HRVATSKA KOMORA INŽENJERA GRAĐEVINARSTVA
15. Dani Hrvatske komore inženjera građevinarstva Opatija, 2021.

Subjektivni parametri u očuvanju energije

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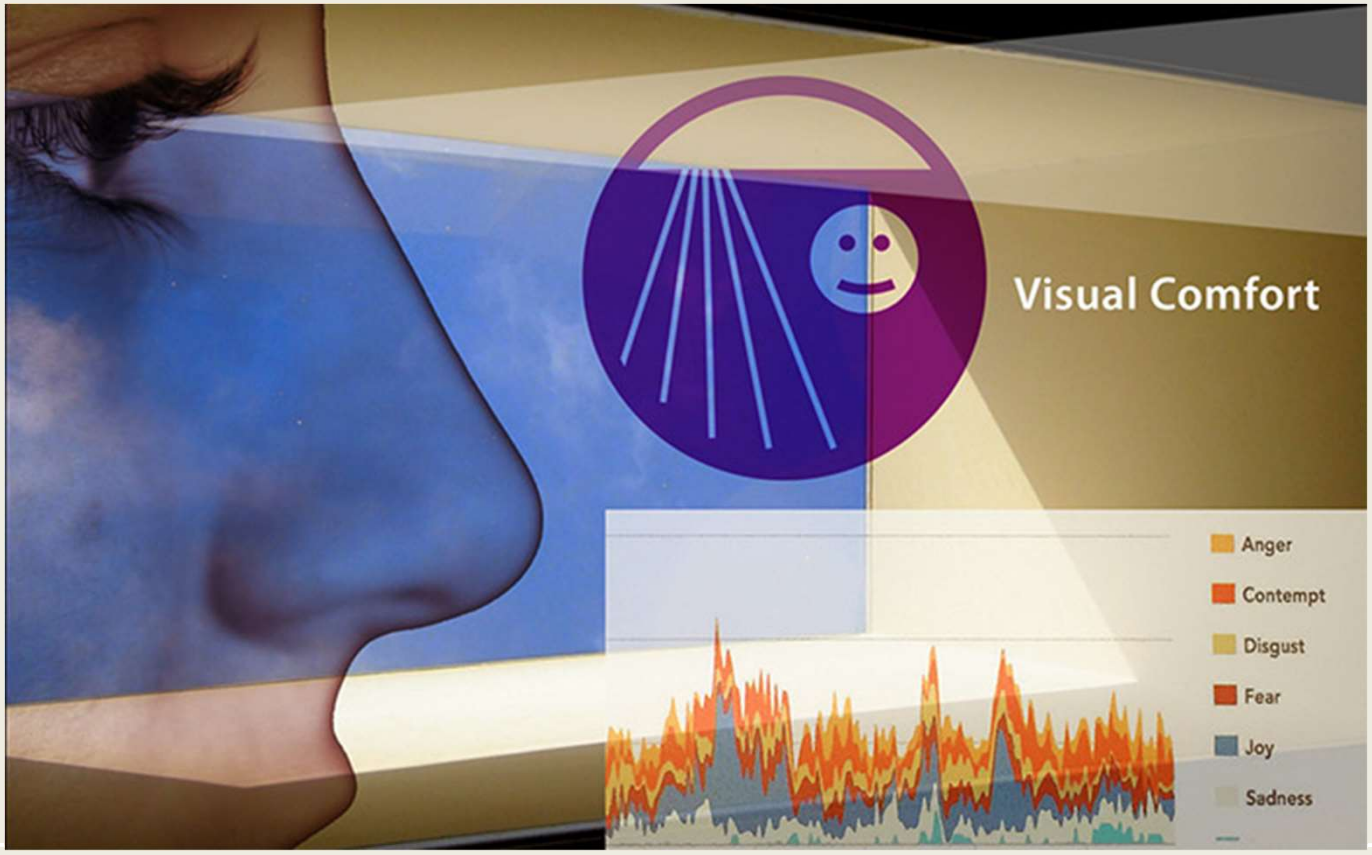
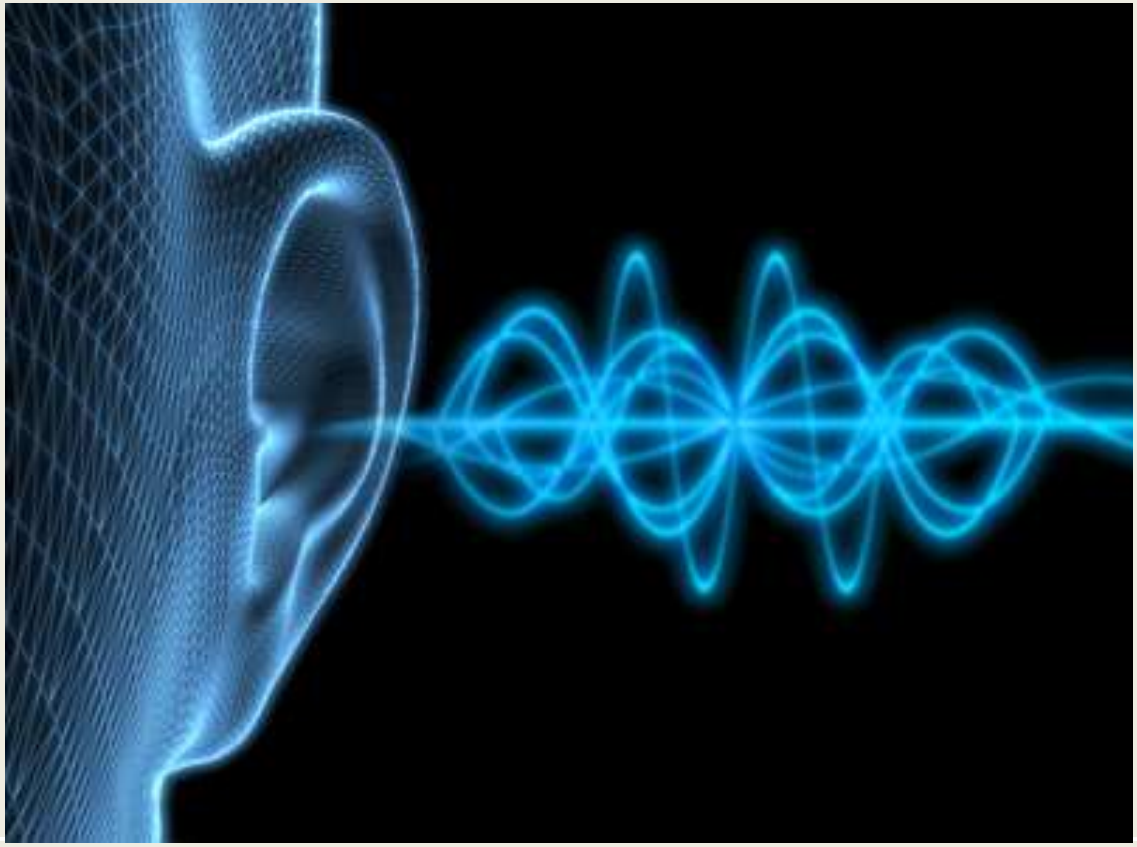
Vizualna udobnost je subjektivna percepcija prikladnosti rasvjete uzimajući u obzir njenu ujednačenost, razinu, odsjaj, kontrast, boje i odsutnost stroboskopskog efekta



Akustična udobnost je osjećaj psihofizičkog zadovoljstva koje osoba doživljava tijekom obavljanja određene aktivnosti unutar zvučnog polja



Toplinska udobnost je stanje svijesti koje izražava zadovoljstvo toplinskim stanjem okoliša

HRVATSKA NORMA

HRN EN ISO 7730

ICS: 13.180

Drugo izdanje,
lipanj 2008.

Zamjenjuje HRN EN ISO 7730:2003

Ergonomija toplinskog okoliša – Analitičko utvrđivanje i tumačenje toplinske udobnosti uporabom izračuna PMV i PPD indeksa i lokalnih toplinskih kriterija udobnosti (ISO 7730:2005; EN ISO 7730:2005)

Ergonomics of the thermal enviroment – Analitycal determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria (ISO 7730:2005; EN ISO 7730:2005)

Osjećaj toplinske udobnosti je individualan

Nezadovoljni korisnici

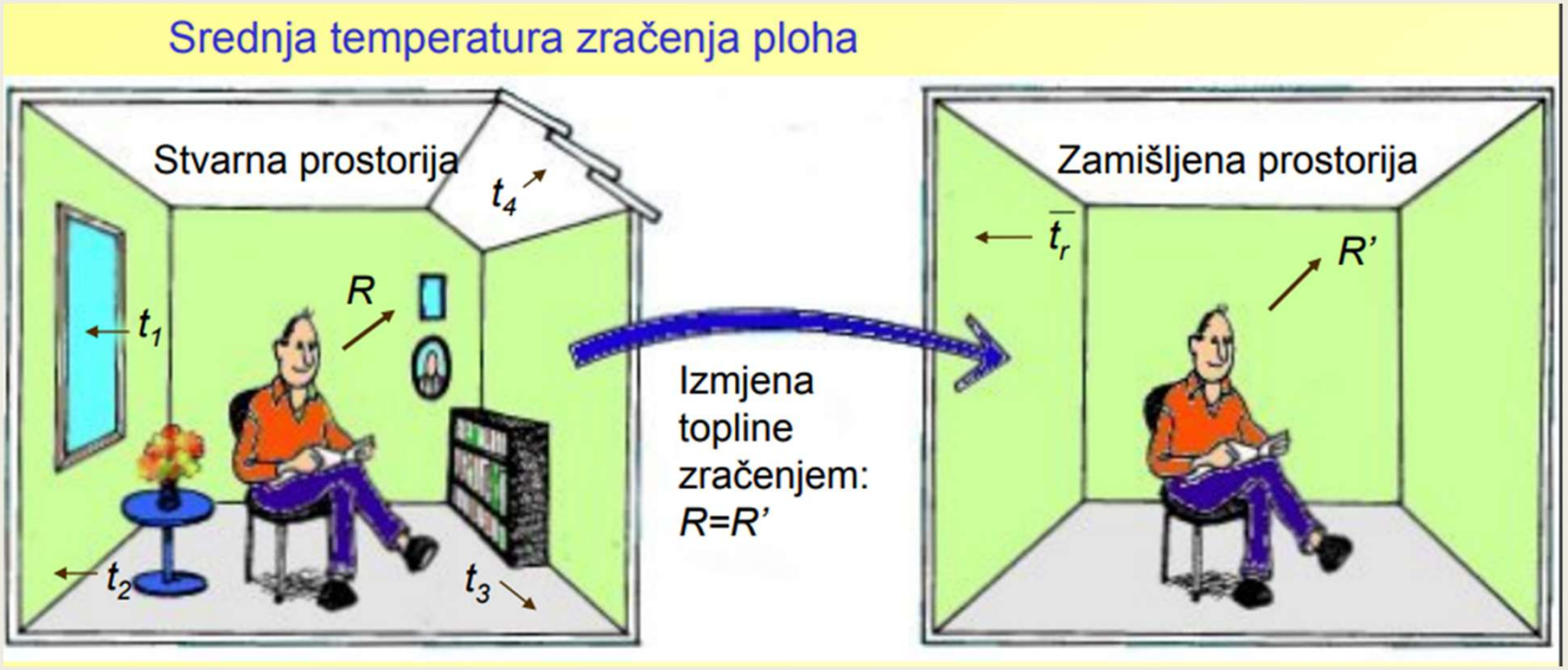
- Smanjena produktivnost rada
- Sklonost poduzimanju mjera kojima se povećava potrošnja energije

Parametri koji utječu na toplinsku udobnost (1):

OKOLIŠNI:

1. Temperatura zraka u prostoriji
2. Srednja temperatura zračenja ploha
3. Brzina strujanja zraka
4. Relativna vlažnost

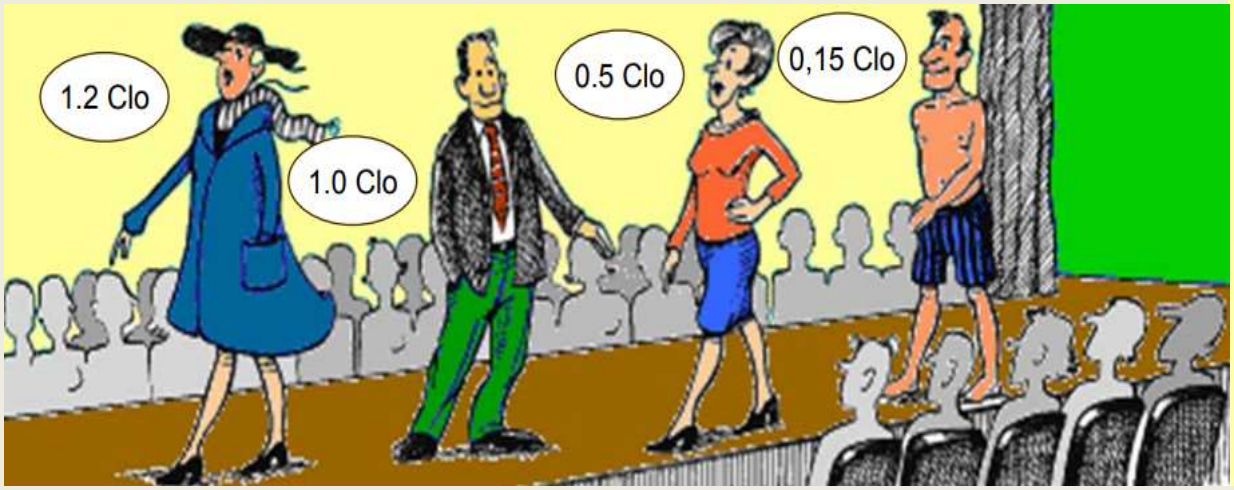
Srednja temperatura zračenja je jednolika temperatura ploha zamišljenog crnog zatvorenog prostora kod koje se događa jednak gubitak topline zračenjem kao i za stvarni zatvoreni prostor s nejednolikim temperaturama ploha

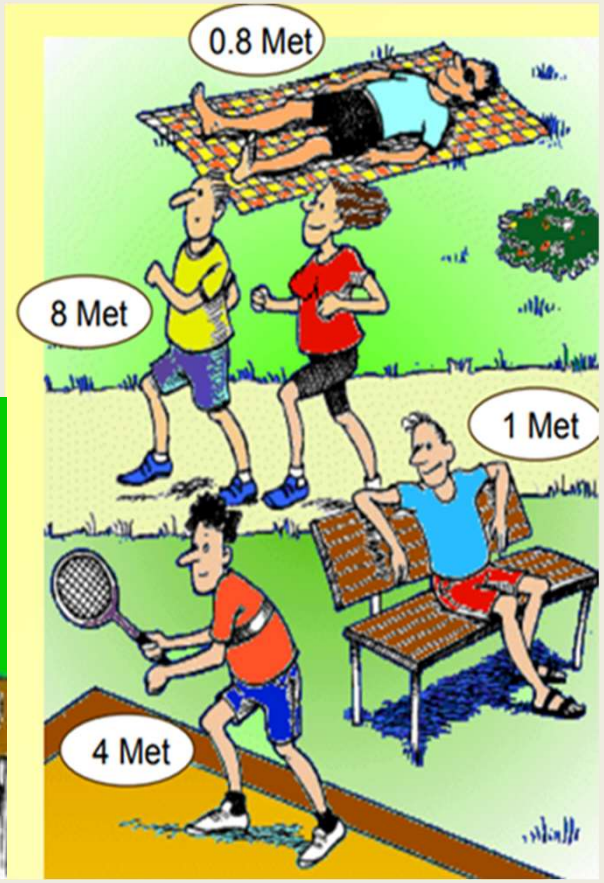


Parametri koji utječu na toplinsku udobnost (2):

OSOBNI:

1. Razina fizičke aktivnosti/metabolički učinak
2. Razina odjevenosti/ukupni toplinski otpor odjeće





1met=58,2 w/m2

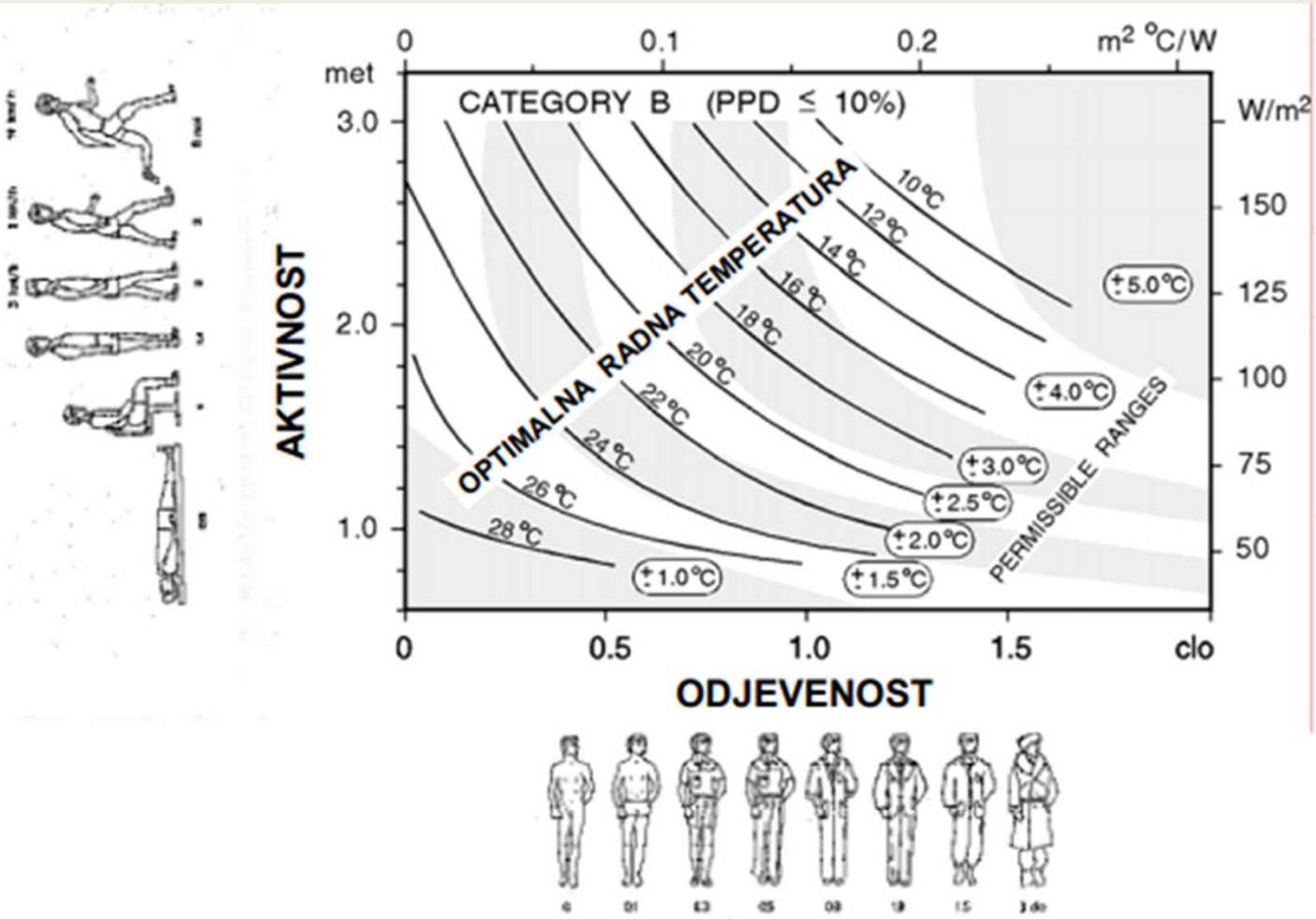
Vrednovanje toplinske udobnosti

Toplinska udobnost se prema normi EN ISO 7730 vrednuje pomoću dva indeksa:

PMV (engl. Predicted Mean Vote) i

PPD (engl. Predicted Percentage of Dissatisfied)

PMV vrednuje razinu ugode, a PPD predviđa postotak nezadovoljnih osoba.



Optimalna temperatura odgovara predviđenom vrednovanju ugodnosti (PMV indeksu) kao funkcija aktivnosti i odjevenosti. Osjenčana područja prikazuju raspon ugodnosti $\pm\Delta t$ oko optimalne unutarnje temperature, koji odgovara rasponu $-0.5 < PMV < +0.5$

Skala PMV indeksa prema normi HRN EN ISO 7730

Toplinska ravnoteža tijela postignuta je kada je proizvedena toplina tijela jednaka onoj izmijenjenoj s okolišem.

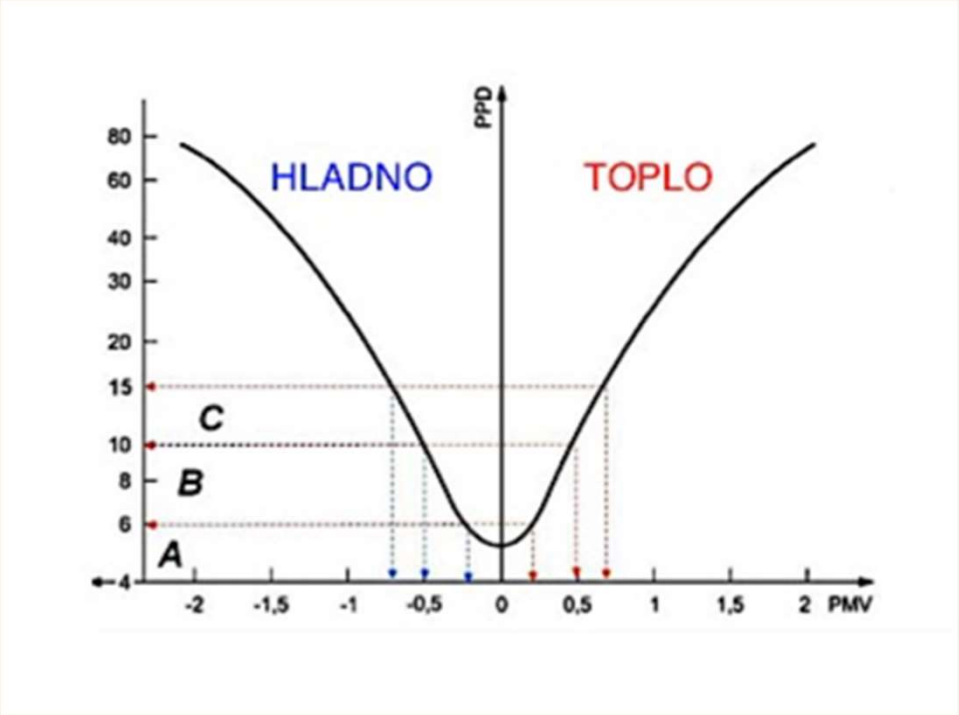
+3	Vruće
+2	Toplo
+1	Blago toplo
0	Neutralno
-1	Prohladno
-2	Hladno
-3	Ledeno

PPD predstavlja postotak nezadovoljnih osoba

...odnosno onih koji bi glasali da im je toplo, vruće, hladno ili ledeno (+3, +2, -2, -3)

U normi je dana jednadžba za izračun PPD.

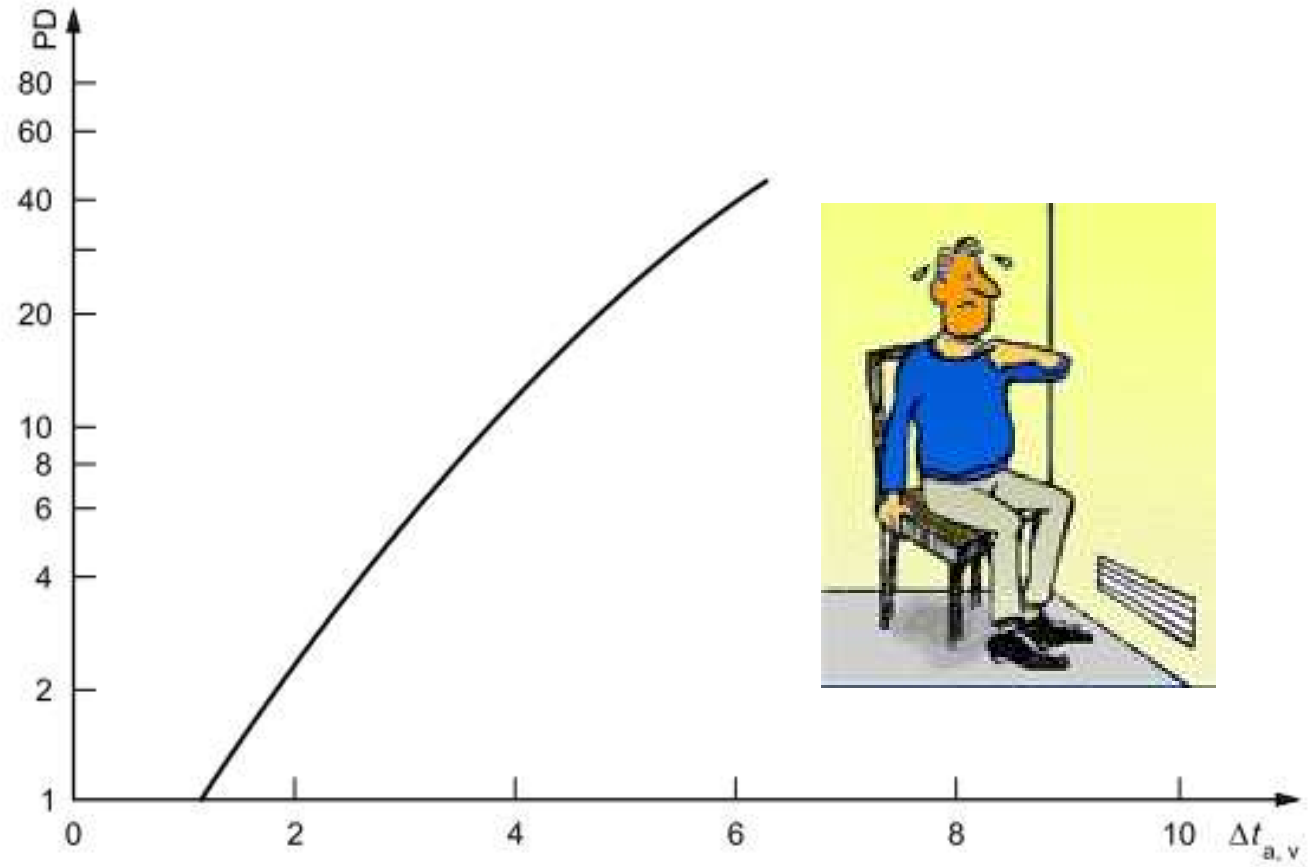
PPD kao funkcija od PMV



Toplinska udobnost u različitim prostorijama podijeljena je u 3 kategorije: A, B i C.

Kategorije toplinskog okoliša i utjecaj lokalne neugode prema EN ISO 7730

Kategorija	Toplinsko stanje cijelog tijela		Lokalna neugoda			
	PPD (%)	PMV	DR (%)	PD (%)		
				Razlika temp. po visini	Topli ili hladni podovi	Razlika temp. ploha
A	<6	-0,2 < PMV < +0,2	<10	<3	<10	<5
B	<10	-0,5 < PMV < +0,5	<20	<5	<10	<5
C	<15	-0,7 < PMV < +0,7	<30	<10	<15	<10

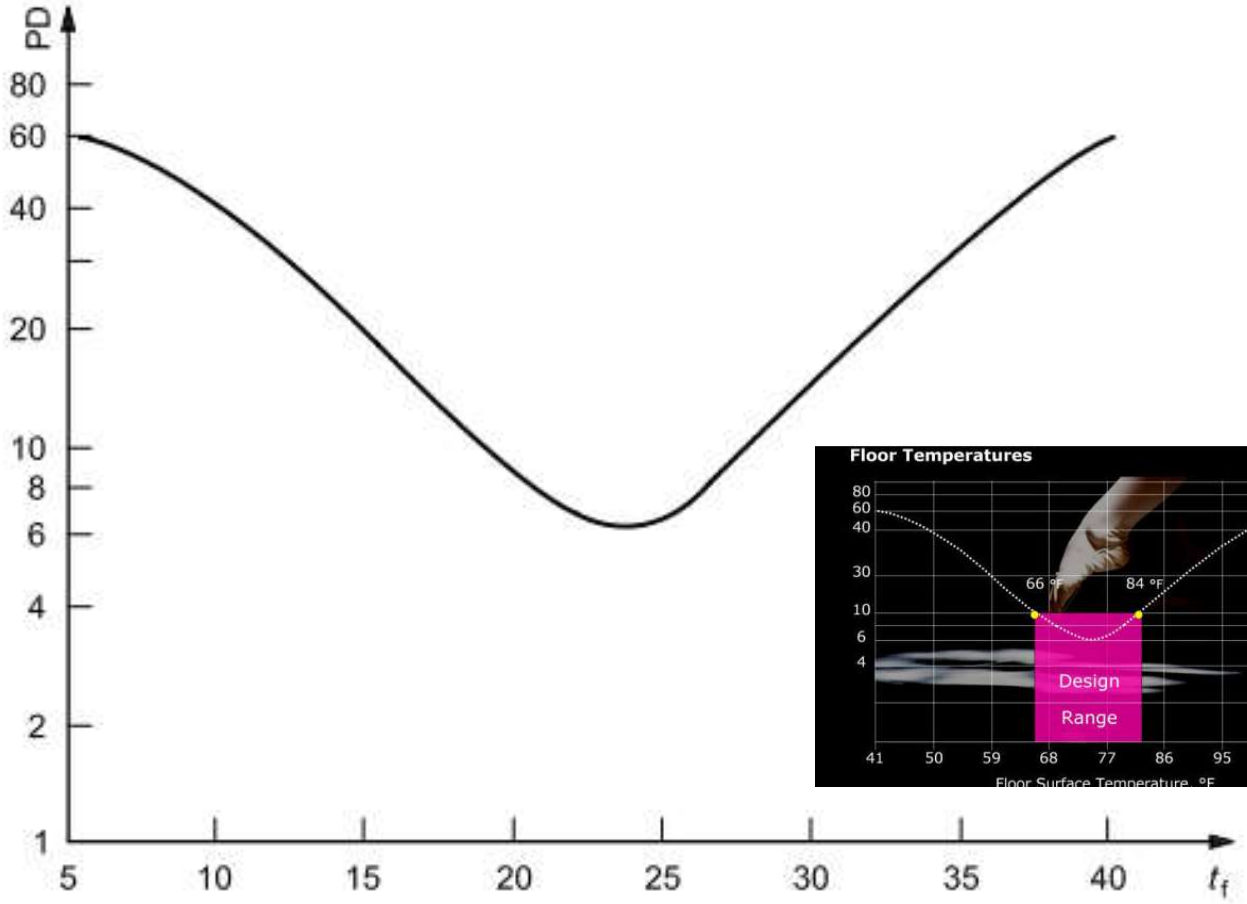


Key

PD percentage dissatisfied, %

$\Delta t_{a,v}$ vertical air temperature difference between head and feet, °C

Figure 2 — Local discomfort caused by vertical air temperature difference

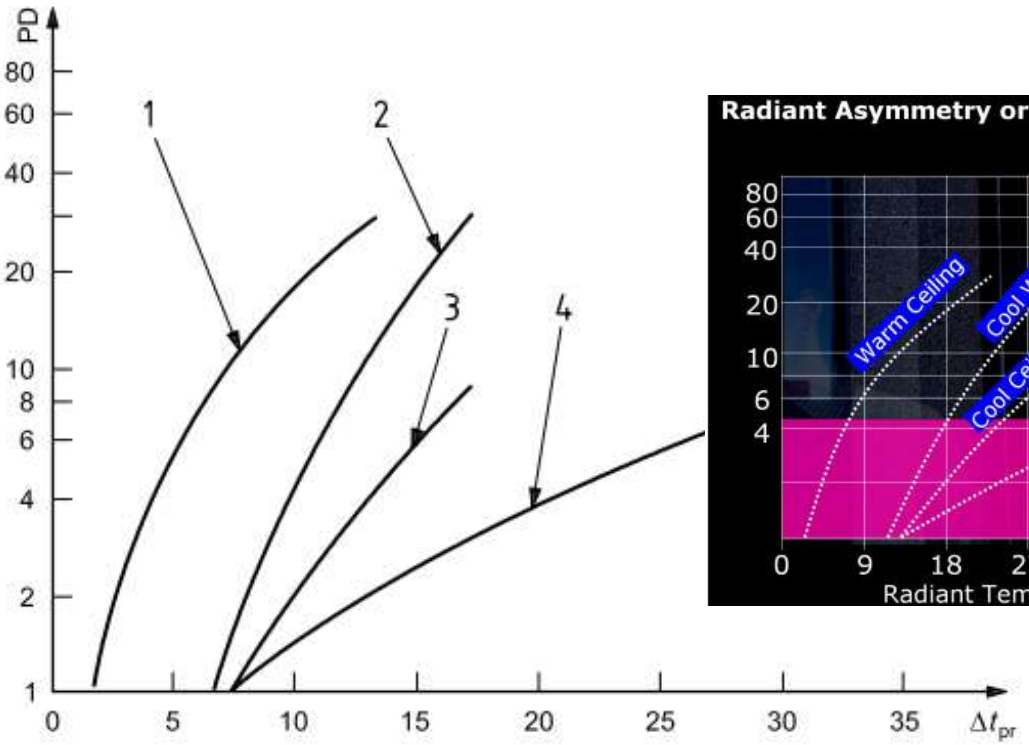


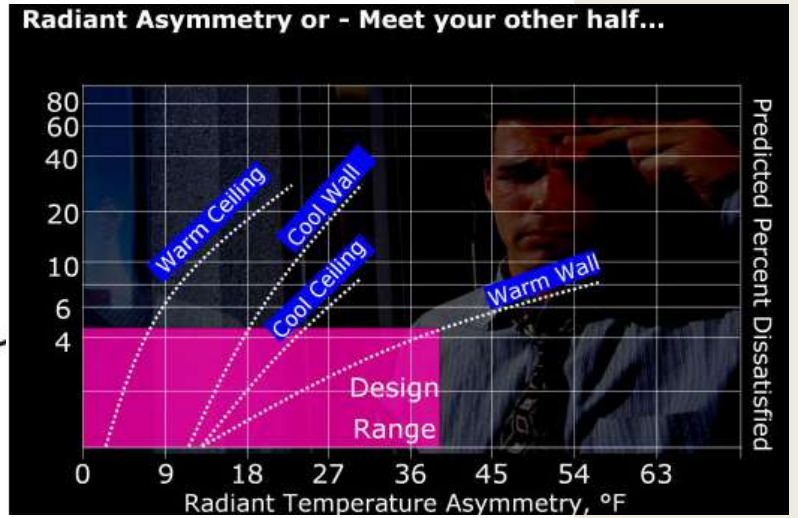
Key

PD percentage dissatisfied, %

t_f floor temperature, °C

Figure 3 — Local thermal discomfort caused by warm or cold floors





Key

PD	percentage dissatisfied, %
Δt_{pr}	radiant temperature asymmetry, °C
1	Warm ceiling.
2	Cool wall.
3	Cool ceiling.
4	Warm wall.

Figure 4 — Local thermal discomfort caused by radiant temperature asymmetry

Tip prostorije/zgrade	Kategorija	Operativna temperatura (°C)	
		Zima (sezona grijanja) Razina odjevenosti ≈ 1,0 clo	Ljeto (sezona hlađenja) Razina odjevenosti ≈ 0,5
Kućanstva (dnevni boravak, spavaonica, kuhinja i sl.) Razina aktivnosti (sjedenje)≈ 1,2 met	I	21	25,5
	II	20	26
	III	18	27
Kućanstva (ostave, hodnici i sl.) Razina aktivnosti (hodanje, stajanje) ≈ 1,6 met	I	18	/
	II	16	/
	III	14	/
Uredi Razina aktivnosti (sjedenje)≈ 1,2 met	I	21	25,5
	II	20	26
	III	19	27
Auditorij Razina aktivnosti (sjedenje)≈ 1,2 met	I	21	25,5
	II	20	26
	III	19	27
Restoran Razina aktivnosti (sjedenje)≈ 1,2 met	I	21	25
	II	20	26
	III	19	27
Učionica Razina aktivnosti (sjedenje)≈ 1,2 met	I	21	25
	II	20	26
	III	19	27
Dječji vrtić Razina aktivnosti (stajanje, hodanje) ≈ 1,4 met	I	19	24,5
	II	17,5	25,5
	III	16,5	26
Trgovački centar Razina aktivnosti (stajanje, hodanje) ≈ 1,6 met	I	17,5	24
	II	16	25
	III	15	26

Preporučene vrijednosti operativne temperature prema HRN EN 15251: 2008

Optimalna operativna temperatura je idealna temperatura koja bi odgovarala za PMV=0 odnosno da su svi ljudi u prostoriji zadovoljni.

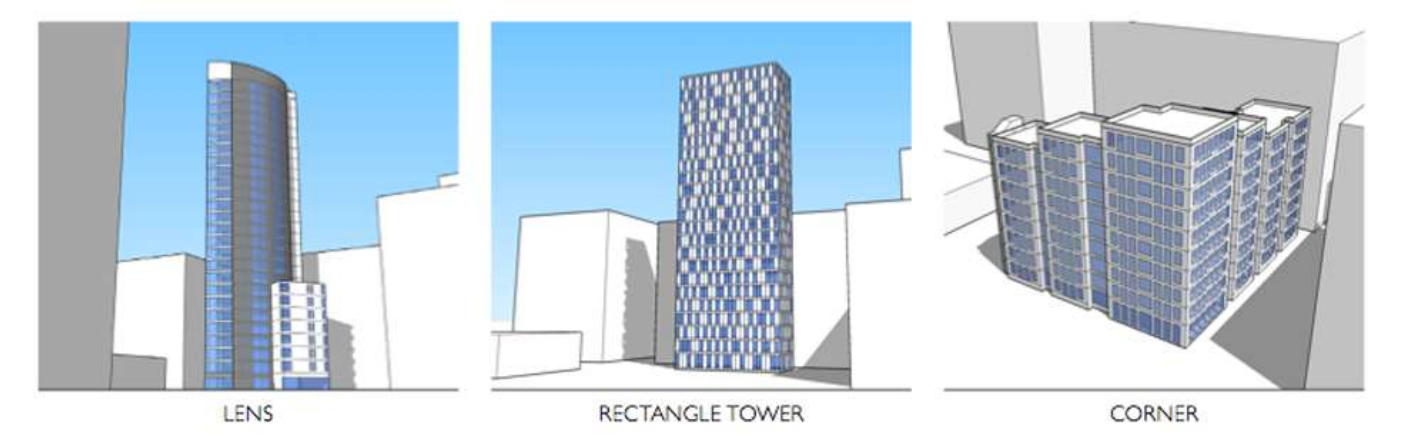
Kategorije I, II i III odgovaraju kategorijama A, B i C.

Temperatura crnog zatvorenog prostora kod koje bi osoba izmijenila jednak iznos energije zračenjem i konvekcijom s okolišem kao i u stvarnom nejednolikom okruženju

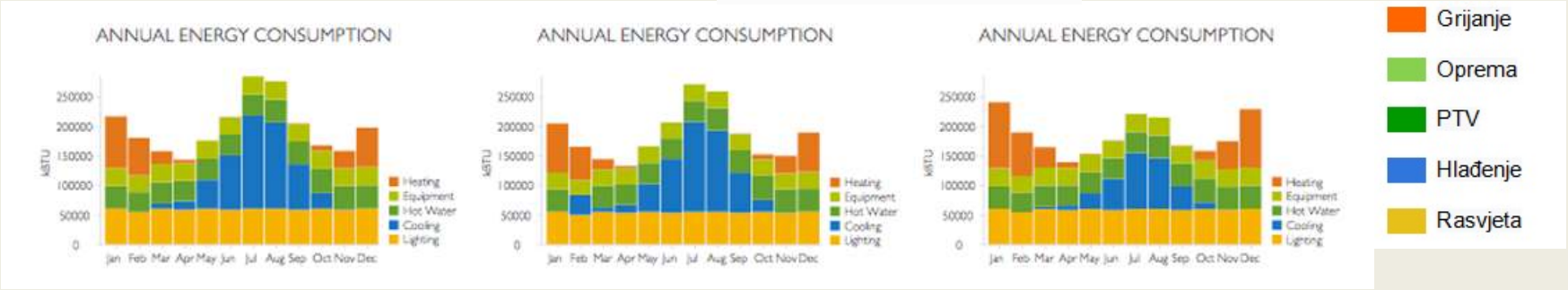
Energetske simulacije

Softverski alati za simulaciju energije u konceptualnoj fazi projektiranja omogućuju vizualizaciju potrošnje energije u zgradama.

Komparativnom analizom predloženog i izmijenjenog dizajna olakšana je identifikacija područja koja imaju najveći potencijal uštede energije.



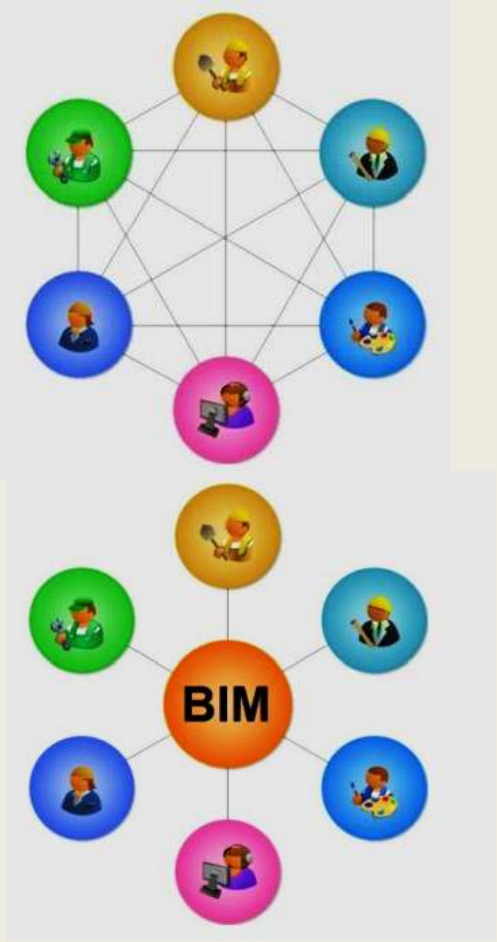
GODIŠNJA POTROŠNJA ENERG 1 kWh x 3.142 = 3.142 kBtu



https://sefaira.com/

BIM (eng. Building Information Model/Modeling/Management)

Skup tehnologija, postupaka i pravila koji omogućuje da više sudionika surađuje u projektiranju, građenju i upravljanju građevinom u virtualnom prostoru.



- Cjeloviti uvid u projekt ➡ visoke performanse pri projektiranju racionalne upotrebe energije i toplinske zaštite, zaštite od buke, toplinske, akustičke, vizualne udobnosti …
- Ostvarivanje uvjeta za željenu opciju specifičnih ciljeva (nzeb, LEED, ”zelene zgrade”...)
- Informacije dostupne u realnom prostoru i vremenu (vidljive promjene u projektima ”drugih” struka)
- Poboljšana komunikacija i suradnja sudionika u gradnji (projektanta, investitora, izvođača, stručnog i projektantskog nadzora…) i drugih dionika

GLOBALNO PREPOZNATI SUSTAVI CERTIFICIRANJA ODRŽIVE GRADNJE

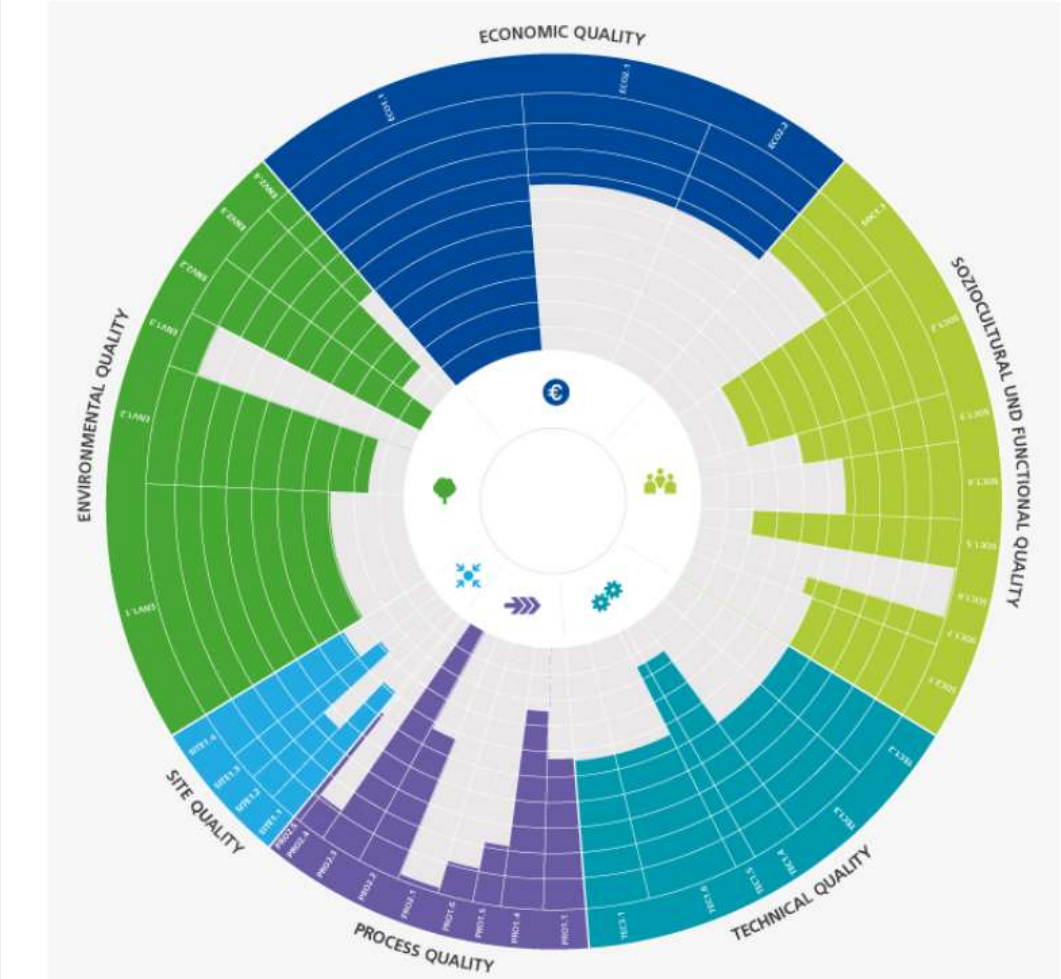
- LEED (engl. Leadership in Energy and Environmental Design), SAD (1998.)
- BREEAM (engl. Building Research Establishment Environmental Assessment Methodology) UK (1990.)
- DGNB (njem. Deutsche Gesellschaft für Nachhaltiges Bauen) Njemačka (2007.)

Certificirane zgrade u odnosu na konvencionalne zgrade postižu višu tržišnu vrijednost i višu cijenu najma, te su traženije na tržištu!

MATRIX

DGNB

DGNB
Deutsche Gesellschaft für Nachhaltiges Bauen
German Sustainable Building Council



PLATINUM – 80 %

GOLD – 65 %

SILVER – 50 %

PREUZETO: https://blog.dgnb.de/en/

KRITERIJI ZA VANJSKU OVOJNICU

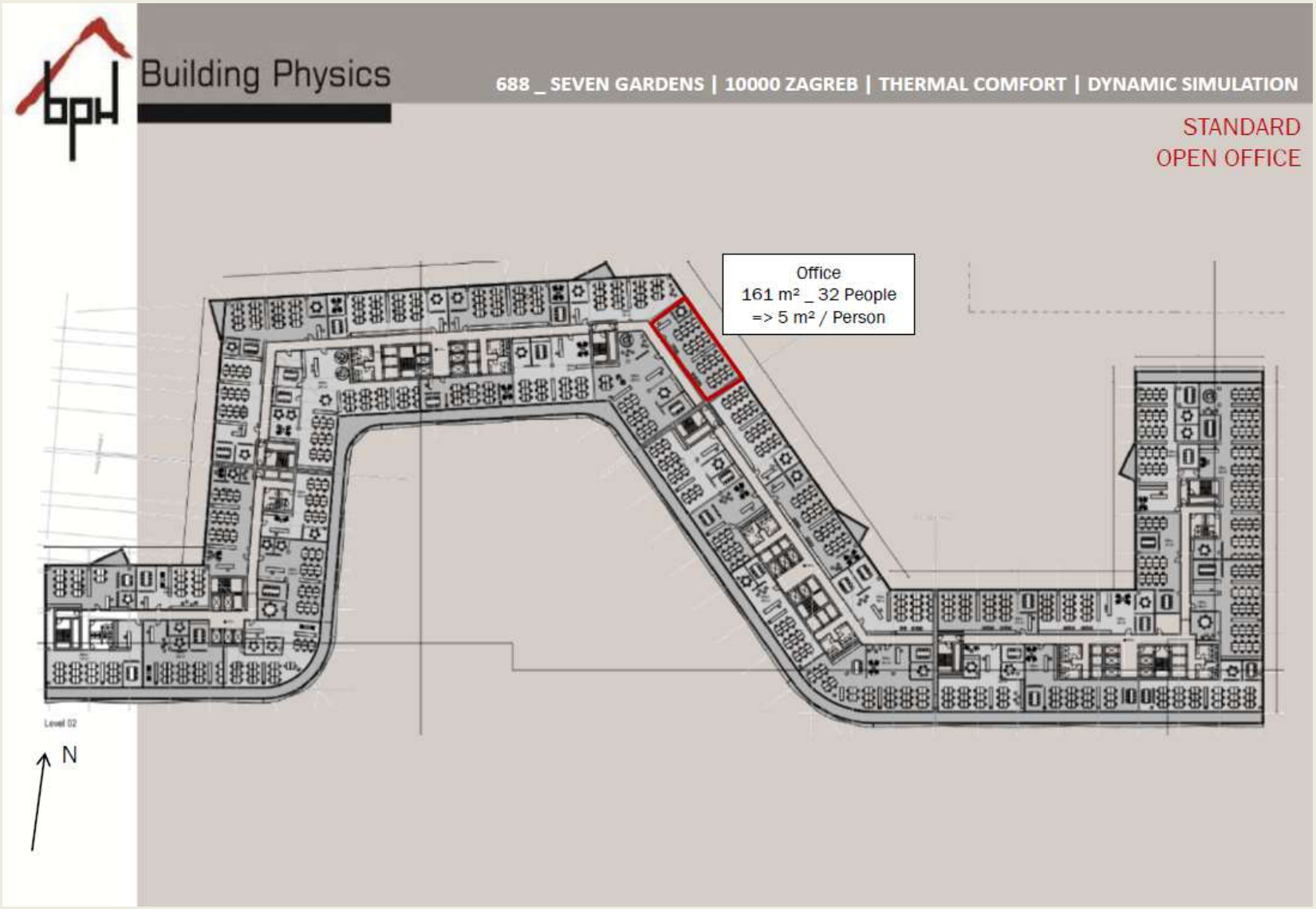
NO.	KEY PERFORMANCE INDICATORS (KPIS)	UNIT
KPI 1	Heat transfer coefficients, differentiated by different exterior components	[W/m²*K]
KPI 2	Thermal heat bridge correction factors	[W/m²*K]
KPI 3	Air exchange rate	[1/h]
KPI 4	Solar transmittance parameter	[-]
KPI 5	Number of exceeding temperature hours, corresponds to Level(s) indicator 4.2: Time outside of thermal comfort range – Time out of range	[kh/a]
KPI 6	Number of exceeding temperature hours in 2030 and 2050, corresponds to Level(s) indicator 5.1: Time outside of thermal comfort range – Time out of range 2030/2050	[kh/a]

NO.	INDICATOR		POINTS
1	**Heat transfer**		
1.1	**Heat transfer coefficients**		
	Evaluation of the indicator is not possible (see Appendix A Detailed description)		**0**
	Office **Education** **Shopping centre** **Department stores**	W/(m²·K)	**Max. 40**
	Logistics **Production** **Hotel**		
	Consumer market		**Max. 45**
	Opaque exterior components *	≤ min. country	**20**
	Transparent exterior components *	specific	
	Curtain wall	mandatory	
	Glass roofs, strip lights, skylights	requirement	
	Opaque exterior components *	-15% of the	**30**
	Transparent exterior components *	min.	
	Curtain wall	mandatory	
	Glass roofs, strip lights, skylights	U-Value	
	Opaque exterior components *	-30% of the	**40**
	Transparent exterior components *	min.	
	Curtain wall	mandatory	
	Glass roofs, strip lights, skylights	U-Value -	
	For: **Consumer market**		**45**
	Note for **Logistics** **Production** :		
	Buildings with low heating levels must be evaluated via indicator 1.3		

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

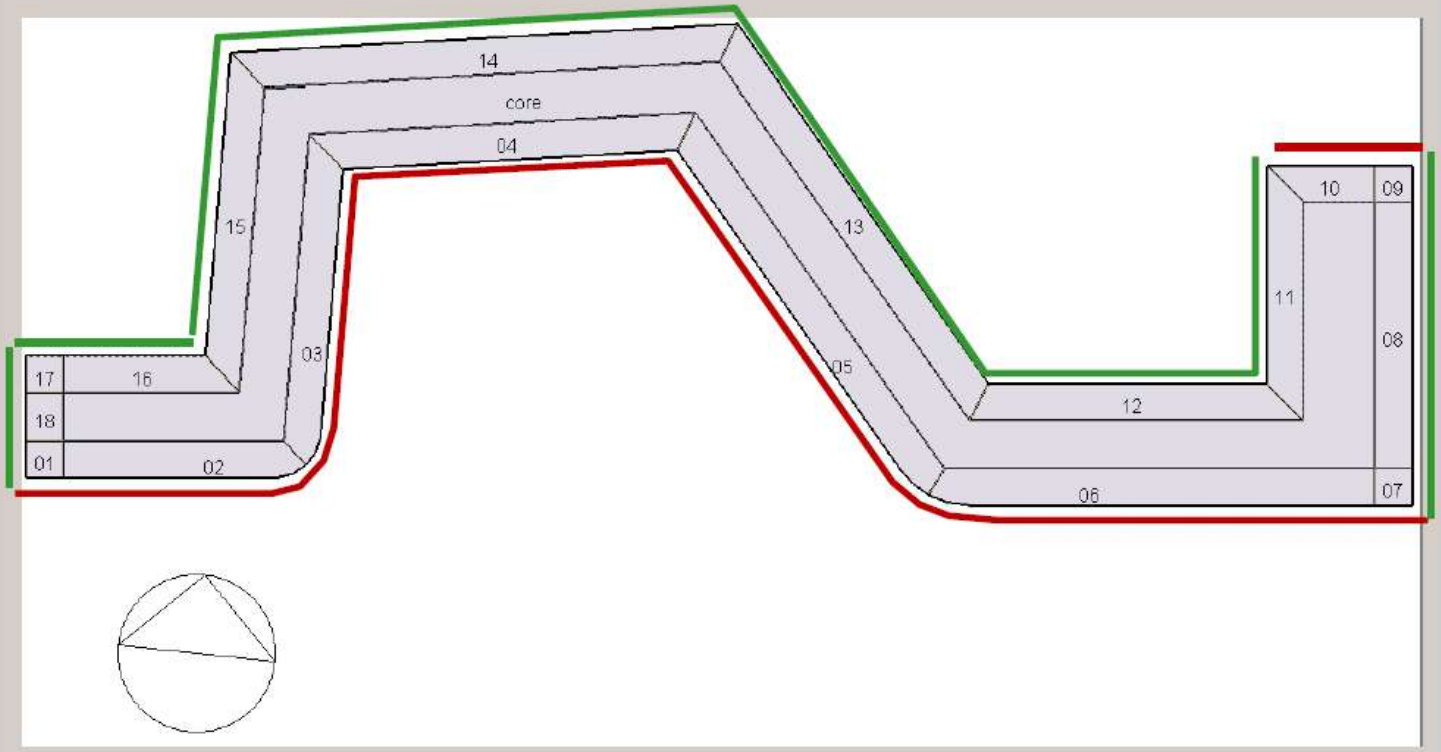
SEVEN GARDENS


Building Physics
688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION
STANDARD
OPEN OFFICE
Office
161 m² _ 32 People
=> 5 m² / Person
Level 02
N

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

6th FLOOR PLAN _ THERMAL ZONES SIMULATED MODEL



Façade with overhang construction (Glazing height 2,9 m)

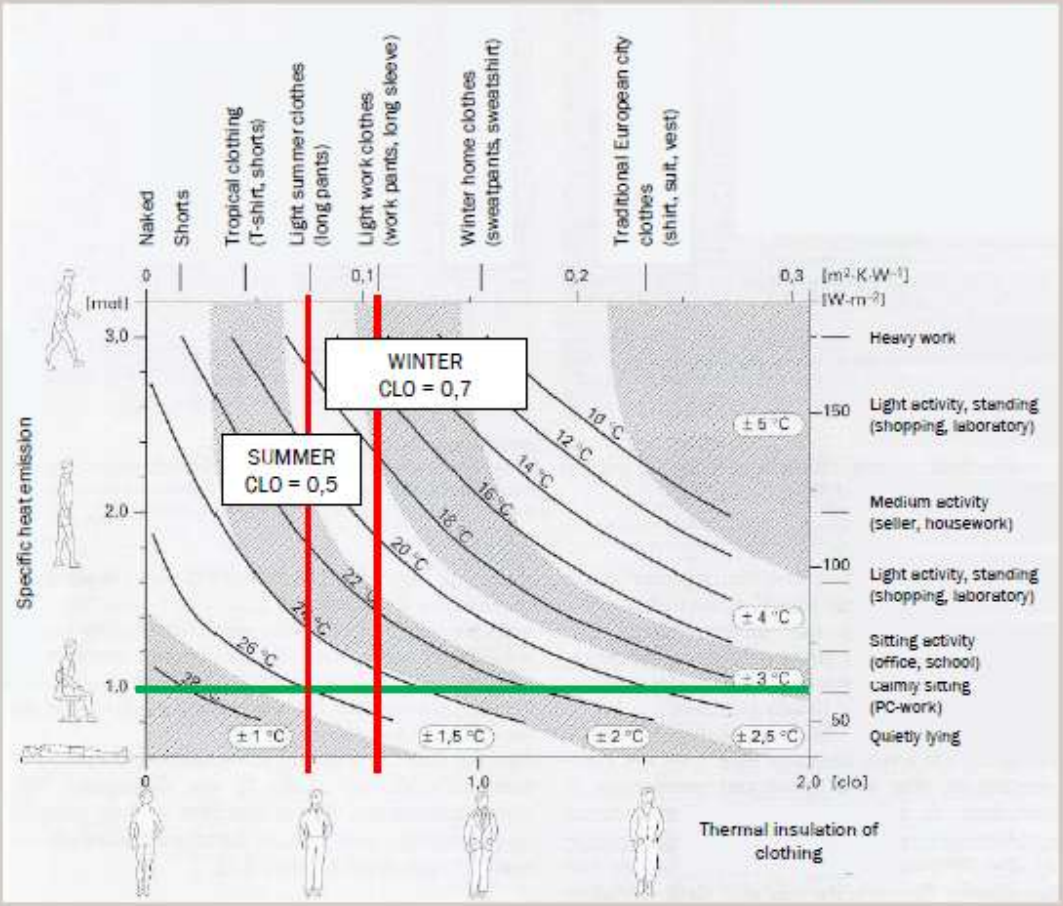
Façade with balustrade _ height 60 cm (Glazing height 2,3 m)

EVALUATION OF THERMAL COMFORT
REQUIREMENT CLASSES _ CONFORMITY CRITERIA _ EN ISO 7730

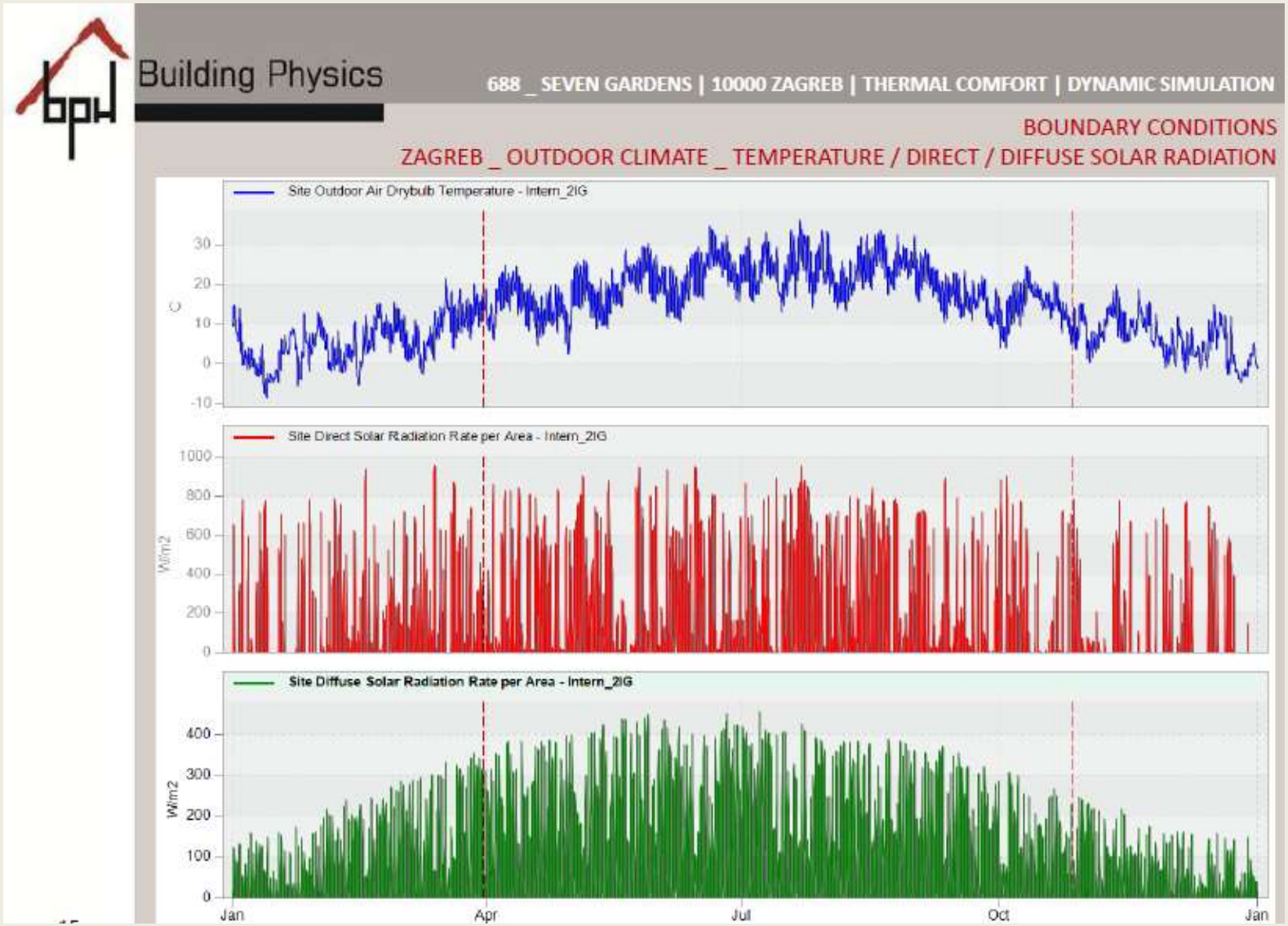
Category	Rating of thermal sensibility with respect to the whole body		Specific discomfort expressed in PPD, on the basis of:			
	Predicted percentage of dissatisfied [PPD]	Predicted mean vote [PMV]	Draft	Vertical stratification of room air temperature	Too warm or too cold floor	Asymmetric heat radiation of the surfaces
A	< 6 %	−0,2 < PMV < +0,2	< 15 %	< 3 %	< 10 %	< 5 %
B	< 10 %	−0,5 < PMV < +0,5	< 20 %	< 5 %	< 10 %	< 5 %
C	< 15 %	−0,7 < PMV < +0,7	< 25 %	< 10 %	< 15 %	< 10 %

Remarks: PPD _ PREDICTED PERCENTAGE OF DISSATISFIED (%);
PMV _ PREDICTED MEAN VOTE;

BOUNDARY CONDITIONS
THERMAL INSULATION OF CLOTHING



OFFICE
MET 1,0


Building Physics
688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION
BOUNDARY CONDITIONS
ZAGREB _ OUTDOOR CLIMATE _ TEMPERATURE / DIRECT / DIFFUSE SOLAR RADIATION
Site Outdoor Air Drybulb Temperature - Intern_2IG
C
30
20
10
0
-10
Site Direct Solar Radiation Rate per Area - Intern_2IG
W/m2
1000
800
600
400
200
0
Site Diffuse Solar Radiation Rate per Area - Intern_2IG
W/m2
400
300
200
100
0
Jan
Apr
Jul
Oct
Jan

BOUNDARY CONDITIONS
FAÇADE PROPERTIES

Wärmedämmglas

Produktbezeichnung	Aufbau außen/ SZR/ (Mitte/ SZR/) innen	U_g-Wert (EN 673)	g-Wert	Lichttransmission	äq. Farbwiedergabeindex in Durchsicht	Lichtreflexionsgrad nach außen	Energieabsorption außen	Energieabsorption mitte	Energieabsorption innen	Shading Coefficient (g-Wert EN 410/SZR)	Selektivitätskennzahl	Dicke	Gewicht
	mm	W/(m²K)	%	%		%	%	%	%	%		mm	kg/m²
iplus top 1.1 on Clearlite	4/16/4	1,1	64	82	98	12	7	–	7	74	1,28	24	20
iplus top 1.1 on Clearlite	6/16/6	1,1	63	80	98	12	10	–	8	72	1,27	28	30
iplus top 1.1 on Clearlite	4/12/4	1,3	64	82	98	12	7	–	7	74	1,28	20	20
iplus top 1.1 on Clearlite	6/12/6	1,3	63	80	98	12	10	–	8	72	1,27	24	30
iplus advanced 1.0 on Clearlite	4/16/4	1,0	57	77	98	15	8	–	8	66	1,35	24	20
iplus advanced 1.0 on Clearlite	4/12/4	1,2	56	77	98	15	8	–	8	64	1,35	20	20
iplus top 1.1 T on Clearlite	4/16/4	1,1	66	82	98	12	7	–	6	76	1,24	24	20
iplus top 1.1 T on Clearlite	6/16/6	1,1	64	81	98	12	10	–	8	74	1,27	28	30
iplus top 1.1 T on Clearlite	4/12/4	1,3	66	82	98	12	7	–	6	76	1,24	20	20
iplus top 1.1 T on Clearlite	6/12/6	1,3	64	81	98	12	10	–	8	74	1,27	24	30
iplus advanced 1.0 T on Clearlite	4/16/4	1,0	62	81	98	13	7	–	6	71	1,31	24	20
iplus advanced 1.0 T on Clearlite	6/16/6	1,0	60	80	97	13	10	–	7	69	1,33	28	30
iplus advanced 1.0 T on Clearlite	4/12/4	1,2	62	81	98	13	7	–	6	71	1,31	20	20
iplus advanced 1.0 T on Clearlite	6/12/6	1,2	60	80	97	13	10	–	7	69	1,33	24	30
iplus top 3	4/16/4/16/4	0,6	53	74	97	16	13	4	5	61	1,40	44	30
iplus top 3	4/12/4/12/4	0,7	53	74	97	16	13	4	5	61	1,40	36	30
iplus top 3C	4/12/4/12/4	0,5	53	74	97	16	13	4	5	61	1,40	36	30
iplus top 3C	4/10/4/10/4	0,6	53	74	97	16	13	4	5	61	1,40	32	30
iplus 3LS	4/16/4/16/4	0,7	62	74	99	17	7	9	5	71	1,19	44	30
iplus 3LS	4/12/4/12/4	0,8	62	74	99	17	7	9	5	71	1,19	36	30
iplus 3CLS	4/12/4/12/4	0,6	62	74	99	17	7	9	5	71	1,19	36	30
iplus 3CLS	4/10/4/10/4	0,7	62	74	99	17	7	9	5	71	1,19	32	30
iplus Energy N on Clearlite	4/16/4	1,0	41	73	97	12	22	–	1	47	1,78	24	20
iplus Energy N on Clearlite	6/16/4	1,0	41	73	96	12	26	–	1	47	1,78	26	25
iplus Energy NT on Clearlite	4/16/4	1,0	42	74	99	12	20	–	1	48	1,76	24	20
iplus Energy NT on Clearlite	6/16/4	1,0	42	73	99	12	23	–	1	48	1,74	26	25
iplus AF & iplus top 1.1 on Clearlite	4/16/4	1,1	61	76	99	16	13	–	6	70	1,25	24	20
iplus AF top on Clearlite	4/16/4	1,1	58	76	99	16	17	–	2	67	1,31	24	20
iplus AF Energy N	4/16/4	1,0	39	69	98	16	27	–	1	45	1,77	24	20
iplus AF Energy N	4/12/4/12/4	0,7	36	62	97	18	27	1	2	41	1,75	36	30
iplus AF top 3	4/12/4/12/4	0,7	50	69	98	19	18	4	4	57	1,38	36	30
iplus AF 3LS	4/12/4/12/4	0,8	59	69	99	20	12	8	5	68	1,17	36	30

: kennzeichnet die Lage der Schichten; mittlere Scheibe bei Dreifachverglasungen aus Clearlite.

Remarks: Exemplary glazing type for double (triple) insulation glazing used in dynamic building simulations (Source: Interpane)
Frame to glazing ratio _ frame _ 10 % -> glazing _ 90 %;
Double insulation glazing _ Ug = 1,0 W/(m²*K) _ g = 0,62 _ TL = 81 %
Triple insulation glazing _ Ug = 0,6 W/(m²*K) _ g = 0,53 _ TL = 74 %

BOUNDARY CONDITIONS
SHADING DEVICES _ INTERNAL _ PRODUCT EXAMPLE
TEXTILE SCREEN _ e.g. SOLTIS SCREEN

Ref.	TS	RS	AS	TV n-h	TV n-n	g_{tot}*	g_{tot}'	NCS-Farbsystem
92-2012	7	30	63	6	5	0.08	0.46	S 4010 Y 30 R
92-2013	18	57	25	16	4	0.14	0.38	S 0540 Y 10 R
92-2039	3	8	89	3	3	0.07	0.53	S 8010 B 90 G
92-2043	2	12	86	2	3	0.06	0.52	-
92-2044	20	70	10	19	5	0.14	0.34	S 0500 N
92-2045	3	35	62	3	3	0.05	0.45	-

TS: Strahlungstransmission in %
RS: Strahlungsreflexion in %
AS: Strahlungsabsorption in %
TS + RS + AS = 100 % der einfallenden Energie

g_{tot}*: Sonnenschutzfaktor außen
g_{tot}': Sonnenschutzfaktor innen
Verglasung Typ «C»: doppelte Isolierverglasung, schwach wärmeleitend auf der Isolierinnenseite der zum Raum gewandten Glasscheibe (4 + 16 + 4; Argon-Füllung).

TVn-h: Transmission von sichtbarem Licht normal-hemisphärisch in %
TVn-n: Transmission von sichtbarem Licht normal-normal in %

A : Die der Sonne zugewandte Aluminiumseite
B : Die der Sonne zugewandte farbige Seite

Remarks: SHADING DEVICES _ INTERNAL _ SET POINT q,sol = 200 W/m²
Shading devices are activated, when the direct + diffuse solar radiation incident on the window exceeds the 200 W/m²

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

BOUNDARY CONDITIONS
SHADING DEVICES _ EXTERNAL _ PRODUCT EXAMPLE
WAREMA SecuTex _ 44601 _ SILBER

Dessin	Außenliegende Farbe (bei zweifarbigen Dessins)	Öffnungsfaktor in %	Lichtdurchlassgrad in %	Lichtreflexionsgrad in %	Lichtabsorptionsgrad in %	Strahlungsdurchlassgrad in %	Strahlungsreflexionsgrad in %	Strahlungsabsorptionsgrad in %	Farbwiedergabeindex R_a	Pflegeanleitung
44600	weiß	1	57	9	34	55	8	37	98	
	silber	1	53	9	38	54	8	38	98	
44601	silber	1	51	4	45	52	4	44	98	
44602	grau	1	20	3	77	24	4	72	99	
	silber	1	50	3	47	52	4	44	99	
44600	weiß	4	48	15	37	46	14	40	99	
	silber	4	43	15	42	44	14	42	99	
44601	silber	4	47	7	46	48	7	45	98	
44602	grau	4	18	5	77	21	6	73	99	
	silber	4	41	5	54	43	6	51	99	

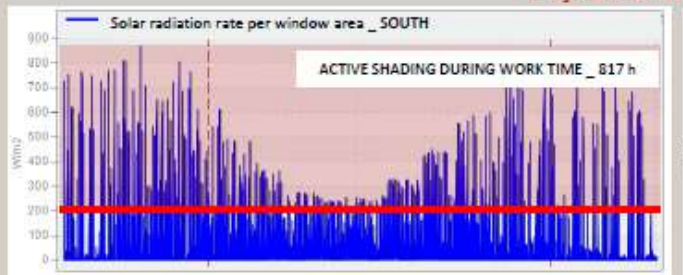
Remarks: SHADING DEVICES _ EXTERNAL _ SET POINT q,sol = 200 W/m²
Shading devices are activated, when the direct + diffuse solar radiation incident on the window exceeds the 200 W/m²

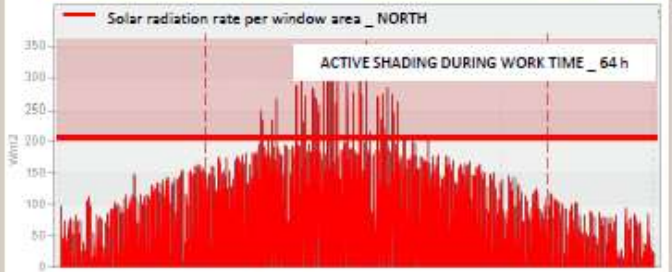
Building Physics

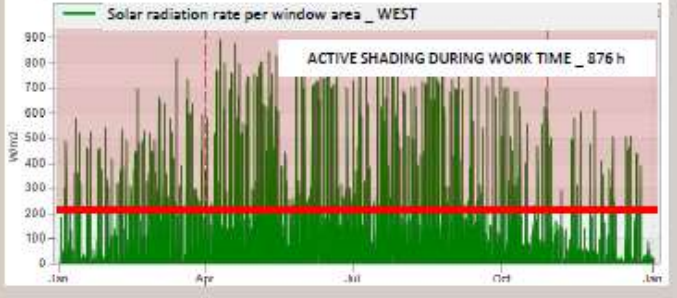
688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

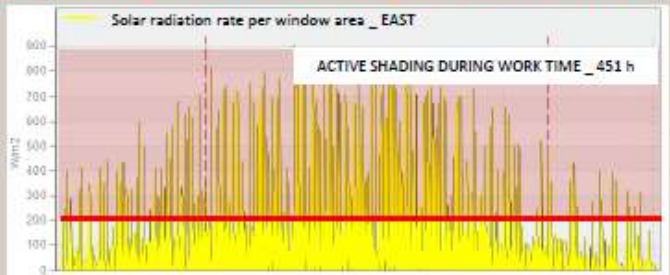
BOUNDARY CONDITIONS

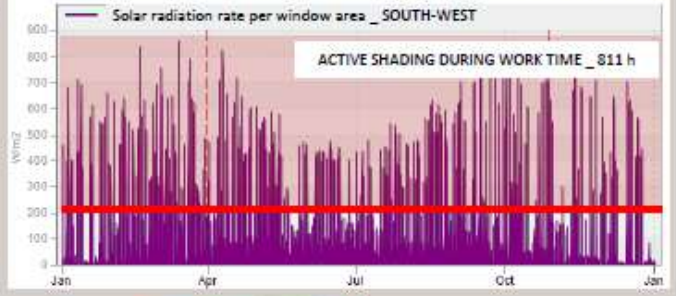
FAÇADE ORIENTATIONS _ SHADING DEVICES _ SET POINT 200 W/m²

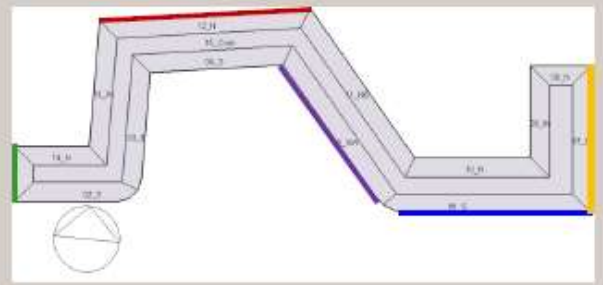










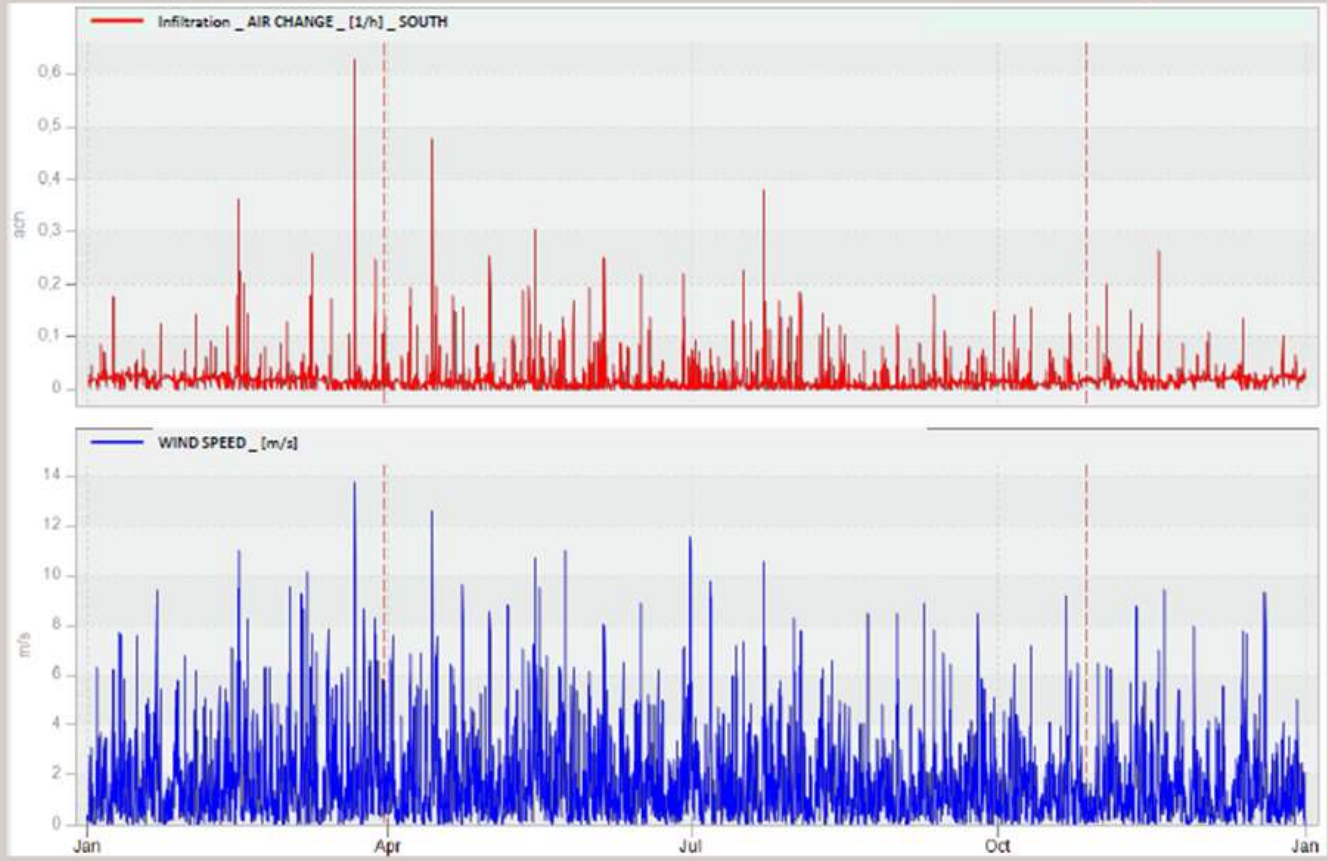


Remarks: Set point of external/internal shading devices _ 200 W/m²;
Work time total 2.871 h (8°° - 20°° _ Monday – Friday = 2.871 h)

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

BOUNDARY CONDITIONS
AIRTIGHTNESS OF BUILDING ENVELOPE _ INFILTRATION

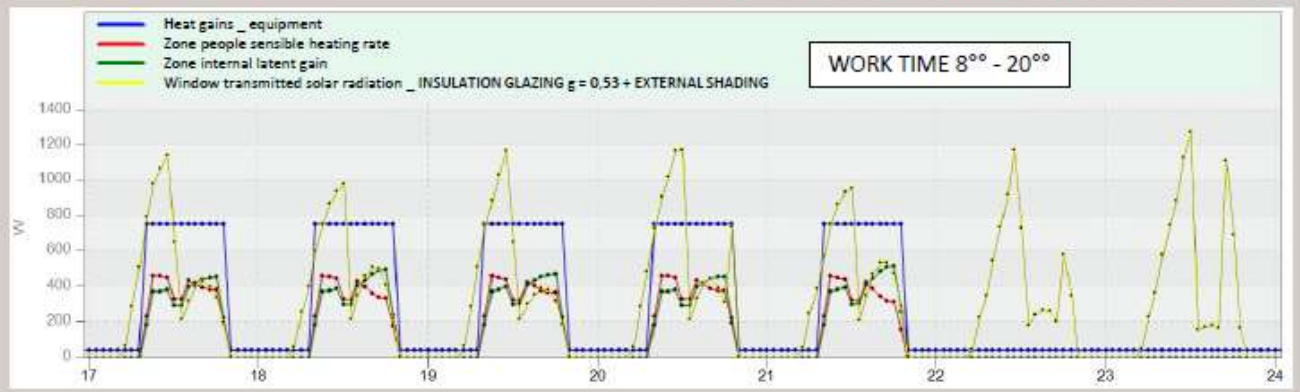


Remark: Infiltration rate depending on wind speed (part of ventilation losses)

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

BOUNDARY CONDITIONS
INTERNAL HEAT GAINS _ OFFICE _ WEST
TYPICAL SUMMER WORK WEEK _ WORK TIME 8°° - 20°°



OCCUPANCY

```
Office_OpenOff_Occ,
Fraction,
Through: 31 Dec,
For: Weekdays SummerDesignDay,
Until: 08:00, 0,
Until: 09:00, 0.5,
Until: 12:00, 1,
Until: 14:00, 0.75,
Until: 19:00, 1,
Until: 20:00, 0.5,
Until: 24:00, 0,
For: Weekends,
Until: 24:00, 0,
For: Holidays,
Until: 24:00, 0,
For: WinterDesignDay AllOtherDays,
Until: 24:00, 0;
```

EQUIPMENT

```
Office_OpenOff_Equip,
Fraction,
Through: 31 Dec,
For: Weekdays SummerDesignDay,
Until: 08:00, 0.05394,
Until: 20:00, 1,
Until: 24:00, 0.05394,
For: Weekends,
Until: 24:00, 0.05394,
For: Holidays,
Until: 24:00, 0.05394,
For: WinterDesignDay AllOtherDays,
Until: 24:00, 0;
```

Remarks: Office equipment _ 100 W per workplace (energy efficient laptops and LED lights);
People (light office work) 123 W/Person (latent + sensible heat gains)

VARIANTS

V1 _ EXTERNAL SHADING SCREENS + TRIPLE INSULATION GLAZING _ Ug = 0,6 W/(m²*K) _ g = 0,53 _ TL = 74 %

V2 _ EXTERNAL SHADING SCREENS + DOUBLE INSULATION GLAZING _ Ug = 1,0 W/(m²*K) _ g = 0,62 _ TL = 81 %

V3 _ INTERNAL SHADING SCREENS + DOUBLE INSULATION GLAZING _ Ug = 1,0 W/(m²*K) _ g = 0,62 _ TL = 81 %

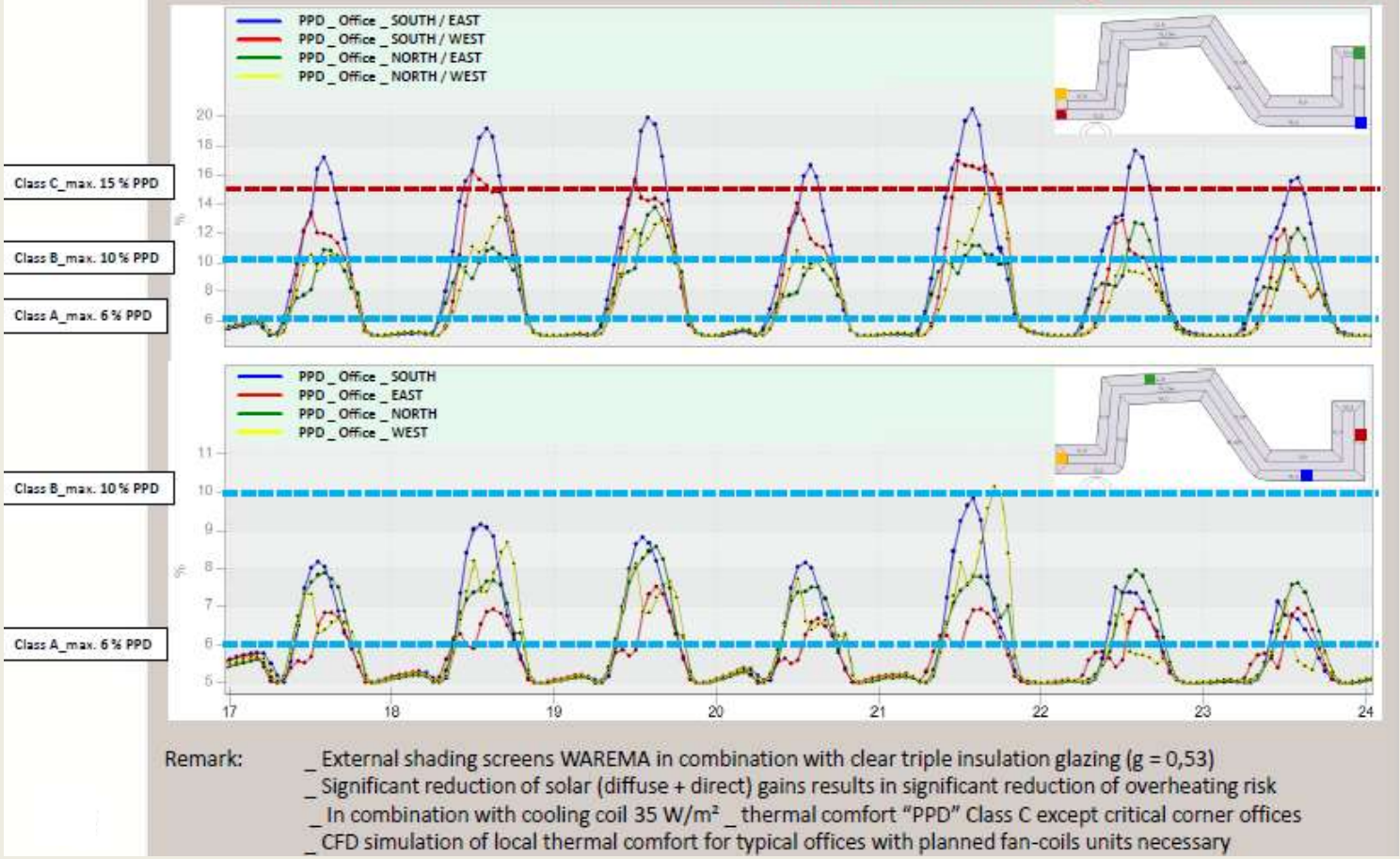
DYNAMIC ENERGY SIMULATIONS _ THERMAL COMFORT
"PPD" _ PREDICTED PERCENTAGE OF DISSATISFIED (%)
RESULTS

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

V1 _ EXTERNAL SHADING SCREENS + TRIPLE INSULATION GLAZING _ g = 0,53

THERMAL COMFORT "PPD" _ CRITICAL SUMMER WEEK



Remark:

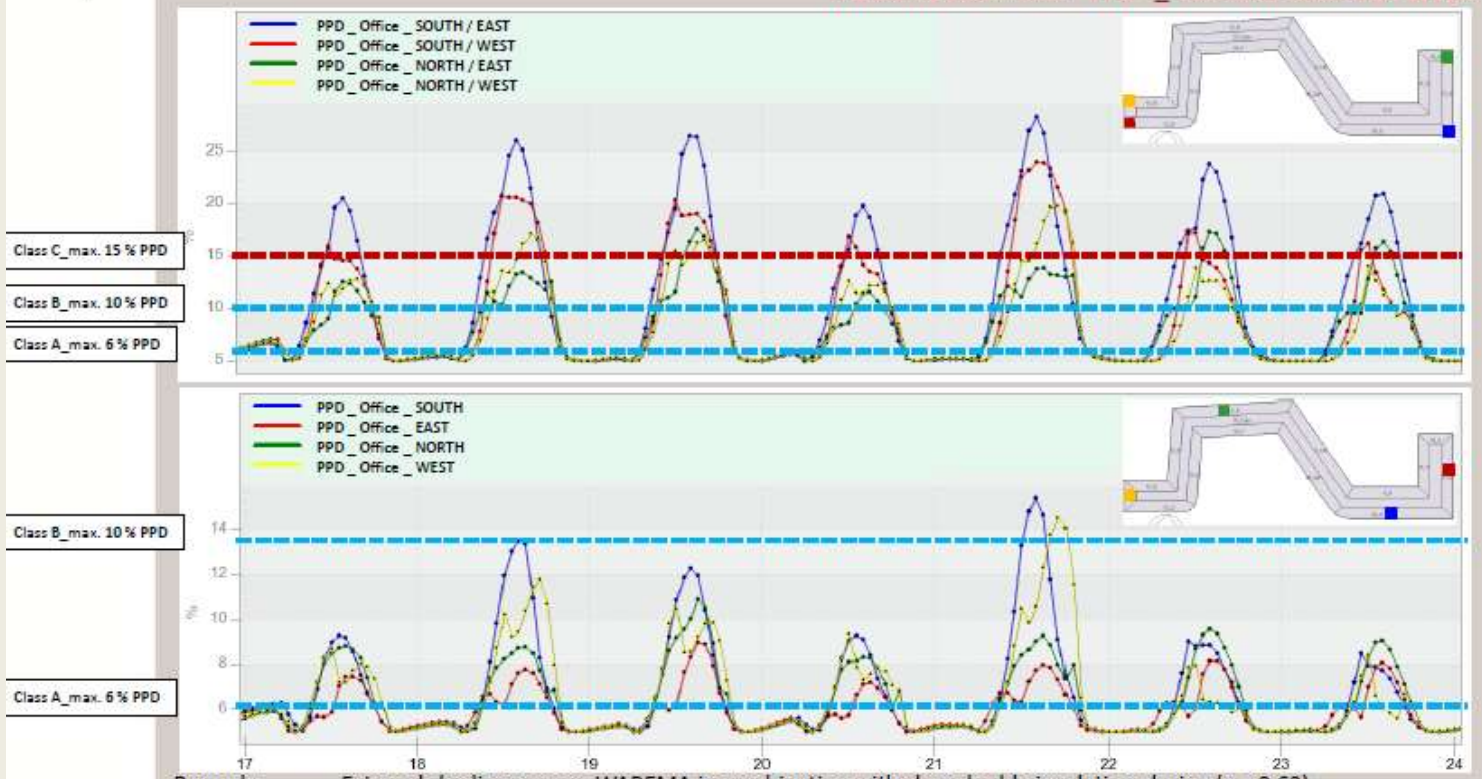
_ External shading screens WAREMA in combination with clear triple insulation glazing (g = 0,53)
_ Significant reduction of solar (diffuse + direct) gains results in significant reduction of overheating risk
_ In combination with cooling coil 35 W/m² _ thermal comfort "PPD" Class C except critical corner offices
_ CFD simulation of local thermal comfort for typical offices with planned fan-coils units necessary

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

V2 _ EXTERNAL SHADING SCREENS + DOUBLE INSULATION GLAZING _ g = 0,62

THERMAL COMFORT "PPD" _ CRITICAL SUMMER WEEK



Remark:

_ External shading screens WAREMA in combination with clear double insulation glazing (g = 0,62)

_ Significant reduction of solar (diffuse + direct) gains results in significant reduction of overheating risk

_ In combination with cooling coil 35 W/m² _ some hours above thermal comfort "PPD" Class C

_ Higher cooling coil necessary (e.g. 40 W/m²)

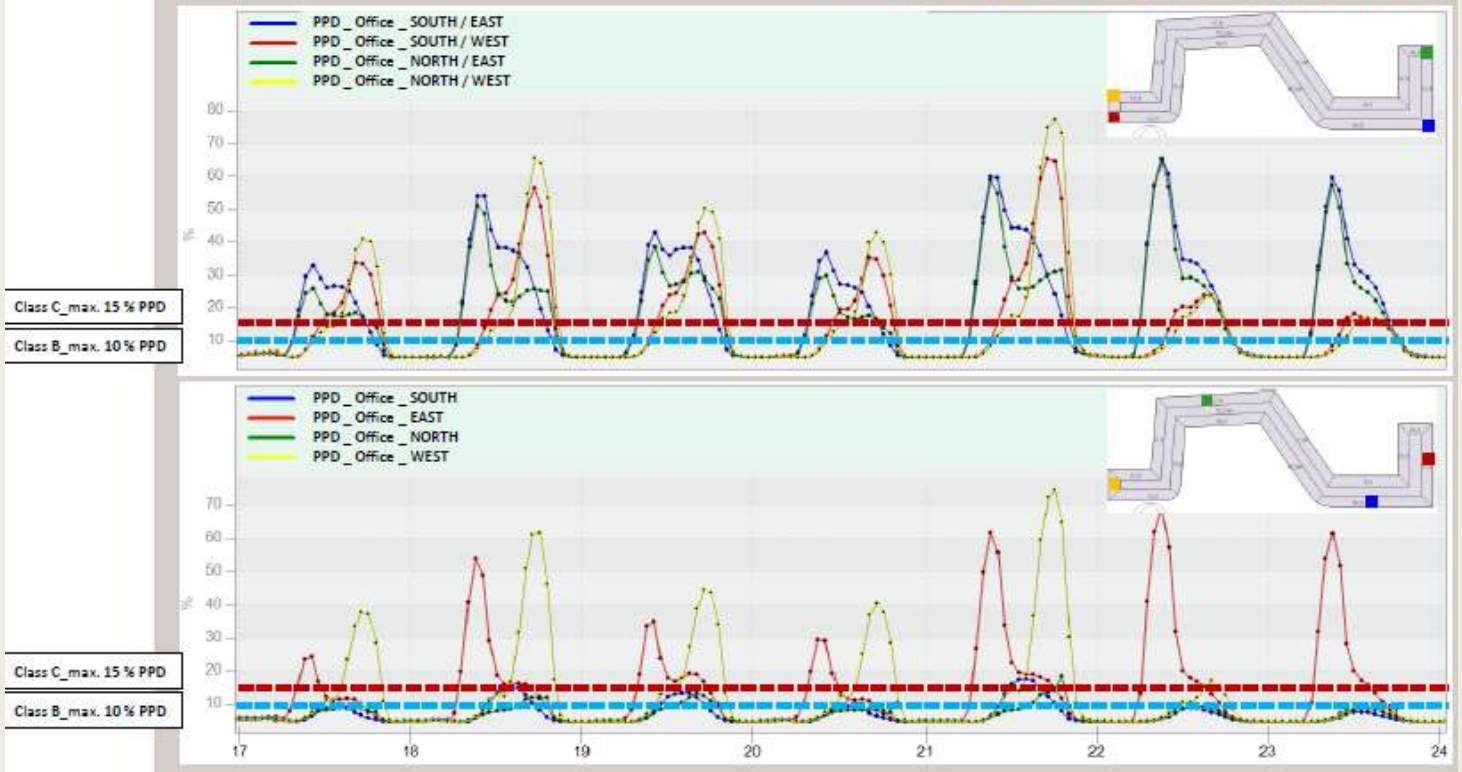
_ CFD simulation of local thermal comfort for typical offices with planned fan-coils units necessary

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

V3 _ INTERNAL SHADING SCREENS + DOUBLE INSULATION GLAZING _ g = 0,62

THERMAL COMFORT "PPD" _ CRITICAL SUMMER WEEK



Remark:

_ Internal shading screen SOLTIS in combination with clear double insulation glazing (g = 0,62);

_ Low effectivity of internal shading, causes high thermal discomfort in interior;

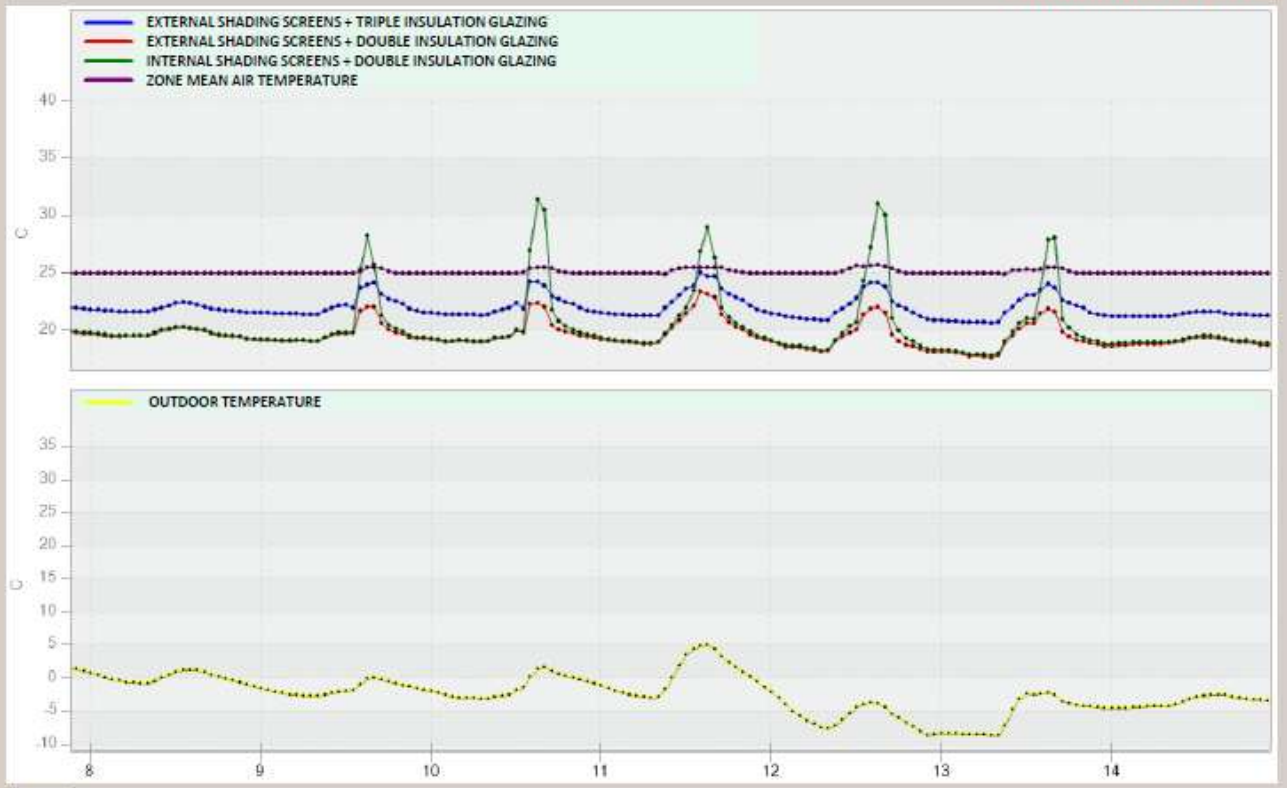
_ Very warm internal screen during hours with direct solar impact causes high levels of PPD especially for the work places nearest to the glazing and internal shading device (local thermal discomfort)

DYNAMIC ENERGY SIMULATIONS
INTERIOR SURFACE TEMPERATURES _ GLAZING
RESULTS

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

INTERIOR SURFACE TEMPERATURES _ GLAZING
CRITICAL WINTER WEEK



Remark:

_ During winter days without direct solar radiation on façade _ difference between triple / double glazing ca. 2 – 3 K

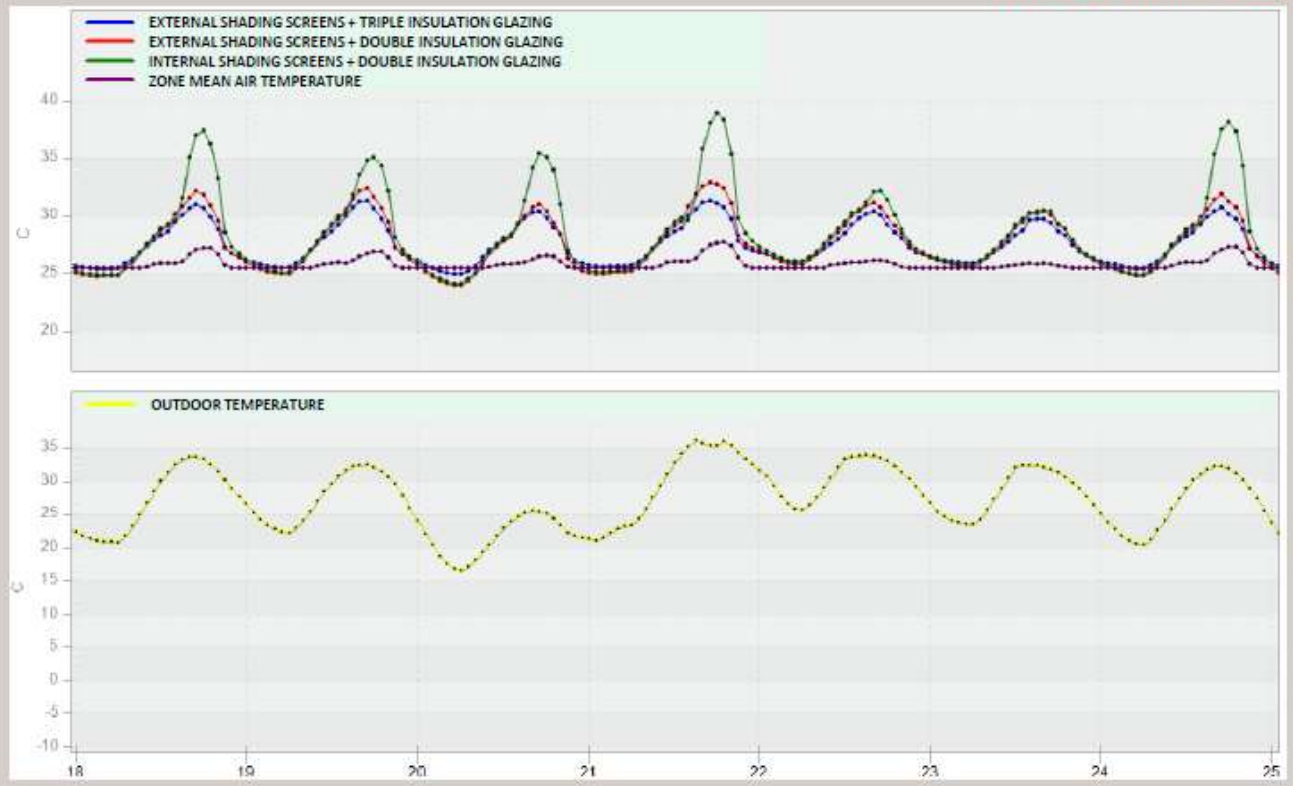
_ During winter days with direct solar radiation on façade _ difference between internal / external shading ca. 5 – 10 K

_ Due to low surface temperatures on double glazing during winter _ triple insulation glazing recommended

Building Physics

688 _ SEVEN GARDENS | 10000 ZAGREB | THERMAL COMFORT | DYNAMIC SIMULATION

INTERIOR SURFACE TEMPERATURES _ GLAZING
CRITICAL SUMMER WEEK



Remark:

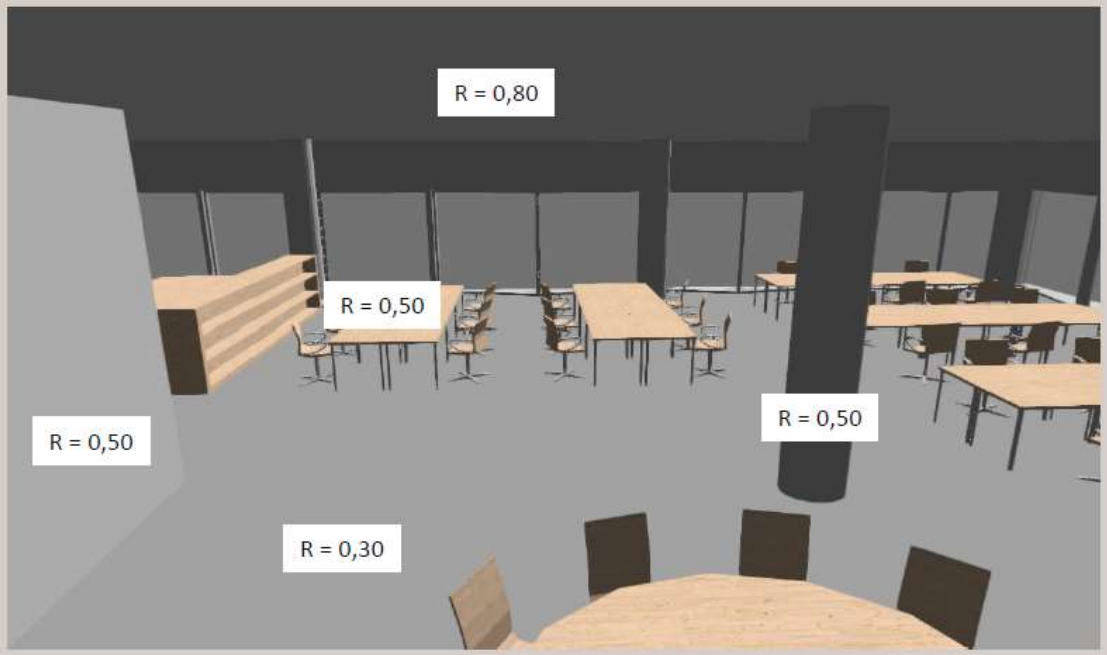
_ During summer days with direct solar radiation on façade _ difference between internal / external shading ca. 5 – 7 K

_ Due to high surface temperatures on internal shading during summer _ external shading recommended

Building Physics

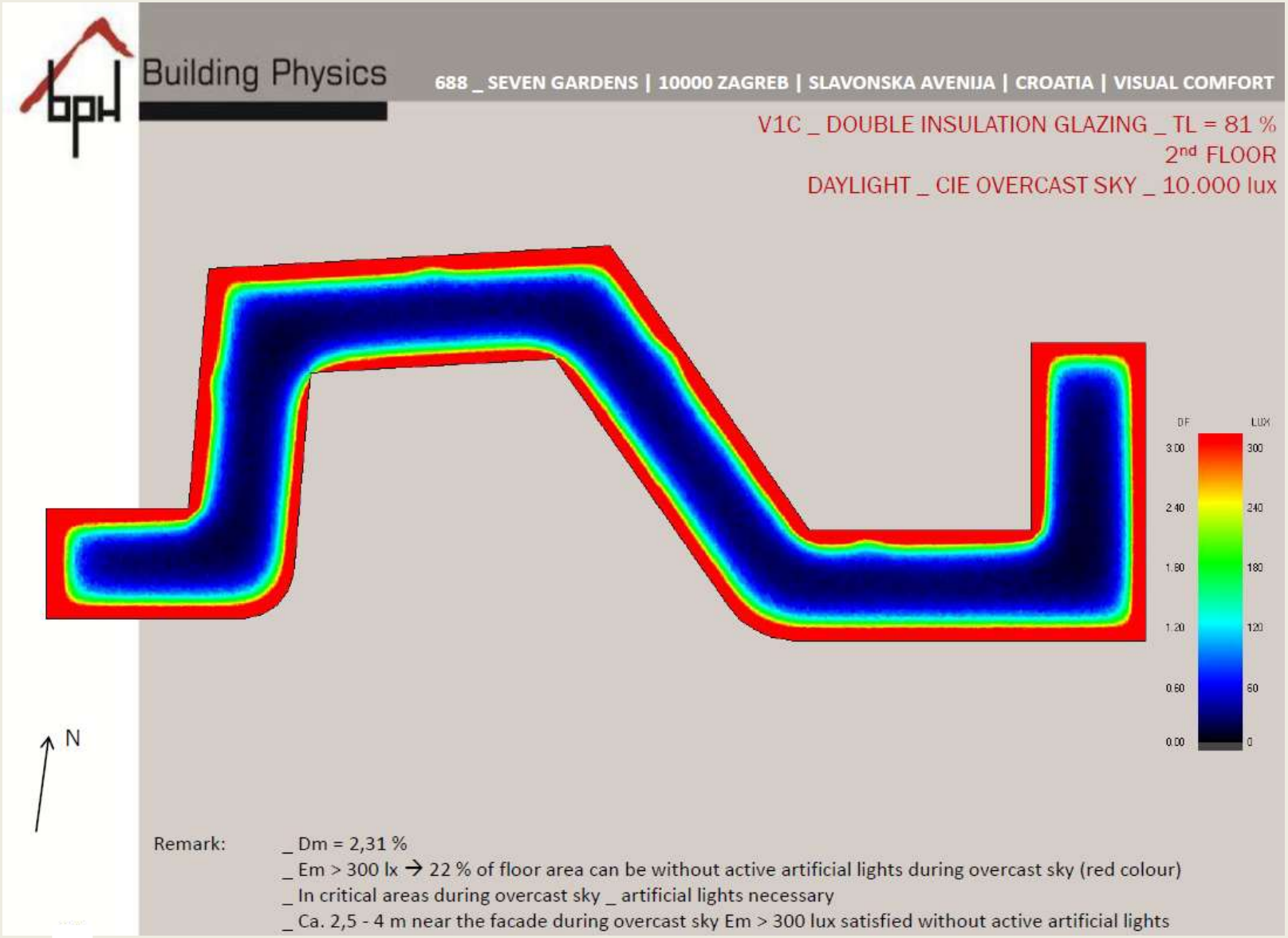
688 _ SEVEN GARDENS | 10000 ZAGREB | SLAVONSKA AVENIJA | CROATIA | VISUAL COMFORT

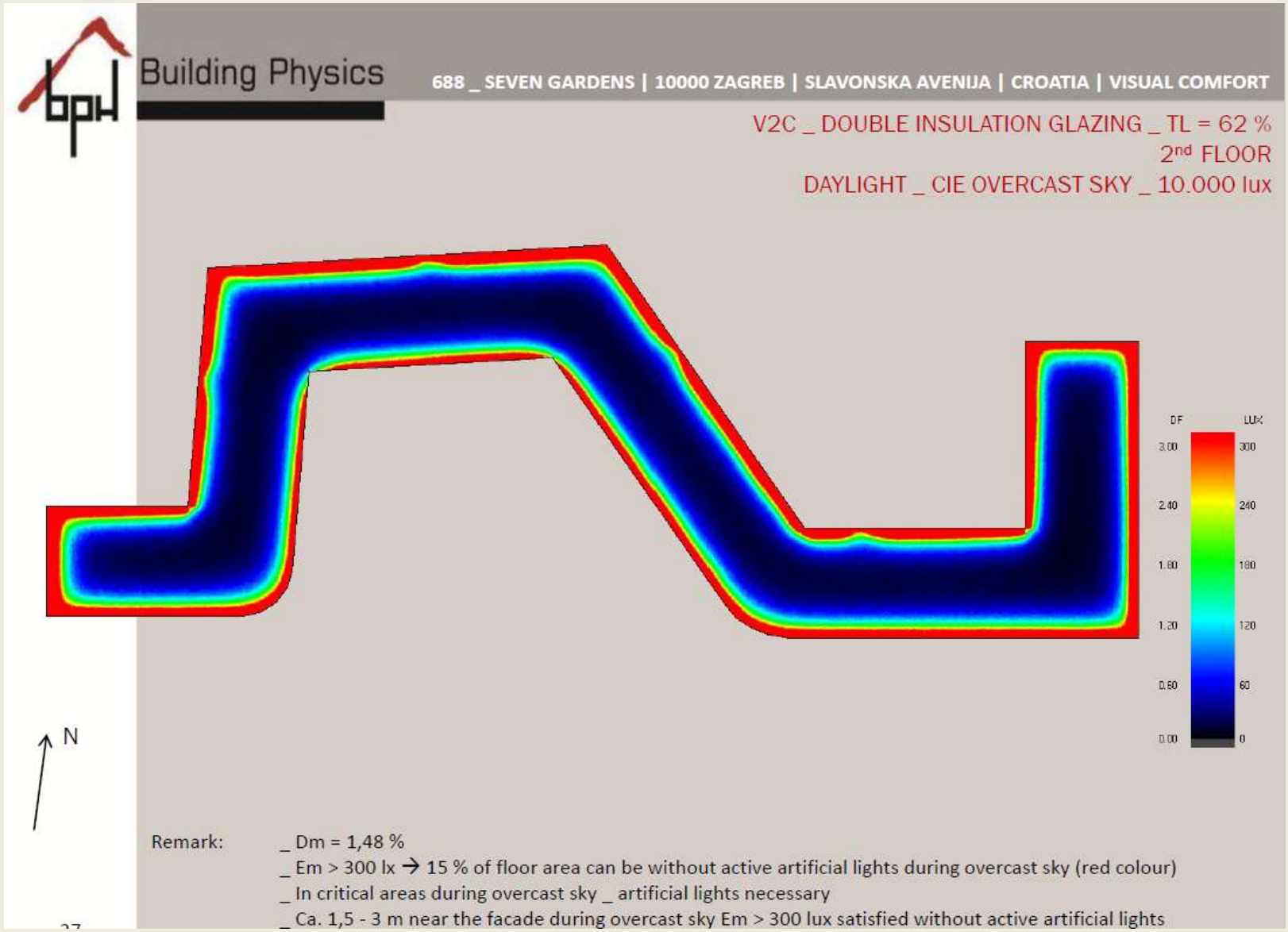
SEVEN GARDENS
SURFACE REFLECTANCE _ OFFICE



Surface reflectances

_ Ceiling:	R = 0,80	(Recommended values from EN 12464-1:2011, 4.2 are 0,7 - 0,9)
_ Walls:	R = 0,50	(Recommended values from EN 12464-1:2011, 4.2 are 0,5 - 0,8)
_ Floor:	R = 0,30	(Recommended values from EN 12464-1:2011, 4.2 are 0,2 - 0,4)
_ Work desks:	R = 0,50	


Building Physics
688 _ SEVEN GARDENS | 10000 ZAGREB | SLAVONSKA AVENIJA | CROATIA | VISUAL COMFORT
V1C _ DOUBLE INSULATION GLAZING _ TL = 81 %
2nd FLOOR
DAYLIGHT _ CIE OVERCAST SKY _ 10.000 lux
DF
LUX
3.00
2.40
1.80
1.20
0.60
0.00
300
240
180
120
60
0
N
Remark:
_ Dm = 2,31 %
_ Em > 300 lx → 22 % of floor area can be without active artificial lights during overcast sky (red colour)
_ In critical areas during overcast sky _ artificial lights necessary
_ Ca. 2,5 - 4 m near the facade during overcast sky Em > 300 lux satisfied without active artificial lights


Building Physics
688 _ SEVEN GARDENS | 10000 ZAGREB | SLAVONSKA AVENIJA | CROATIA | VISUAL COMFORT
V2C _ DOUBLE INSULATION GLAZING _ TL = 62 %
2nd FLOOR
DAYLIGHT _ CIE OVERCAST SKY _ 10.000 lux
DF
LUX
3.00
2.40
1.80
1.20
0.60
0.00
300
240
180
120
60
0
N
Remark:
_ Dm = 1,48 %
_ Em > 300 lx → 15 % of floor area can be without active artificial lights during overcast sky (red colour)
_ In critical areas during overcast sky _ artificial lights necessary
_ Ca. 1,5 - 3 m near the facade during overcast sky Em > 300 lux satisfied without active artificial lights

Literatura

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Hvala na pažnji

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