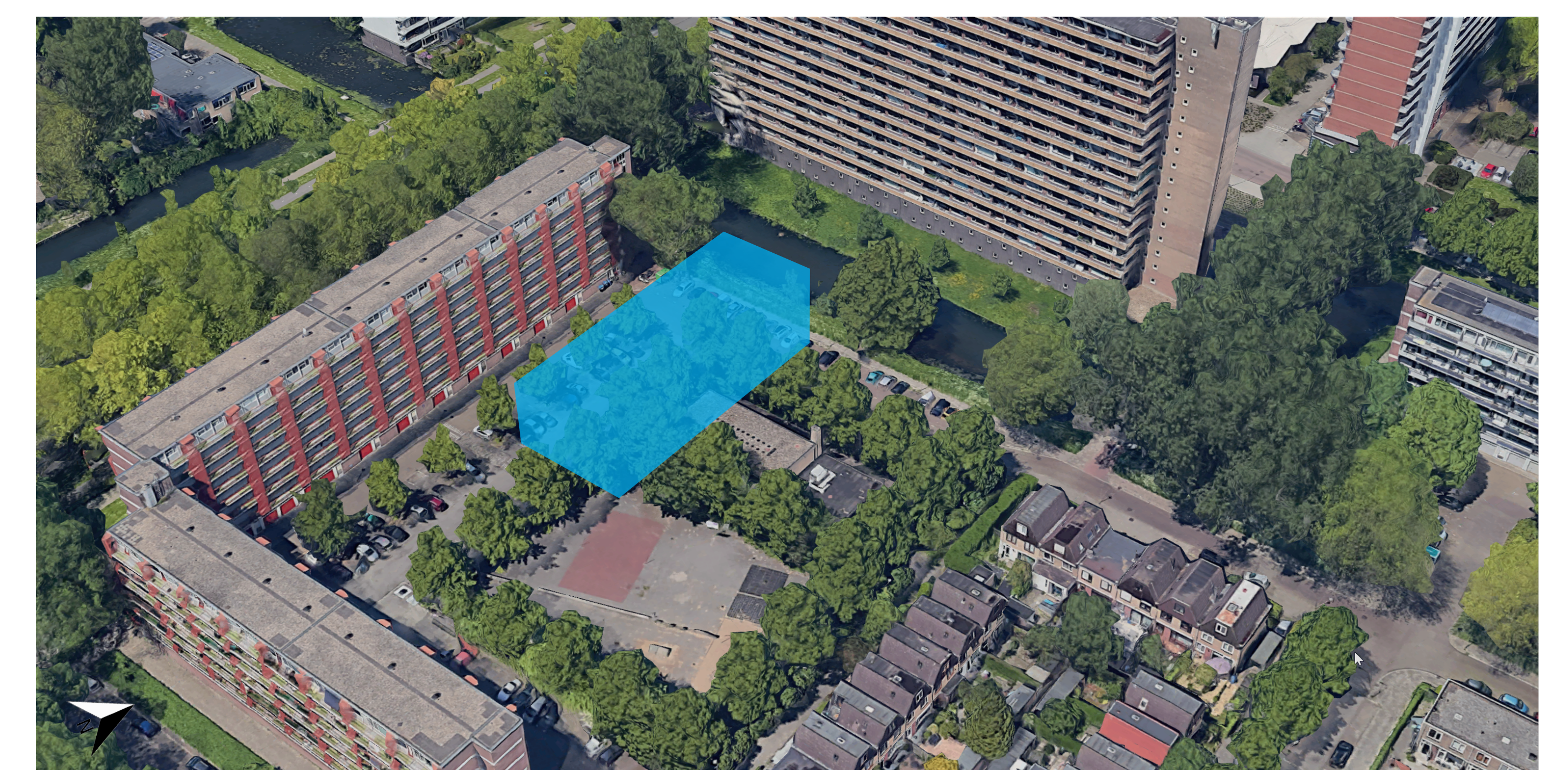
Long. 5.4728



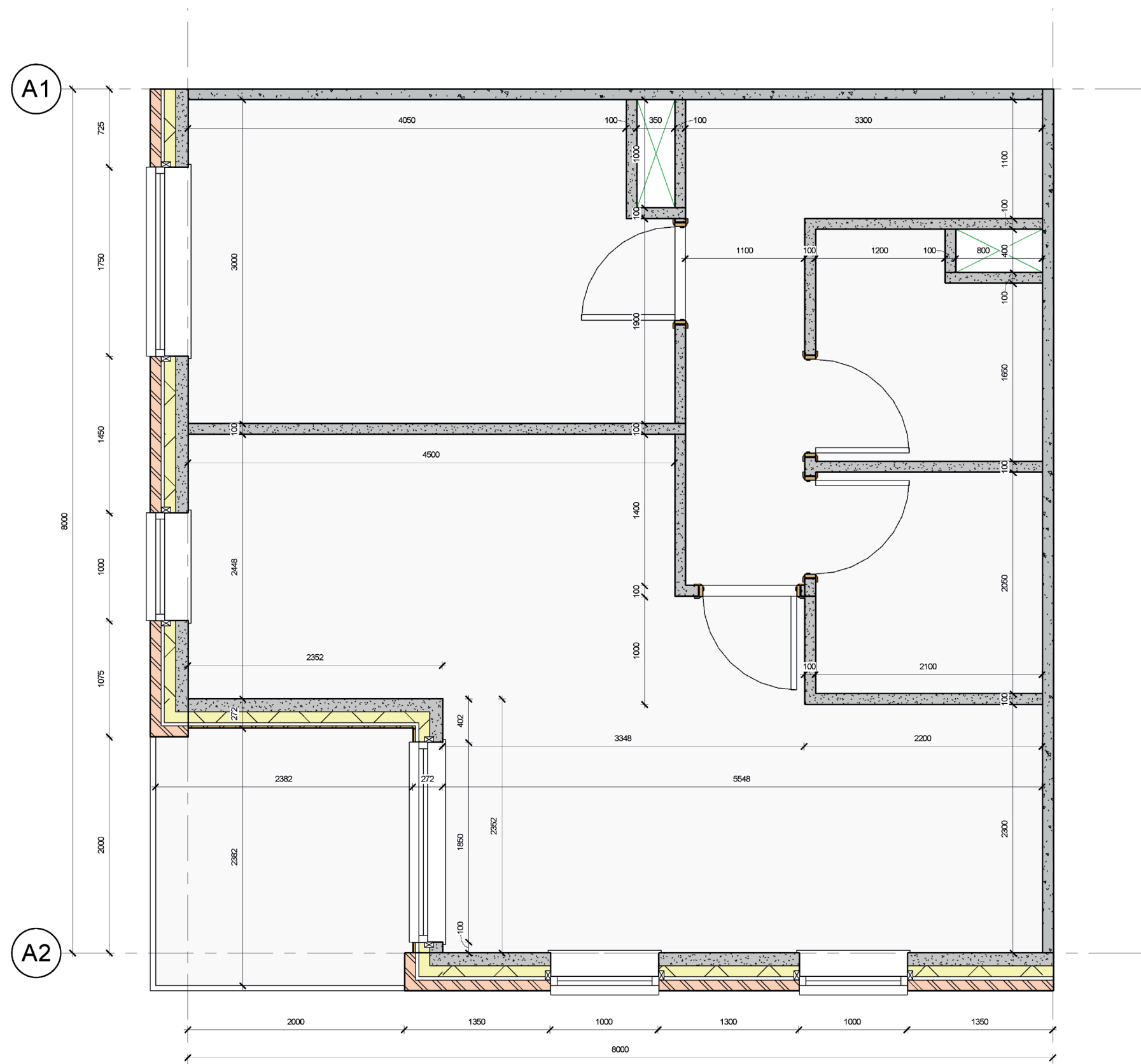
Delft

Lat. 51.9958

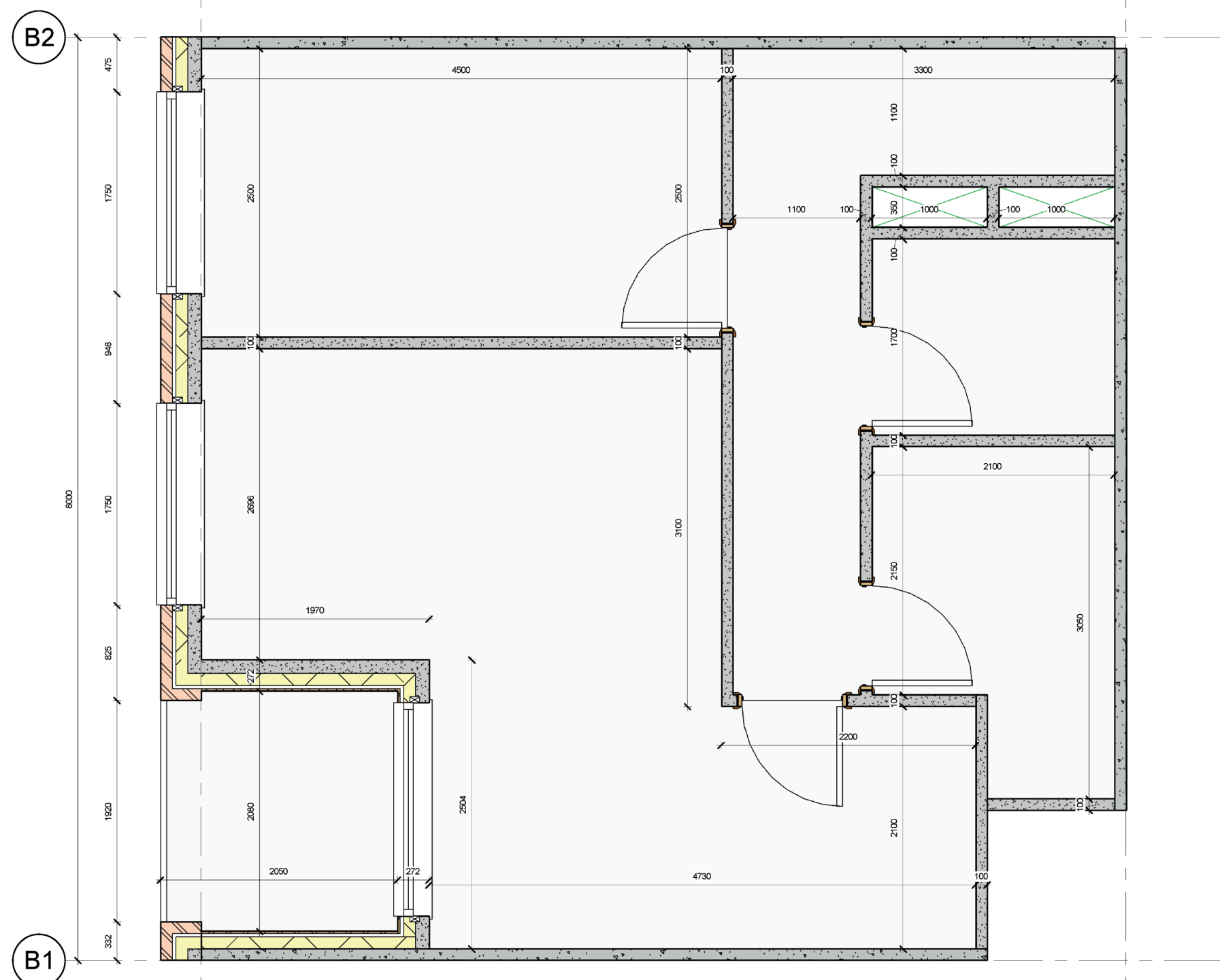
Long. 4.3560



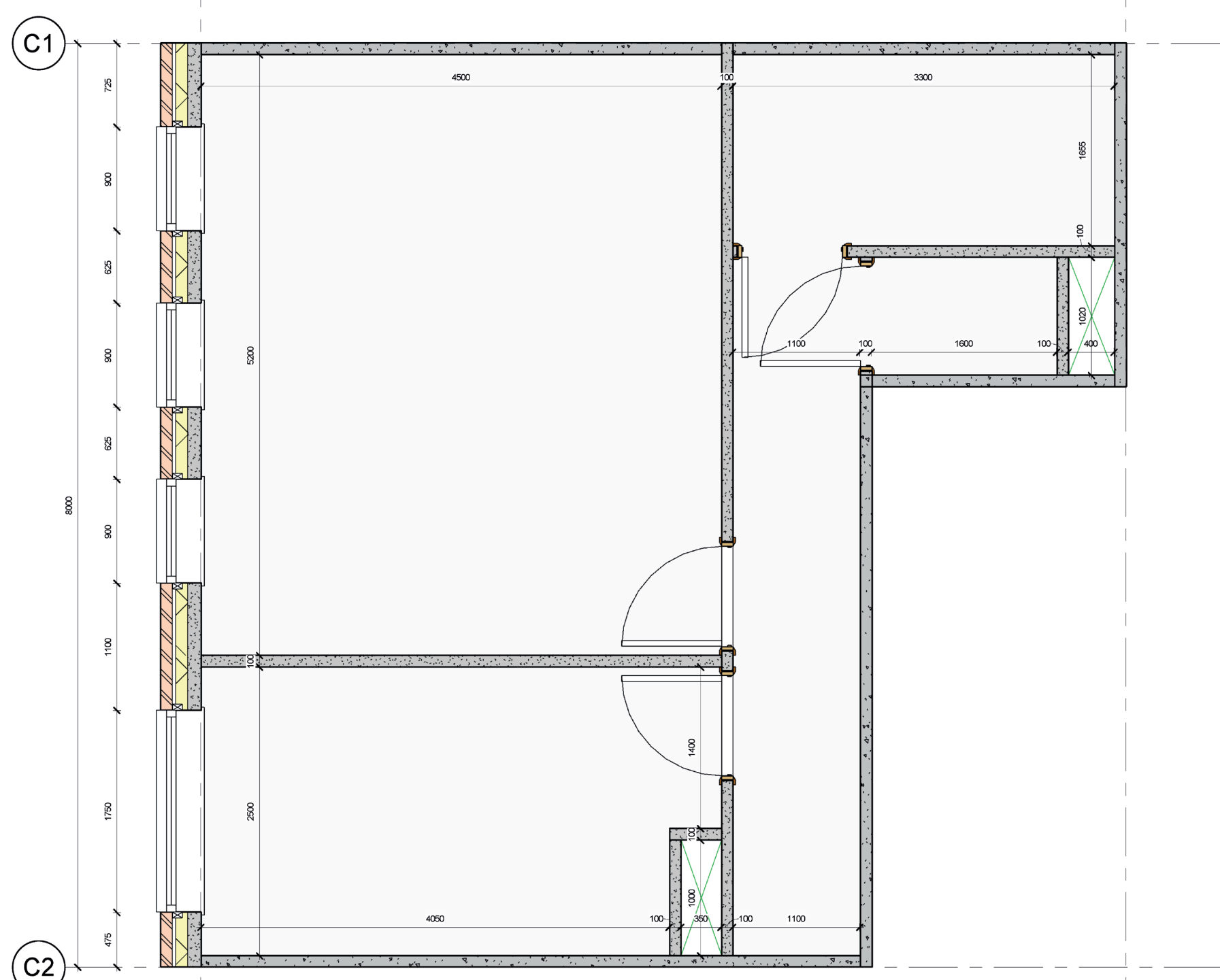
Type A



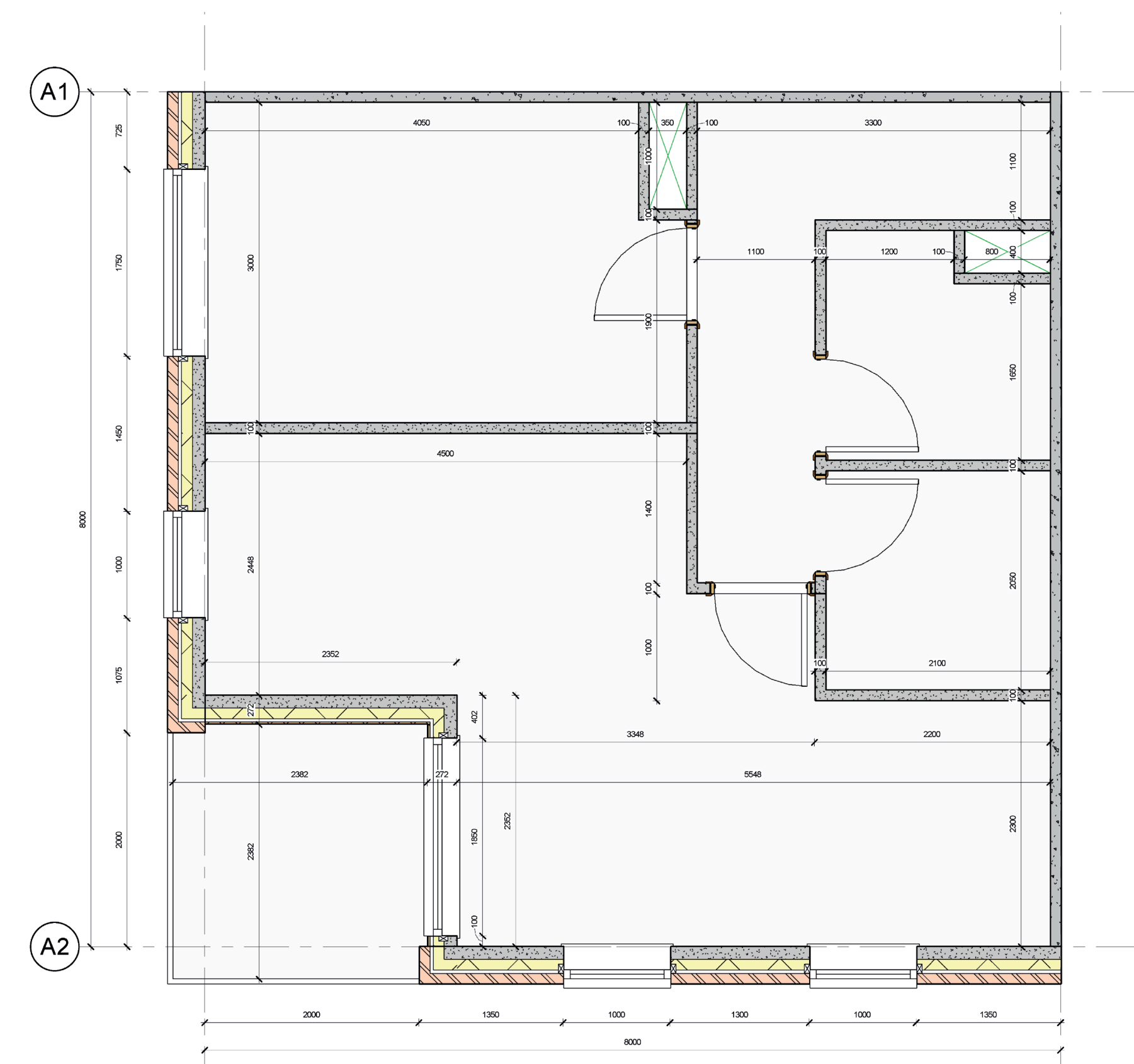
Type B



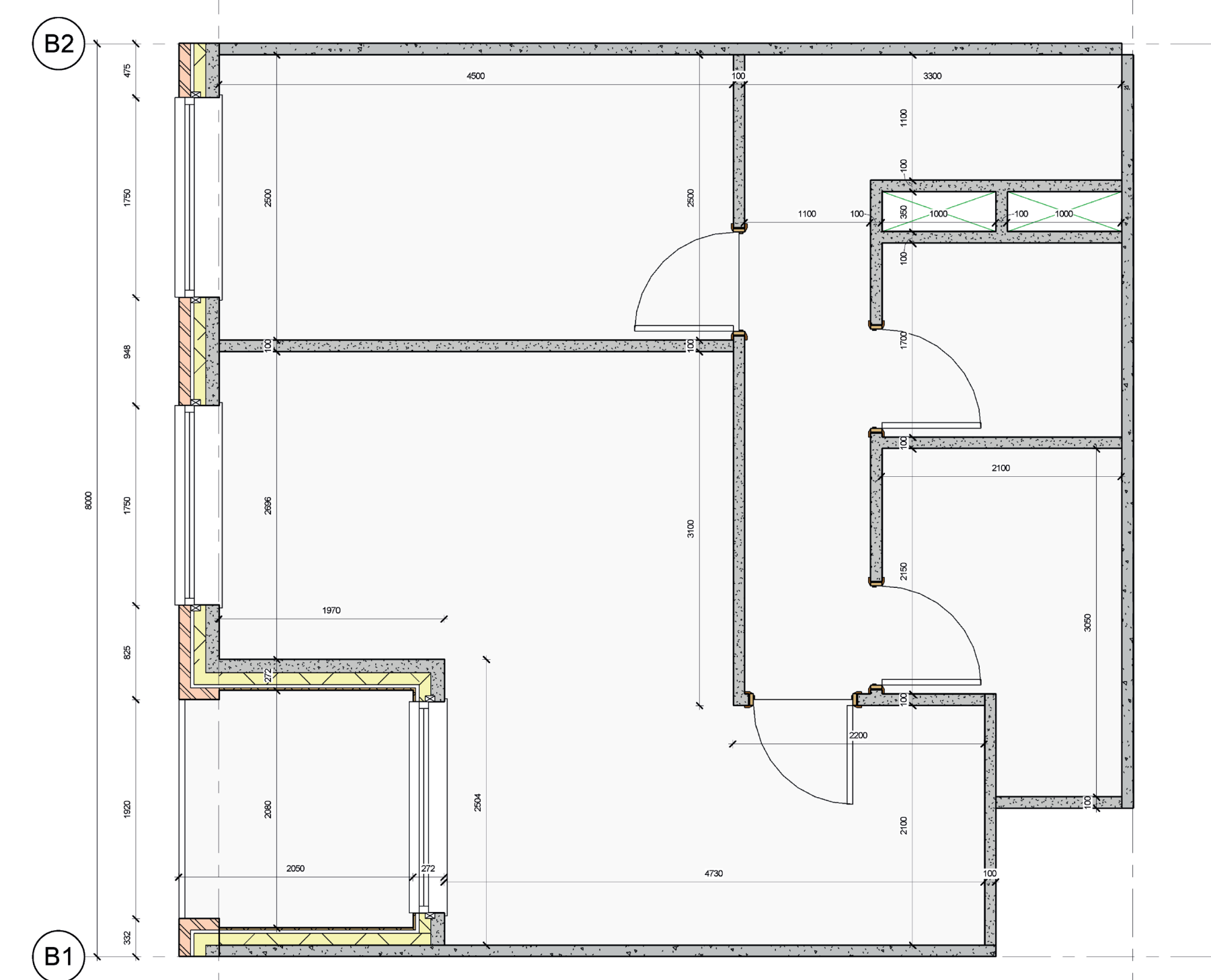
Type C



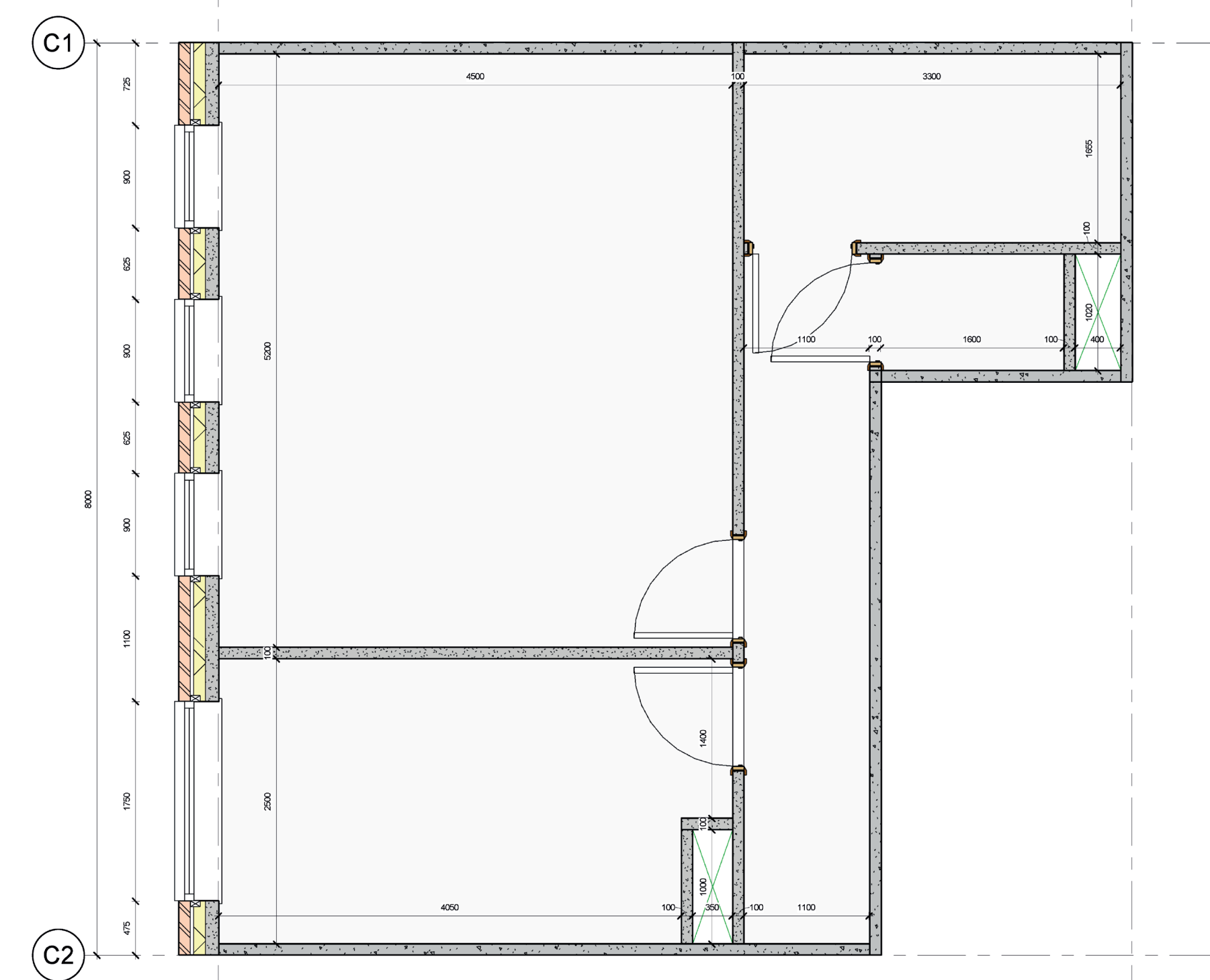
Type A



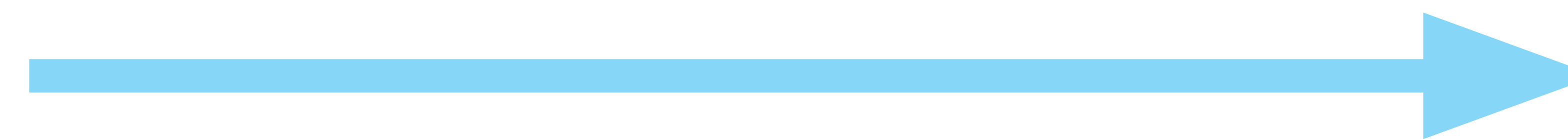
Type B



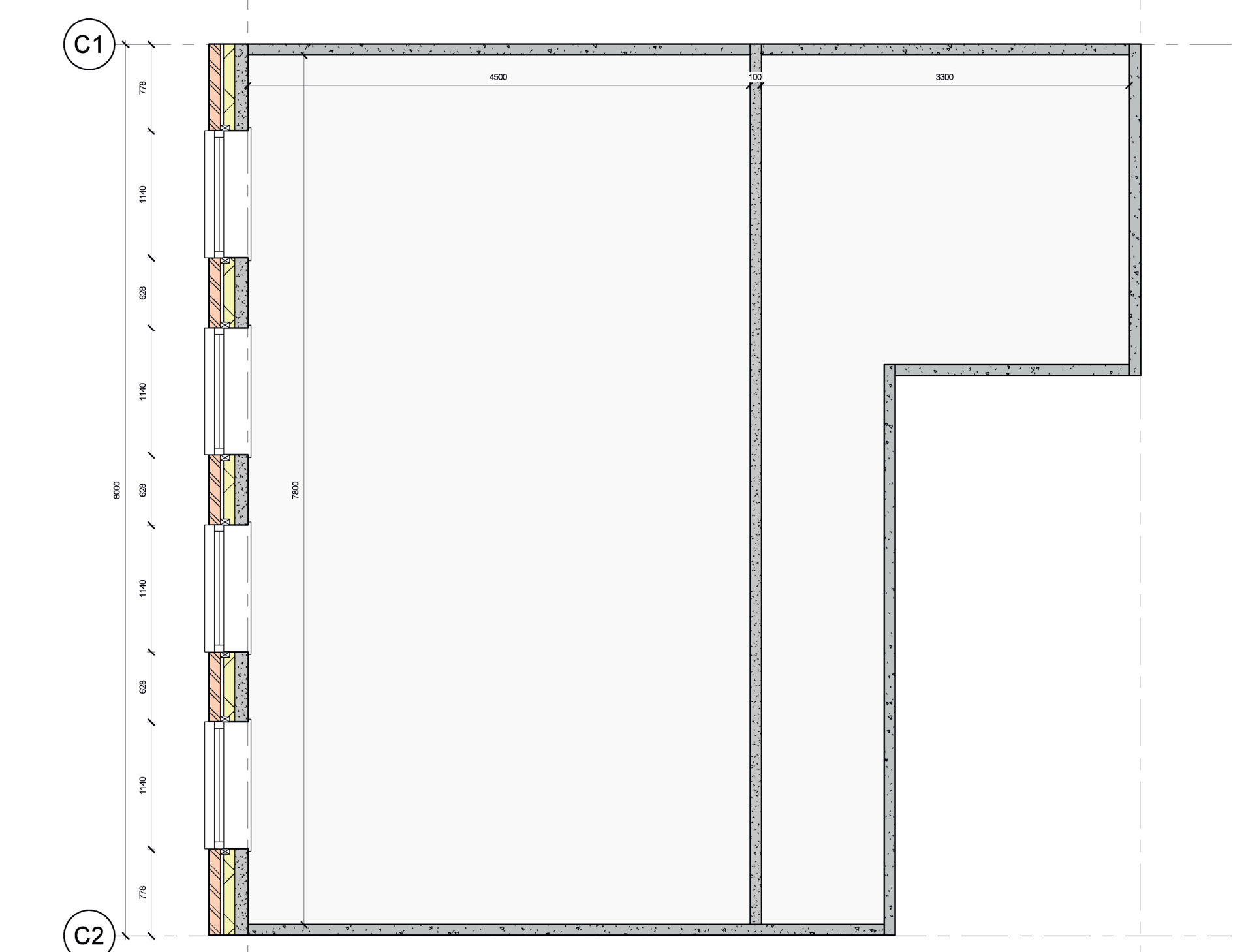
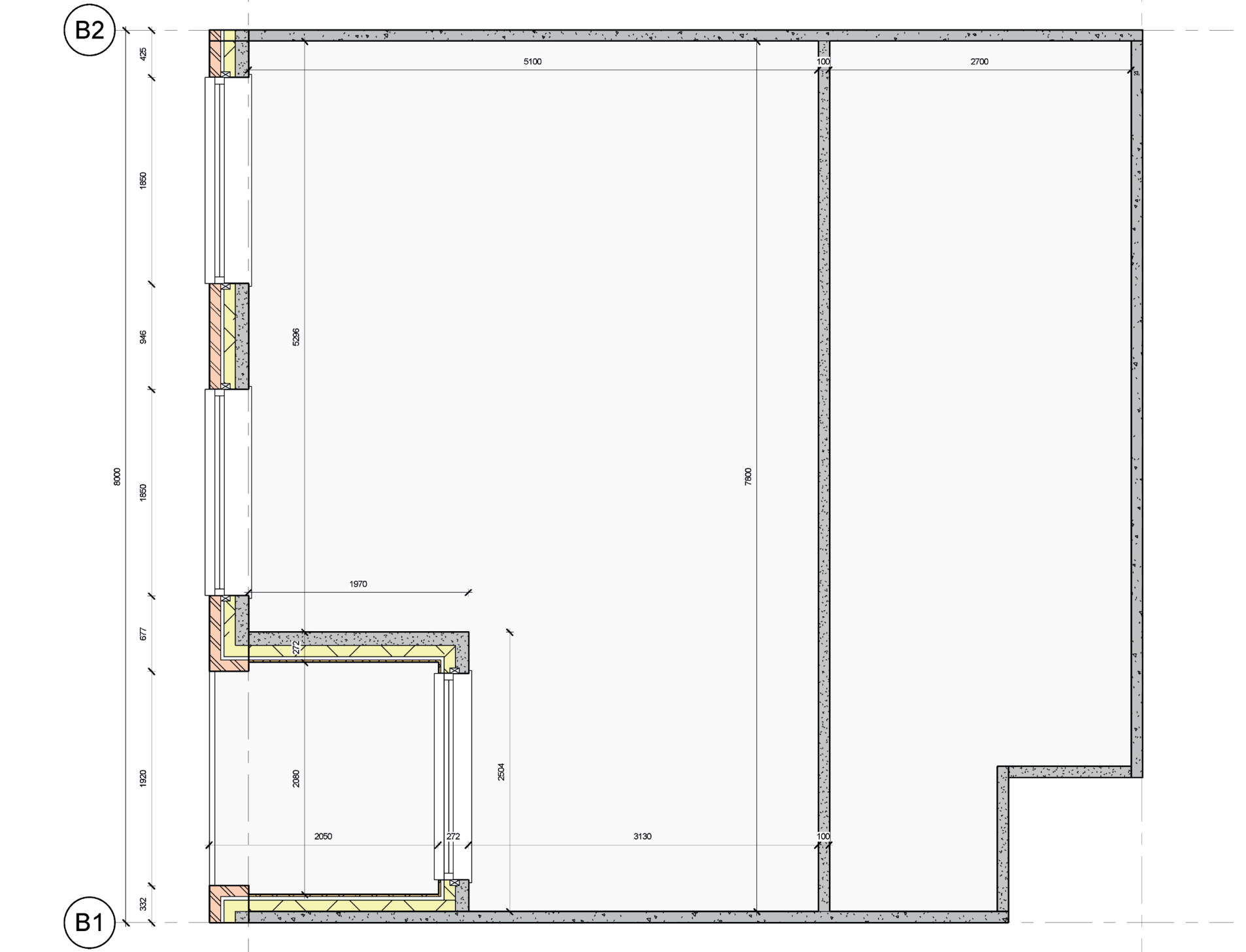
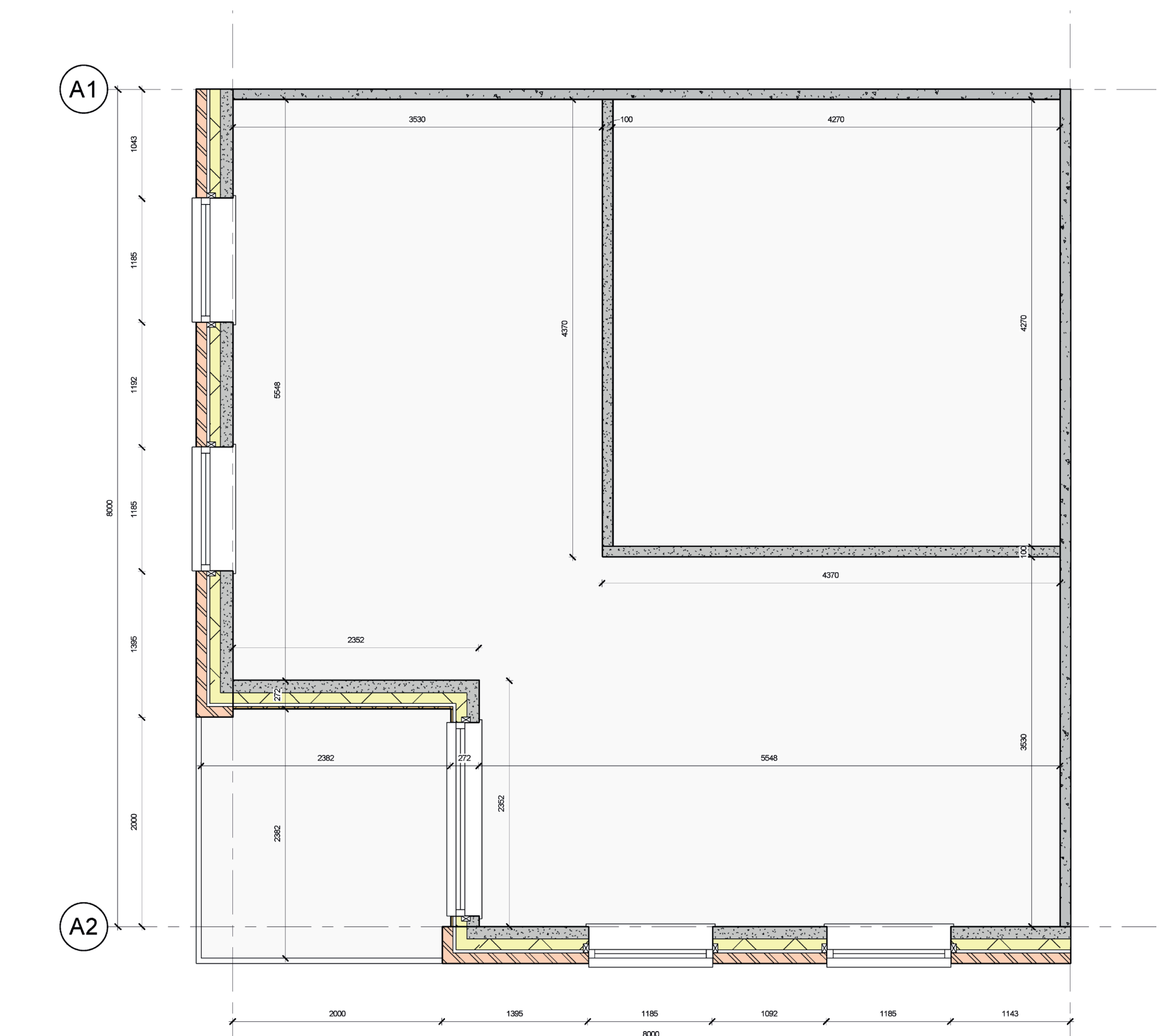
Type C



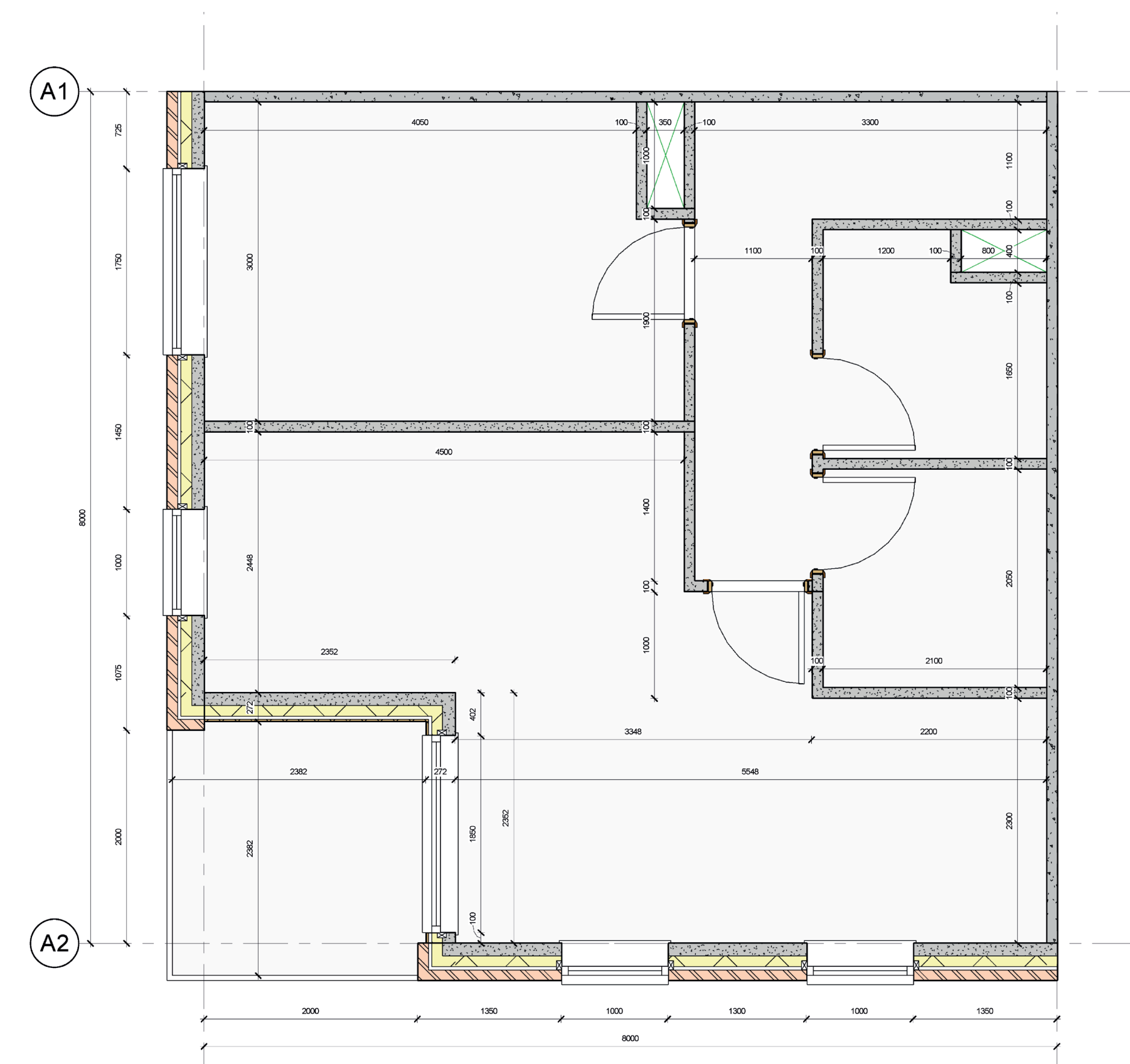
Simplify the layout



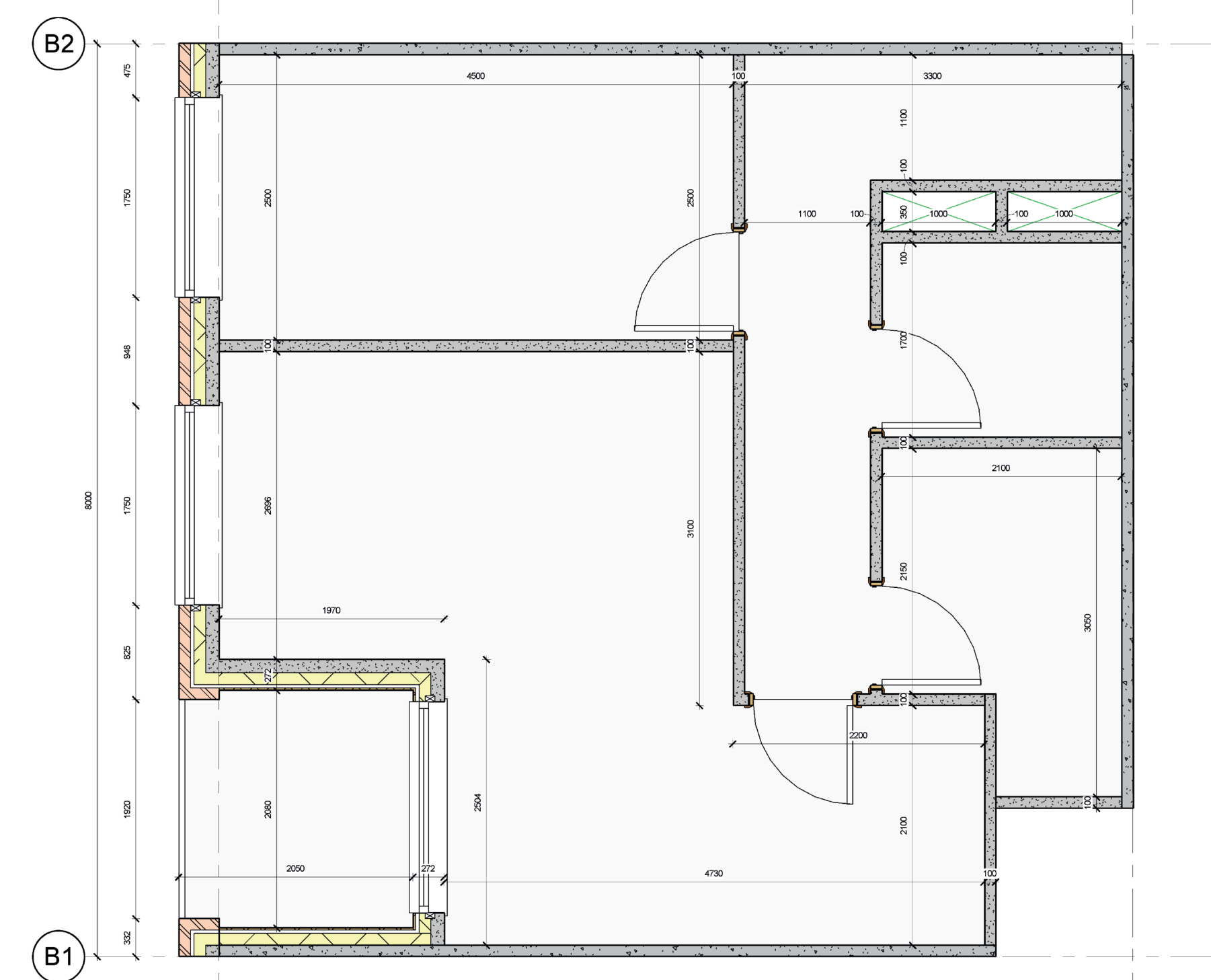
- No interior walls
- evenly spaced facade



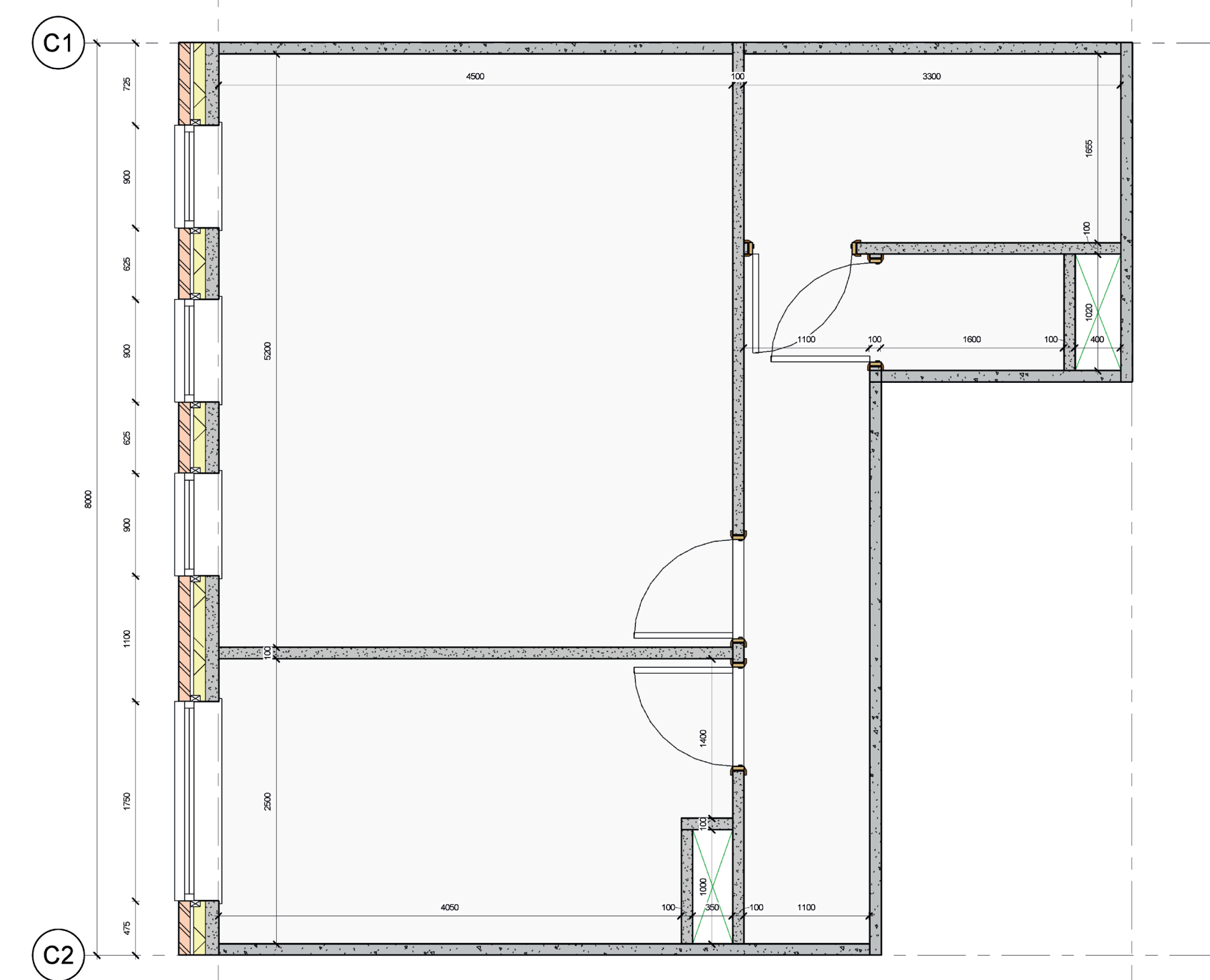
Type A



Type B



Type C



Compliant to the
Dutch building code

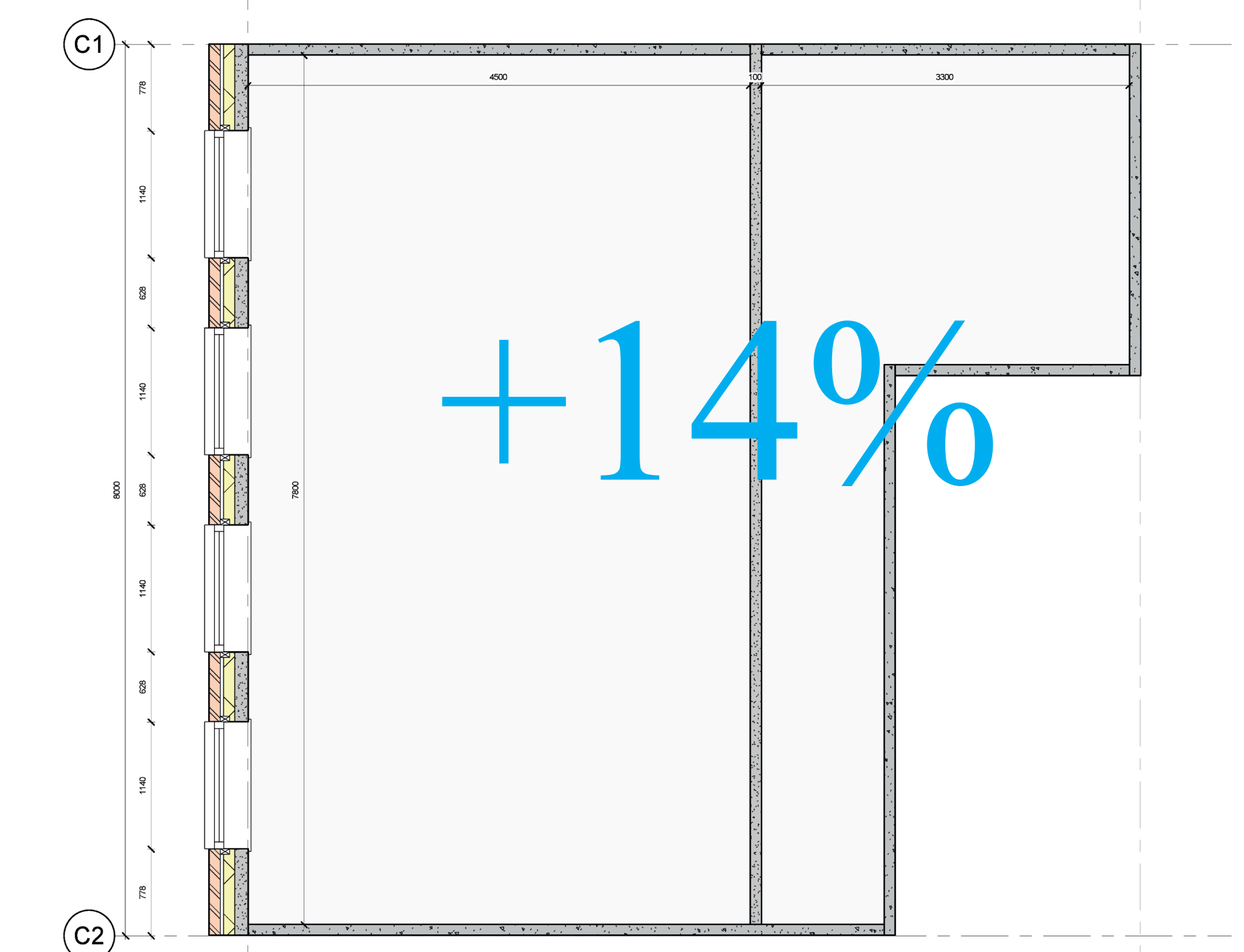
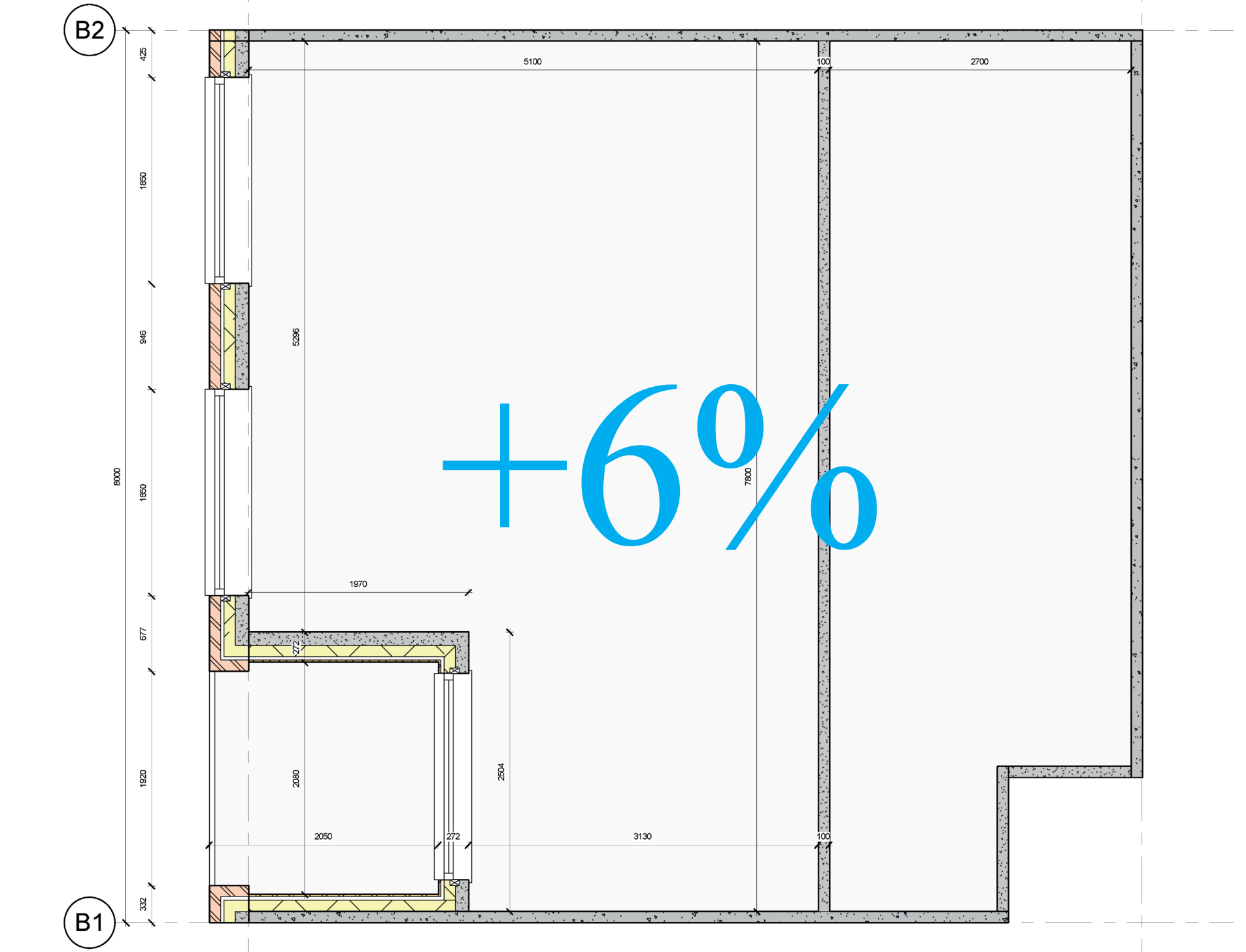
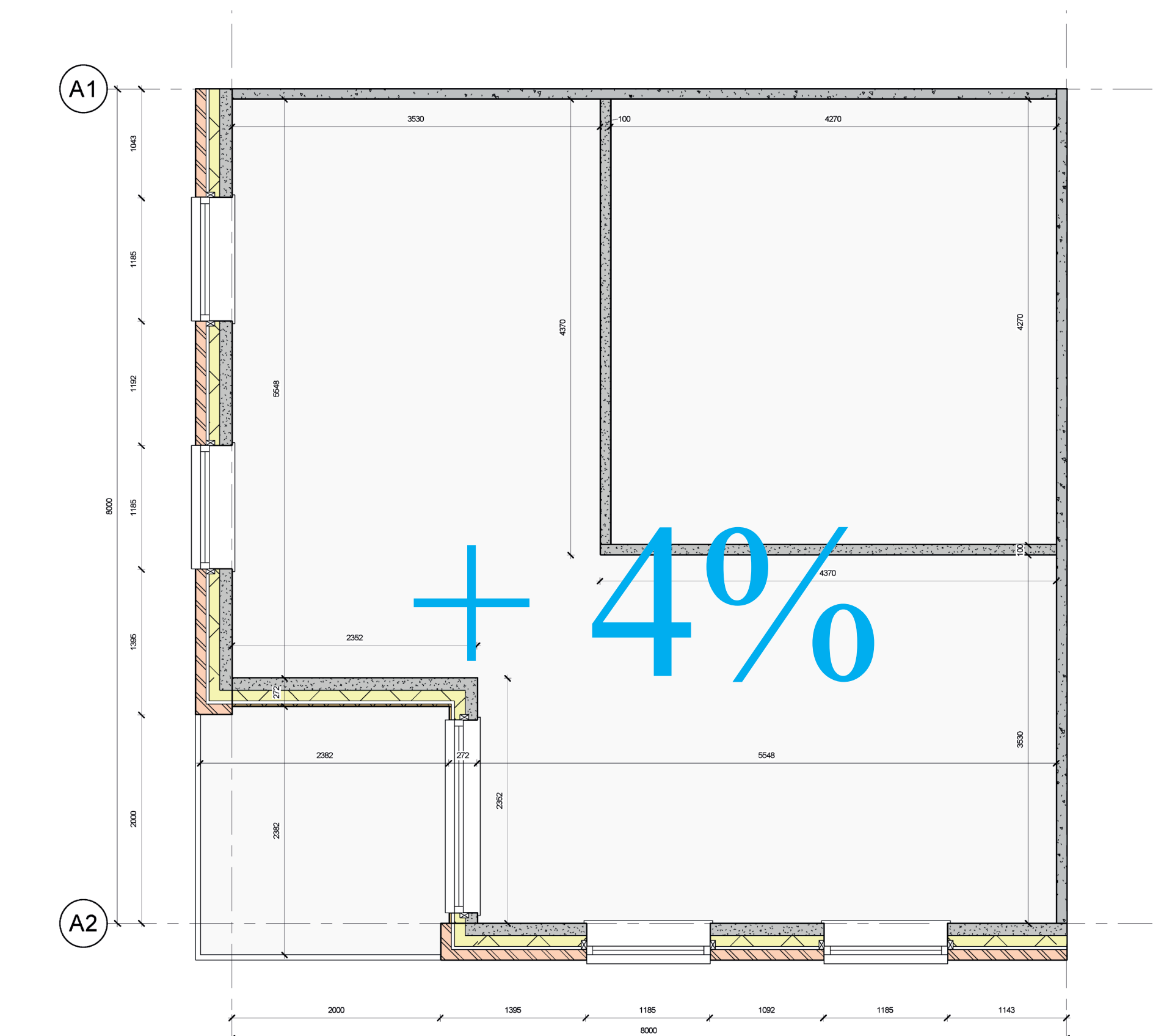


BBL

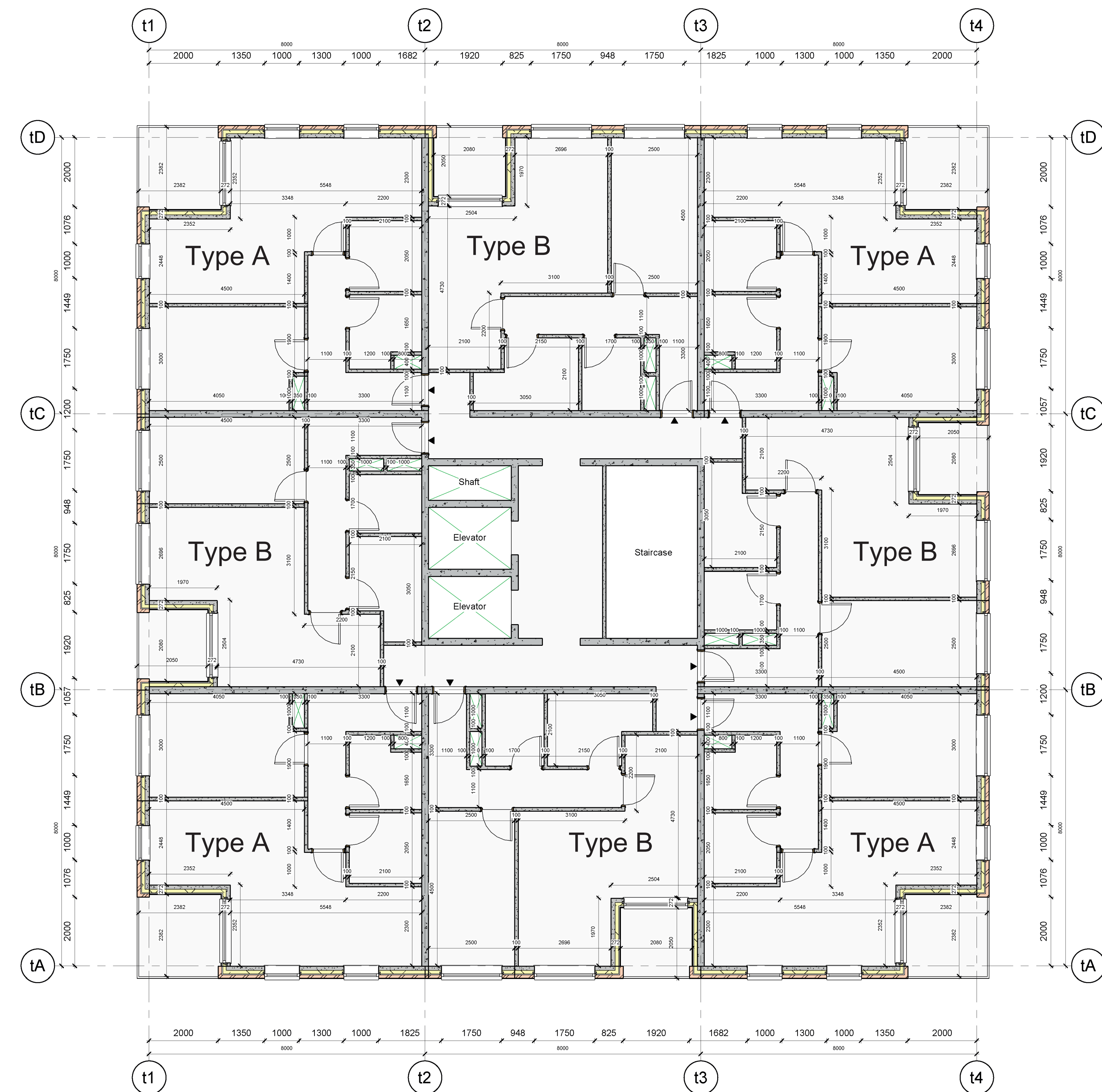
$DF_1 \geq 50$

$EU_{\min}$

$DA_{300} \geq 50$



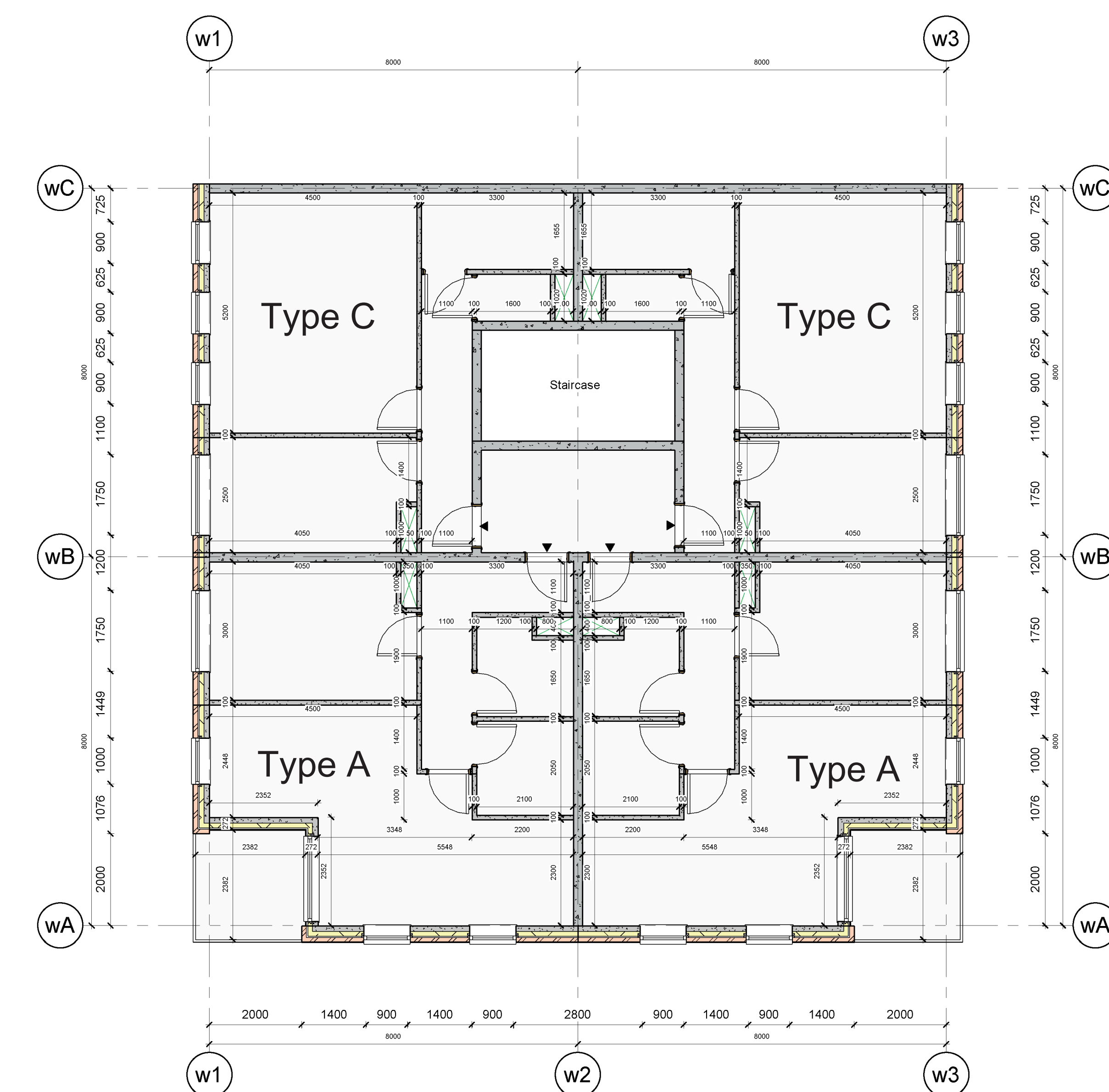
Tower building



23 building floors (69m)

high density areas

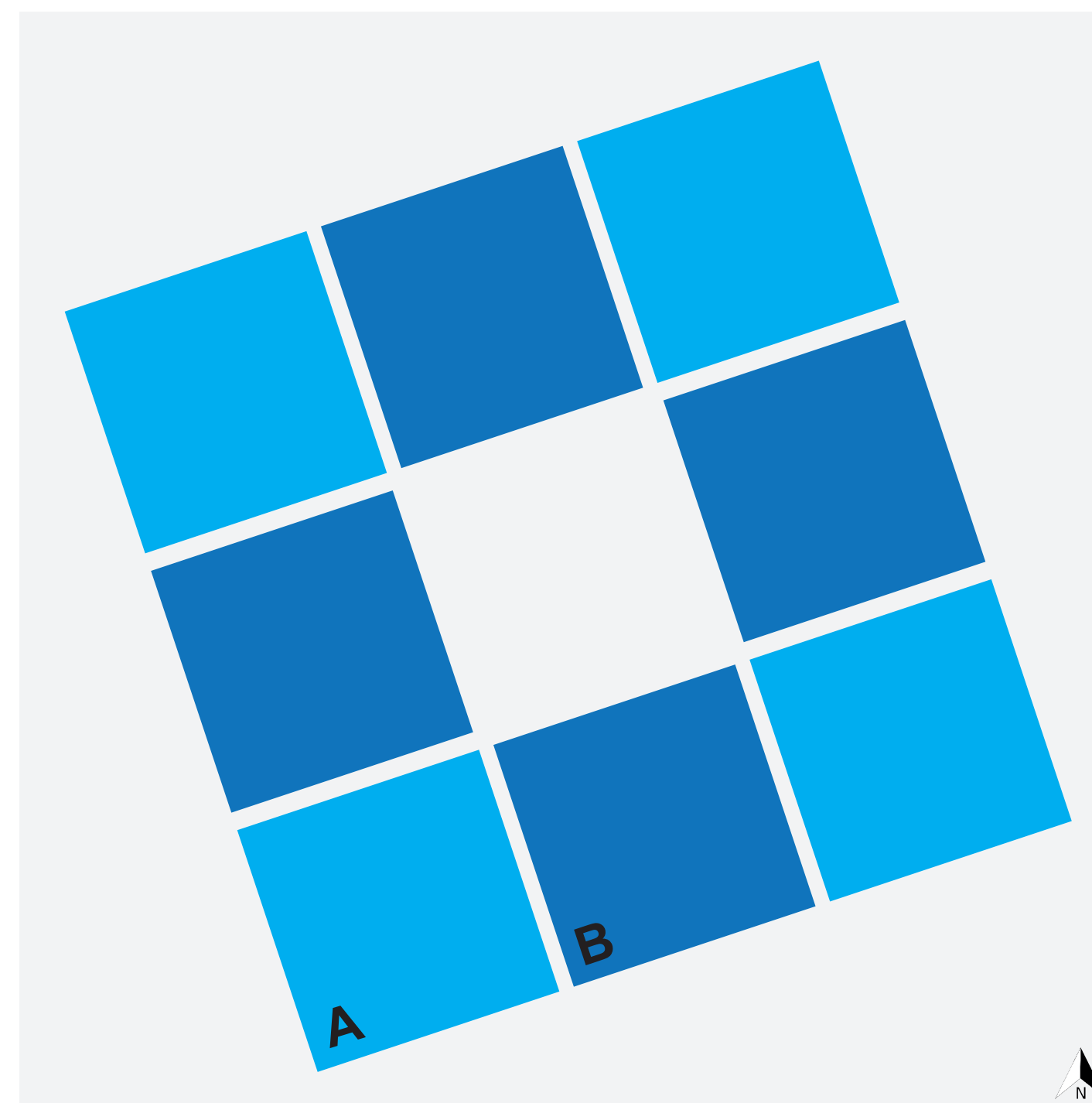
Walk-up apartments



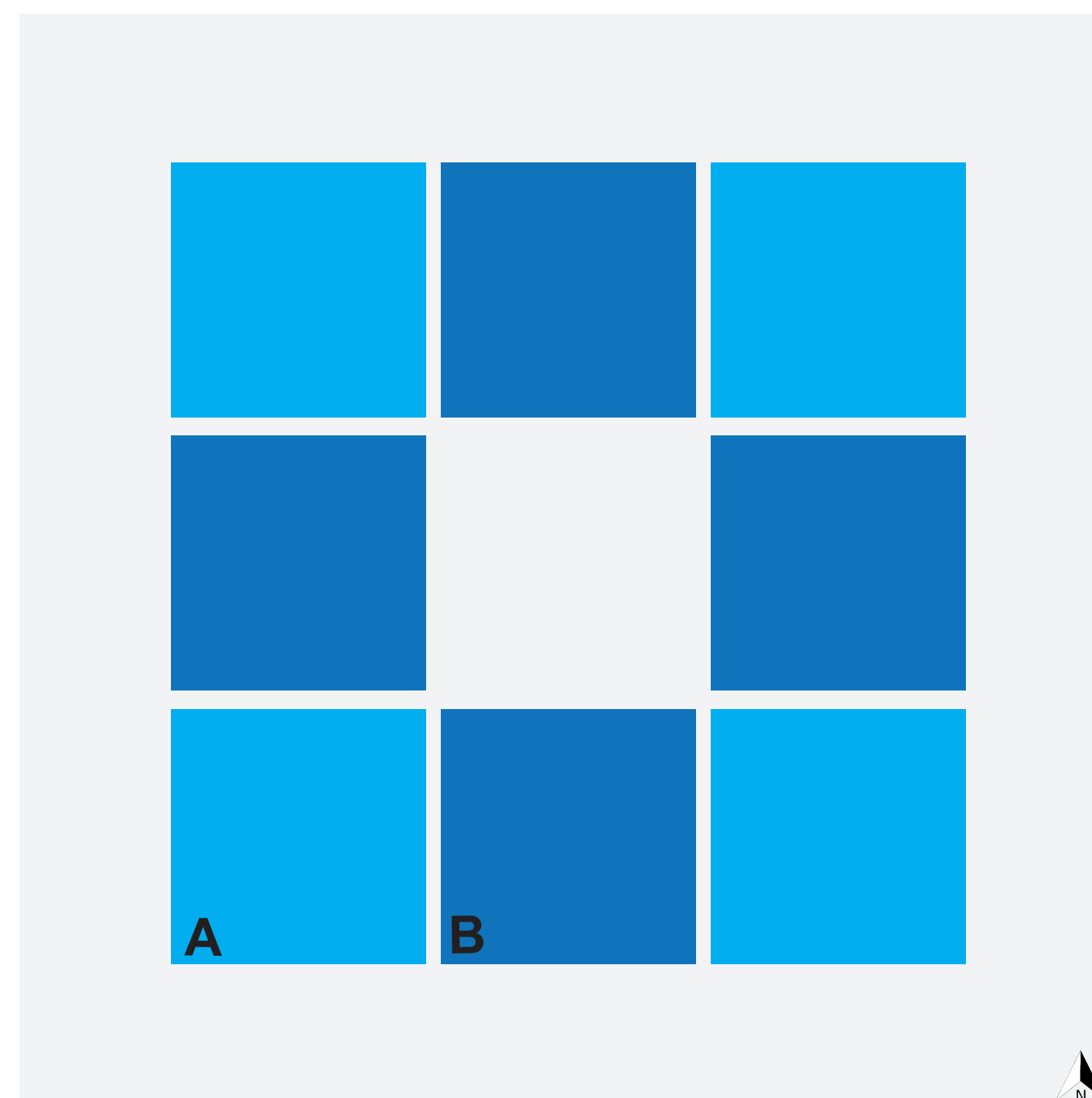
5 building floors (15m)

medium density areas

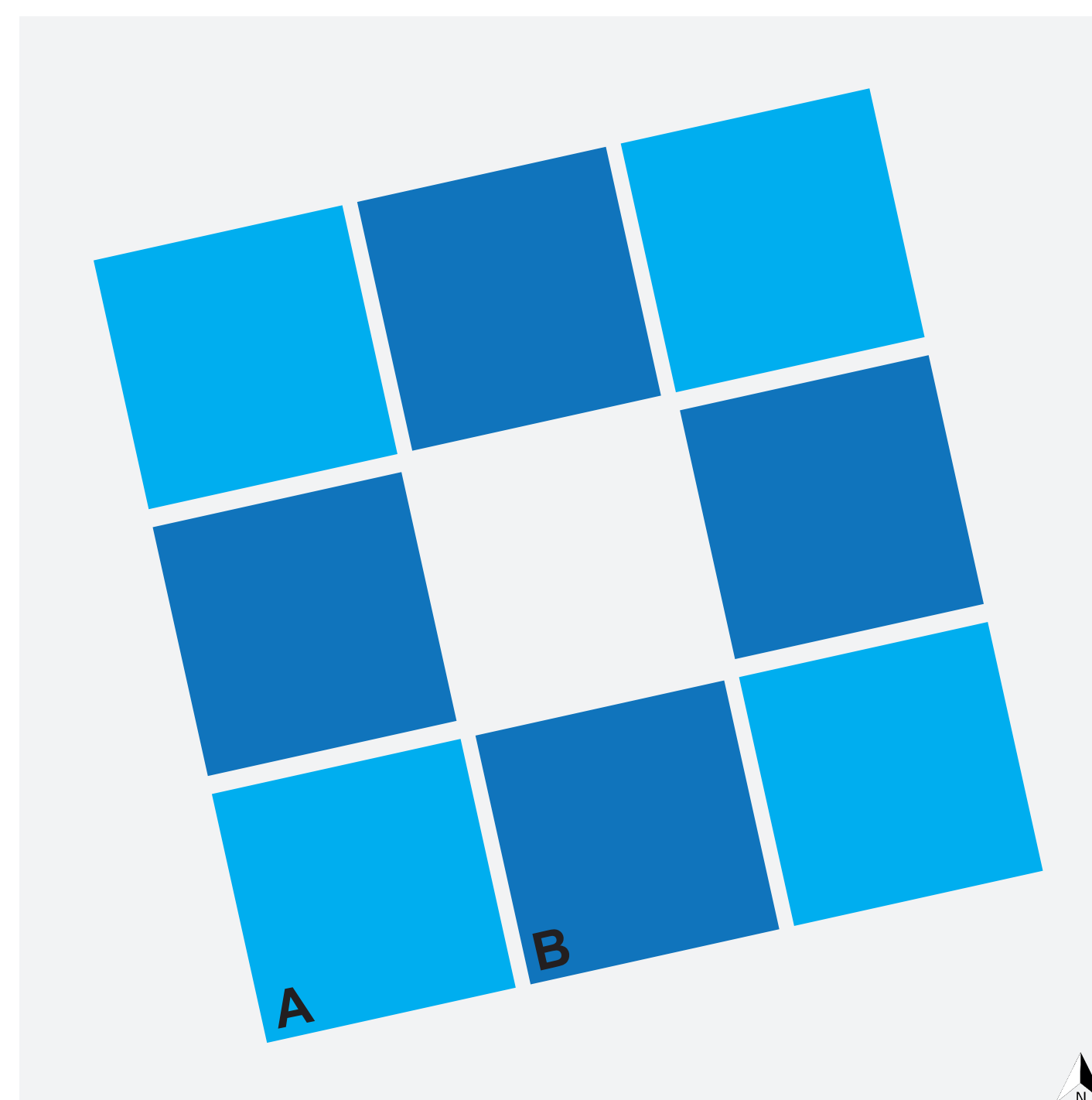
Tower building



Rotterdam Maritime
18.4°
4x type A
4x type B

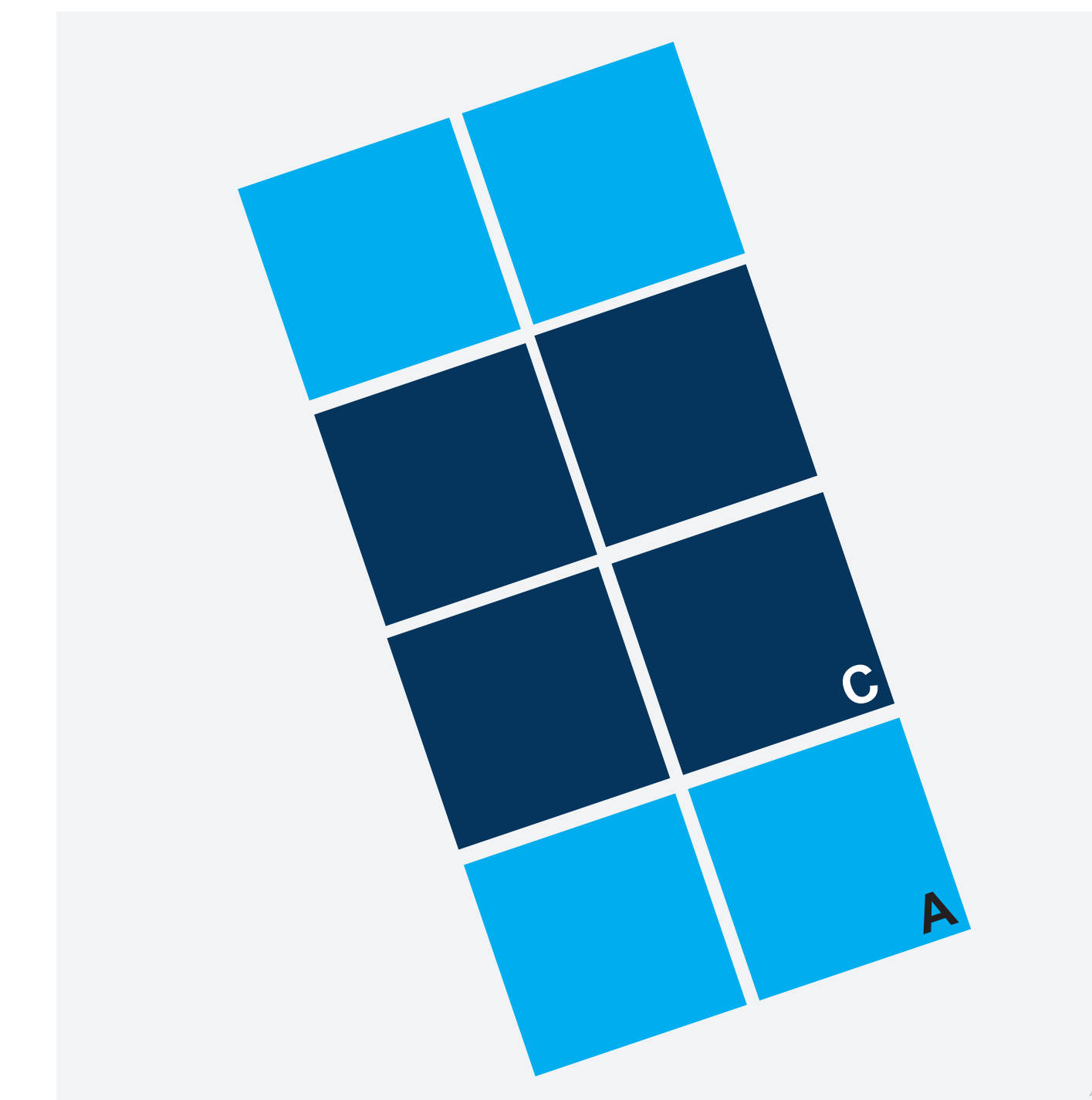


Amsterdam
0.0°
4x type A
4x type B

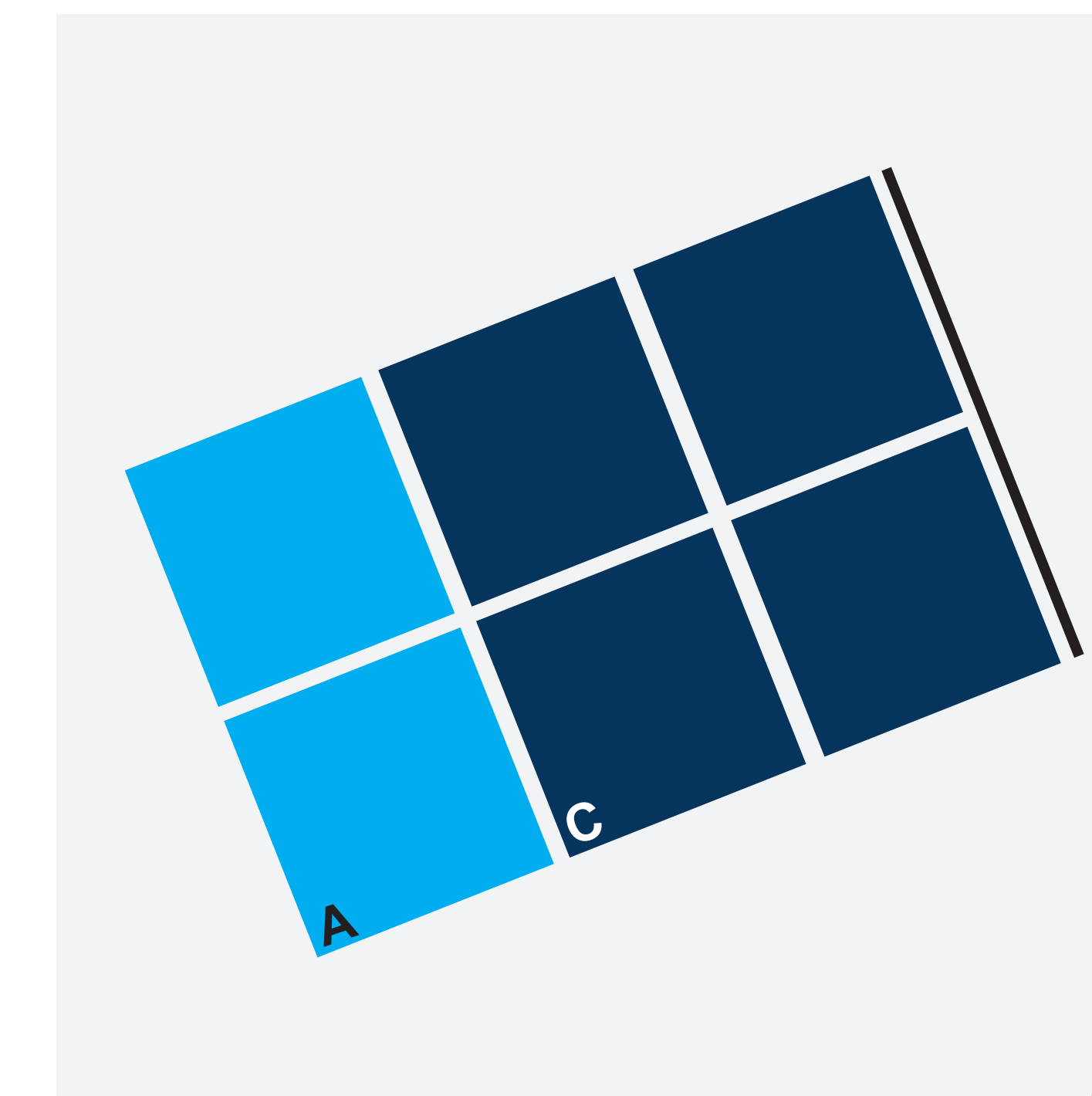


Eindhoven
12.5°
4x type A
4x type B

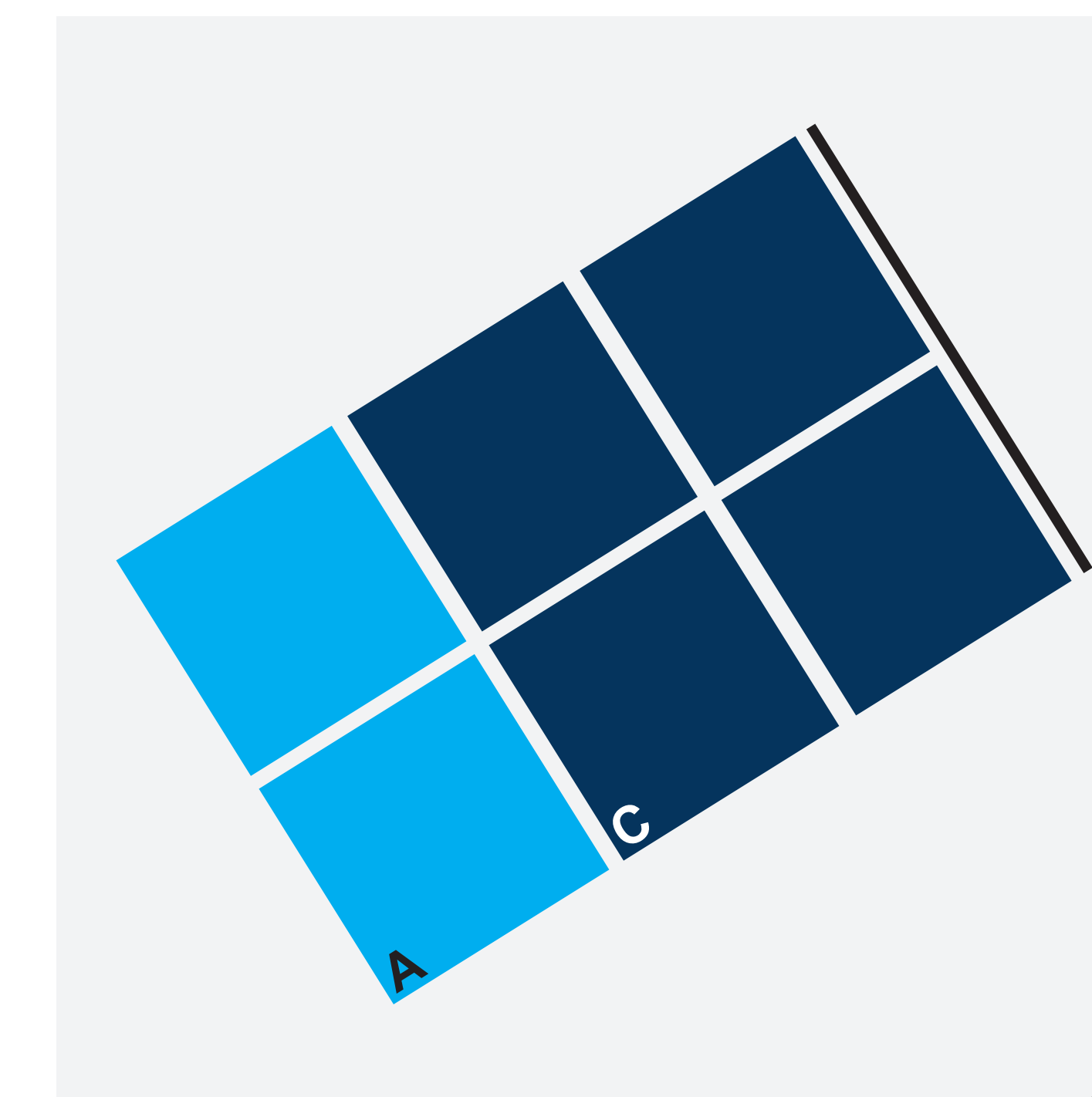
Walk-up apartments



Delft
18.7°
4x type A
4x type C

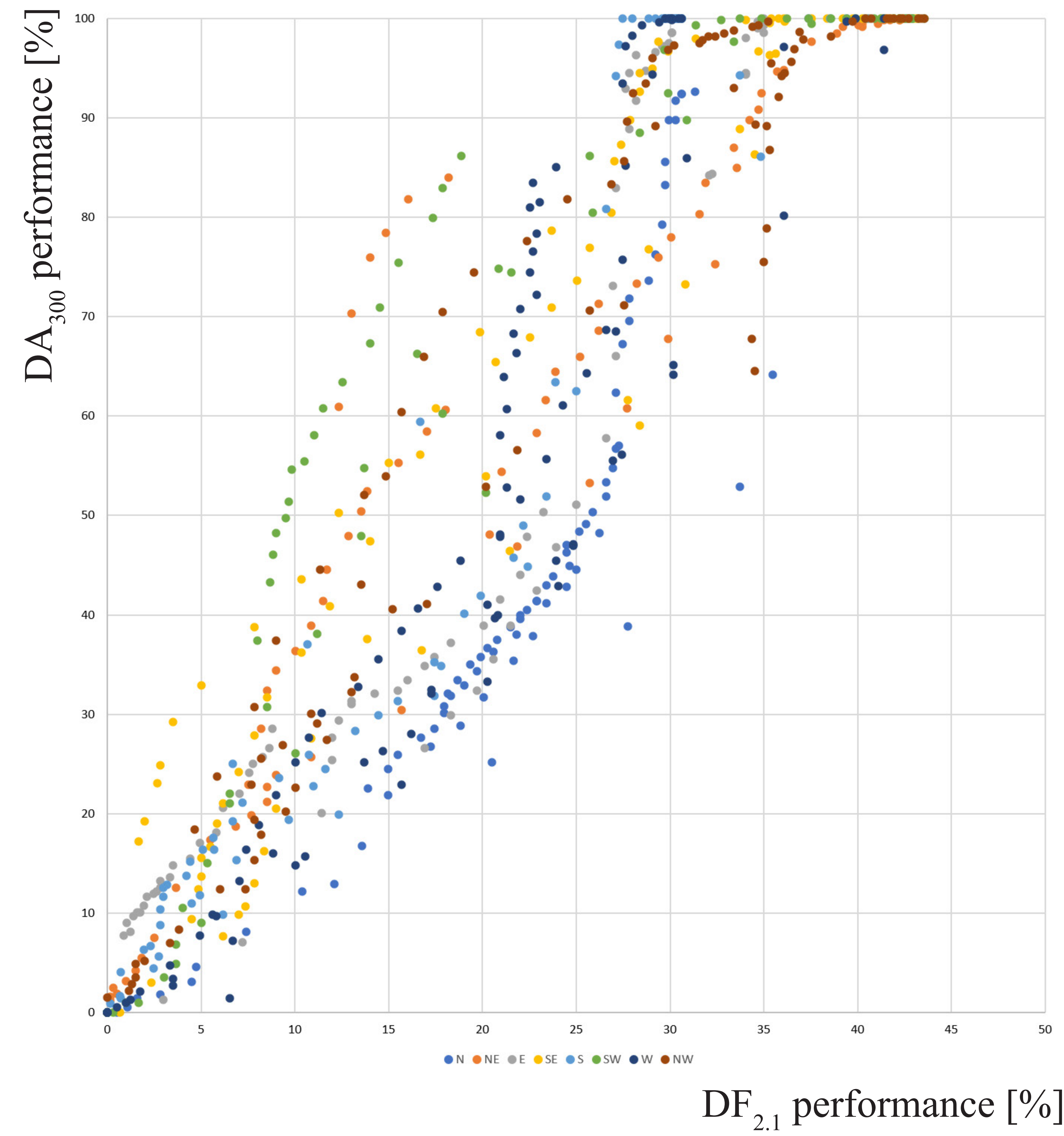


Utrecht
21.6°
1x type A
4x type C



Rotterdam North
32.0°
2x type A
4x type C

- 684 residences simulated
- 4788 performance values
- Data analysis



orientation	city	city_ID	FSI	FSI_rank	GSI	GSI_rank	OSR	OSR_rank	level	svf_bin
NE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	0
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	0
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	0
SE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	0
SW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	0
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	0
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	0
NW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	0
NE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	1
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	1
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	1
SE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	1
SW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	1
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	1
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	1
NW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	1
NE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	2
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	2
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	2
SE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	2
SW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	2
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	2
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	2
NW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	2
NE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	3
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	3
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	3
SE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	3
SW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	3
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	3
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	3
NW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	3
NE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	4
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	4
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	4
SE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	4
SW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	4
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	4
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	4
NW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	4
NE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	5
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	5
E	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	5
SE	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	5
SW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	5
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	5
W	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	5
NW	delft	6	1.0100	1.0000	0.15	1	0.84	1.00	7.61	5
W	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	0
N	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	0
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	0
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	0
W	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	1
N	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	1
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	1
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	1
W	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	2
N	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	2
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	2
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	2
W	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	3
N	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	3
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	3
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	3
W	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	4
N	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	4
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	4
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	4
W	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	5
N	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	5
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	5
S	utrecht	4	1.7422	3.0000	0.59	6.00	0.24	4.00	2.84	5
W	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	0
NW	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	0
SE	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	0
SE	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	0
W	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	0
W	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	0
NW	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	1
NW	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	1
SE	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	1
SE	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	1
W	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	1
W	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	1
NW	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	2
NW	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	2
SE	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	2
SE	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	2
W	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	2
W	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	2
NW	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	3
NW	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	3
SE	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	3
SE	rdam noord	5	1.1943	2.0000	0.34	3.00	0.55	2.00	3.46	3

Sufficient &
healthy daylight

Daylighting in
urban areas

Results &
analysis

Mitigation
strategies

Daylighting performance

VS.

static/dynamic

non-visual stimulus

urban density

building floor

sky view factor

Daylighting performance

VS.

static/dynamic

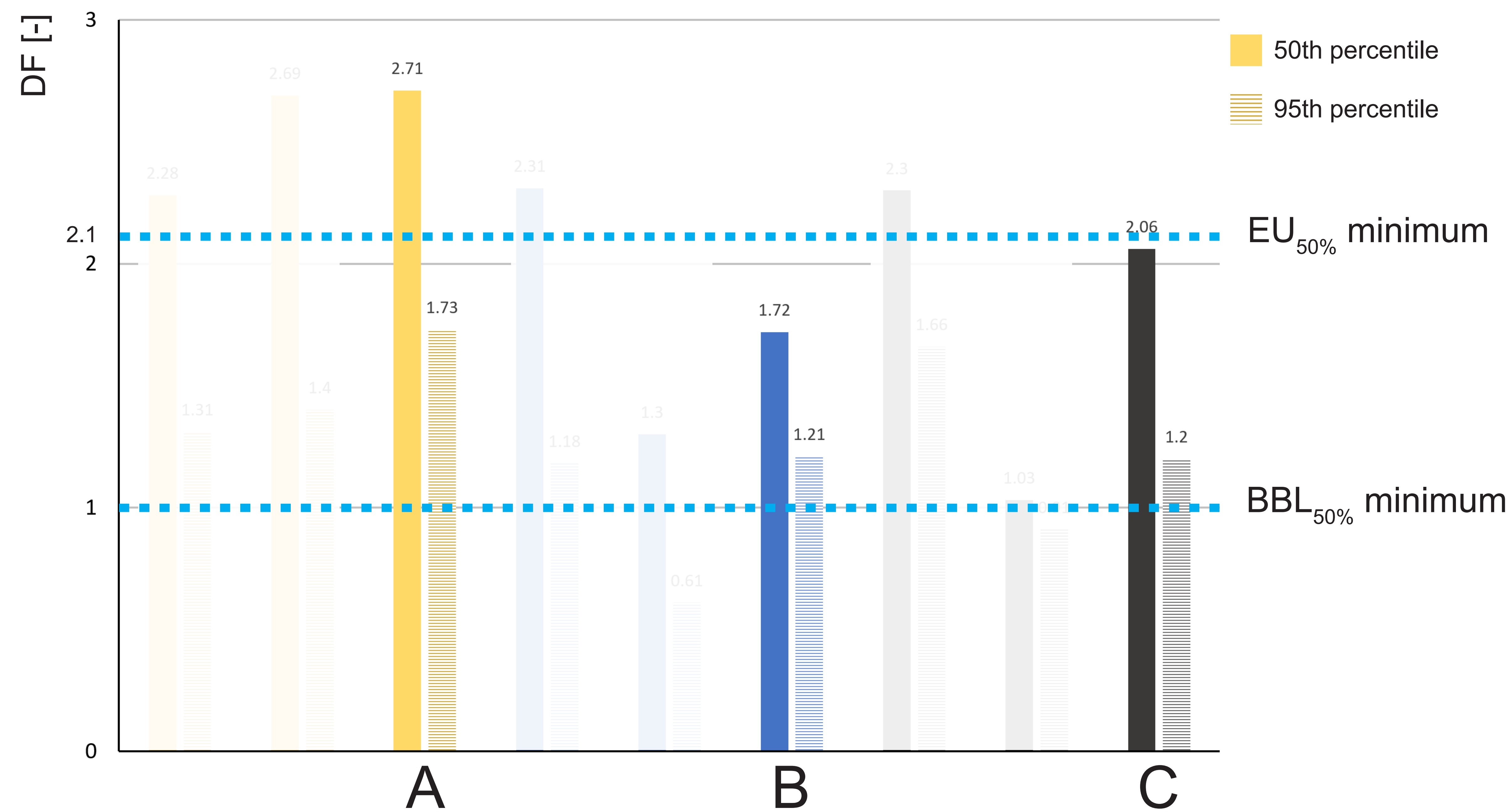
non-visual stimulus

urban density

building floor

sky view factor

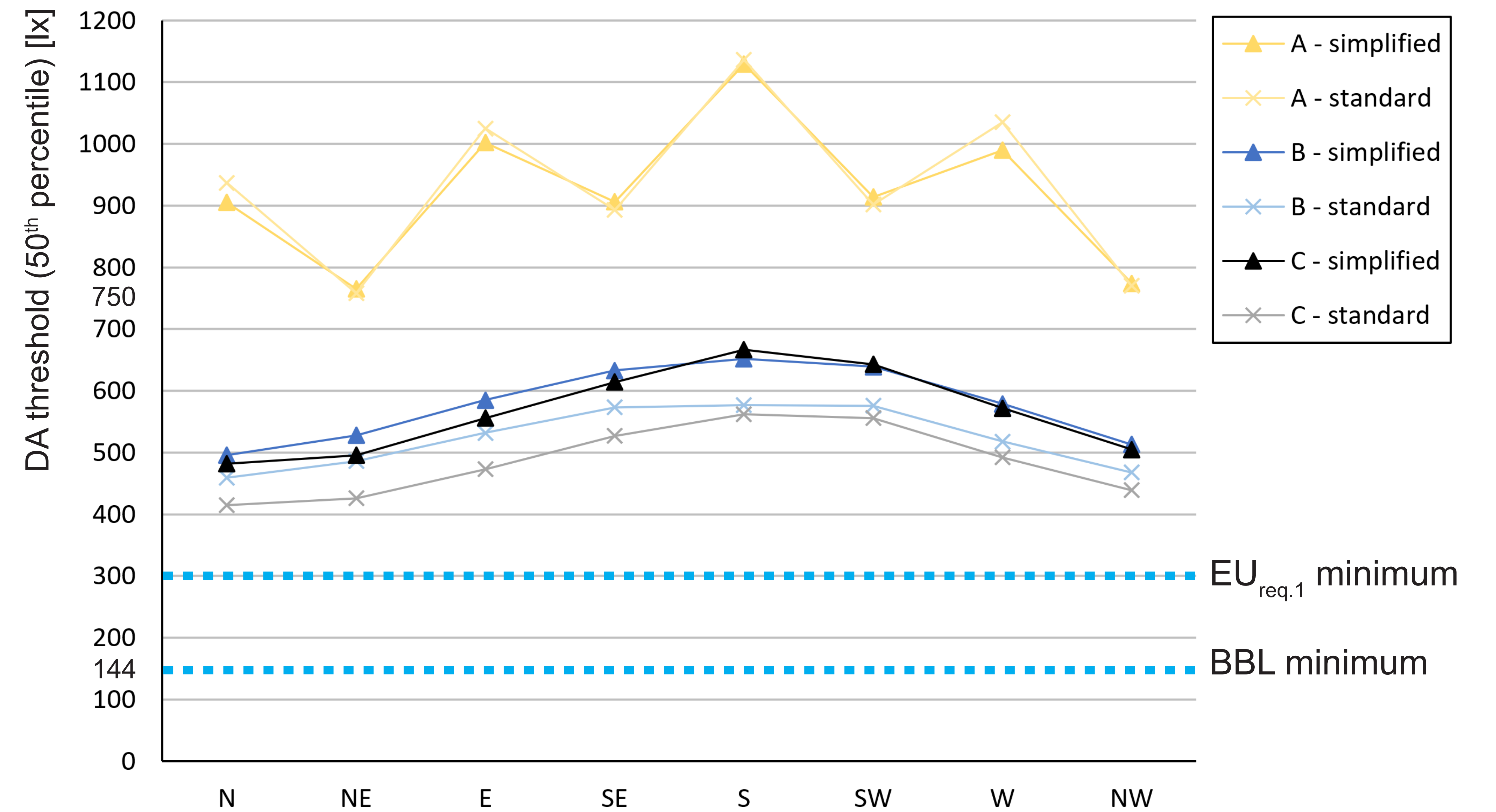
static



All fulfil BBL

Type A fulfils EU_{min}

dynamic

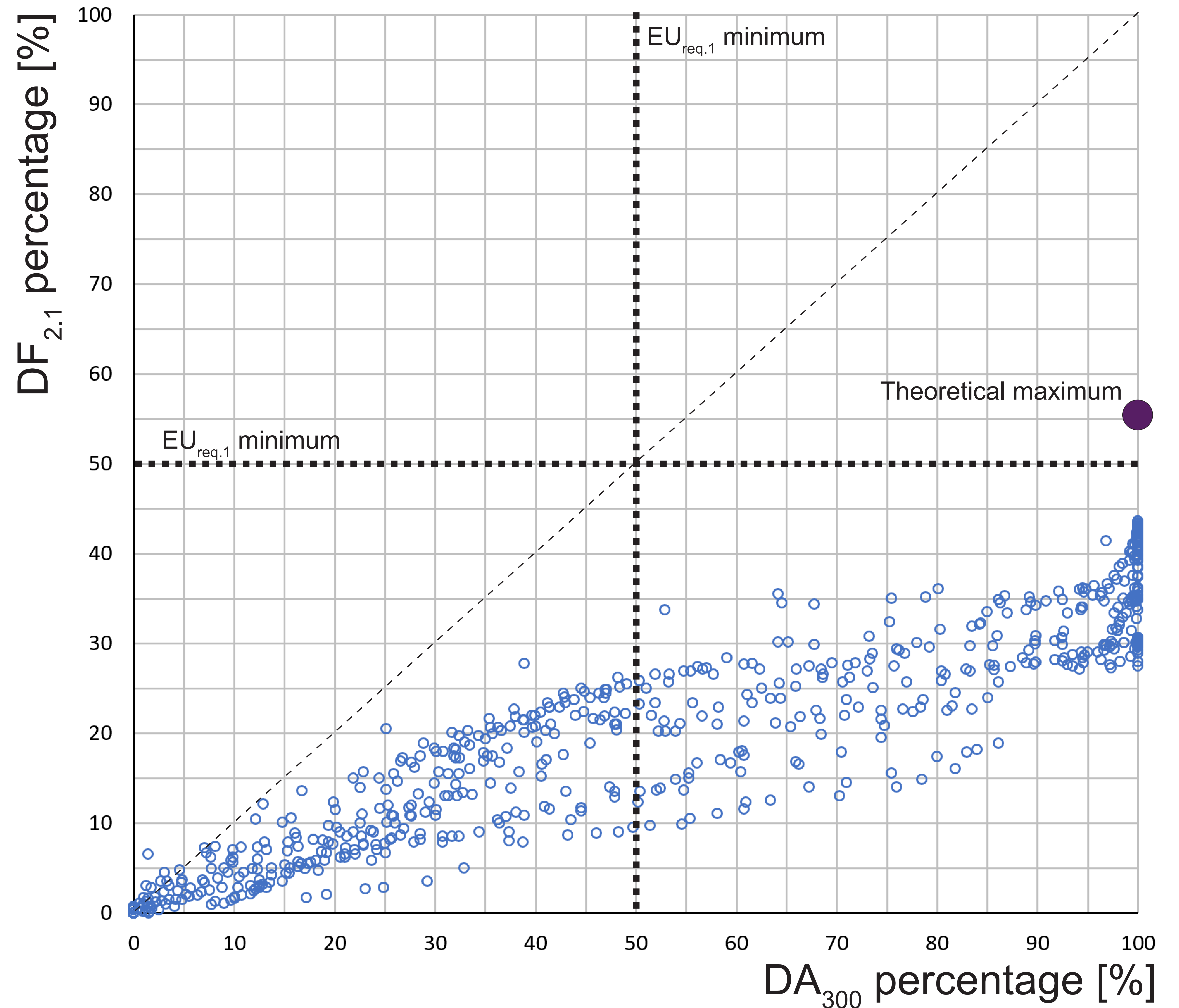


All fulfil BBL

All fulfil EU_{min}

static/dynamic

- No residence fulfils the Static 'stress test' simulation
- Dynamic simulation more optimistic



Daylighting performance

VS.

static/dynamic

non-visual stimulus

urban density

building floor

sky view factor

What is sufficient visual daylight?

non-visual daylight

Dutch building code 144 lx

N/A

Recommended 300 lx

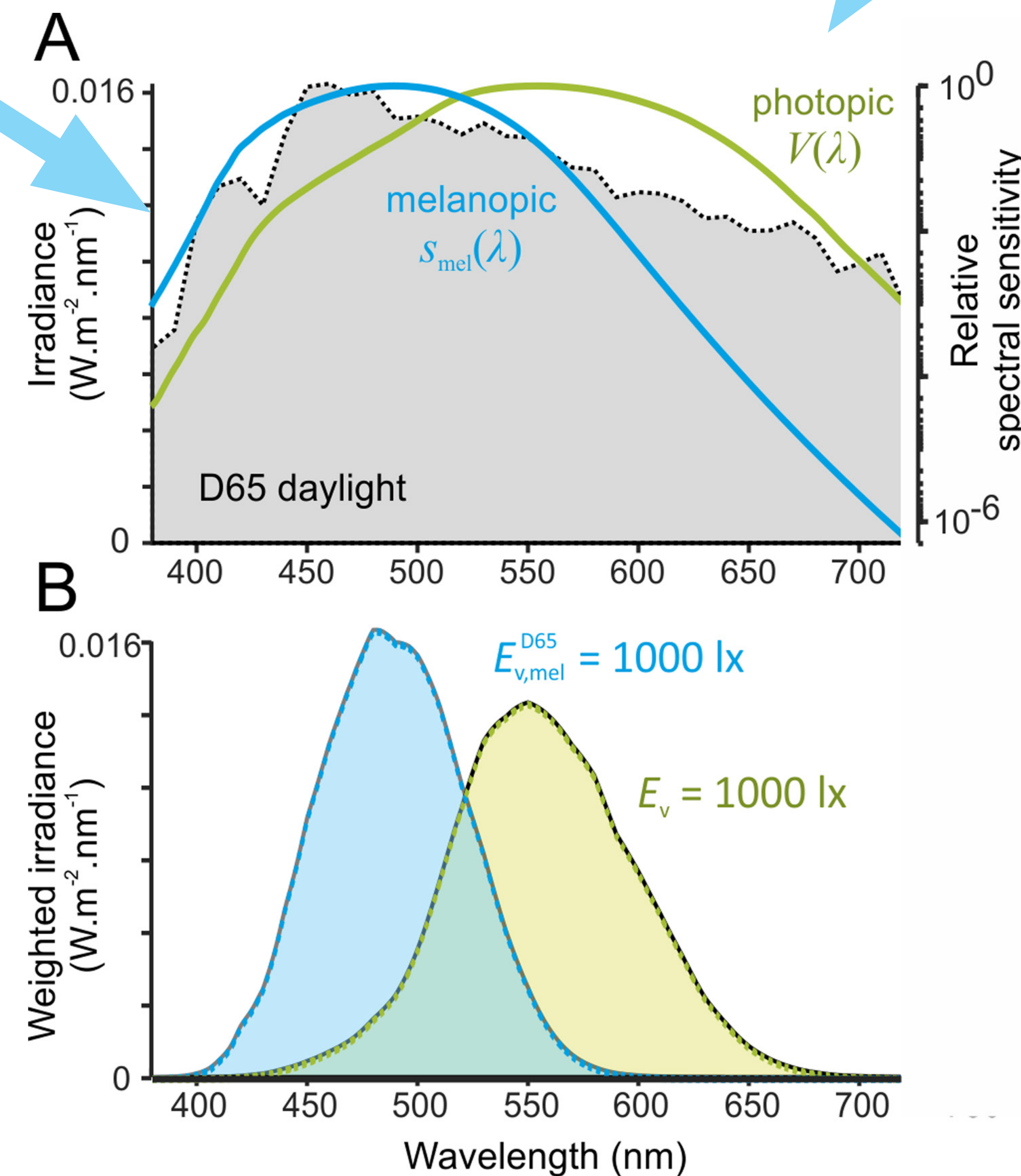
250 M-EDI

M-EDI = melanopic-equivalent daylight illuminance

M-EDI intermezzo

melanopic illuminance:
how we feel

photopic illuminance:
what we see

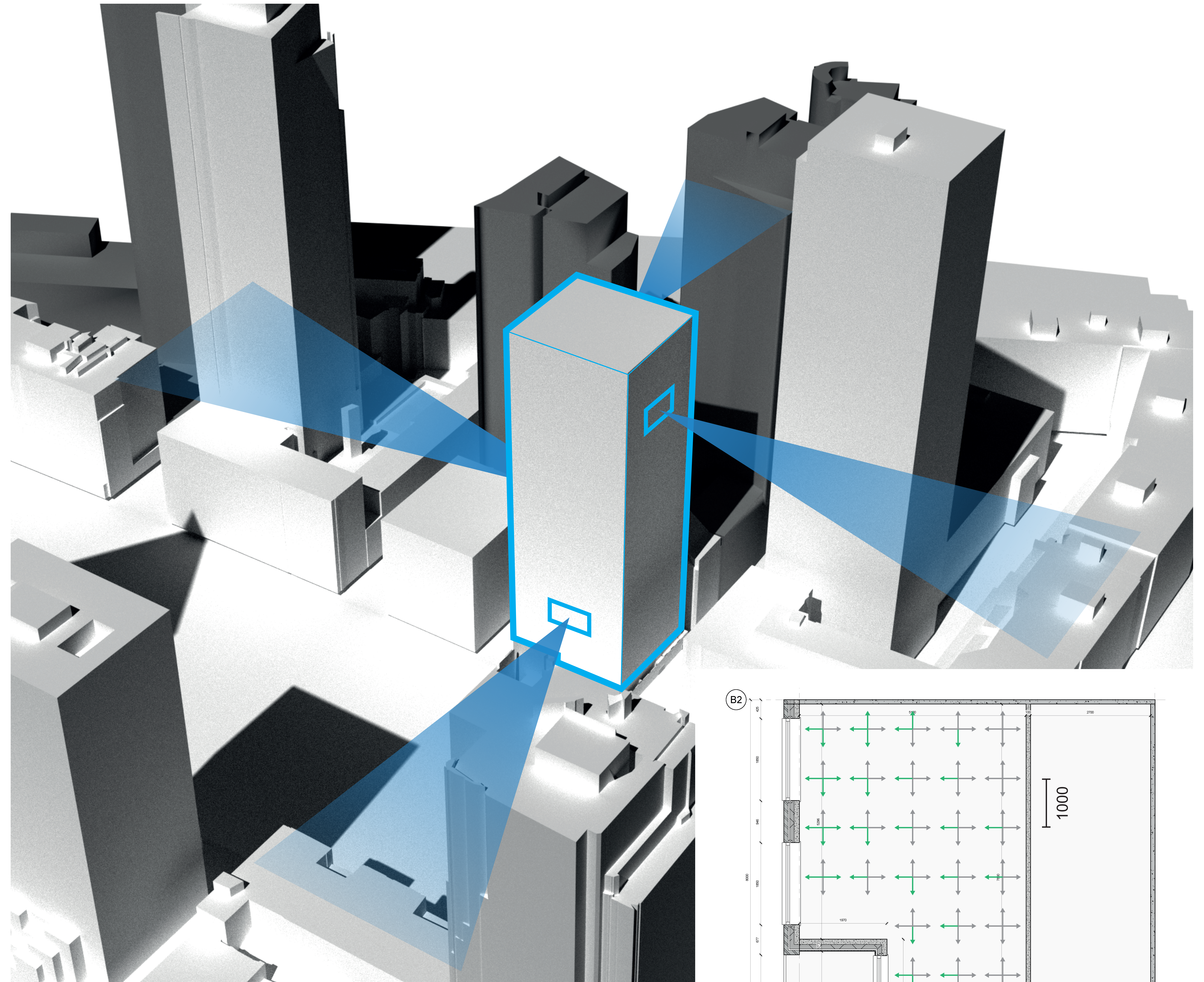


- Mostly ‘blue’ light
- M-EDI

- All colours
- Lux

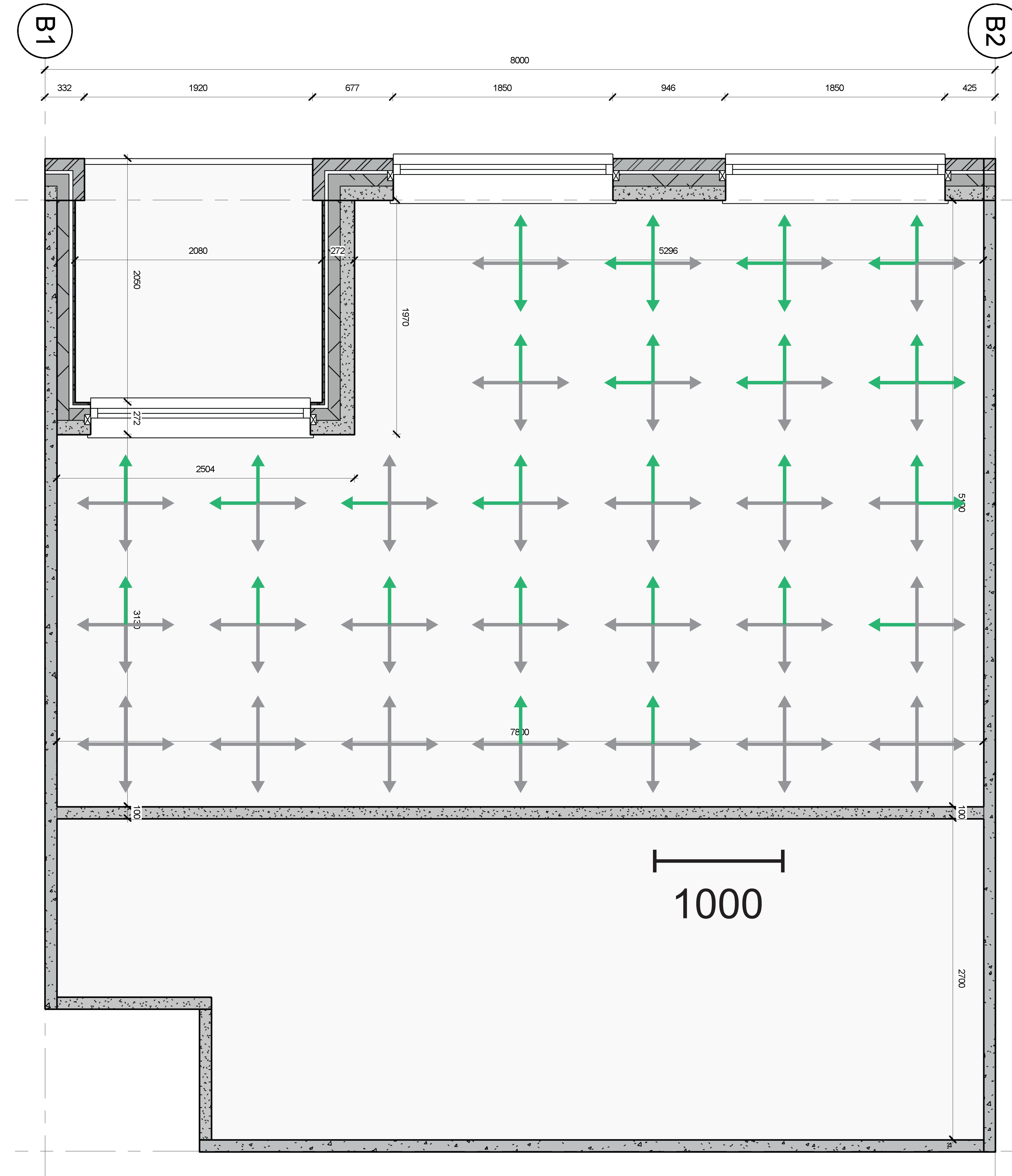
non-visual stimulus

- Type B residence
- Rotterdam Maritime context
- from 08:00 to 18:00
- Sunny day around Solstices & equinoxes



non-visual stimulus

- Melanopic autonomy
- Melanopic isotropy
- BBL/EU_{min} residences
- Eye position (vertical)



$$MA_{250} = 82.7\%$$

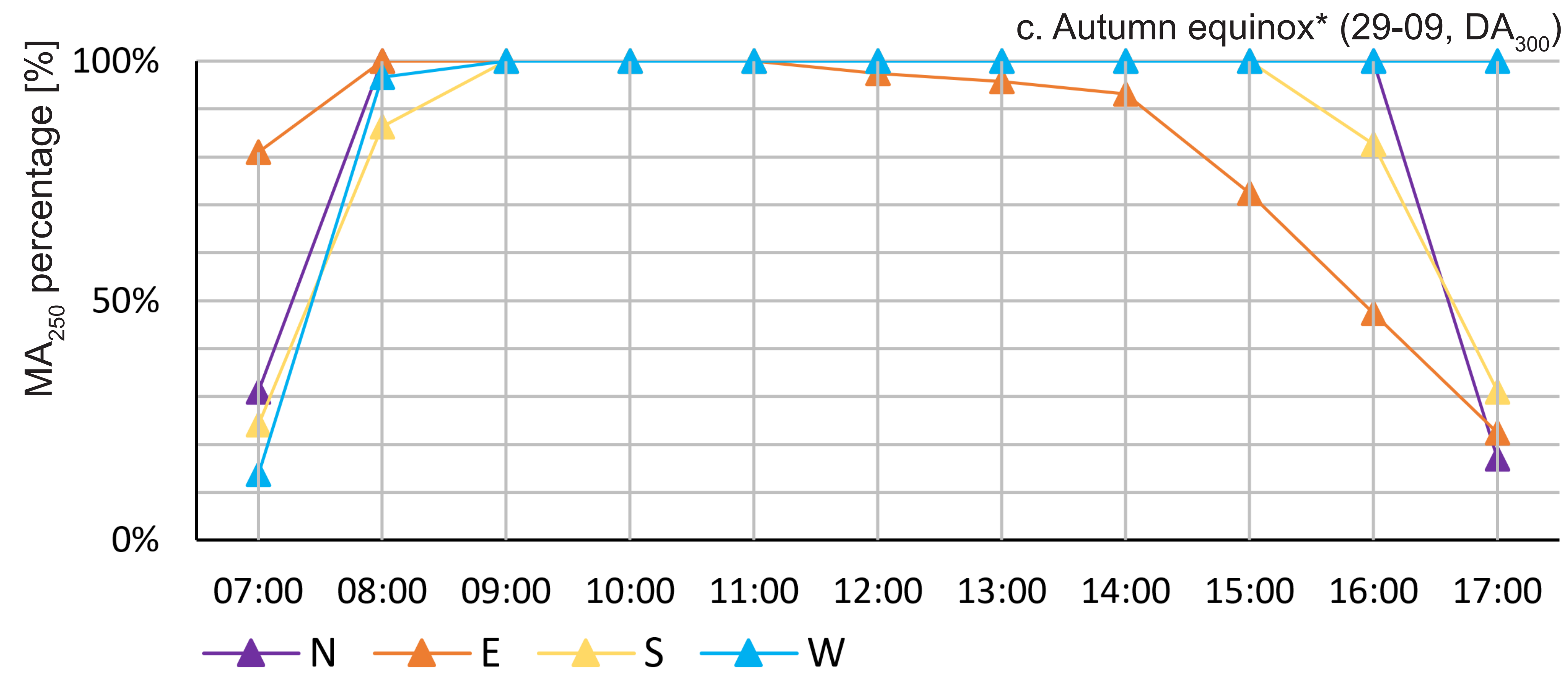
24 out of 29 sensor points fulfil the recommendation.

$$MI_{250} = 31.0\%$$

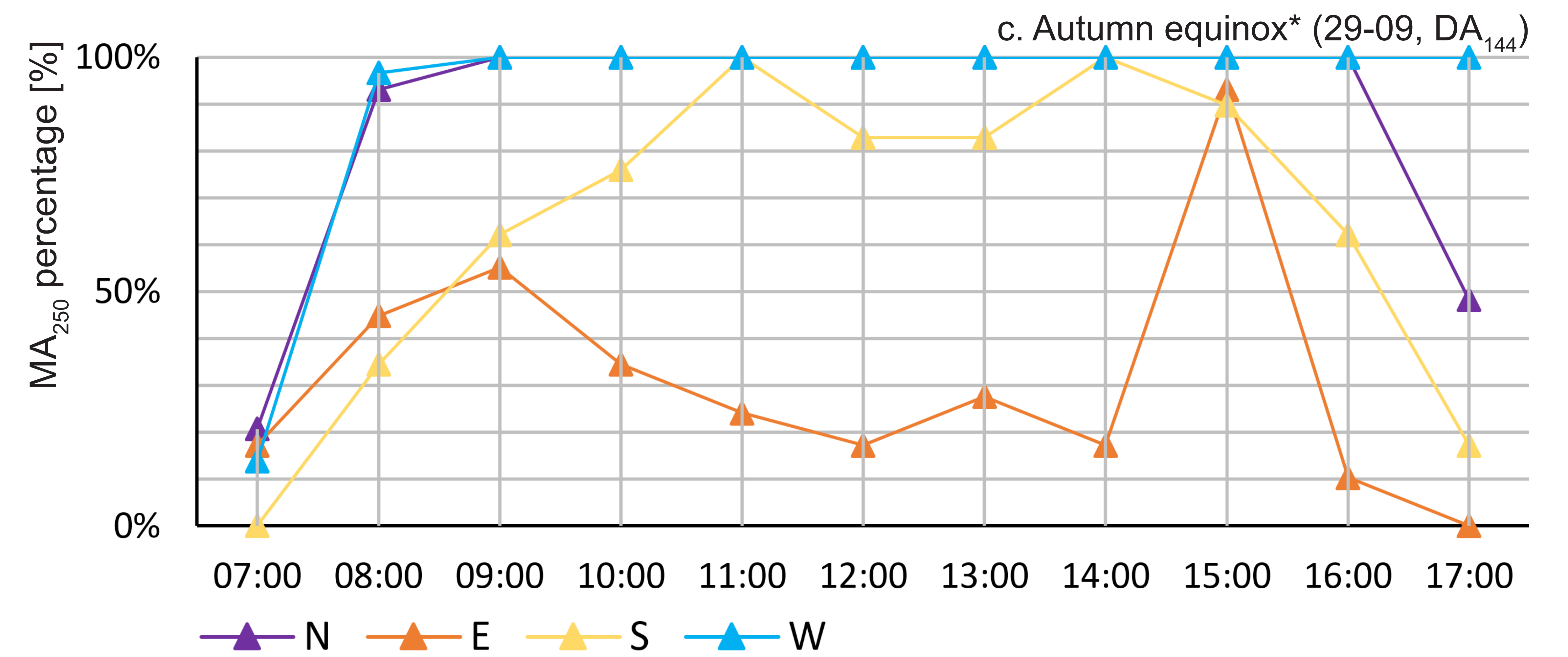
36 out of 116 vectors fulfil the recommendation.

Melanopic autonomy

DA₃₀₀ | EU_{min} requirement

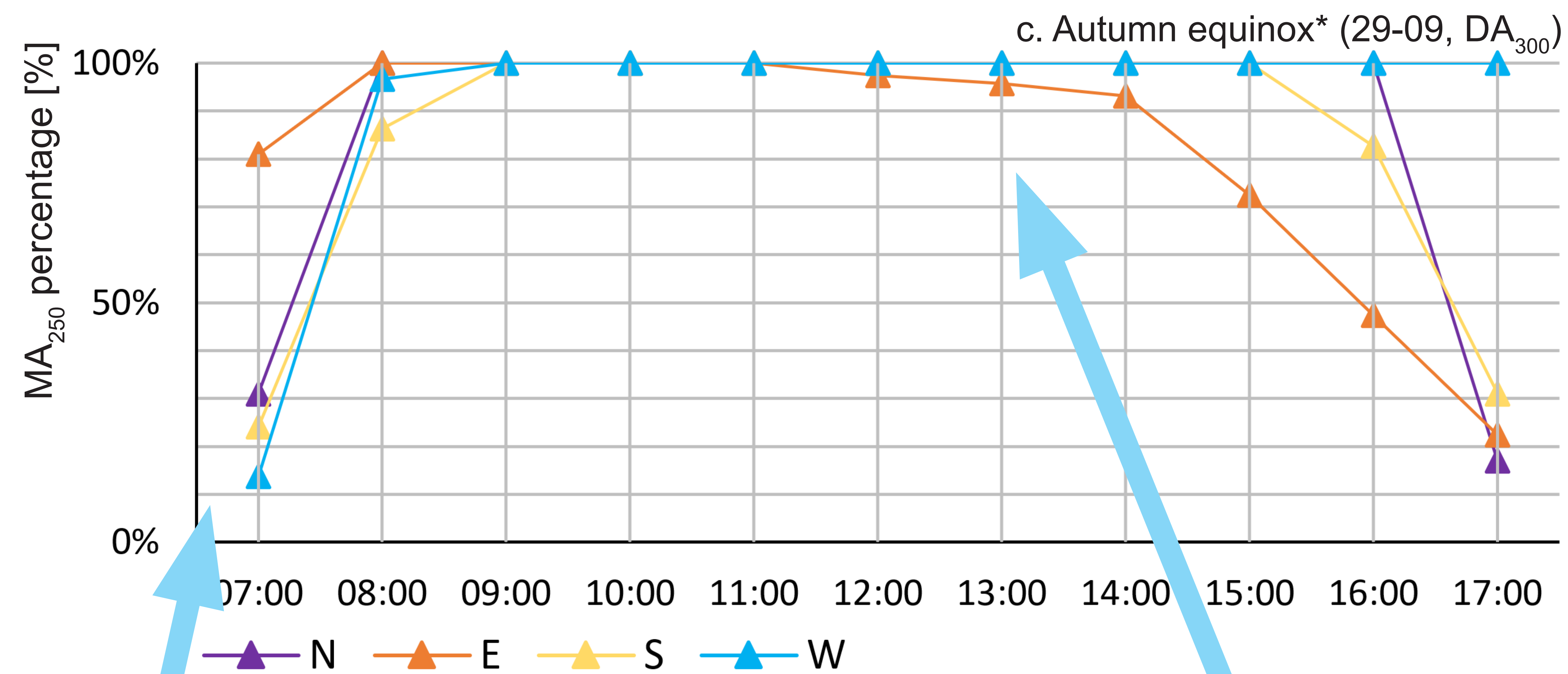


DA₁₄₄ | BBL requirement



Melanopic autonomy

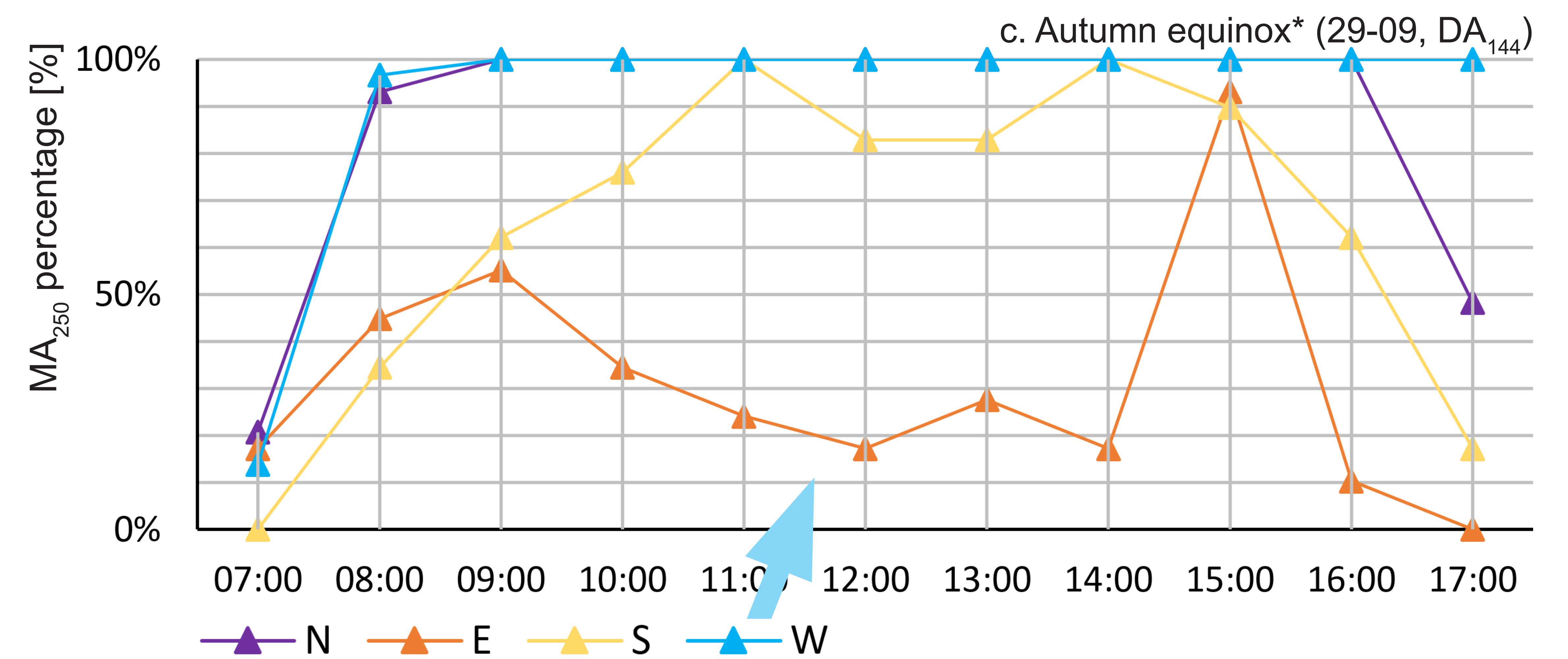
DA_{300} | EU_{min} requirement



insufficient MA

sufficient MA

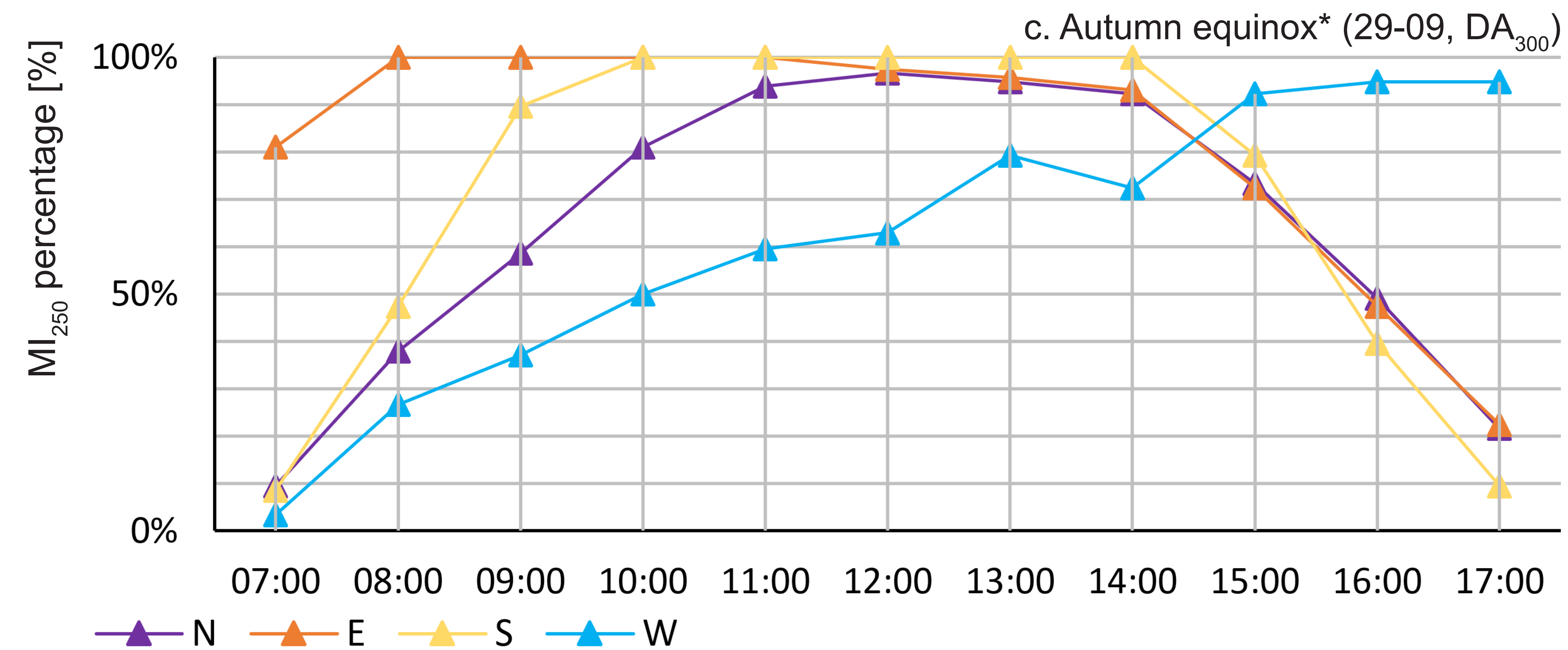
DA_{144} | BBL requirement



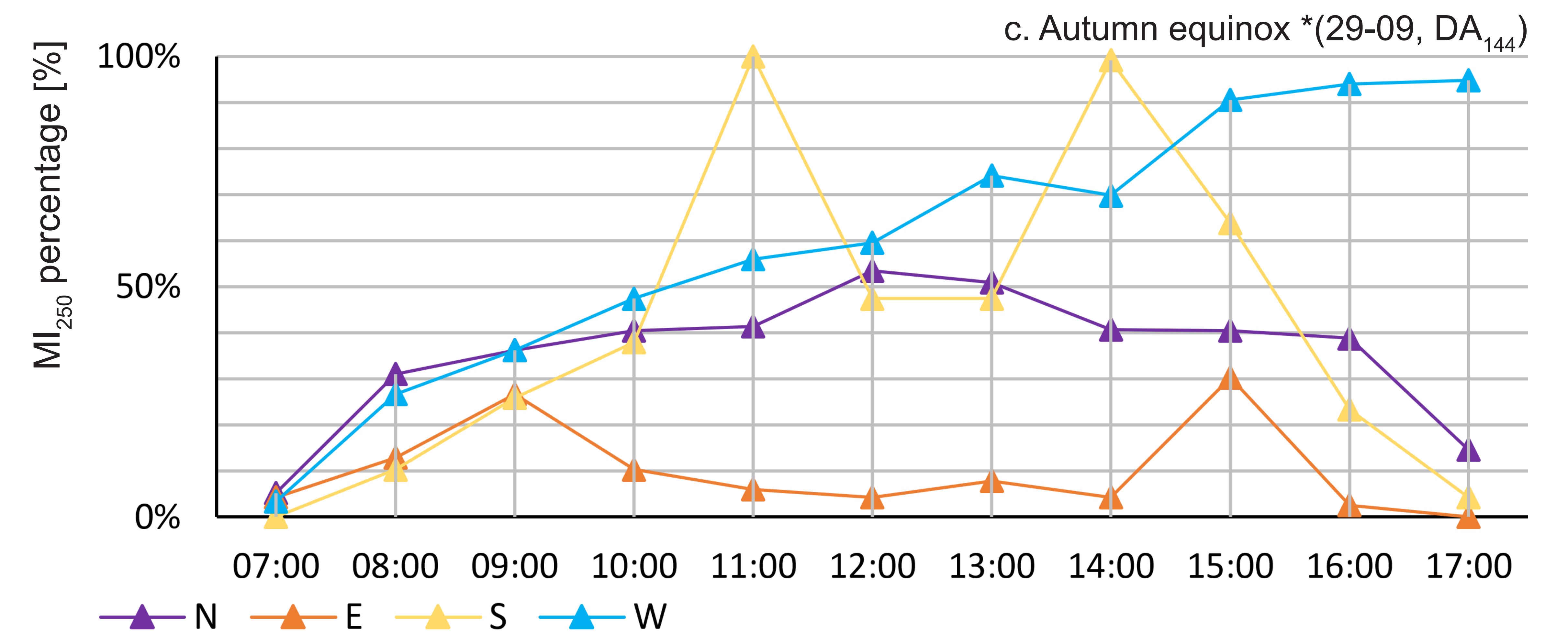
insufficient MA

Melanopic isotropy

DA₃₀₀ | EU_{min} requirement

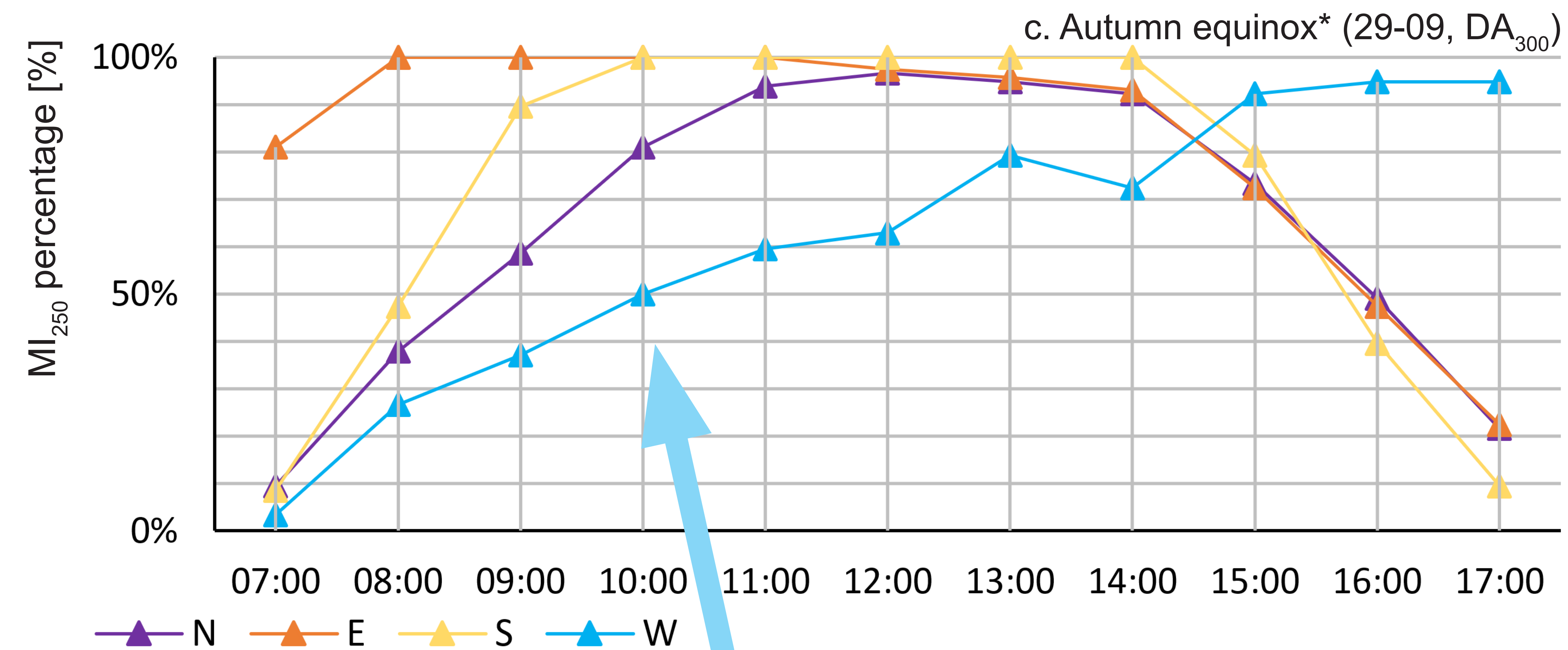


DA₁₄₄ | BBL requirement



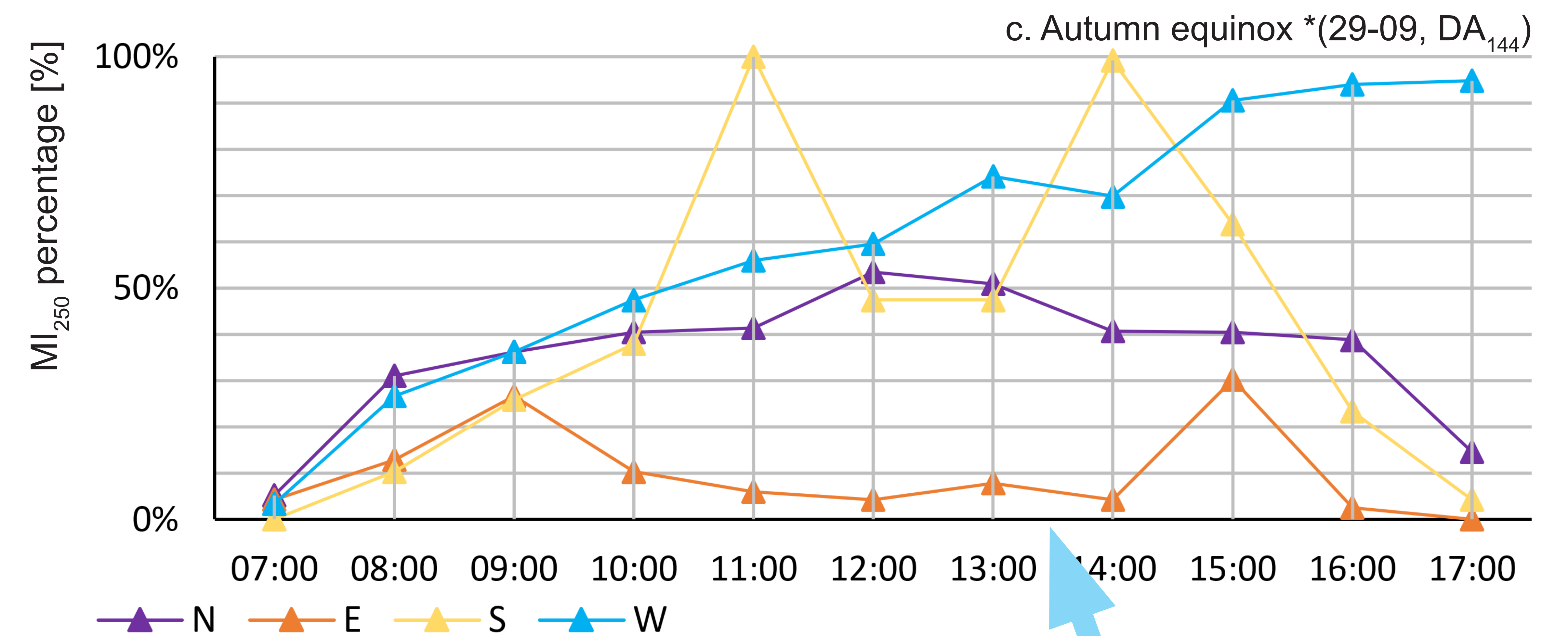
Melanopic isotropy

DA_{300} | EU_{min} requirement



selective for
direction

DA_{144} | BBL requirement



too selective

Are the residences healthy?

	non-visual stimulus	
Residence compliance	MA	MI
Dutch building code 144 lx	Healthy (with no obstr.)	Always selective
Recommended 300 lx	Healthy	not selective

Are the residences healthy?

	non-visual stimulus	
Residence compliance	MA	MI
Dutch building code 144 lx	Healthy (with no obstr.)	Always selective
Recommended 300 lx	Healthy	not selective
Artificial lighting in wintertime		

Daylighting performance

VS.

static/dynamic

non-visual stimulus

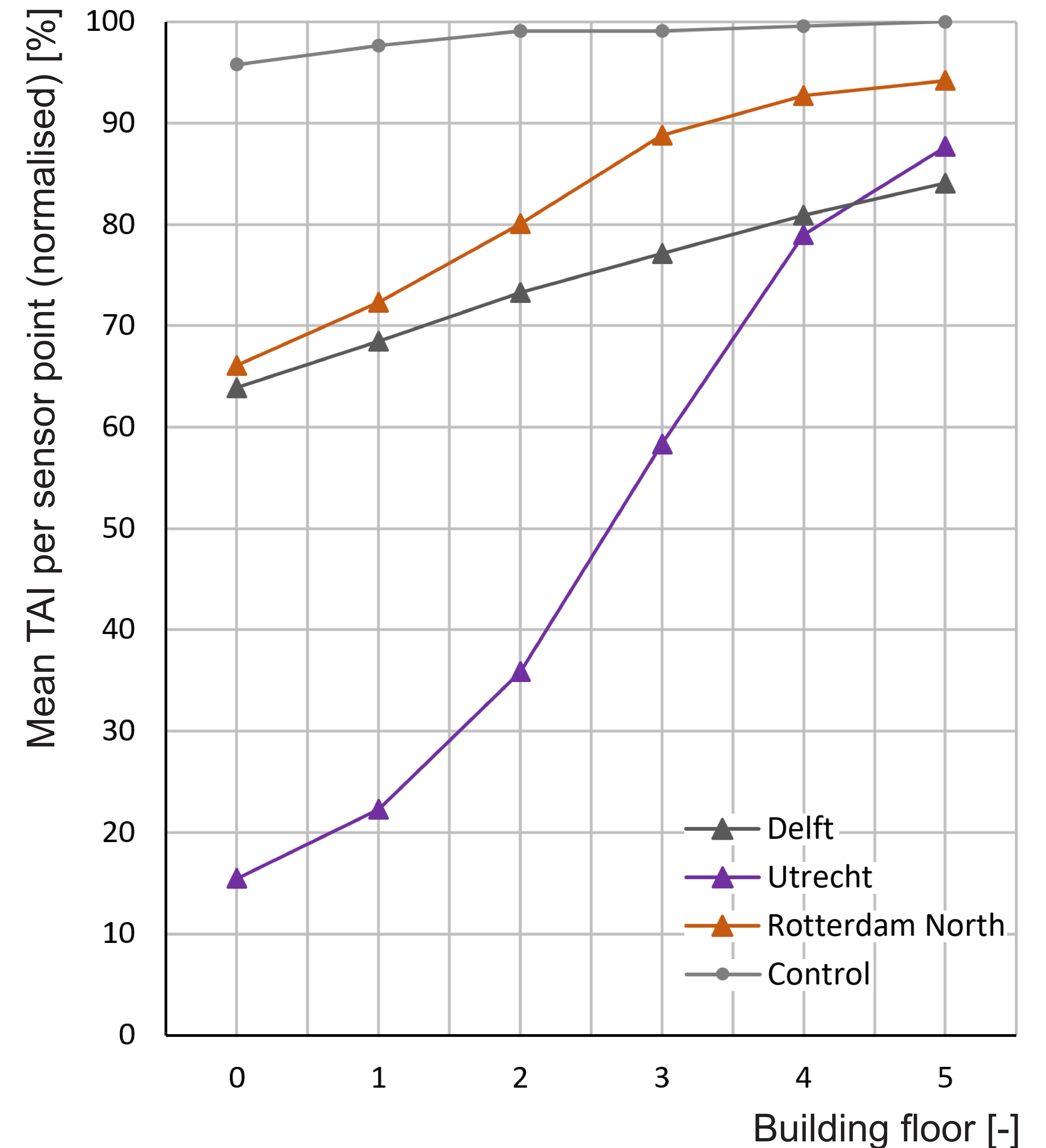
urban density

building floor

sky view factor

urban density: medium

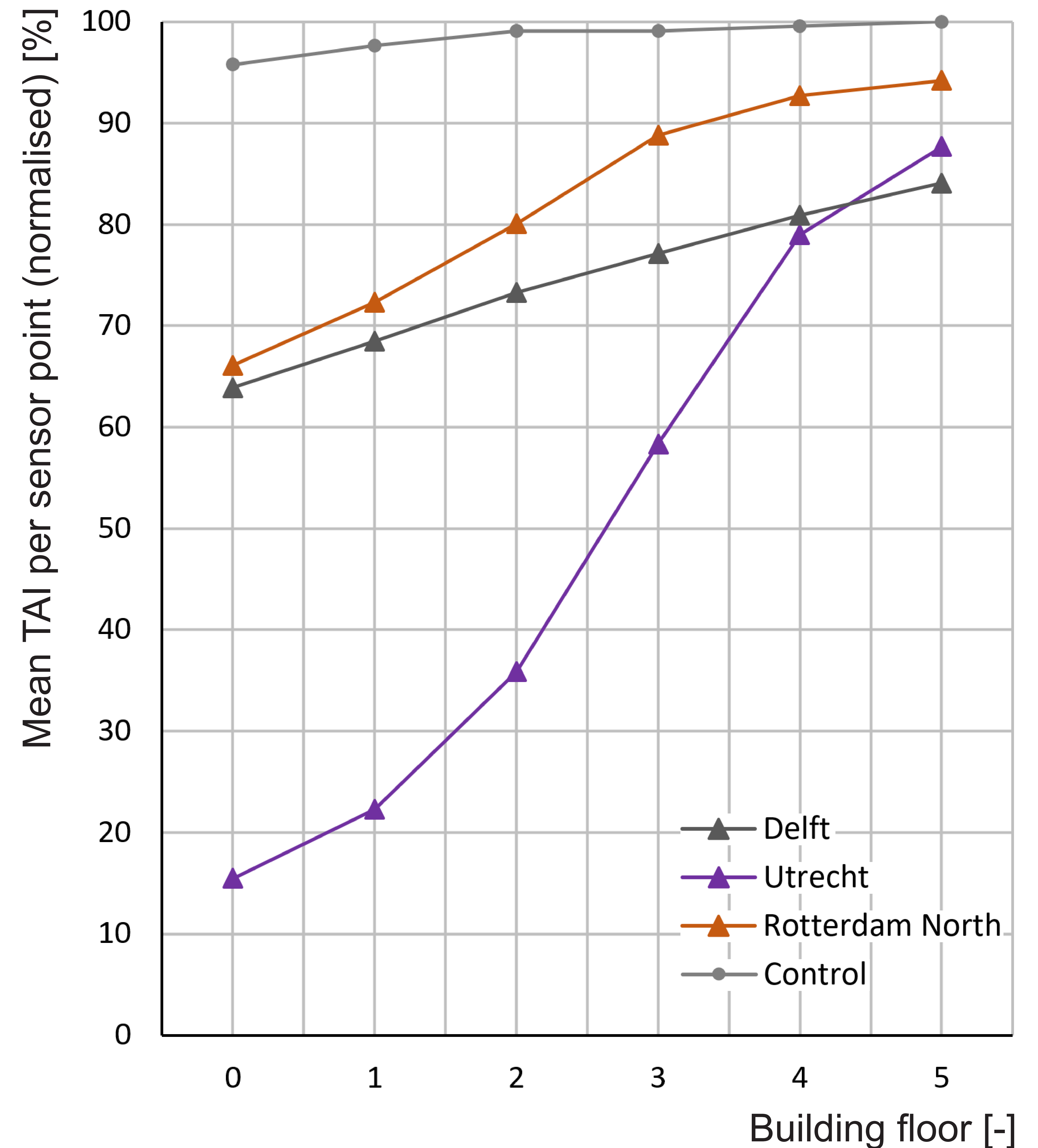
- Mean normalised performance
- 100% = performance without urban context



urban density: medium

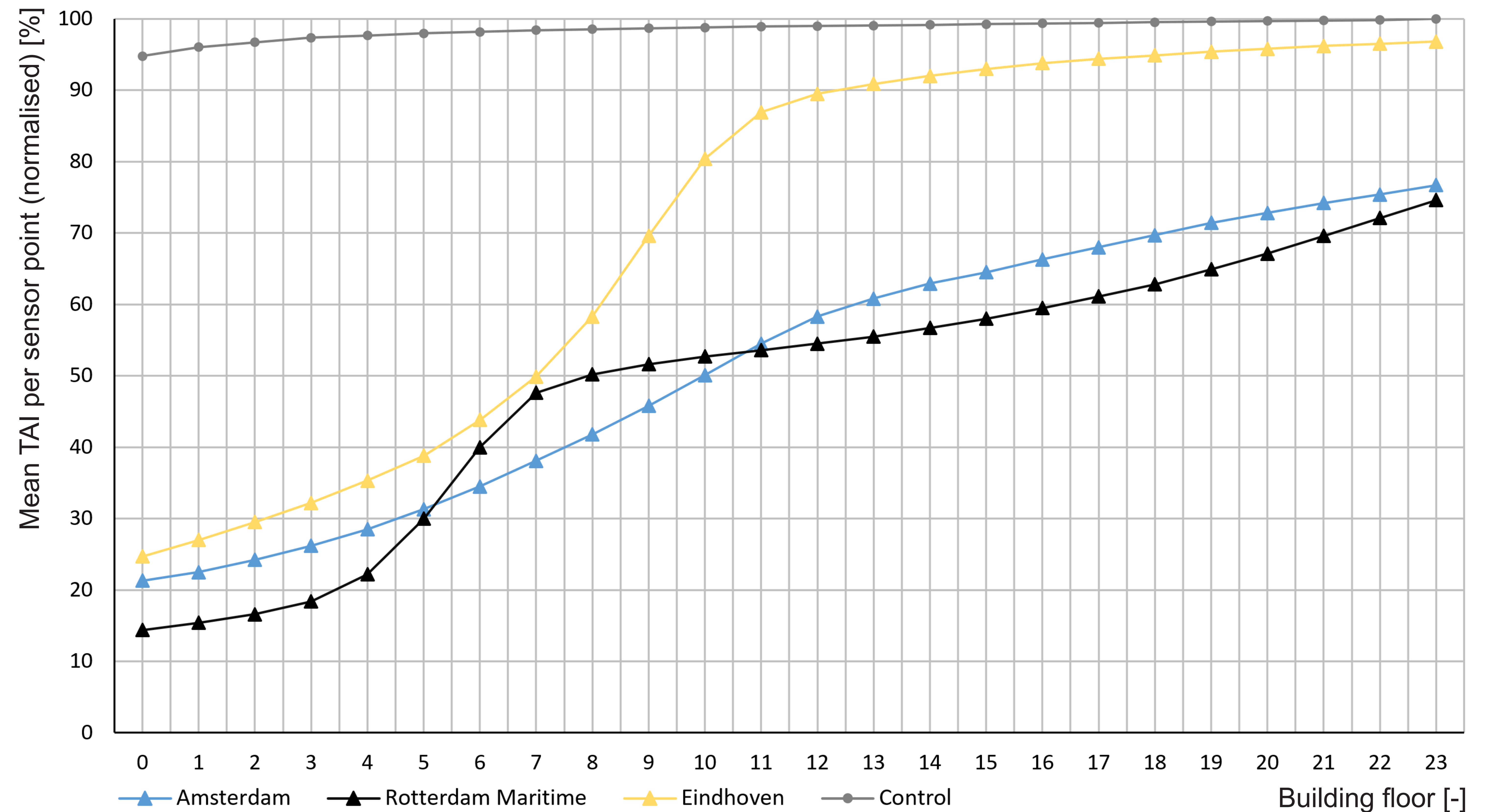
- Mean normalised performance
- 100% = performance without urban context
- Average decrease: 29%
- Worst case decrease: 80%

What causes this?



urban density: high

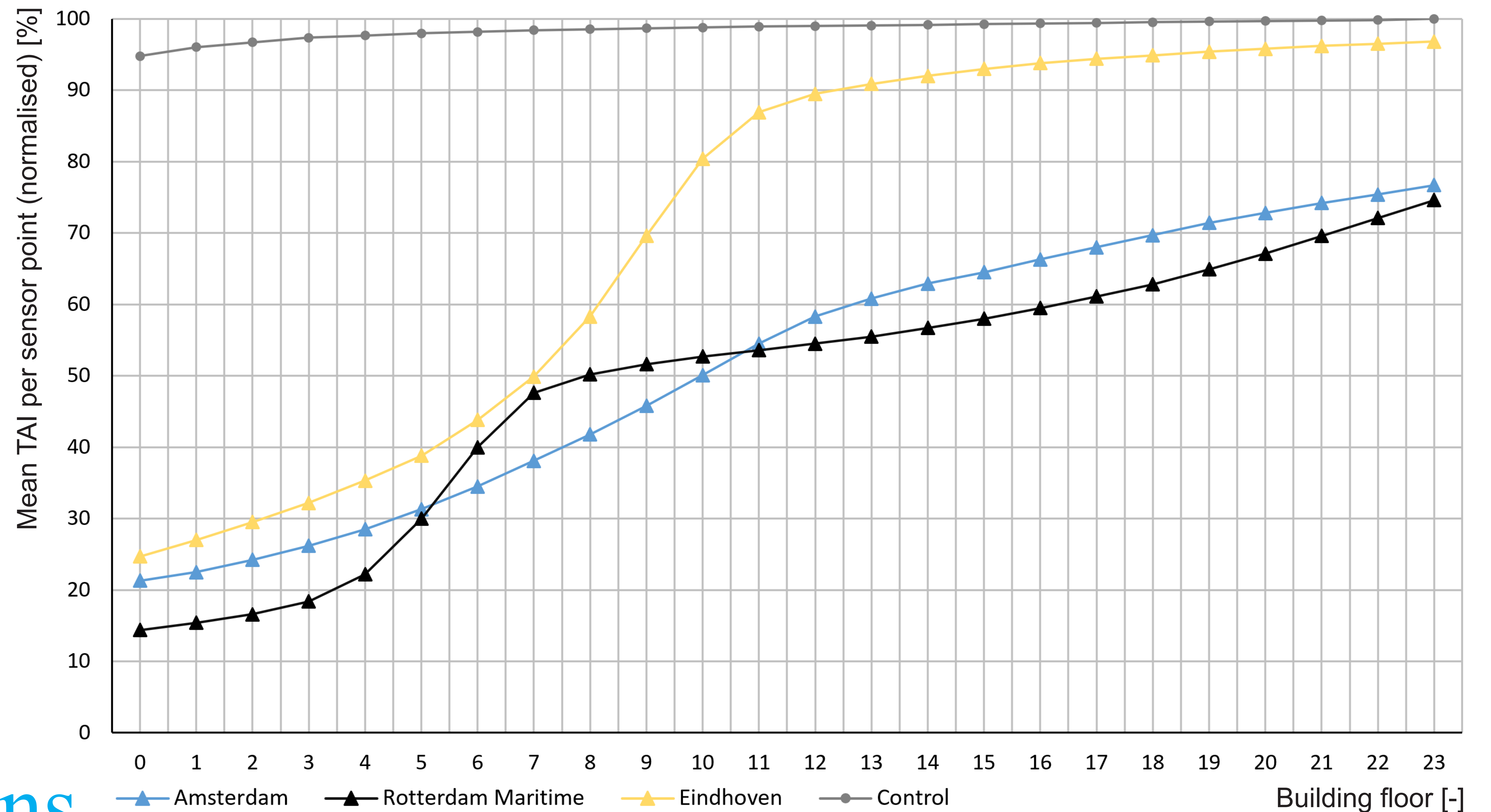
- Mean normalised performance
- 100% = performance without urban context



urban density: high

- Mean normalised performance
- 100% = performance without urban context
- Average decrease: 43%
- Worst case decrease: 80%

What do ‘bad’ simulations have in common?



urban density

- FSI, GSI, OSR on ranks
- performance metric

Is the mean performance affected by urban density?

Is the distribution of performance affected by urban density?

urban density

- FSI, GSI, OSR on ranks
- performance metric

Is the mean performance affected by urban density?

Is the distribution of performance affected by urban density?

in short... yes

urban density

- Null-hypothesis: Results are not significantly different.
- Yes, results are different & not a coincidence

building floors ≤ 10

*independent-
samples median
test*

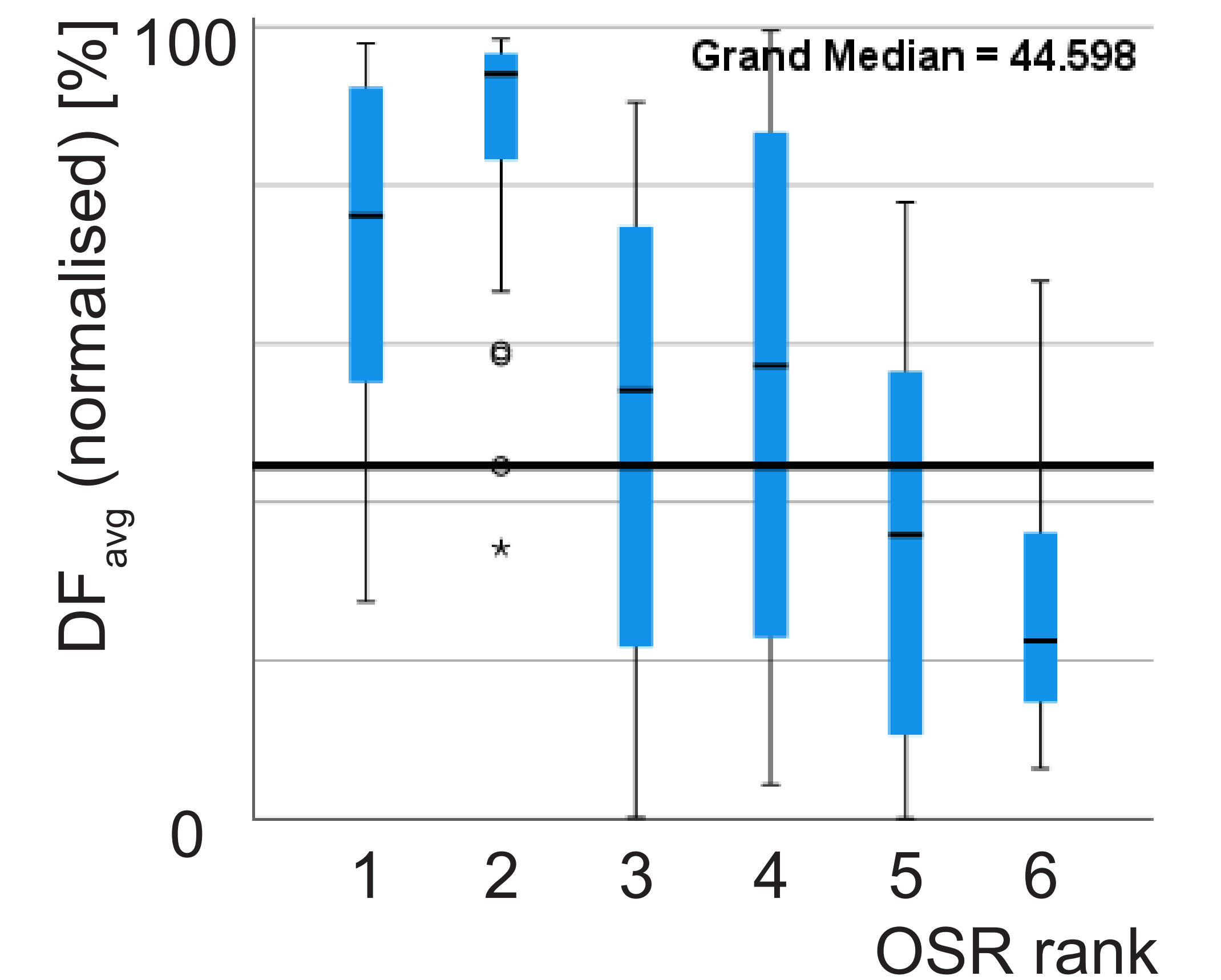
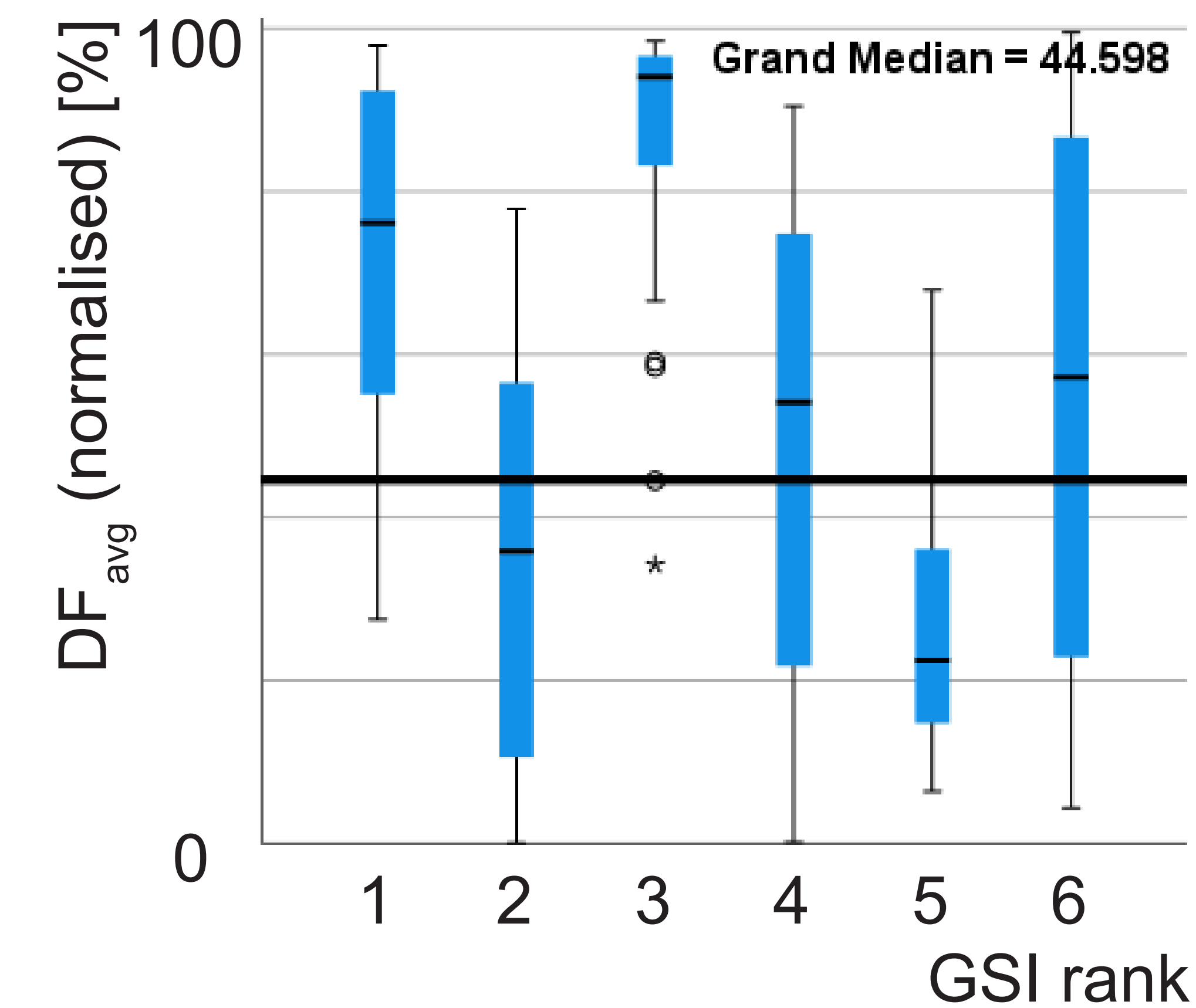
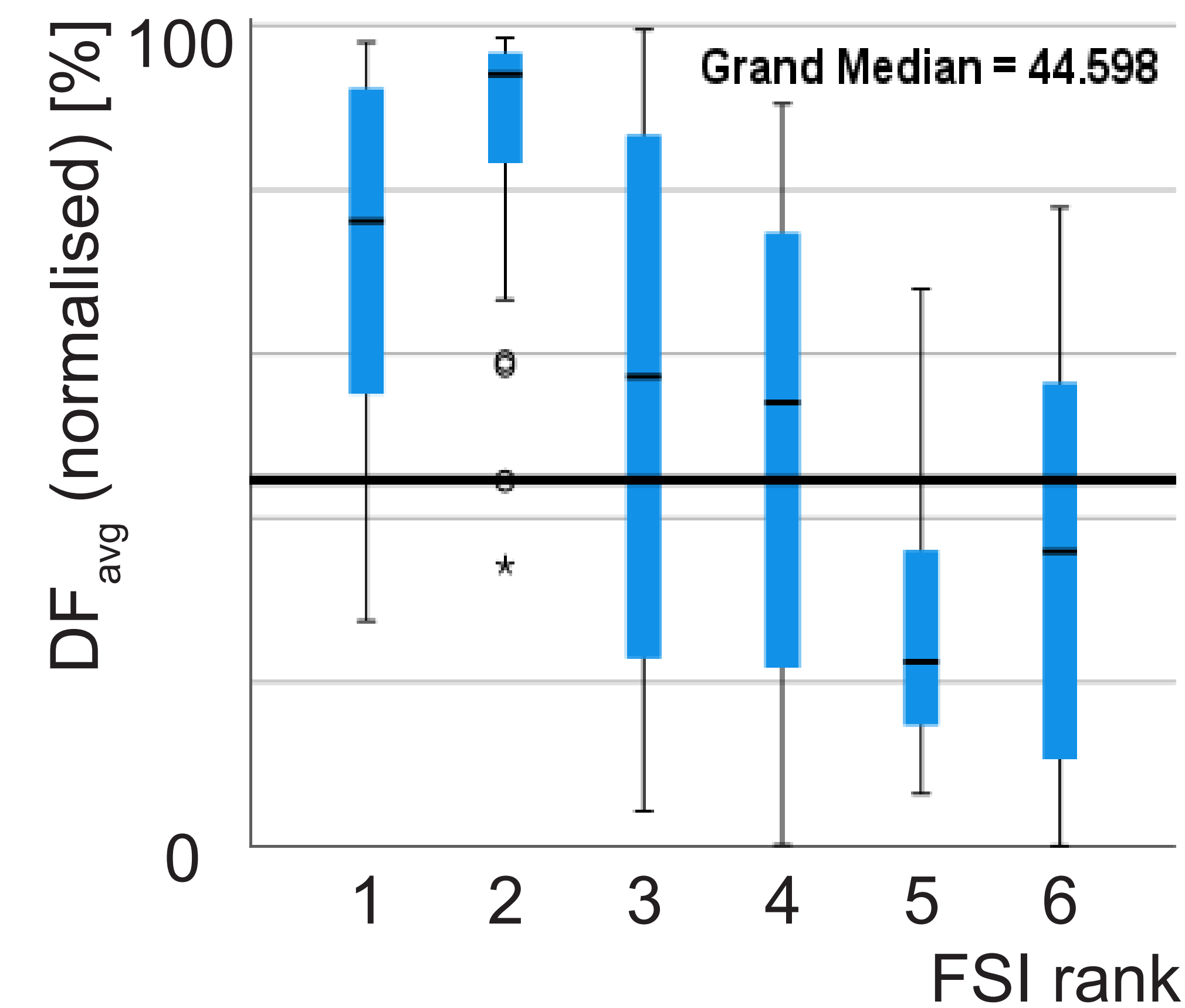
	DF _{avg} (norm.)	TAI (norm.)
FSI	reject (.000)	reject (.000)
GSI	reject (.000)	reject (.000)
OSR	reject (.000)	reject (.000)

*independent-
samples Kruskal-
Wallis test*

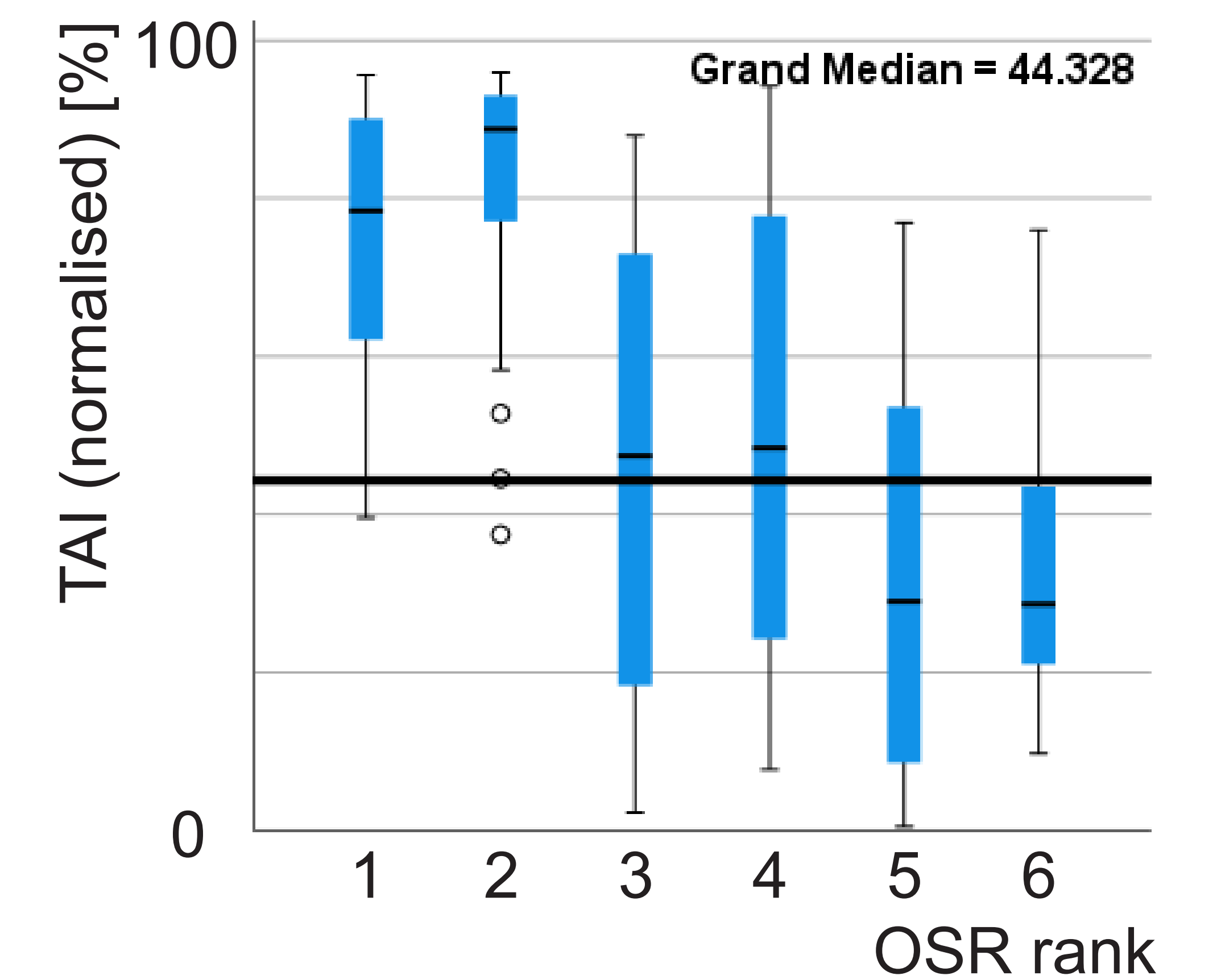
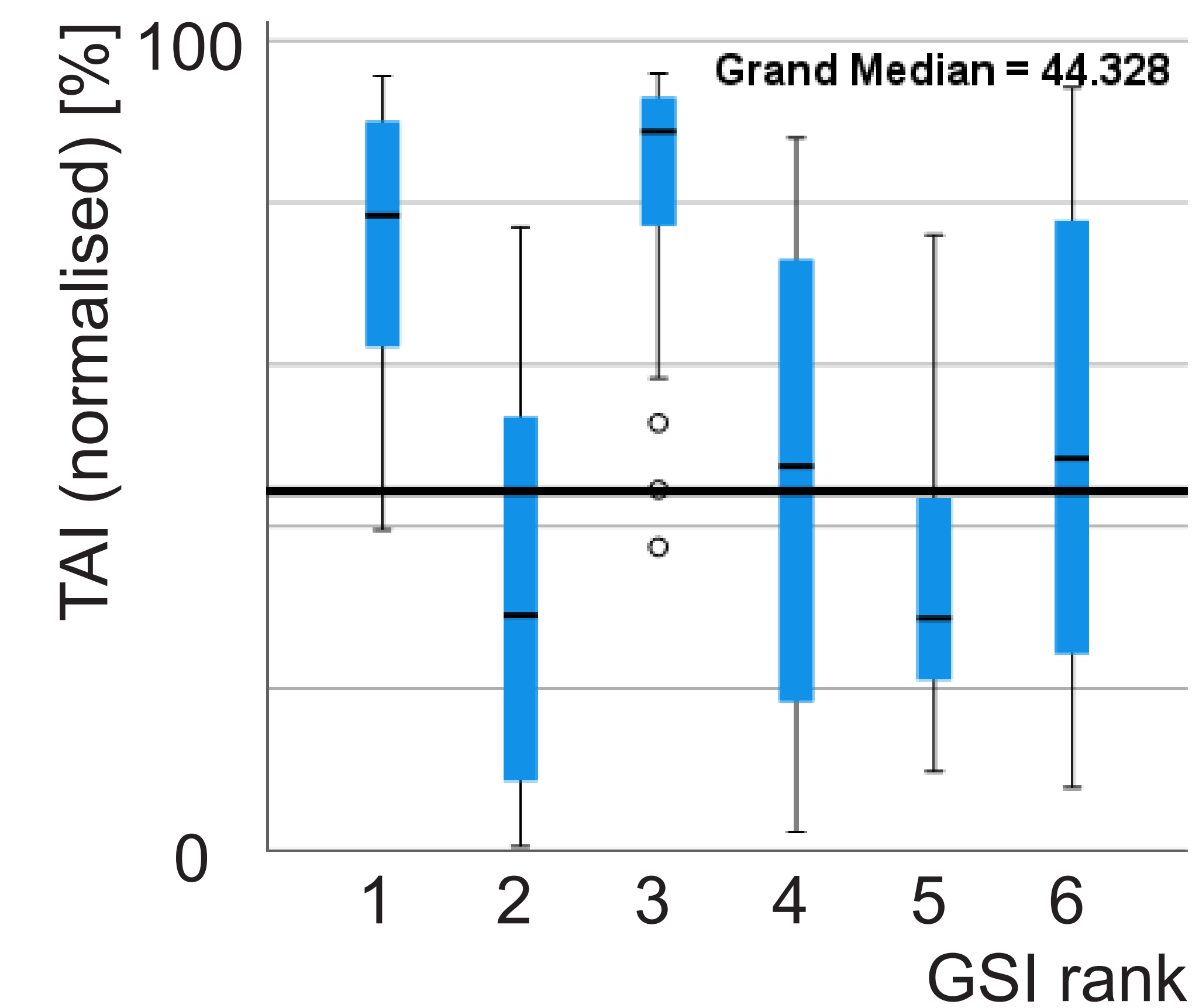
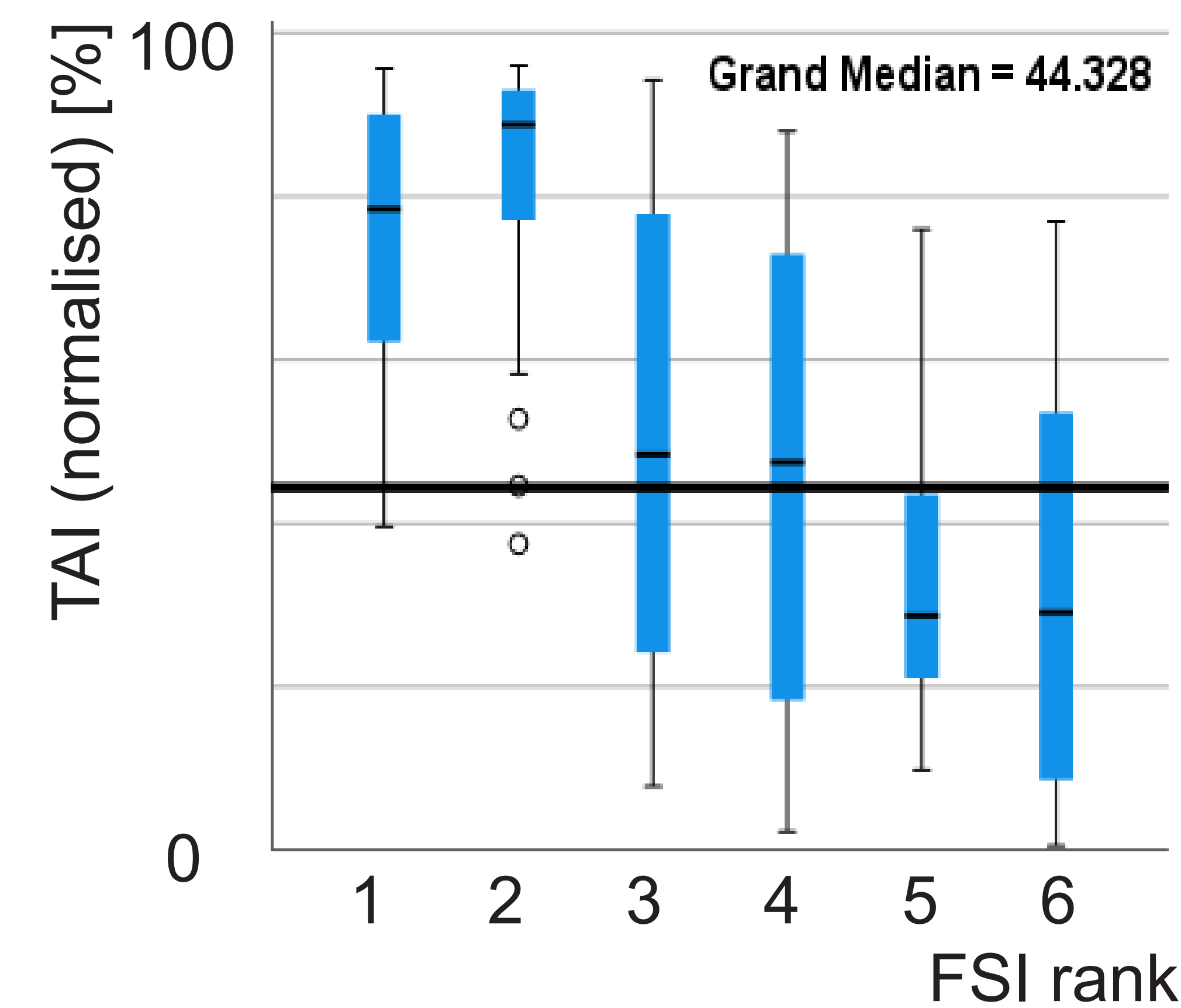
	DF _{avg} (norm.)	TAI (norm.)
FSI	reject (.000)	reject (.000)
GSI	reject (.000)	reject (.000)
OSR	reject (.000)	reject (.000)

Recommendation based on urban density

- Sample size $n=6$: no regression analysis



- FSI/OSR suggest a regression



Daylighting performance

VS.

static/dynamic

non-visual stimulus

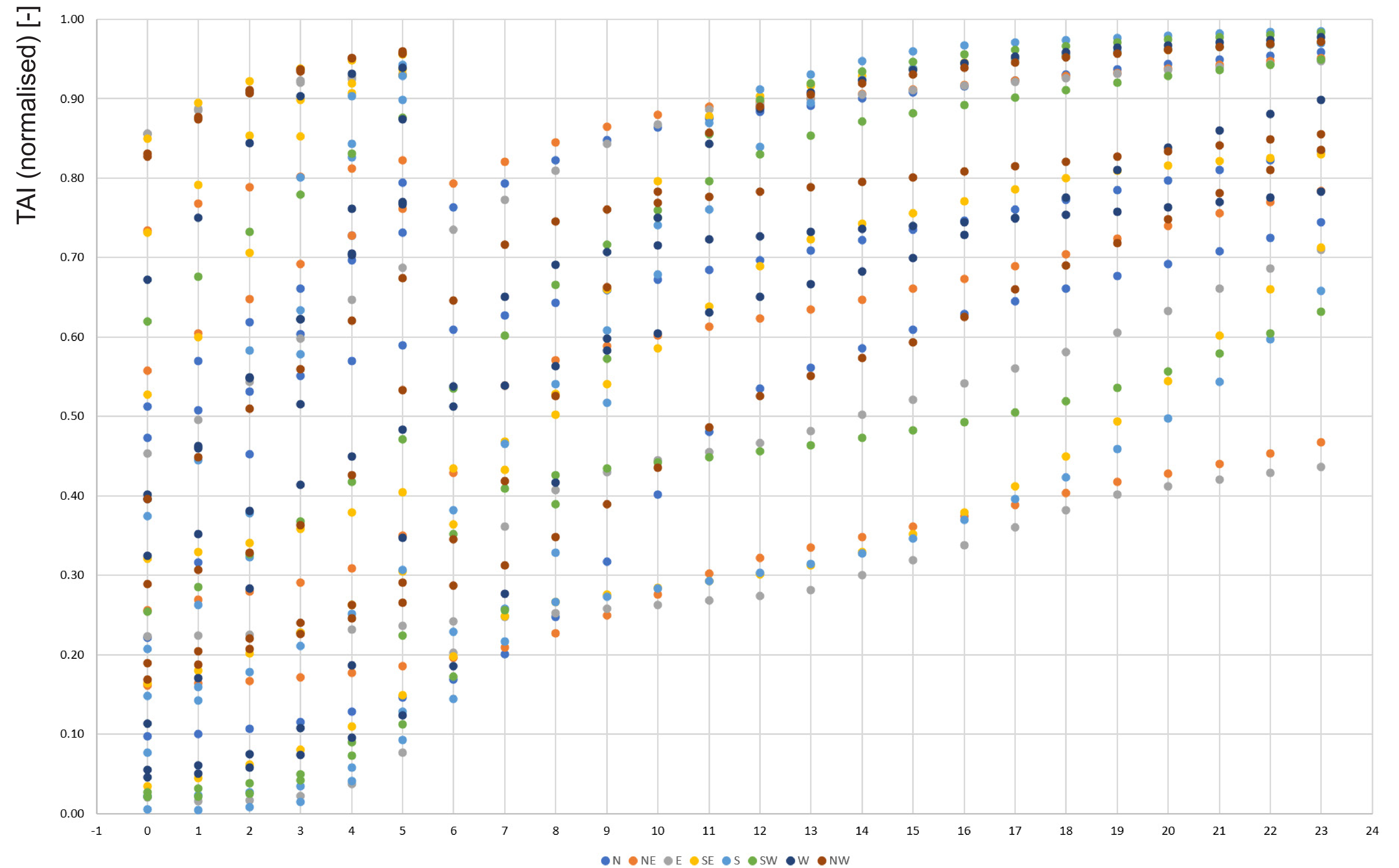
urban density

building floor

sky view factor

Building floor

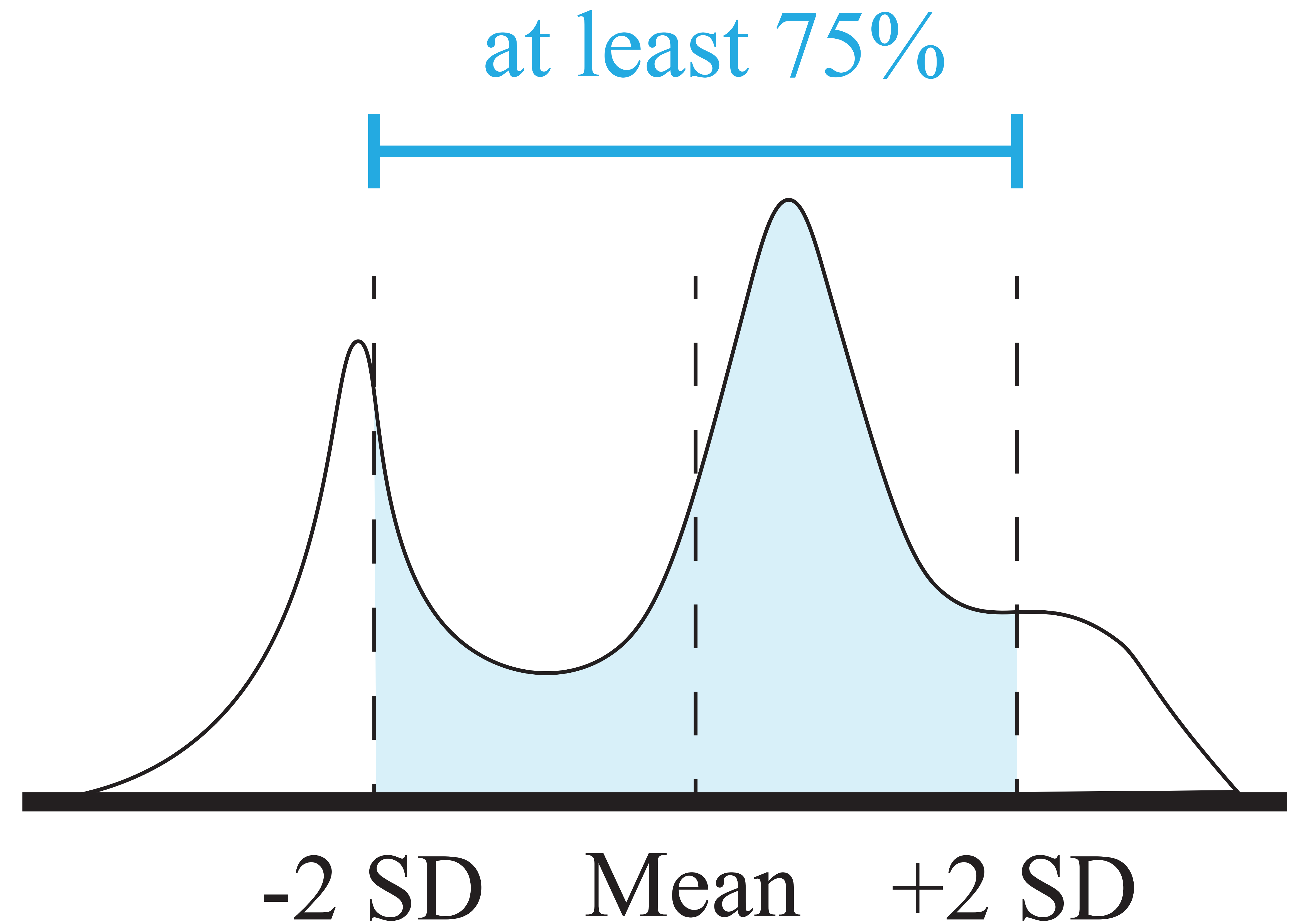
- Split in density
- Mean performance
- Standard deviation



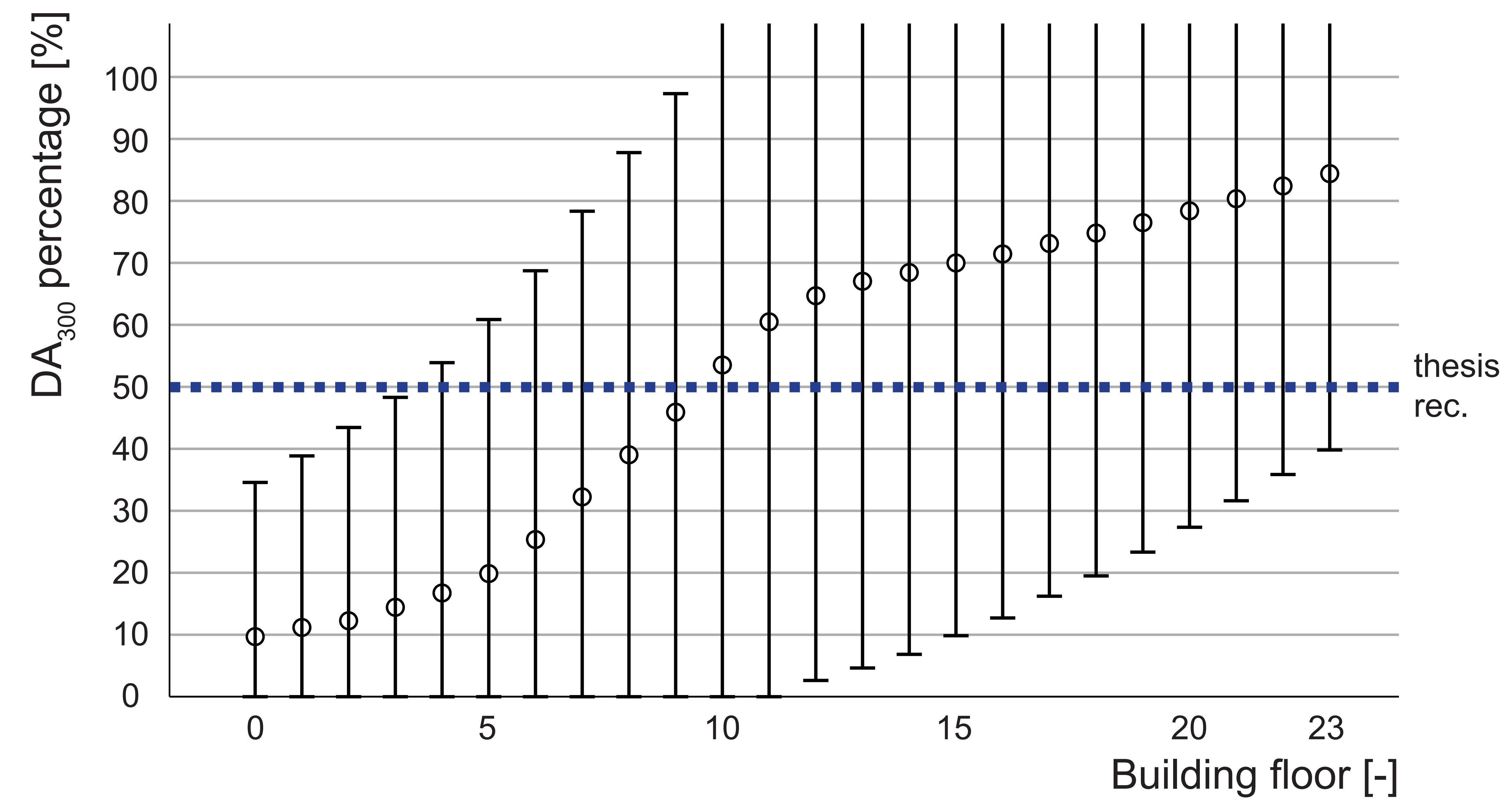
Building floor [-]

Statistics intermezzo

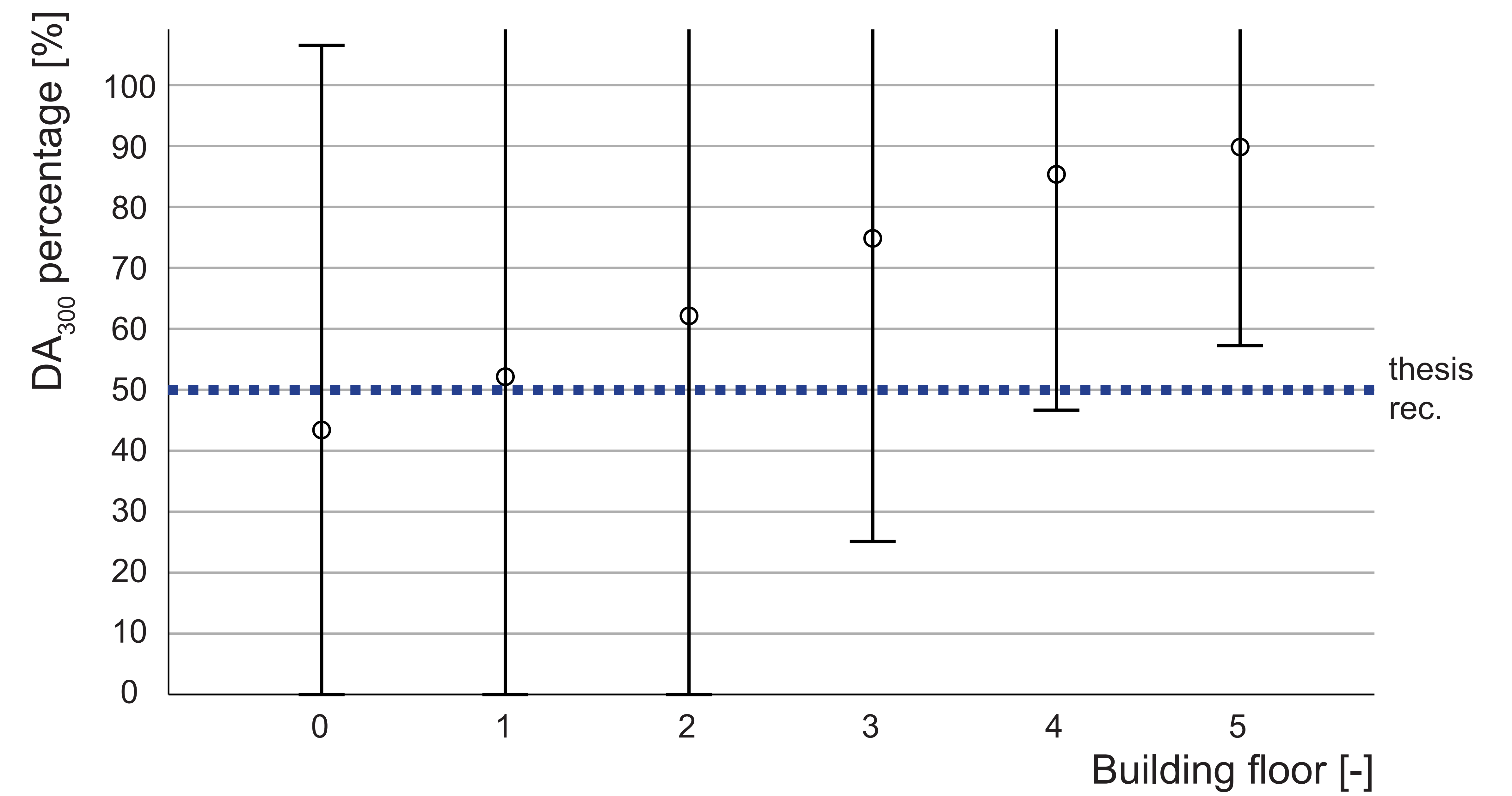
- Not normally distributed?
- Chebychev's theorem (1867)
- $>75\%$ of the results in ± 2 SD



high density

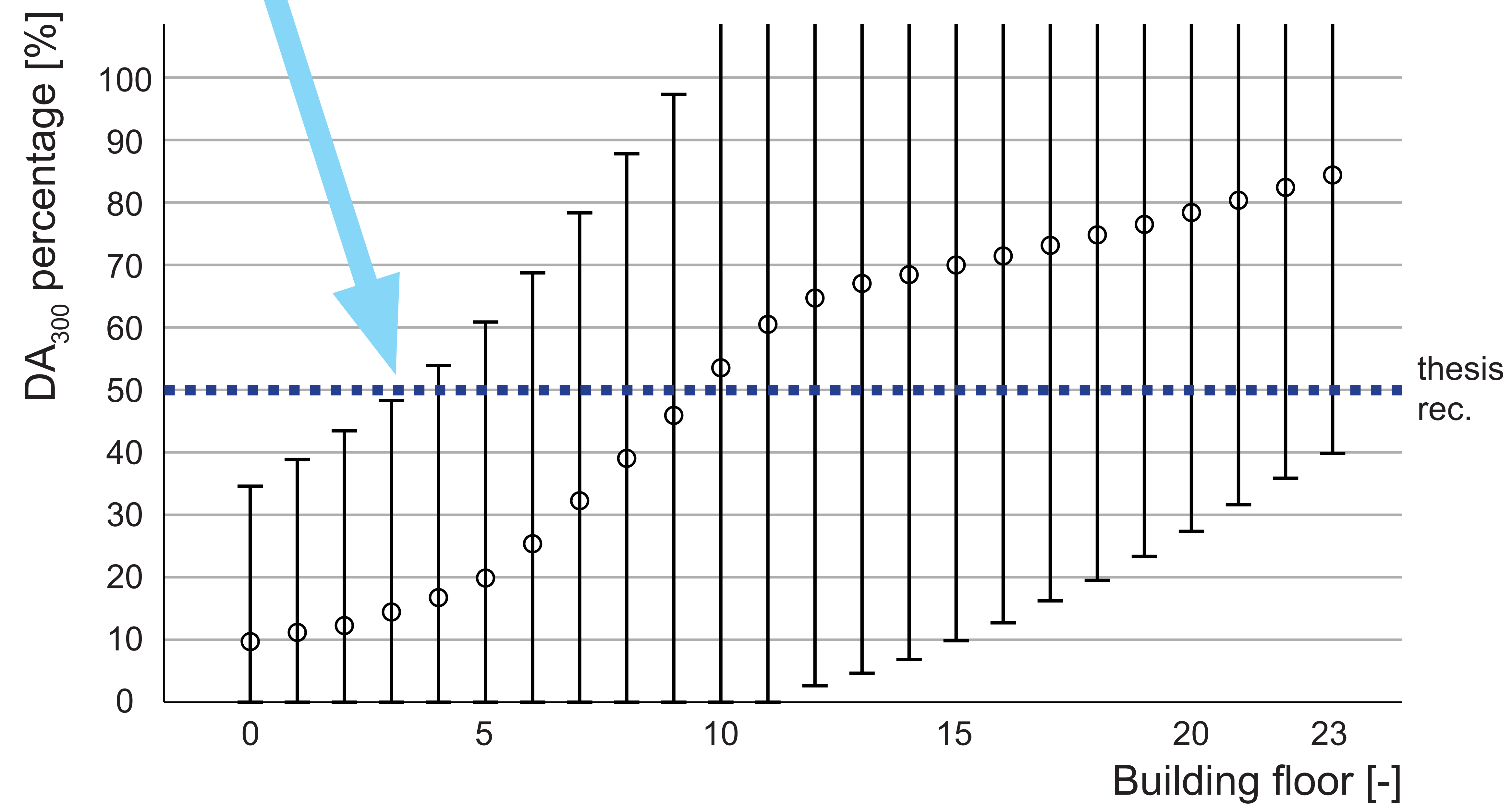


medium density



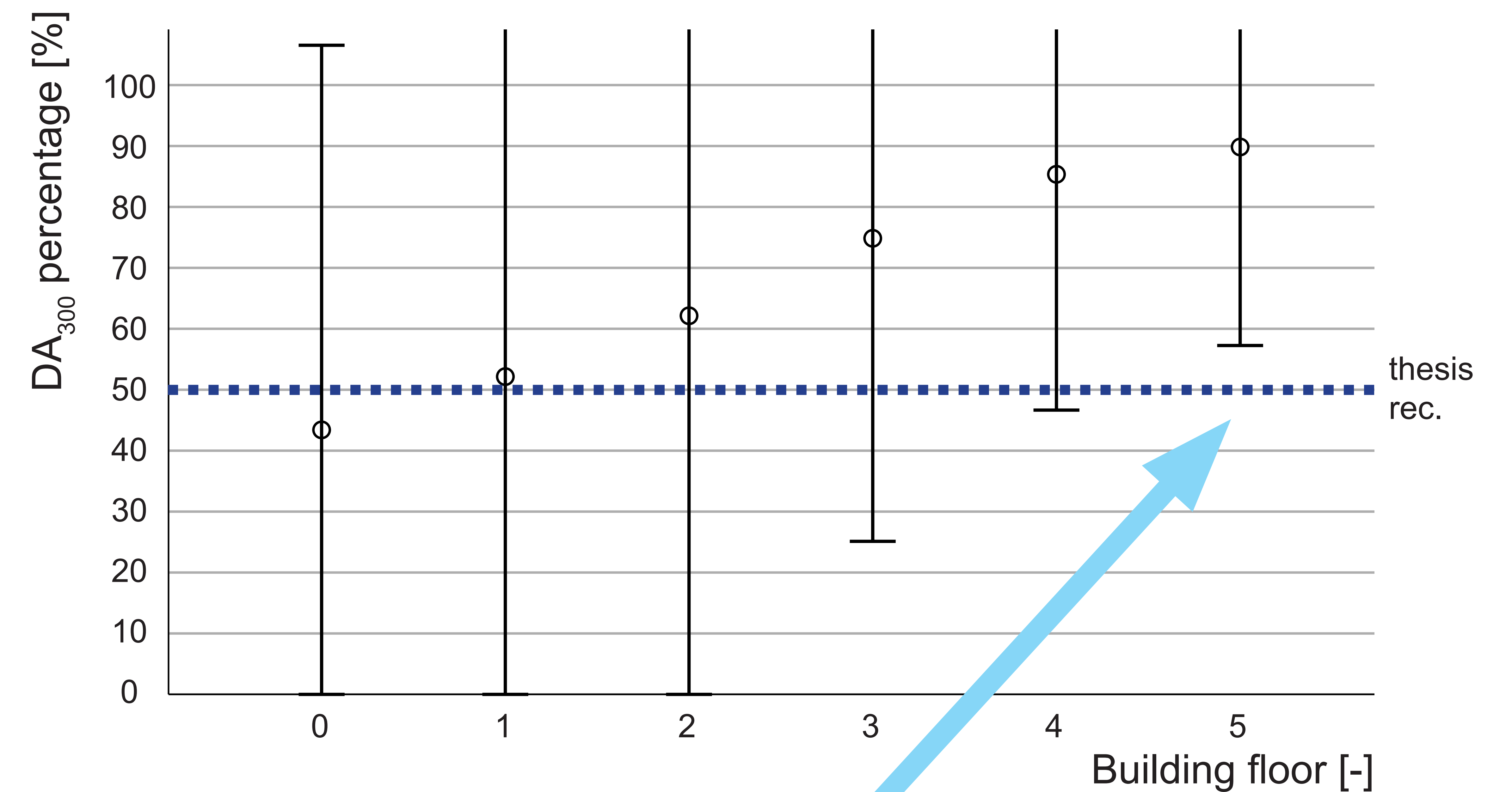
high density

Likely insufficient



medium density

Probably sufficient



Recommendation based on building floor

Risk indication

high density

medium density

acceptable

n/a

≥ 5

normal

≥ 9

$1 \leq 4$

high

$5 \leq 8$

0

unacceptable

≤ 4

n/a

Daylighting performance

VS.

static/dynamic

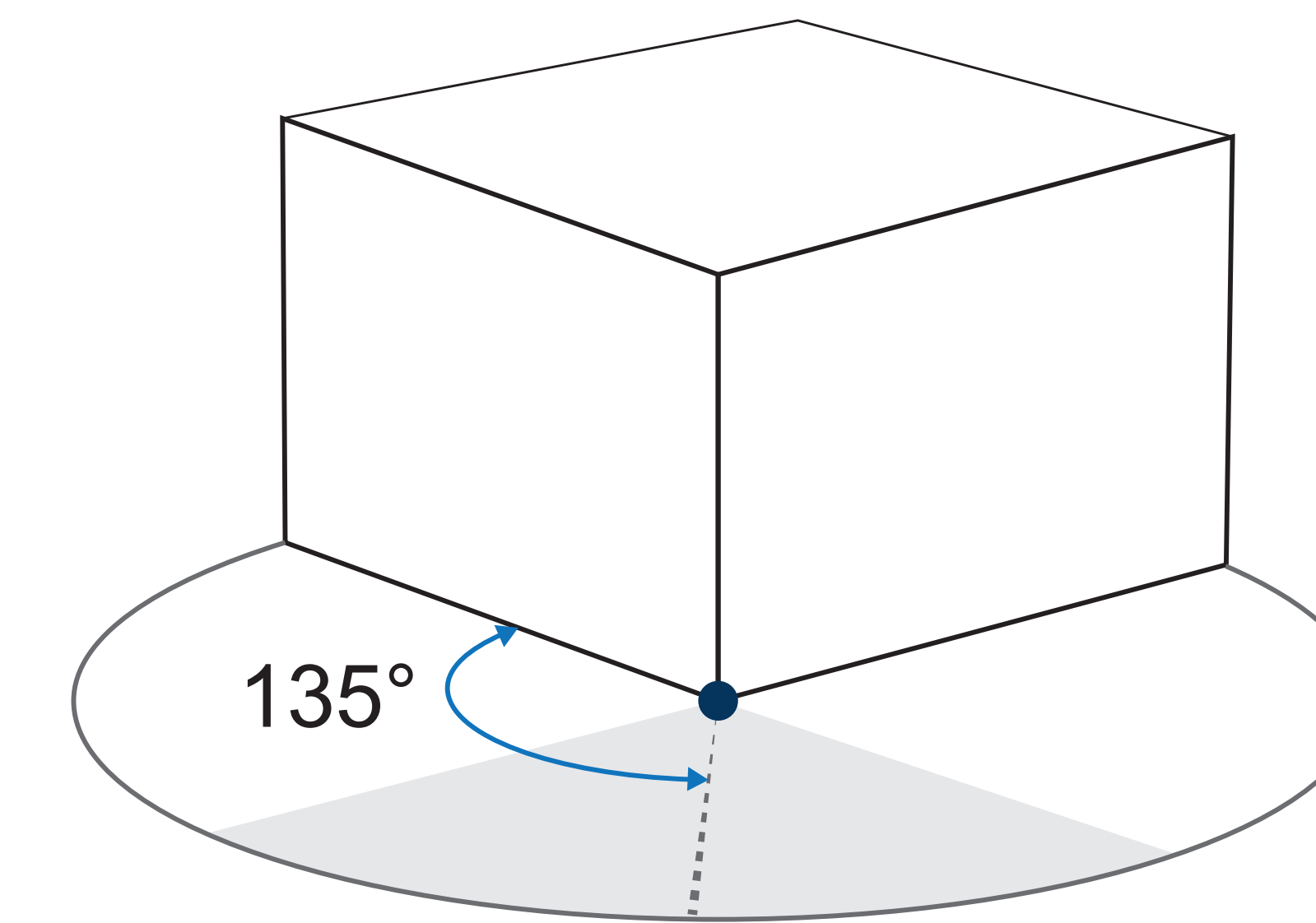
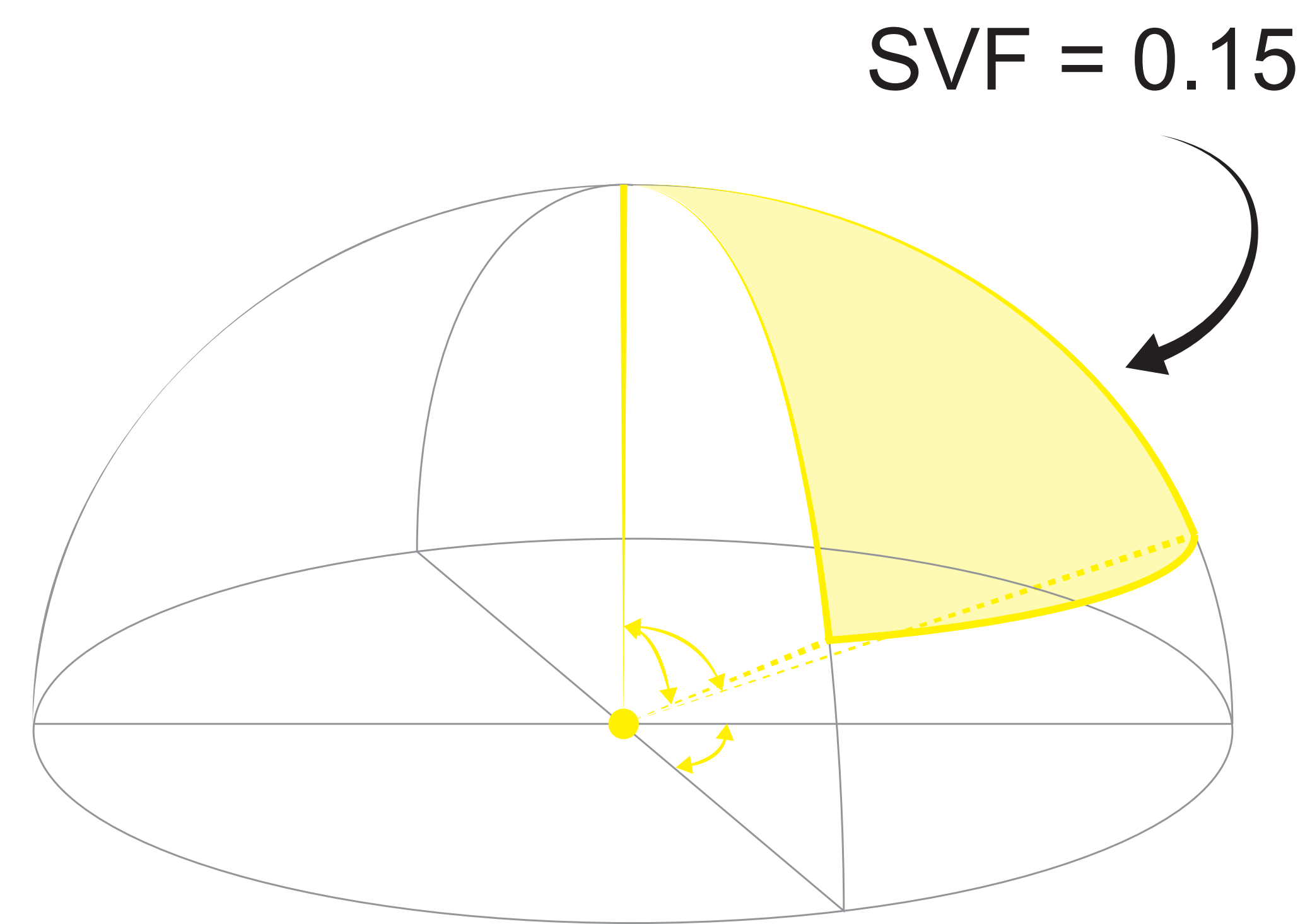
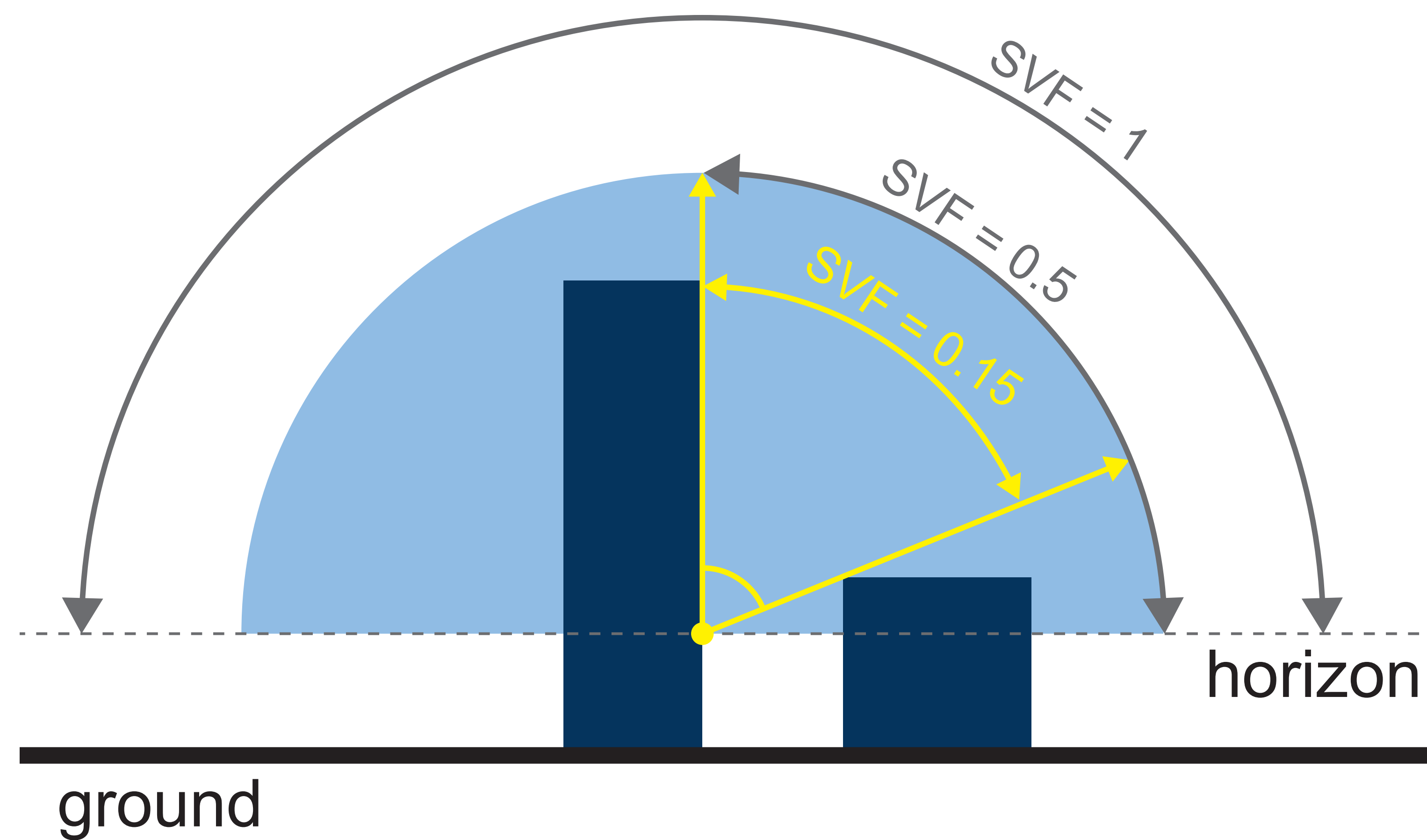
non-visual stimulus

urban density

building floor

sky view factor

sky view factor intermezzo



$$\left(\frac{135}{180} \times 0.5\right) \times 2$$
$$= \text{max. } 0.75$$

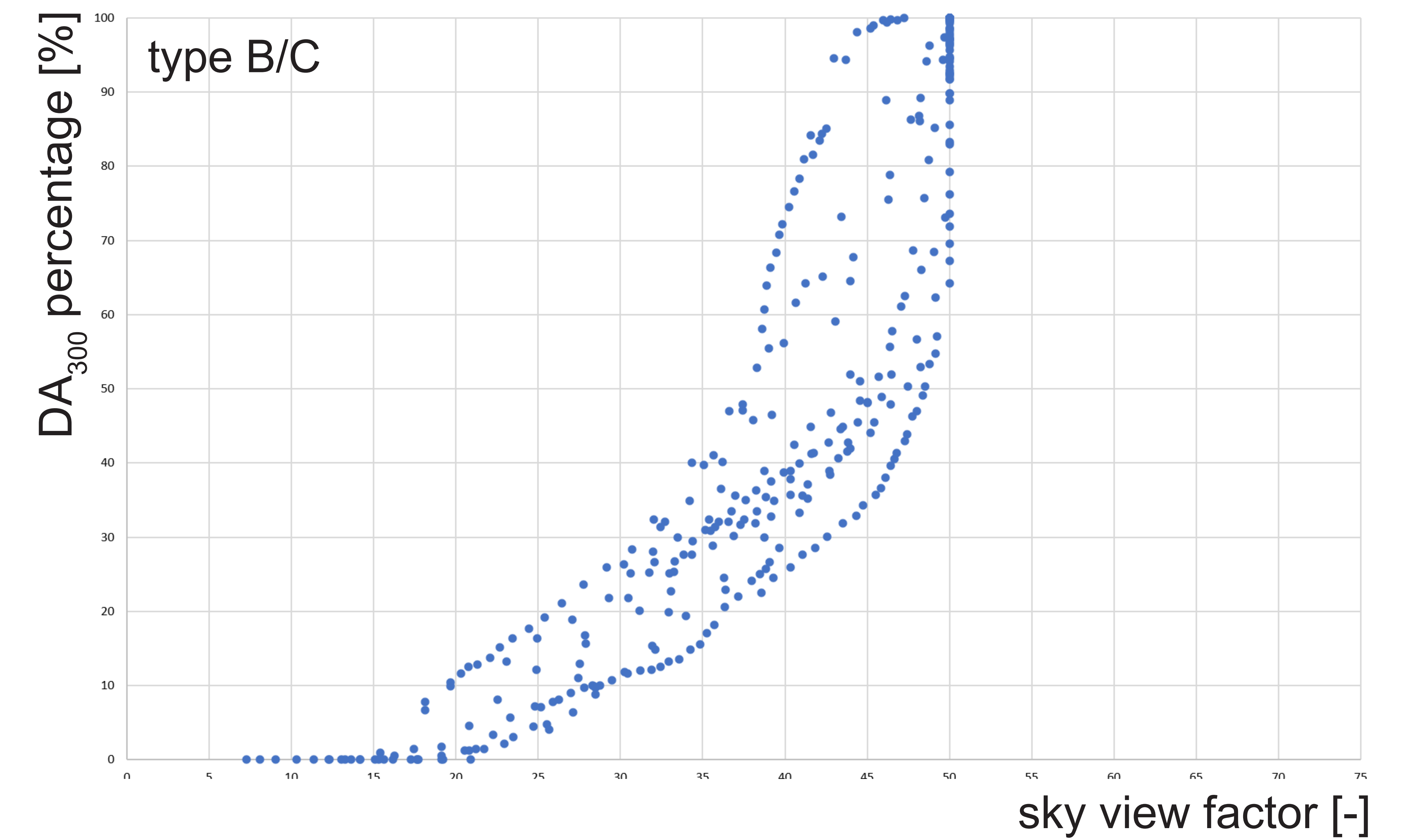
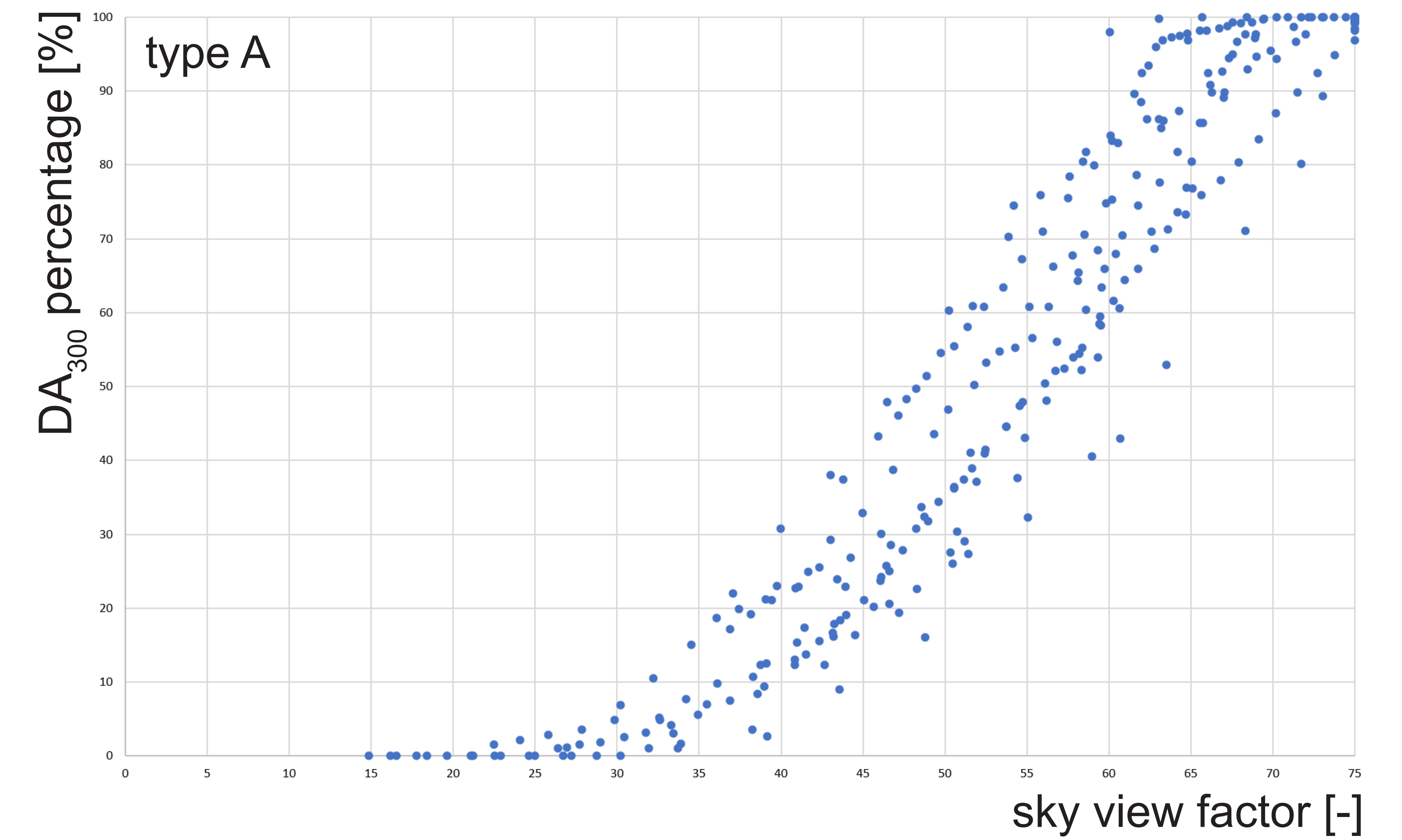
How much of the sky can you see?

Single-oriented facade: $SVF_{\text{max}} = 0.5$

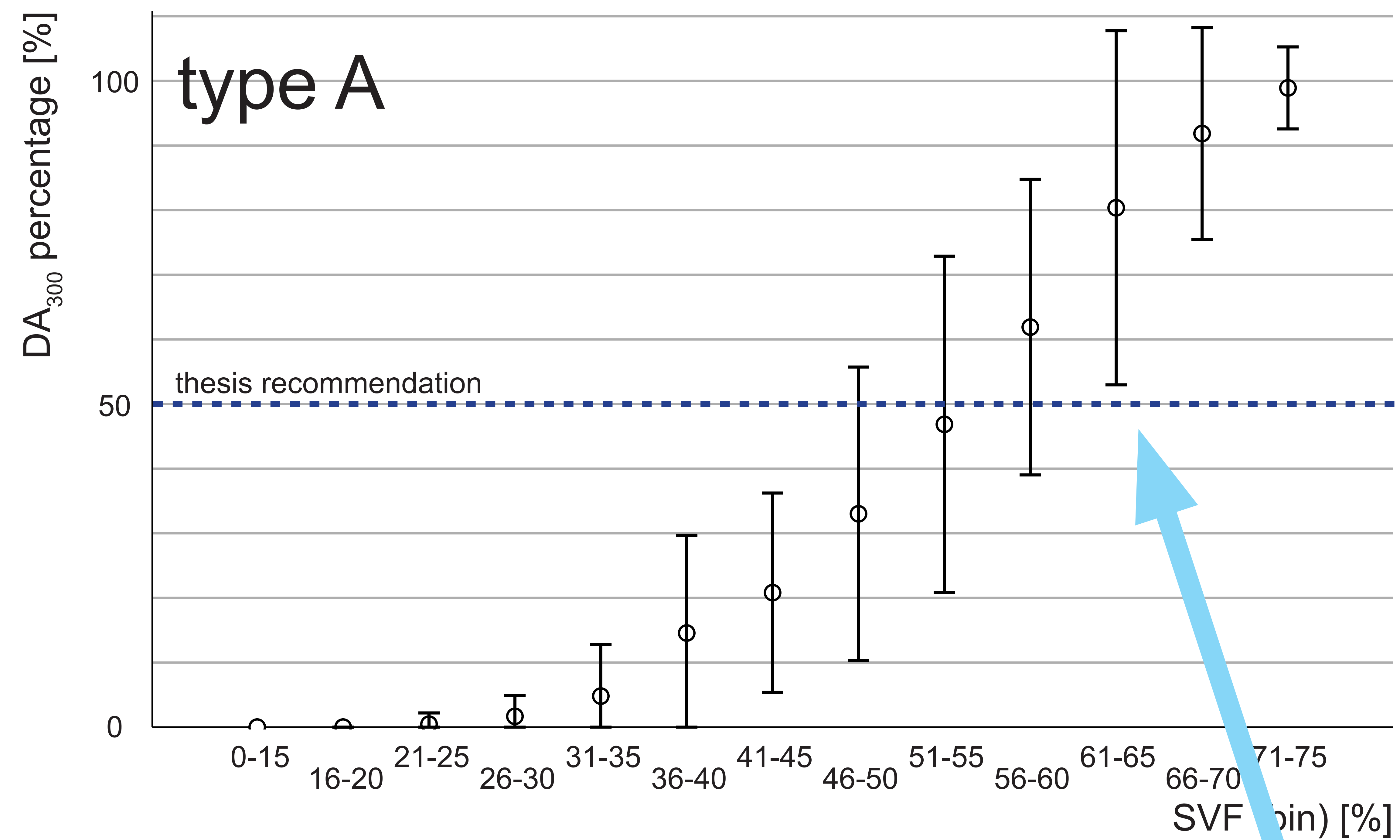
Double-oriented facade: $SVF_{\text{max}} = 0.75$

sky view factor

- Threshold values
- Binning SVF: mean, SD

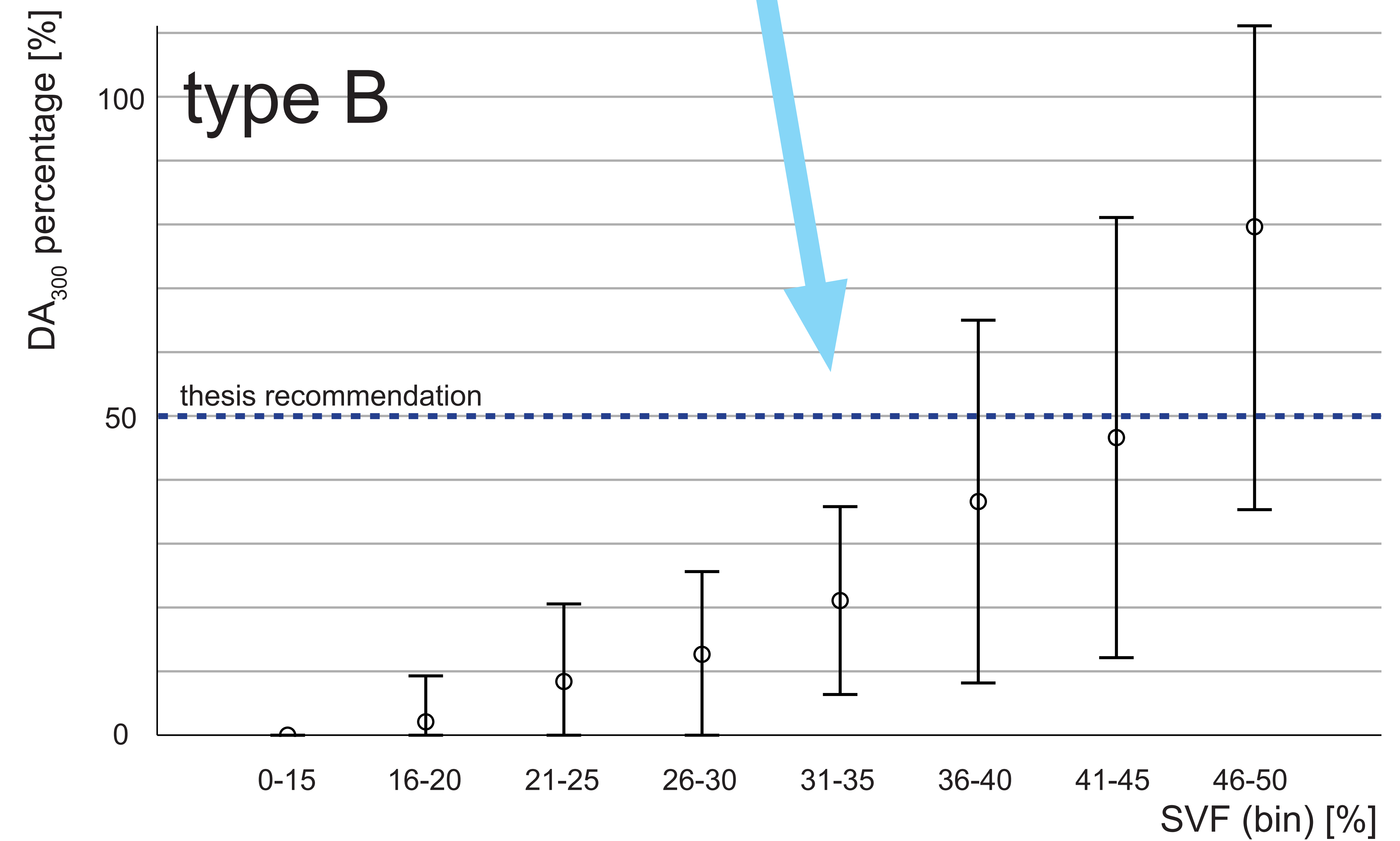


sky view factor



Probably
sufficient

Likely
insufficient



Recommendation based on sky view factor

Risk indication	dynamic		static	
	single	double	single	double
acceptable	n/a	≥ 61	n/a	n/a
normal	$46 \leq 50$	$56 \leq 60$	n/a	n/a
high	$36 \leq 45$	$42 \leq 55$	n/a	n/a
unacceptable	≤ 35	≤ 41	$0 \leq 50$	$0 \leq 75$

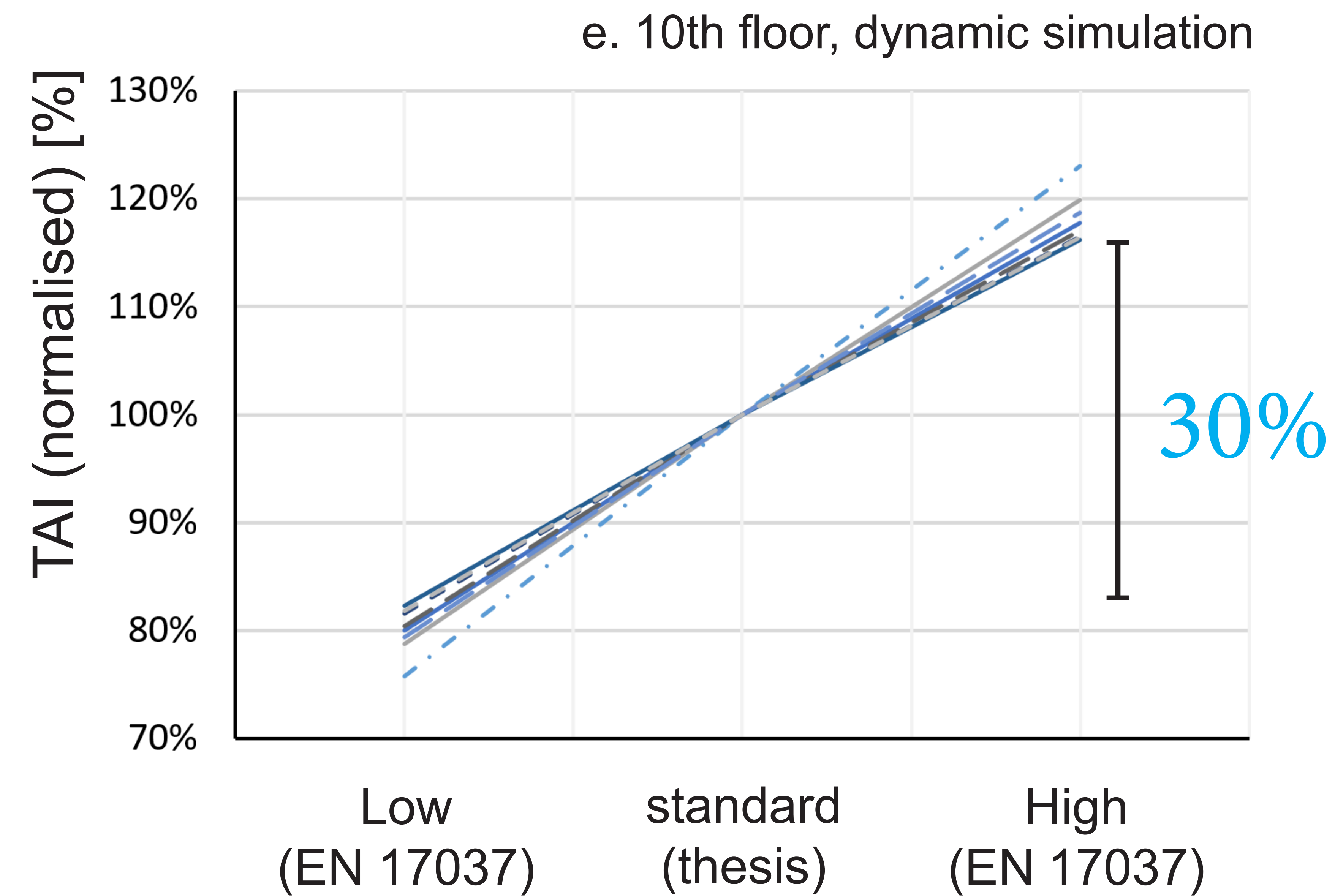
Sufficient &
healthy daylight

Daylighting in
urban areas

Results &
analysis

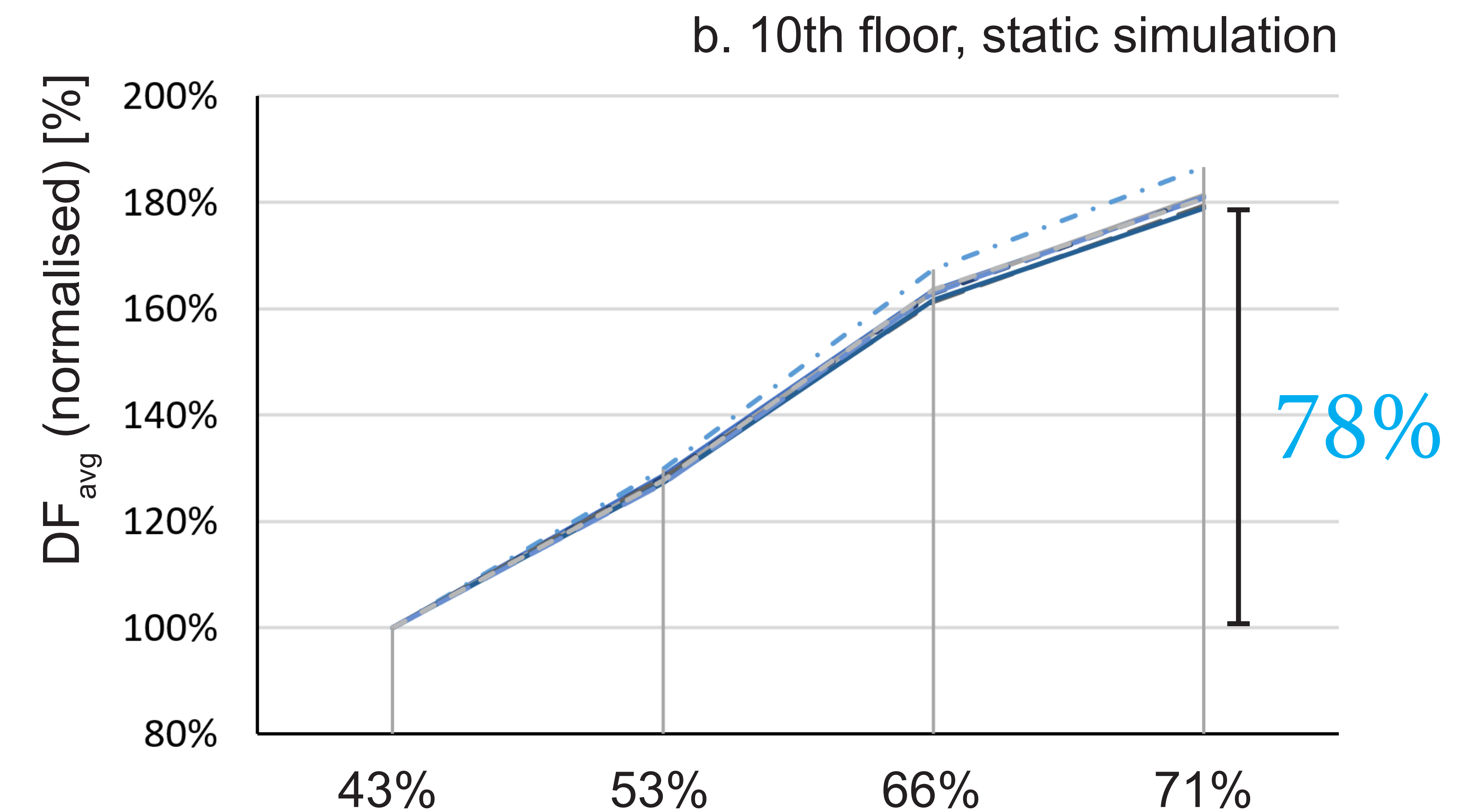
Mitigation
strategies

interior reflectance



- White plaster surfaces
- Light flooring, smooth

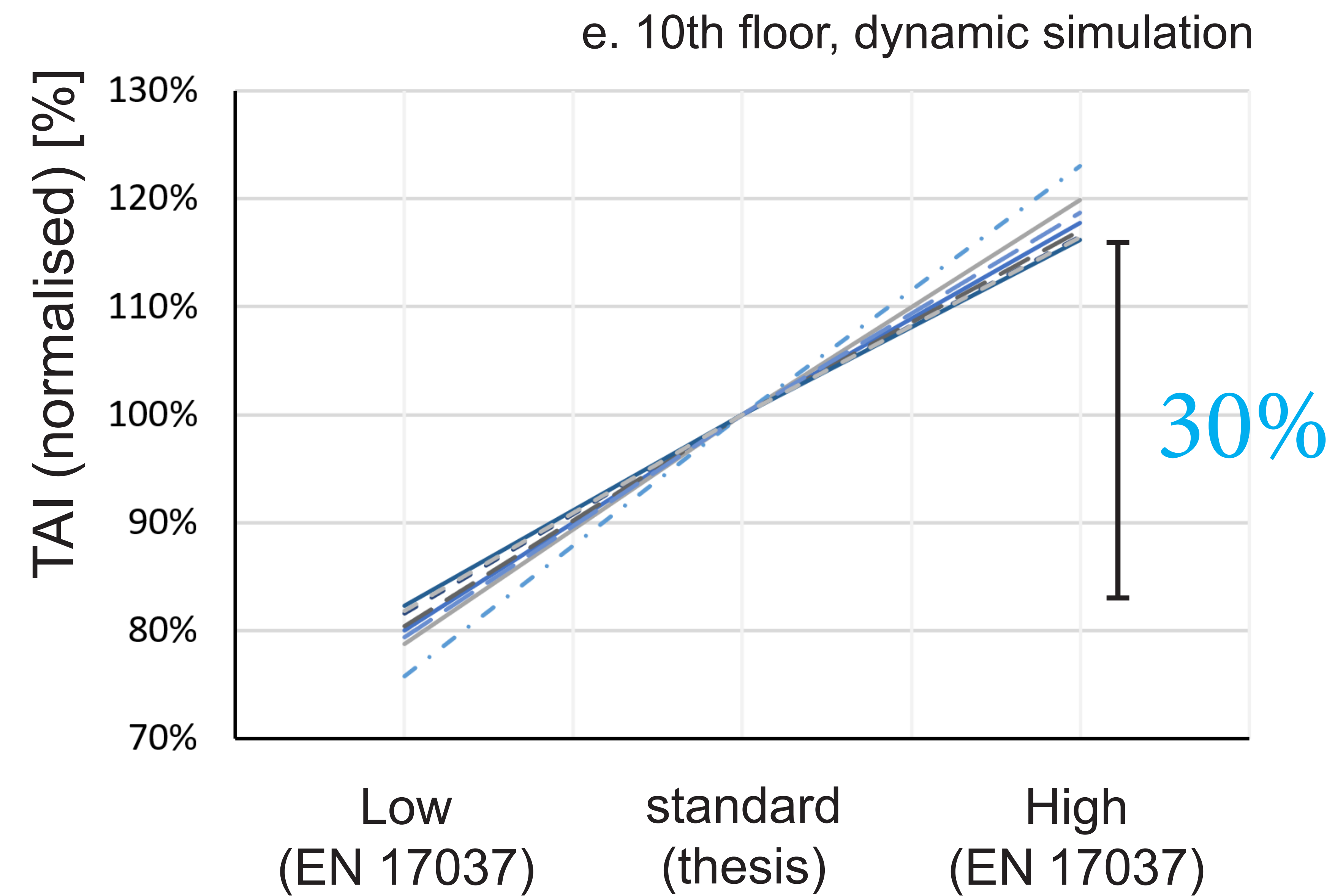
glass transmission



- Double glass
- No sun shading / coating

only in dynamic

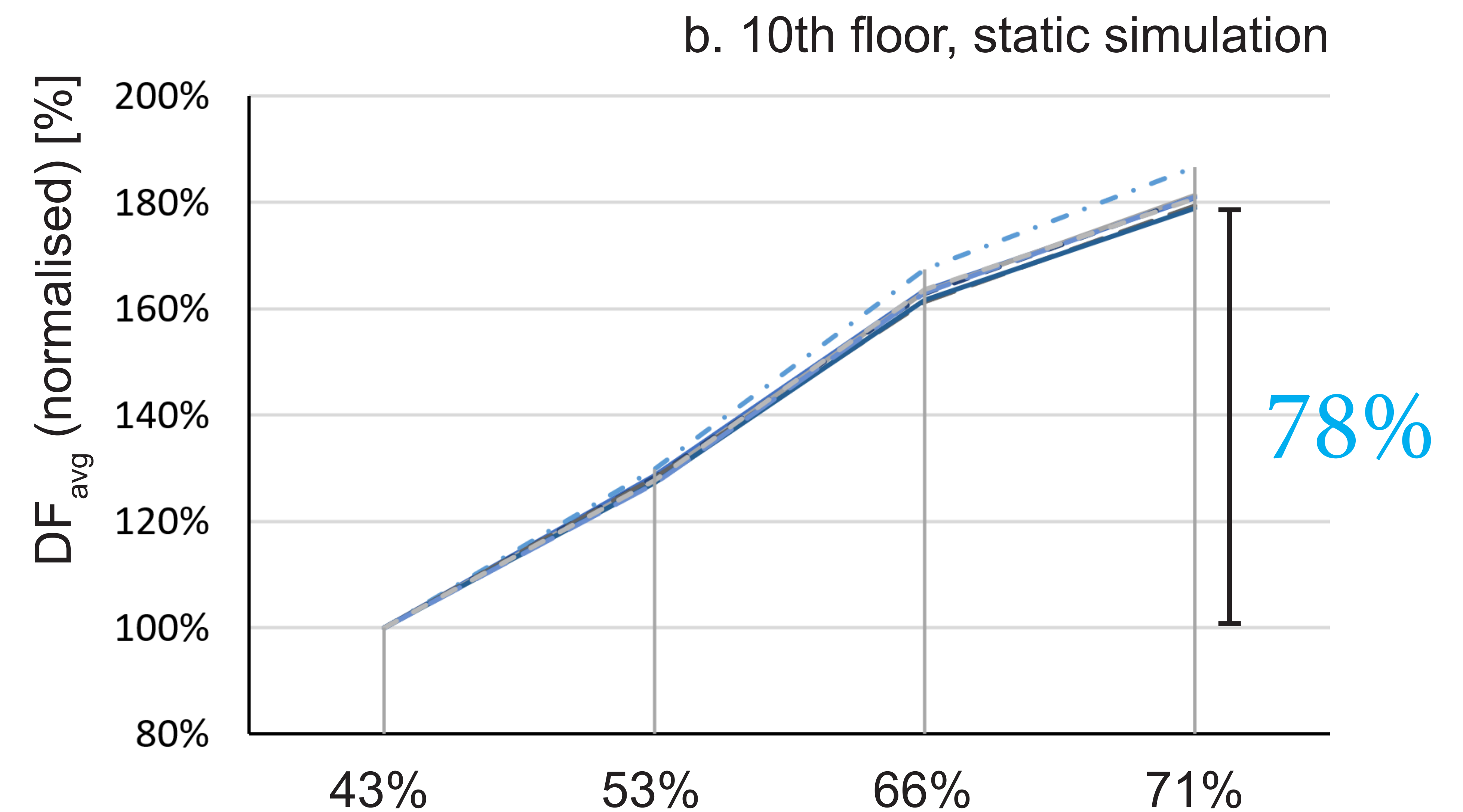
interior reflectance



- White plaster surfaces
- Light flooring, smooth

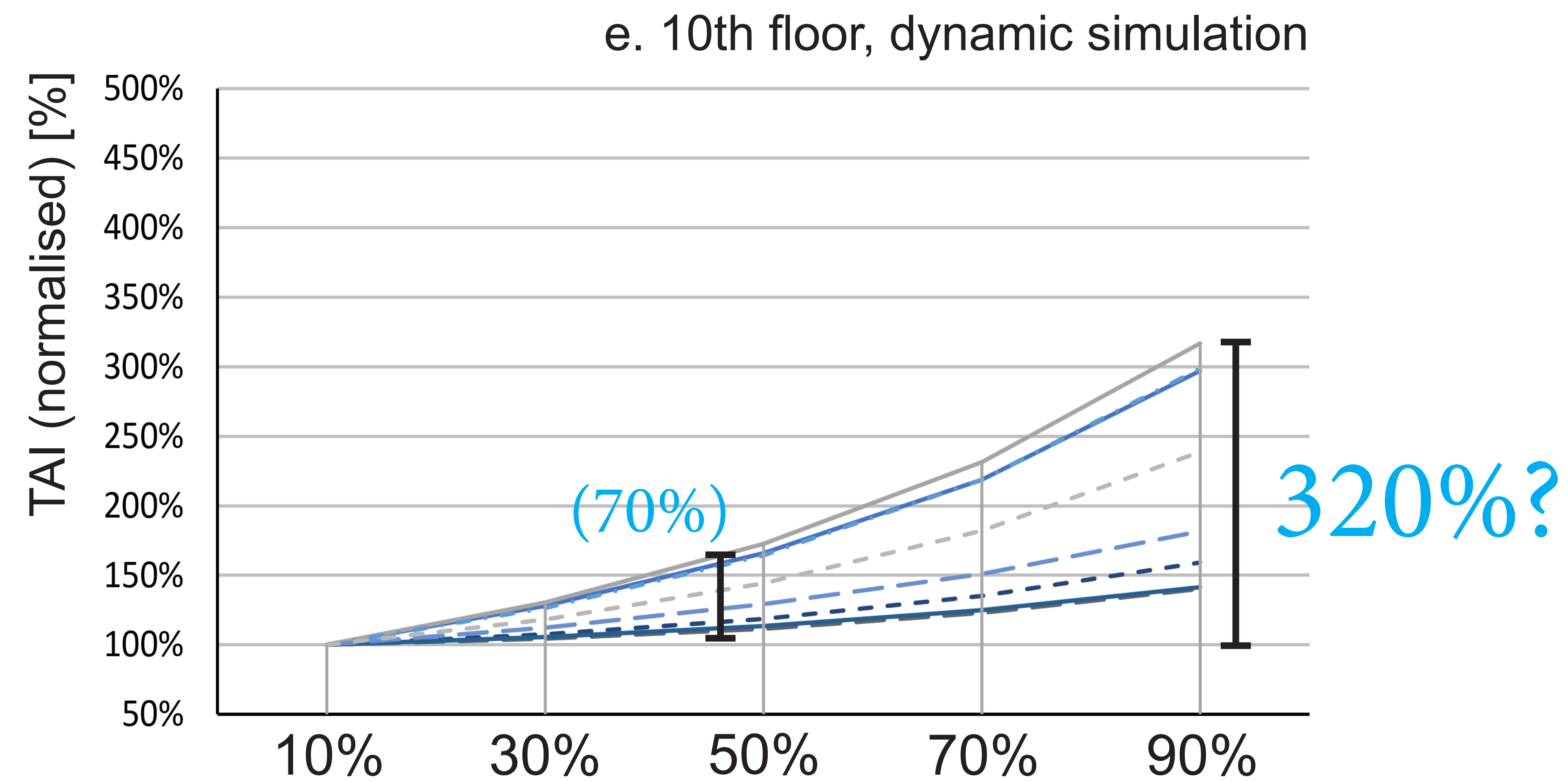
both methods

glass transmission



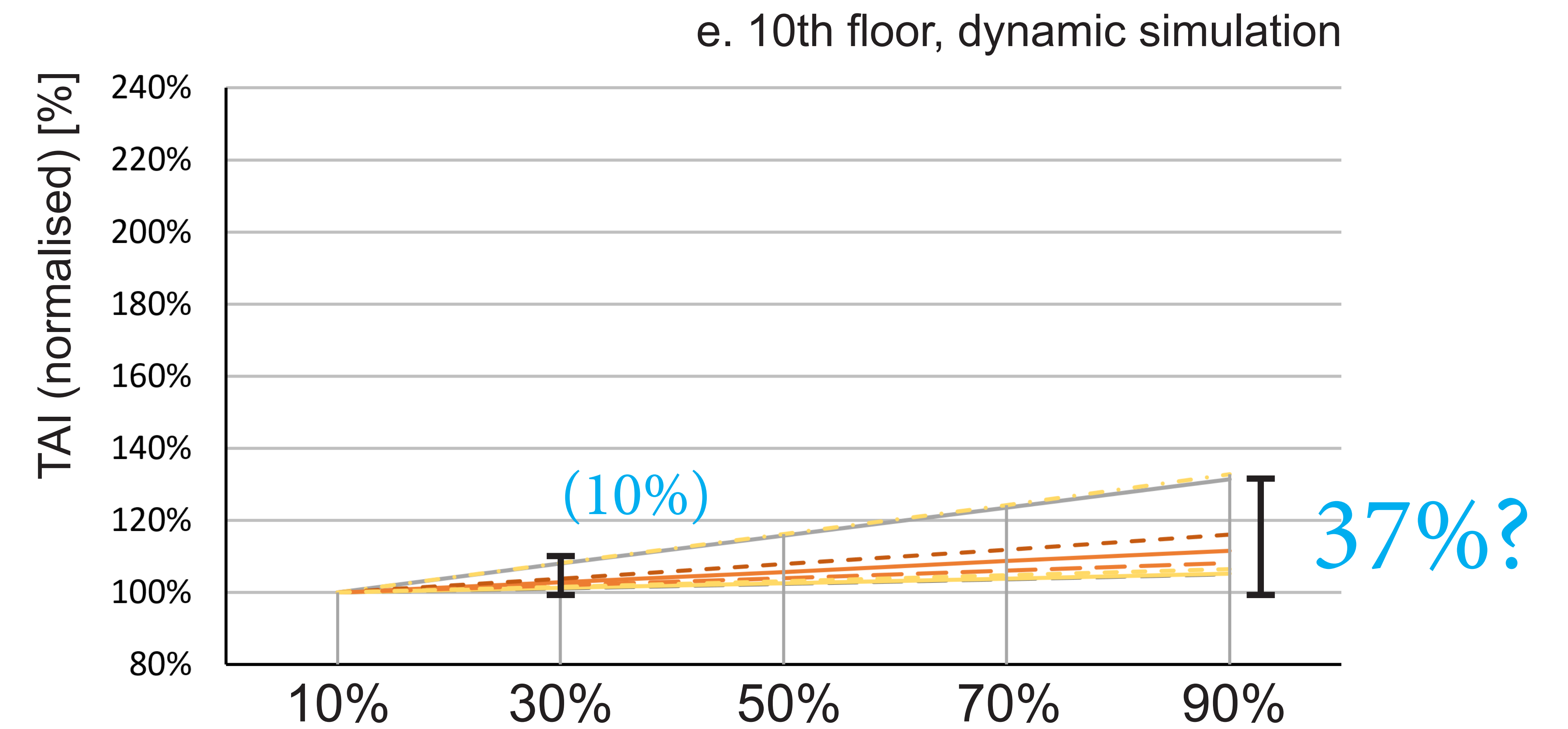
- Double glass
- No sun shading / coating

building reflectance



- White/beige materials
- Less concrete/stone

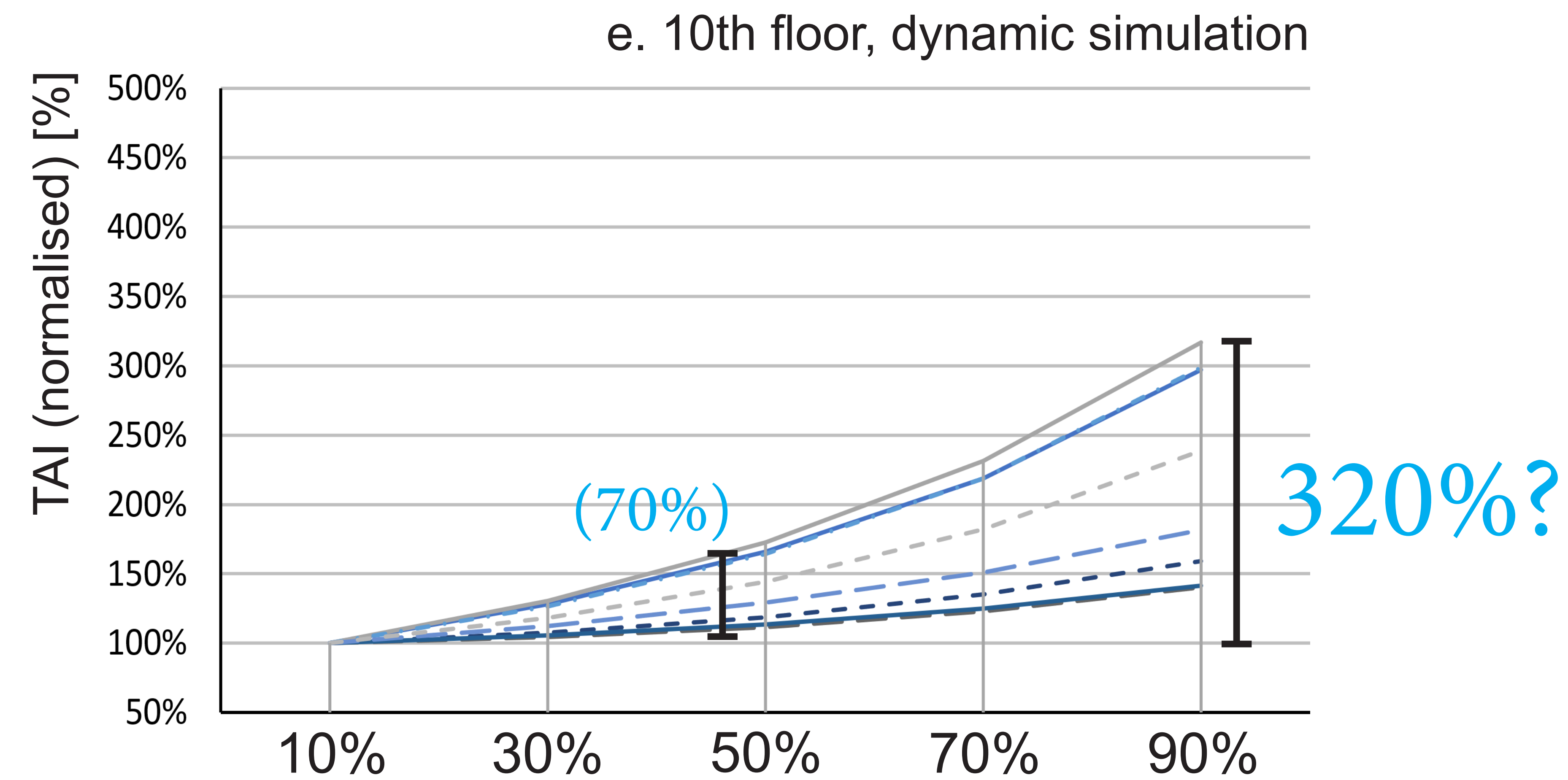
ground reflectance



- More grass
- Less concrete/stone

only in dynamic

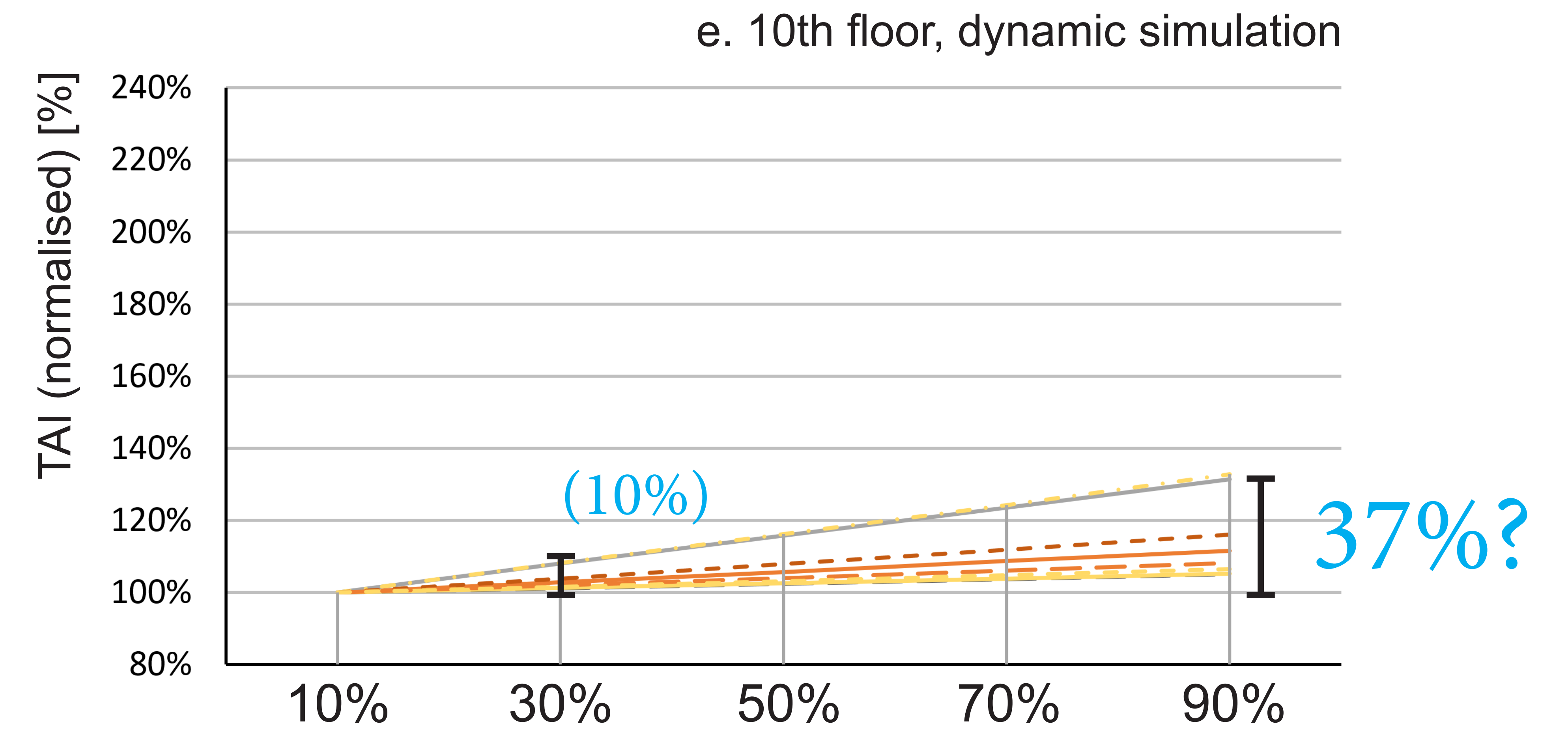
building reflectance



- White/beige materials
- Less concrete/stone

only in dynamic

ground reflectance



- More grass
- Less concrete/stone

Research

Simulation

Analysis

Design

Sufficient &
healthy daylight

Daylighting in
urban areas

Results &
analysis

Mitigation
strategies

Research

Simulation

Analysis

Design

Conclusion

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healthy daylight

Daylighting in
urban areas

Results &
analysis

Mitigation
strategies

recommendations

include urban
context in
daylight
simulation

recommendations

include urban
context in
daylight
simulation

SVF &
building floor
as daylighting
indicators

recommendations

include urban
context in
daylight
simulation

SVF &
building floor
as daylighting
indicators

use dynamic
simulation for
assessment in
urban areas

recommendations

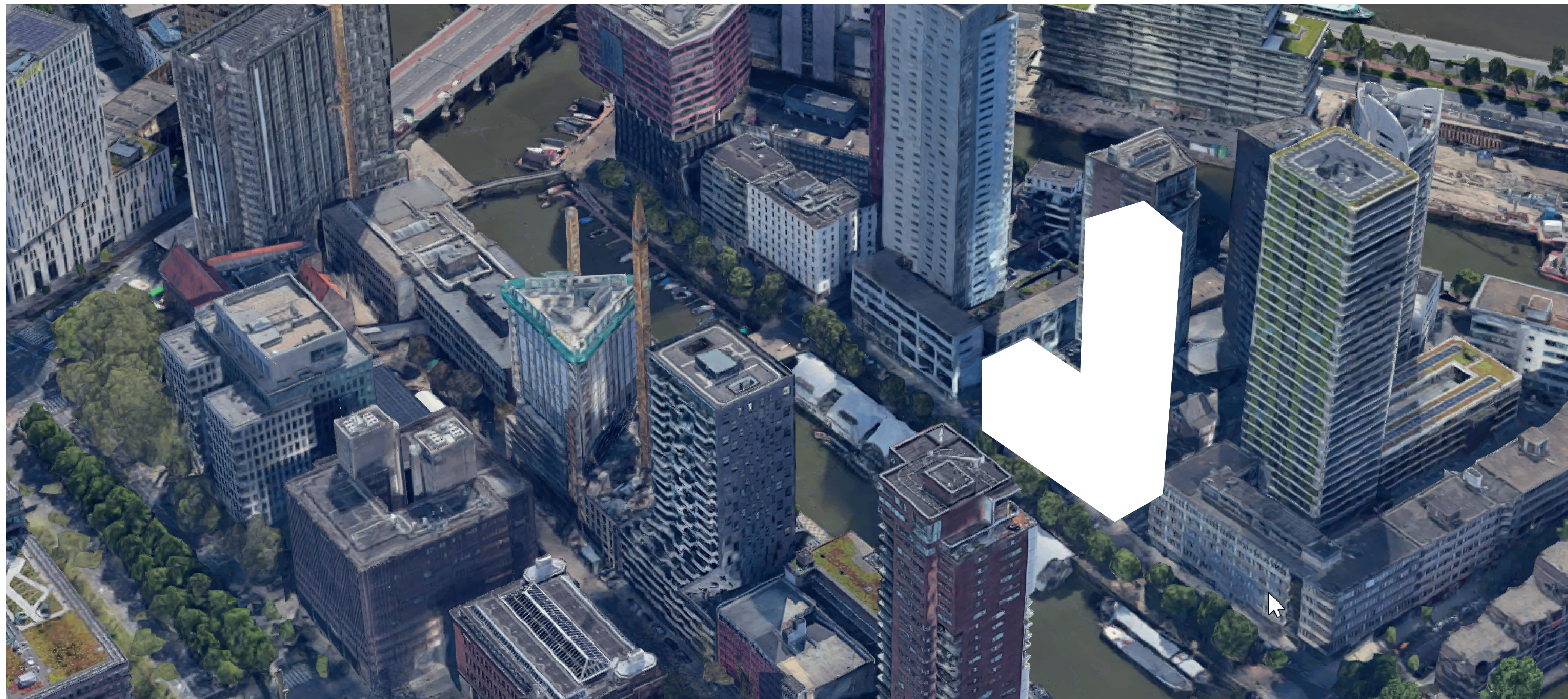
include urban
context in
daylight
simulation

SVF &
building floor
as daylighting
indicators

use dynamic
simulation for
assessment in
urban areas

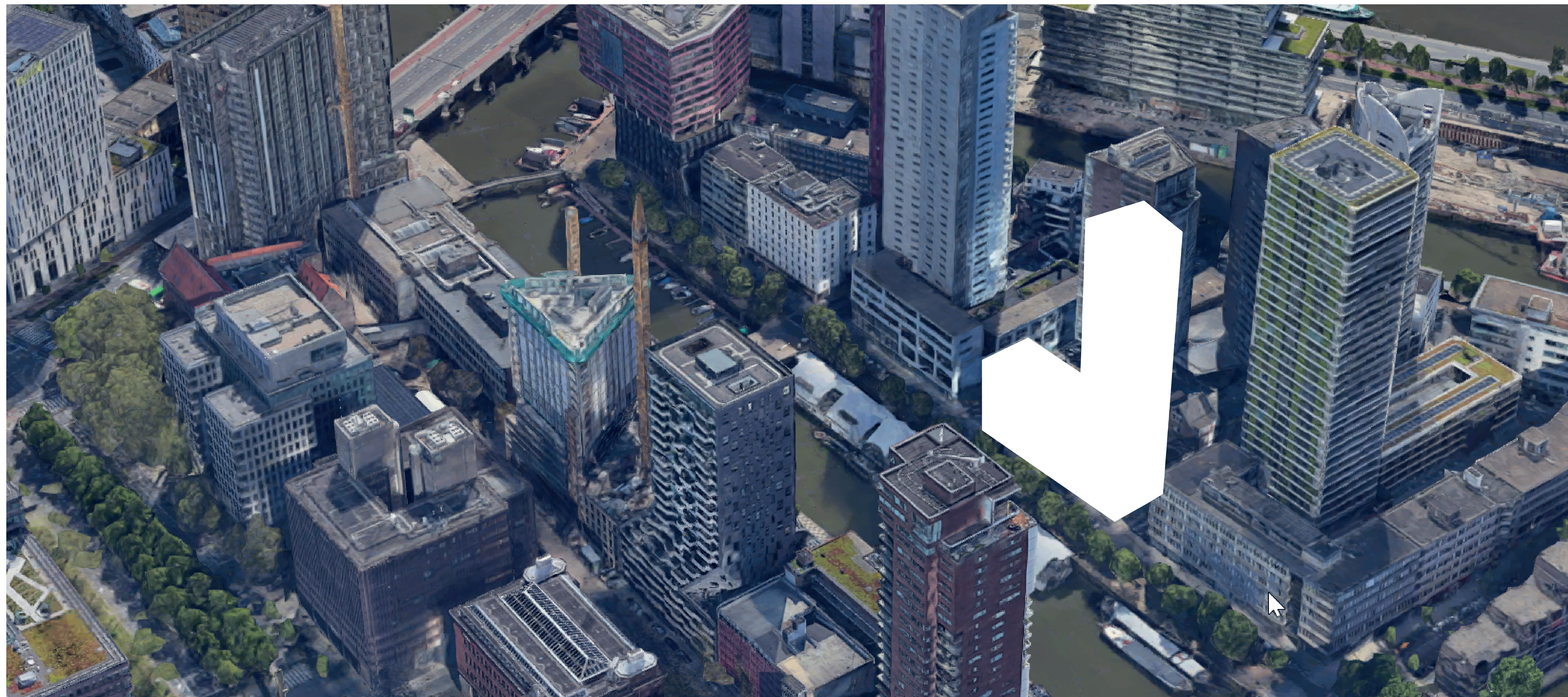
improve
transmission
& reflectance
to increase
performance

What if we apply the
recommendations to
Rotterdam Maritime
context?



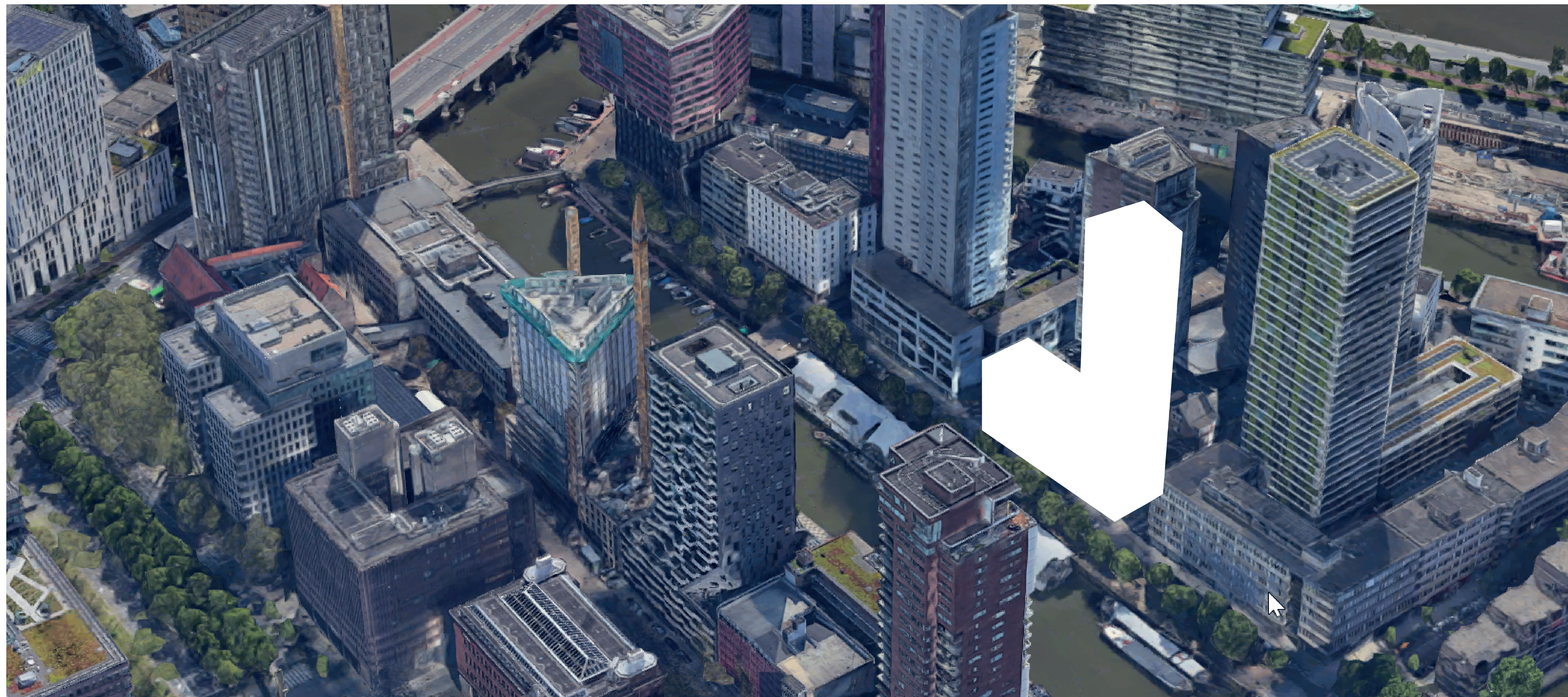
What if we apply the recommendations to Rotterdam Maritime context?

risk level	high	unacceptable
expected	93	52
accordance	90.2%	100%



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122 of 190 residences
perform insufficient

of which 68% could have
been improved/avoided



THANK YOU

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What are the design consequences in Dutch urban areas when context is integrated in current daylighting evaluation methods, regarding visual and non-visual levels of daylight?

Research 1

Which daylighting metrics are currently used to evaluate daylighting performance, and what is sufficient performance for buildings in a Dutch urban setting?

Research 2

What is the relation between daylighting performance and urban density in Dutch context, and how do density indicators correlate with performance?

Simulation 1

What is the impact of varying reflectance values on daylighting performance, regarding interior and exterior faces?

Simulation 2

What is the status quo of the health and wellbeing of humans in urban context, regarding non-visual light exposure in a standard residence?

Design 1

How can we ensure daylighting performance in urban residences with different design strategies, both on urban scale and on building scale?

Change in regulations

- From NEN 2057 to EN 17037

Equivalent
daylighting
surface area



Daylight factor
Daylight autonomy

Surface area



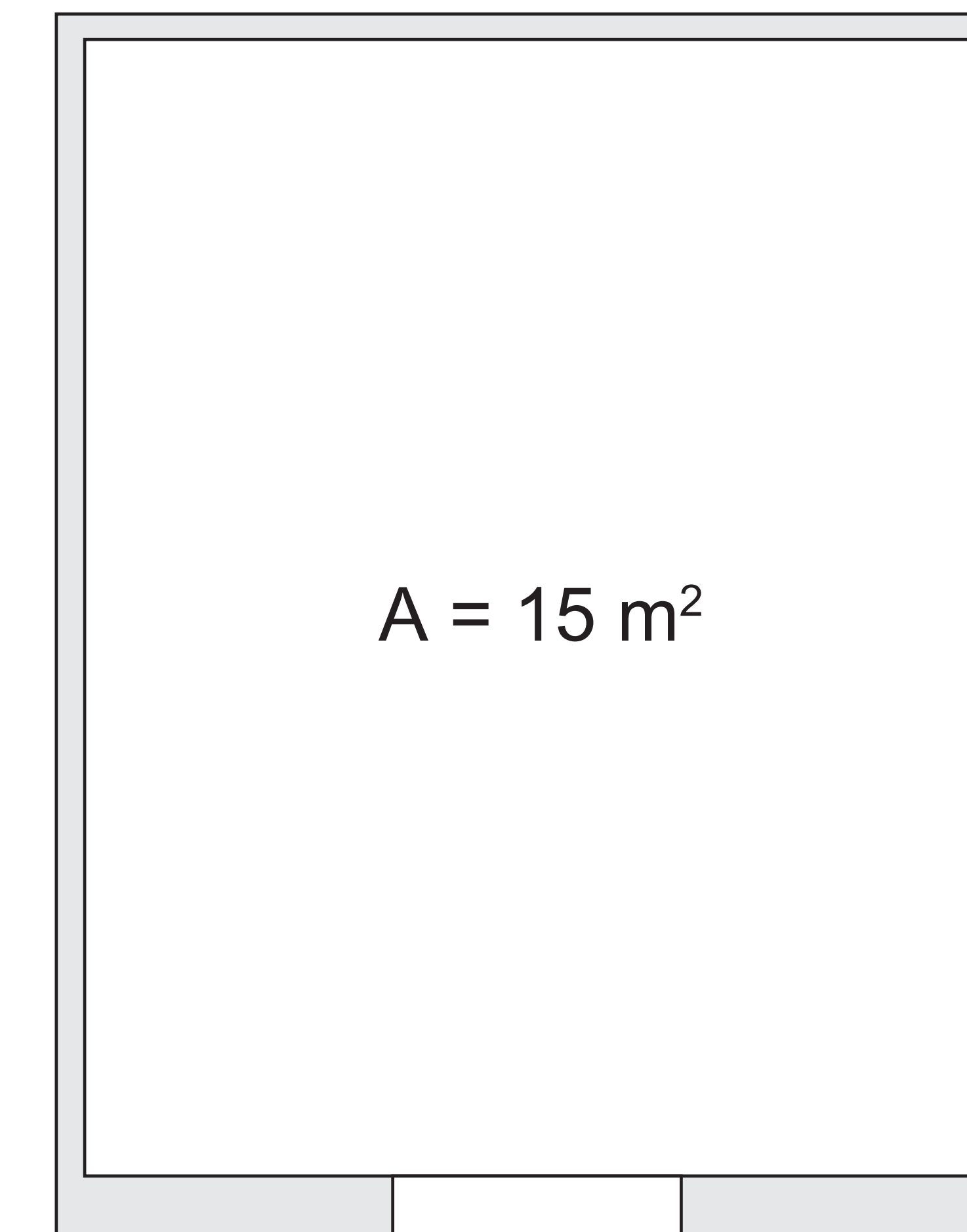
Positioning

Static
simulation



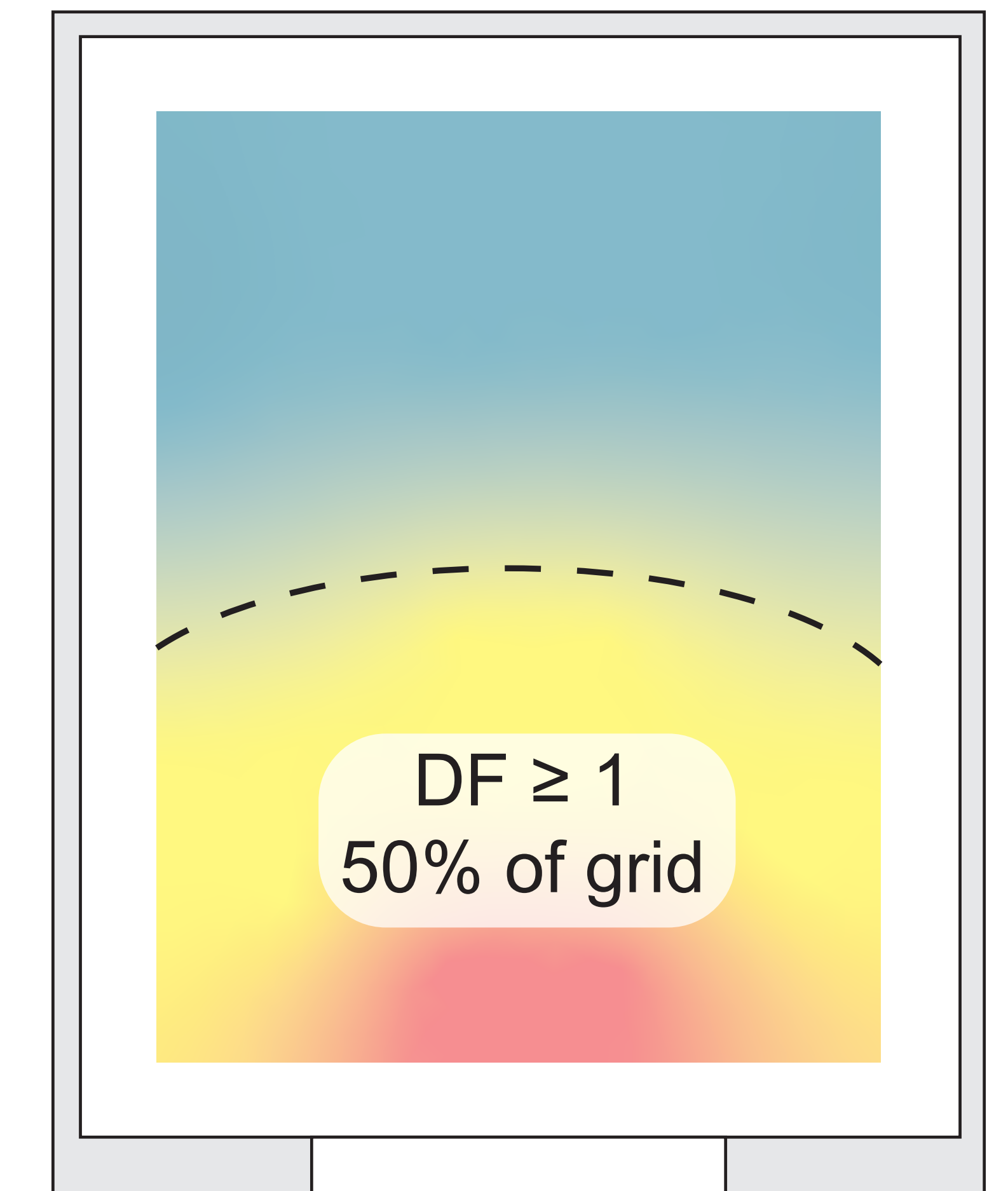
Static or CBDM
simulation

Building Code 2012
current NEN 2057



$A_e = 10\%$ of room area
 $A_w = 1,5 \text{ m}^2$

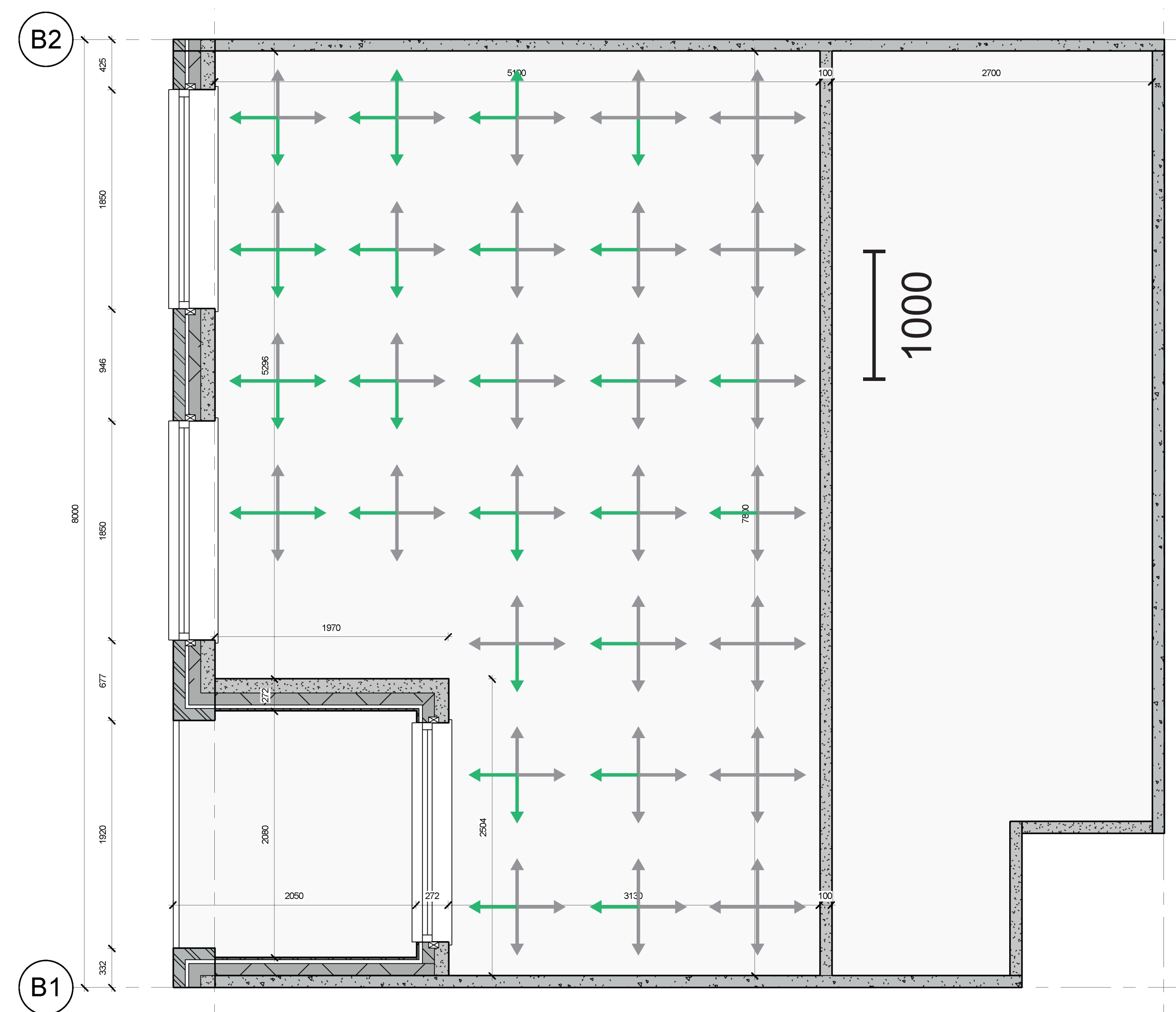
BBL 2024
NEN-EN 17037:2018



Sufficient daylighting is:

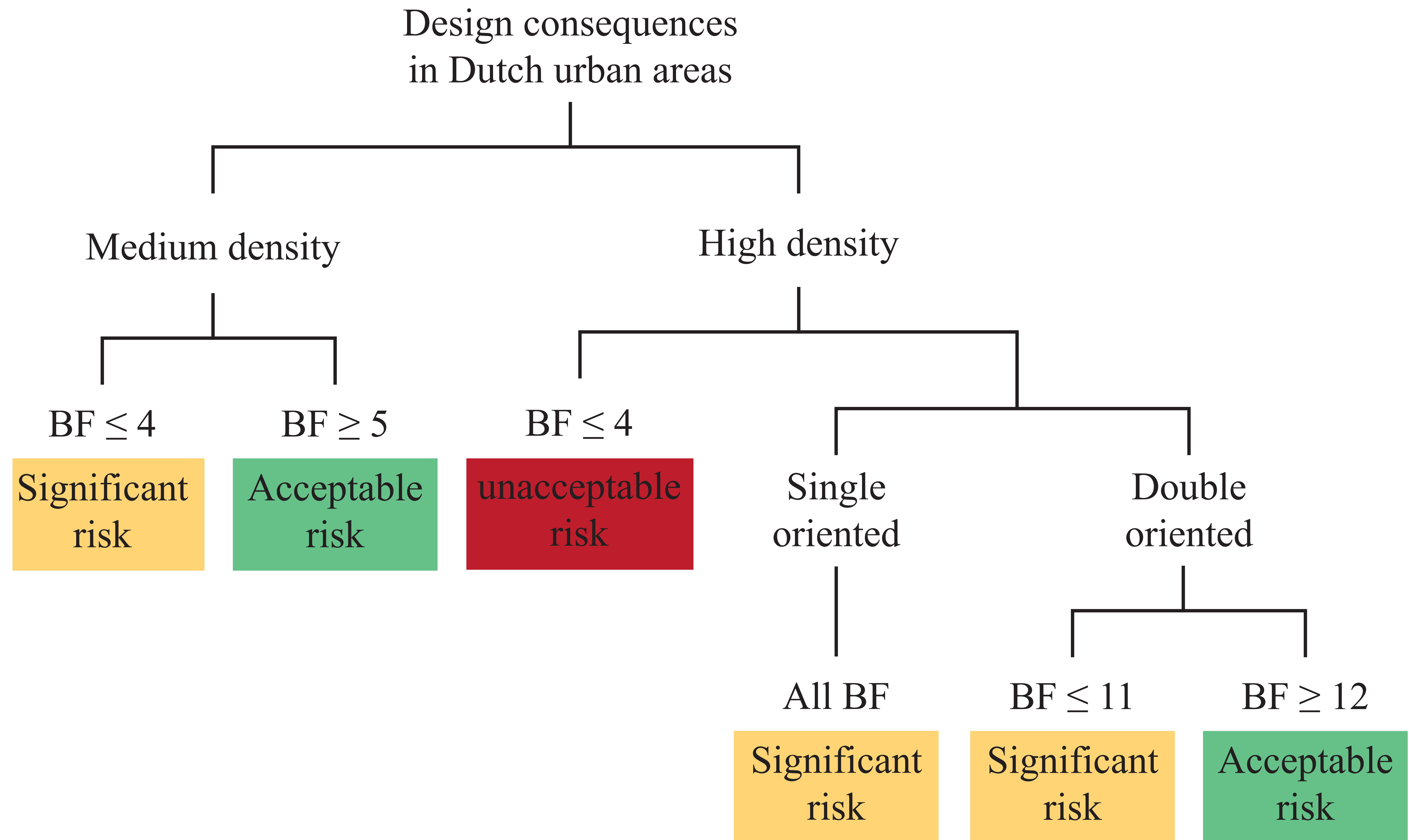
	Visual light	Non-visual light
Recommendation	300 lx (DF _{2.1})	250 M-EDI _{D65}
Lawful minimum	144 lx (DF _{1.0})	-
% of area	50	-
% of time	50	08 -18

- Solstices and equinoxes
- 08:00 to 18:00
- Type B residence
- Rotterdam Maritime Context
- First floor to fulfil requirement



<i>orientation</i>	<i>floor level</i>	<i>sky view factor</i>	<i>DA₃₀₀ percentage</i>	<i>DF_{2.1} percentage</i>
N	20	48.5	50.4	25.9
E	23	47.5	50.4	23.2
S	23	38.0	45.8	21.7
W	9	38.3	52.8	21.3

<i>orientation</i>	<i>floor level</i>	<i>sky view factor</i>	<i>DA₁₄₄ percentage</i>	<i>DF₁ percentage</i>
N	0	38.6	56.2	30.5
E	6	32.0	70.8	41.0
S	12	22.7	50.0	17.1
W	7	31.2	62.3	33.6



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