

Modeliranje elektro sustava na reprezentativnoj zgradi

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- Model potrošnje električne energije
- Sustav rasvjete
- Oprema
- Okupiranost
- Kalibracija modela
- Fotonapon

Model potrošnje električne energije

- Unos i izrada modela za postojeću građevinu
 - Preuzimanje podataka iz energetskeg pregleda, razgovor sa korisnicima o načinu korištenja zgrade i sustava
- Unos i izrada modela za novu građevinu
 - Preuzimanje podataka iz projektne dokumentacije i prosječni načini korištenja

Model potrošnje električne energije

- Sustavi i grupe potrošača:
 - Sustav rasvjete
 - Računala
 - Uredska oprema
 - Kuhinjska oprema
 - Specifični proces u zgradi (u slučaju proizvodnje ili specifične opreme)
 - Ostala oprema

Model potrošnje električne energije

- Za svaki sustav ili grupu potrošača određuje se:
 - Instalirana snaga opreme
 - Raspored korištenja opreme
 - Zoniranje (gdje mi se nalazi koja oprema)
 - Ostali specifični parametri

Sustav rasvjete

- Podaci iz energetskeg pregleda:
 - Instalirana snaga rasvjete – 210 W
 - Tip rasvjete (LED, fluorescentna i slično) - LED
 - Rasvjetljenost prostora – prosječno 200 lx
 - Smještaj u prostoru – zbog jednostavnosti isti parametri u svim prostorima
 - Način korištenja rasvjete - SCHEDULE



nZEB

DesignBuilder - OK_modeliran termotehnički sustav.dsb - Activity - Zagreb, OK

File Edit Go View Tools Help

Navigate, Site

Site

Zagreb, OK

Layout Activity Construction Openings Lighting HVAC Generation Economics CFD

Activity Template

Template

Sector stanovi

Copy of Residential spaces

Zone multiplier 1

☒ Include zone in thermal calculations

☒ Include zone in Radiance daylighting calculations

Floor Areas and Volumes

Occupancy

Contaminant Generation and Removal

Holidays

DHW

Environmental Control

Heating Setpoint Temperatures

Cooling Setpoint Temperatures

Heating Comfort PMV Setpoints

Cooling Comfort PMV Setpoints

Humidity Control

Ventilation Setpoint Temperatures

Minimum Fresh Air

CO2/Contaminant setpoints

Lighting

Target Illuminance (lux) 200

Default display lighting density (W/m2) 0

Compliance

Office Equipment

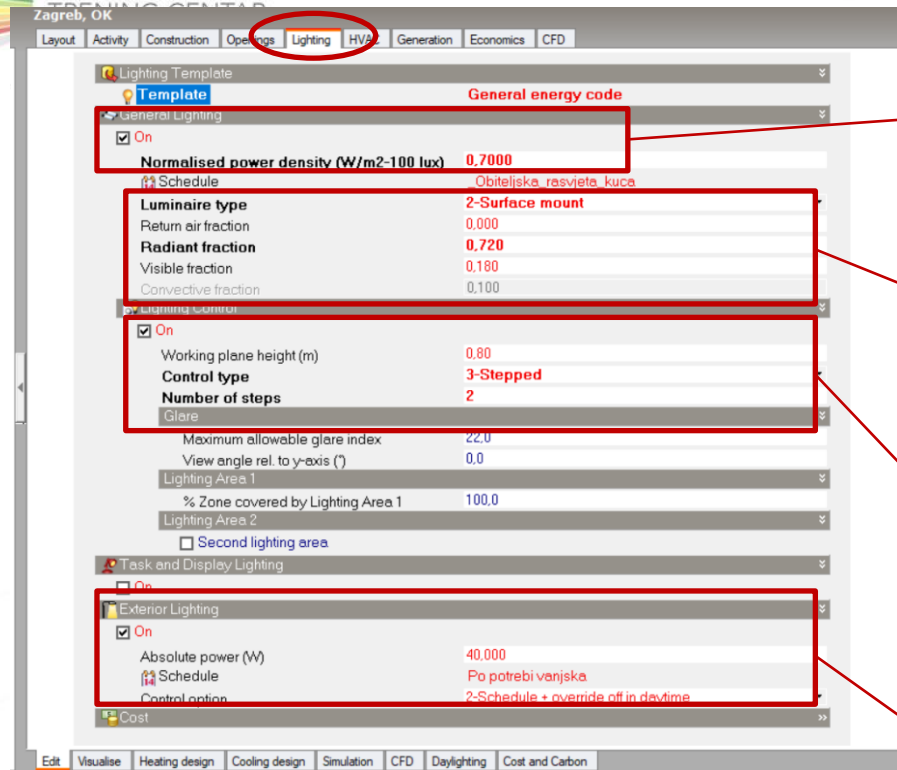
Miscellaneous

Catering

Process

Edit Visualise Heating design Cooling design Simulation CFD Daylighting Cost and Carbon

Definiranje
razine
osvijetljenosti u
zoni u activity
tabu



Zagreb, OK

Layout Activity Construction Openings **Lighting** HVAC Generation Economics CFD

Lighting Template

Template General energy code

General Lighting

☒ On

Normalised power density (W/m²-100 lux) 0.7000

Schedule Obiteljska rasvjeta kuca

Luminaire type 2-Surface mount

Return air fraction 0.000

Radiant fraction 0.720

Visible fraction 0.180

Convective fraction 0.100

BY AUTOMATED SURFACES

☒ On

Working plane height (m) 0.80

Control type 3-Stepped

Number of steps 2

Glare

Maximum allowable glare index 22.0

View angle rel. to y-axis (°) 0.0

Lighting Area 1

% Zone covered by Lighting Area 1 100.0

Lighting Area 2

☐ Second lighting area

Task and Display Lighting

☒ On

Exterior Lighting

☒ On

Absolute power (W) 40,000

Schedule Po potrebi vanjska

Control option 2-Schedule + override off in daytime

Cost

Edit Visualise Heating design Cooling design Simulation CFD Daylighting Cost and Carbon

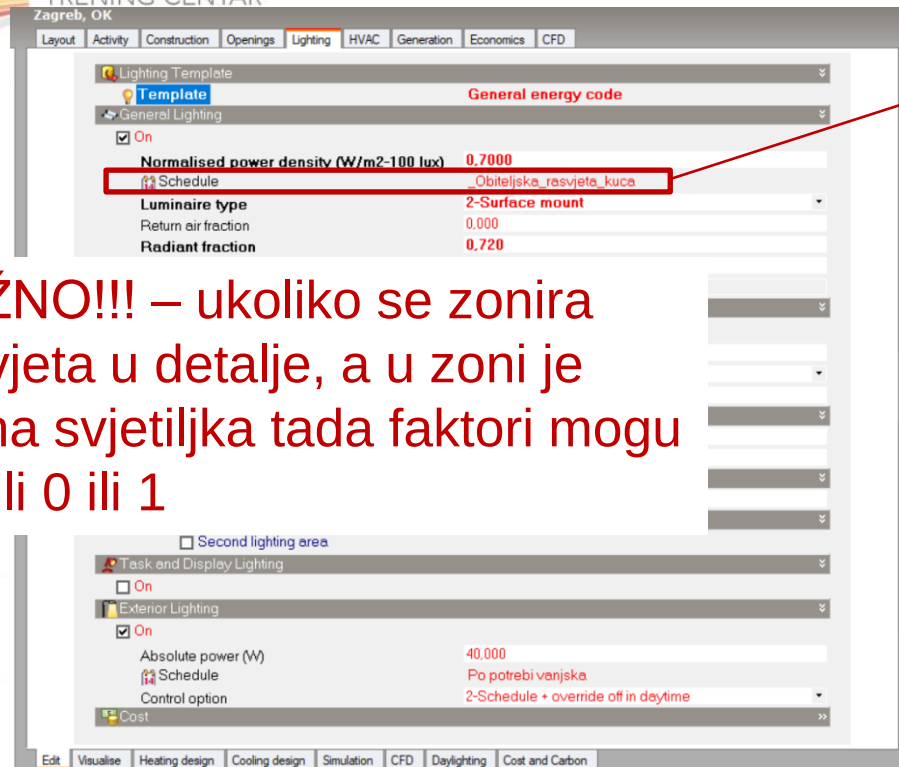
$268 \text{ W}/192 \text{ m}^2 = 1,4 \text{ W}/\text{m}^2$
 Osvjetljenost = 200 lx
 $1,4/2 = 0,7 \text{ W}/(\text{m}^2 \text{ } 100\text{lx})$

Način montiranja svjetiljke –
 utječe na unutarnje dobitke
 U ovom primjeru –
 nadgradna svjetiljka

Upravljanje rasvjetom –
 stepped znači u koracima
 (bez mogućnosti
 prigušenja); 2 koraka –
 uključiti/isključiti

Vanjska rasvjeta

Sustav rasvjete



Layout Activity Construction Openings Lighting HVAC Generation Economics CFD

Lighting Template

Template General energy code

General Lighting

☒ On

Normalised power density (W/m2-100 lux) 0.7000

Schedule Obiteljska_rasvjeta_kuca

Luminaire type 2-Surface mount

Return air fraction 0.000

Radiant fraction 0.720

Second lighting area

Task and Display Lighting

☐ On

Exterior Lighting

☒ On

Absolute power (W) 40.000

Schedule Po potrebi vanjska

Control option 2-Schedule + override off in daytime

Cost

Edit Visualise Heating design Cooling design Simulation CFD Daylighting Cost and Carbon

VAŽNO!!! – ukoliko se zonira rasvjeta u detalje, a u zoni je jedna svjetiljka tada faktori mogu biti ili 0 ili 1

Način korištenja
- Satna distribucija rada sustava rasvjete – udio rasvjete koji se koristi (faktor okupiranosti)

Schedule: Compact
_Visestambena_rasvjeta_stan,
Fraction,
Through: 31 Dec,
For: Weekdays,
Until: 06:00, 0.03,
Until: 07:00, 0.27,
Until: 08:00, 0.20,
Until: 16:00, 0.25,
Until: 18:00, 0.20,
Until: 23:00, 0.30,
Until: 24:00, 0.25,
For: Weekends,
Until: 06:00, 0.06,
Until: 23:00, 0.5,
Until: 24:00, 0.25,
For: Holidays,
Until: 24:00, 0.1,
For: AllOtherDays,
Until: 24:00, 0;

Npr. između 7 i 8
ujutro se koristi
27% instalirane
snage rasvjete
(dnevni boravak,
hodnik, dio soba)

Sustav rasvjete

Način korištenja unosi najveću nesigurnost u proračun
– kalibracija modela

Zagreb, OK

Layout Activity Construction Openings **Lighting** HVAC Generation Economics CFD

Lighting Template General energy code

☒ On

Normalised power density (W/m²-100 lux) 0.7000

Schedule _Obiteljska_rasvjeta_kuca

Luminaire type 2-Surface mount

Return air fraction 0.000

Radiant fraction 0.720

Visible fraction 0.180

Convective fraction 0.100

Lighting Control

☒ On

Working plane height (m) 0.80

Control type 3-Stepped

Number of steps 2

Glare

Maximum allowable glare index 22.0

View angle rel. to y-axis (°) 0.0

Lighting Area 1

% Zone covered by Lighting Area 1 100.0

Lighting Area 2

☐ Second lighting area

Task and Display Lighting

☐ On

Exterior Lighting

☒ On

Absolute power (W) 40.000

Schedule Po potrebi vanjska

Control option 2-Schedule + override off in daytime

Cost

Edit Visualise Heating design Cooling design Simulation CFD Daylighting Cost and Carbon

Edit lighting template - General energy code

Lighting templates

General Output Control Cost

General Lighting

☒ On

Normalised power density (W/m²-100 lux) 3.40

Absolute zone power (W) 0.00

Luminaire type 1-Suspended

Return air fraction 0.00

Radiant fraction 0.42

Visible fraction 0.18

Task and Display Lighting

☐ On

Locked Library data

Help

Lighting Gains

Enter the gains for task and general lighting in W/m².

The 'Output' data is used for generating default lighting loads based on lighting type and required illuminance levels as set in Activity data.

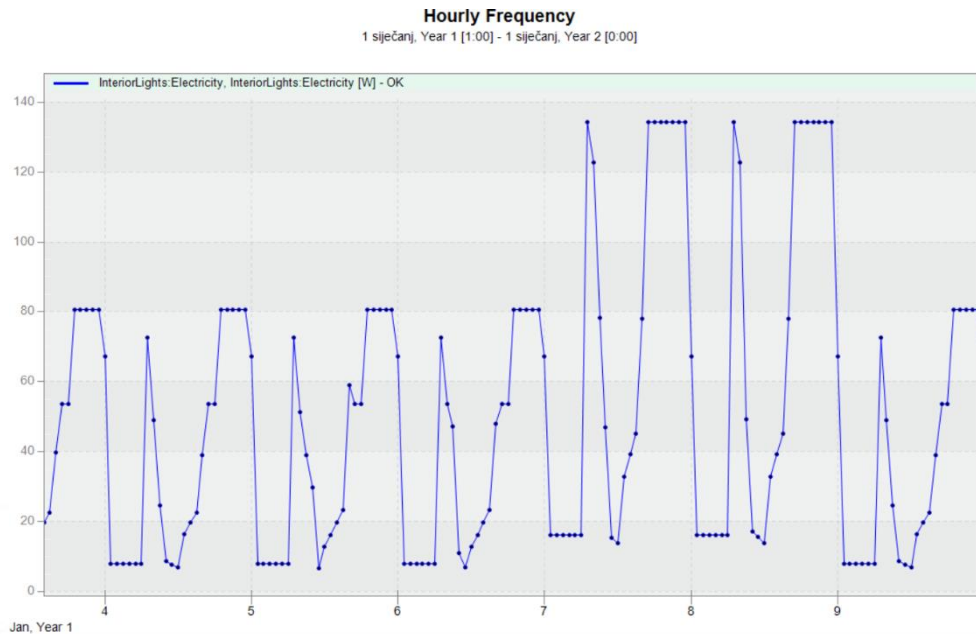
Suspended Surface Mount

Luminous and Louvered Ceiling Return-Air Ducted

Help Cancel OK

Može se izraditi predložak koji definira sve ulazne parametre

Sustav rasvjete



Mogućnost definiranja rasporeda za svaki dan, svaki sat – radi jednostavnosti definiran isti način rada za vikende, odnosno radne dane, ubačen i zaseban raspored za godišnje odmore

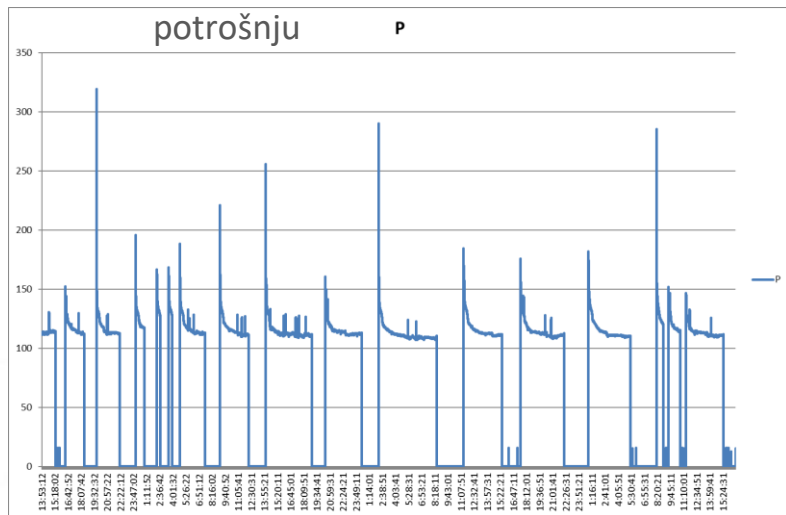
Na sredini svake zone – senzor osvjetljenosti (simulacija osvjetljenosti – utjecaj prirodnog osvjetljenja)

Oprema

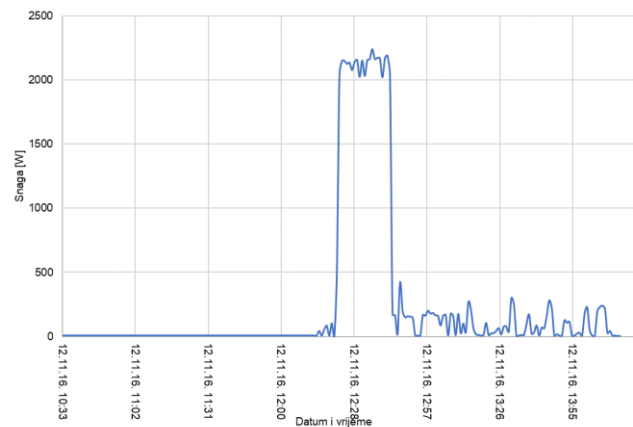
- Podaci iz energetskeg pregleda:
 - Instalirana snaga opreme – 9,77 kW kuhinjske opreme; 4,55 kW ostale opreme
 - Smještaj u prostoru – zbog jednostavnosti isti parametri u svim prostorima
 - Način korištenja pojedine opreme - SCHEDULE

- Ovisno o pojedinim potrošačima i korištenju različita satna opterećenja

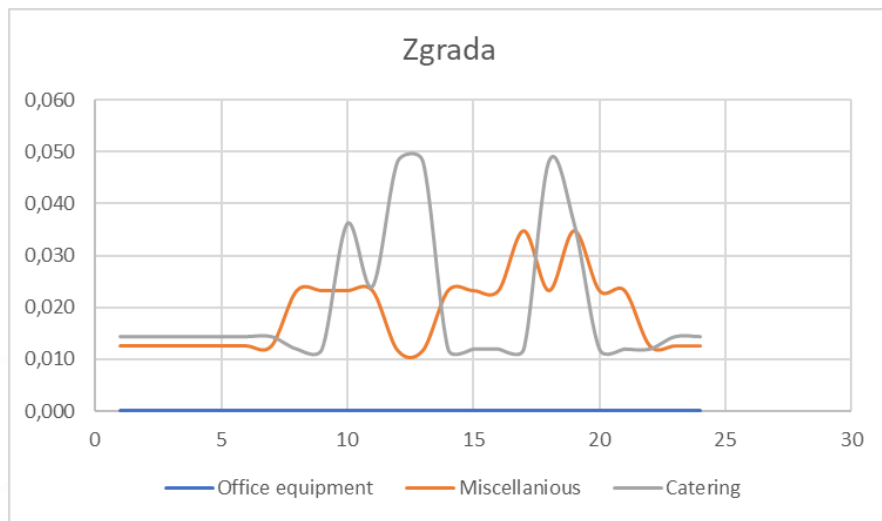
- Primjer 1 – Hladnjak, ima relativno istu satnu potrošnju



- Primjer 2 – Perilica rublja, satno potrošnja značajno varira

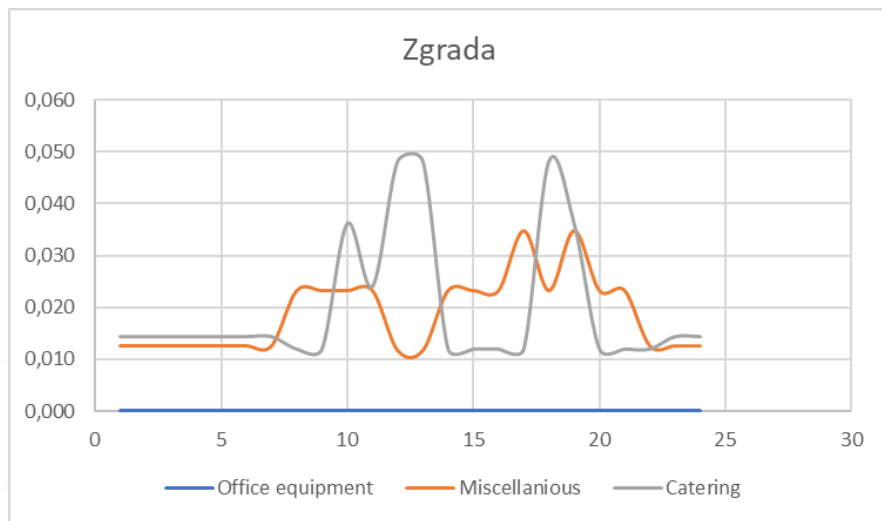


- Razrada modela za karakterističan dan na satnoj razini rada pojedinih uređaja uz određenu vjerojatnost – izrazita nesigurnost bez mjerenja



- Ako je instalirana snaga kuhinjske opreme 9,77 kW, raspored rada kaže kako je maksimalna satna potrošnja 488 Wh
- Samo pećnica u jednom satu utroši oko $2\text{kW} \cdot 0,66 = 1,32 \text{ kWh}$

- Razrada modela za karakterističan dan na satnoj razini rada pojedinih uređaja uz određenu vjerojatnost – izrazita nesigurnost bez mjerenja



- Pećnica nije uključena svaki dan, i to u istom satu – vjerojatnost poklapanja u svakom danu i svakom satu
- Složena procjena interakcije raznih uređaja – najtočniji podaci 15 min krivulje stvarne potrošnje sa brojila

2 mogućnosti unosa u program:

- Unos stvarne snage – u ovom slučaju 9,77 kW za kuhinjsku opremu, odnosno 4,55 kW za ostalu opremu podijeljeno sa kvadraturom
 - Zoniranje – paziti na kvadraturu svakog segmenta gdje se oprema uključuje ili ne uključuje
 - Unos rasporeda sa reduciranim korištenjem
- **Unos normalizirane snage podijeljene sa kvadraturom**
 - Normalizirana snaga se određuje prema maksimumu potrošnje u jednom satu
 - Opet paziti na zoniranje
 - Raspored je određen prema maksimumu

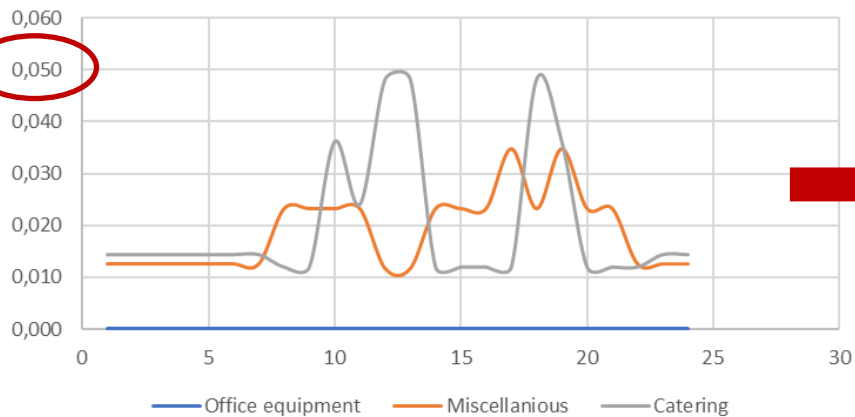
Oprema

60 W/m² - stvarna snaga

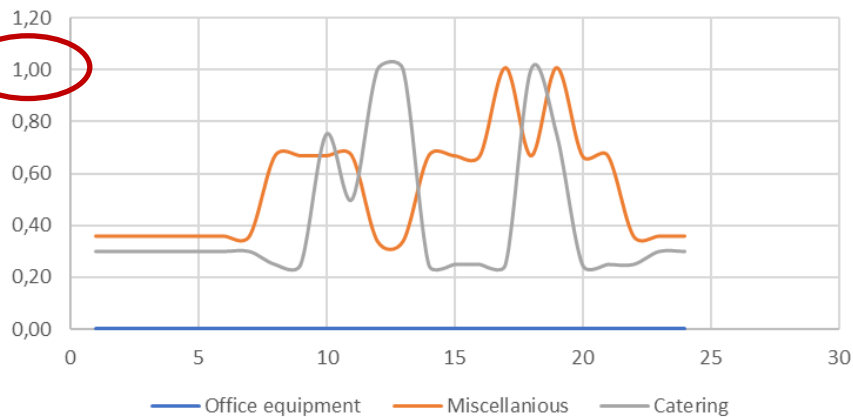


$60 \cdot 0,05 = 3 \text{ W/m}^2$ - normalizirana snaga

Zgrada



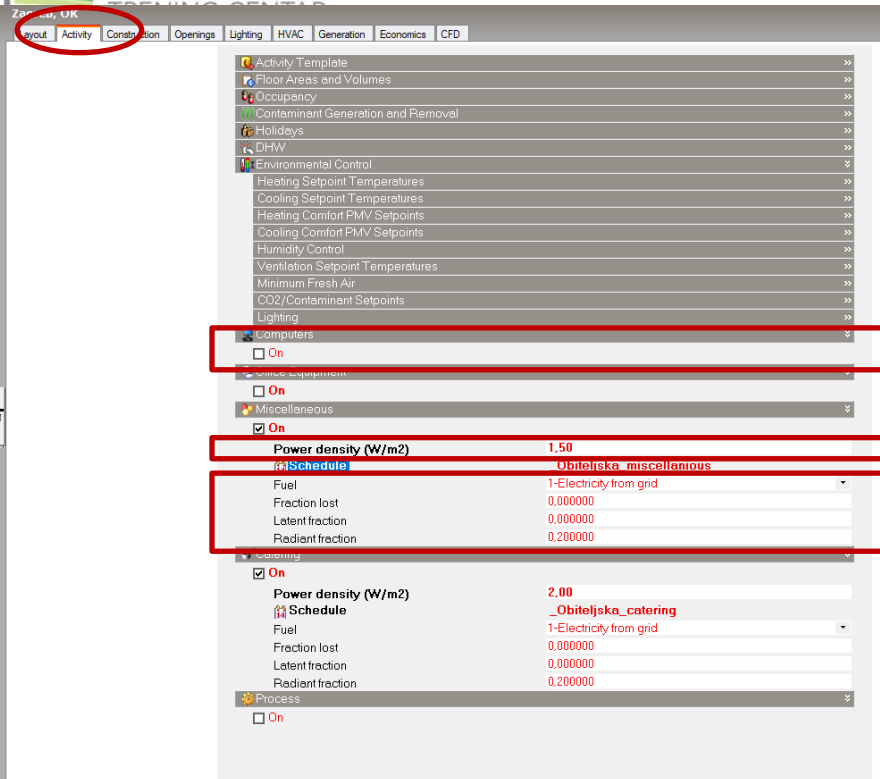
Zgrada



Odabir što od opreme se nalazi u zoni – nema računala

Unos gustoće snage – normalizirane vrijednosti, cijela zgrada jedna zona

Odabir energenta
 Fraction lost – udio topline koji ne završi u prostoru
 Latent fraction – latentna toplota, utjecaj na vlagu
 Radiant Fraction – toplota emitirana zračenjem



Activity Template

Floor Areas and Volumes

Occupancy

Contaminant Generation and Removal

Holidays

DHW

Environmental Control

Heating Setpoint Temperatures

Cooling Setpoint Temperatures

Heating Comfort PMV Setpoints

Cooling Comfort PMV Setpoints

Humidity Control

Ventilation Setpoint Temperatures

Minimum Fresh Air

CO2/Contaminant Setpoints

Lighting

Computers

☐ On

☐ Off

Miscellaneous

☒ On

Power density (W/m²) 1.50

Schedule Obiteljska_miscellaneous

Fuel 1-Electricity from grid

Fraction lost 0.000000

Latent fraction 0.000000

Radiant fraction 0.200000

Lighting

☒ On

Power density (W/m²) 2.00

Schedule Obiteljska_catering

Fuel 1-Electricity from grid

Fraction lost 0.000000

Latent fraction 0.000000

Radiant fraction 0.200000

Process

☐ On

Schedule: Compact
_Obiteljska_miscellaneous
Fraction,
Through: 31 Dec,
For: Weekdays,
Until: 08:00, 0.25,
Until: 12:00, 0.66,
Until: 14:00, 0.33,
Until: 17:00, 0.66,
Until: 18:00, 0.99,
Until: 19:00, 0.66,
Until: 20:00, 0.99,
Until: 22:00, 0.66,
Until: 24:00, 0.25,
For: Weekends,
Until: 08:00, 0.25,
Until: 12:00, 0.66,
Until: 14:00, 0.33,
Until: 17:00, 0.66,
Until: 18:00, 0.99,
Until: 19:00, 0.66,
Until: 20:00, 0.99,
Until: 22:00, 0.66,
Until: 24:00, 0.25,
For: Holidays,
Until: 24:00, 0.25,

Način
korištenja unosi
najveću
nesigurnost u
proračun –
kalibracija
modela

Zagreb, OK

Layout Activity Construction Openings Lighting HVAC Generation Economics CFD

Activity Template	>>
Floor Areas and Volumes	>>
Occupancy	>>
Contaminant Generation and Removal	>>
Holidays	>>
DHW	>>
Environmental Control	>>
Heating Setpoint Temperatures	>>
Cooling Setpoint Temperatures	>>
Heating Comfort PMV Setpoints	>>
Cooling Comfort PMV Setpoints	>>
Humidity Control	>>
Ventilation Setpoint Temperatures	>>
Minimum Fresh Air	>>
CO2/Contaminant Setpoints	>>
Lighting	>>
Computers	>>
☐ On	
Office Equipment	>>
☐ On	
Miscellaneous	>>
☒ On	
Power density (W/m ²)	1.50
Schedule	_Obiteljska_miscellaneous
Fuel	1-Electricity from grid
Fraction lost	0.000000
Latent fraction	0.000000
Radiant fraction	0.200000
Catering	>>
☒ On	
Power density (W/m ²)	2.00
Schedule	_Obiteljska_catering
Fuel	1-Electricity from grid
Fraction lost	0.000000
Latent fraction	0.000000
Radiant fraction	0.200000
Process	>>
☐ On	

Okupiranost

Layout **Activity** Construction Openings Lighting HVAC Generation Economics CFD

Activity Template

Template stanovi

Sector Copy of Residential spaces

Zone multiplier 1

☒ Include zone in thermal calculations

☒ Include zone in Radiance daylighting calculations

Floor Areas and Volumes >>

Occupancy >>

Occupancy density (people/m²) 0.0208

Schedule _Obiteljska_okupiranost

Metabolic >>

Clothing >>

Comfort Radiant Temperature Weighting >>

Contaminant Generation and Removal >>

Holidays >>

DHW >>

Environmental Control >>

Heating Setpoint Temperatures >>

Cooling Setpoint Temperatures >>

Heating Comfort PMV Setpoints >>

Cooling Comfort PMV Setpoints >>

Humidity Control >>

Ventilation Setpoint Temperatures >>

Minimum Fresh Air >>

CO₂/Contaminant Setpoints >>

Lighting >>

Computers >>

Office Equipment >>

Miscellaneous >>

Catering >>

Process >>

Moguće je izraditi predložak koji sadrži ključne parametre – uključuje gustoću opreme, rasporede i slično

Activity templates

General All Gains **Occupancy** Other Gains DHW Environmental control

Computers >>

☐ On

Office Equipment >>

☒ On

Power density (W/m²) 11.77

Absolute zone power (W) 0.00

Radiant fraction 0.200

Workday profile >>

On at 7:00

Off at 20:00

Schedules >>

Schedule Office_OpenOff_Equip

Miscellaneous >>

☐ On

Catering >>

☐ On

Process >>

☐ On

General Lighting >>

☒ On

Workday profile >>

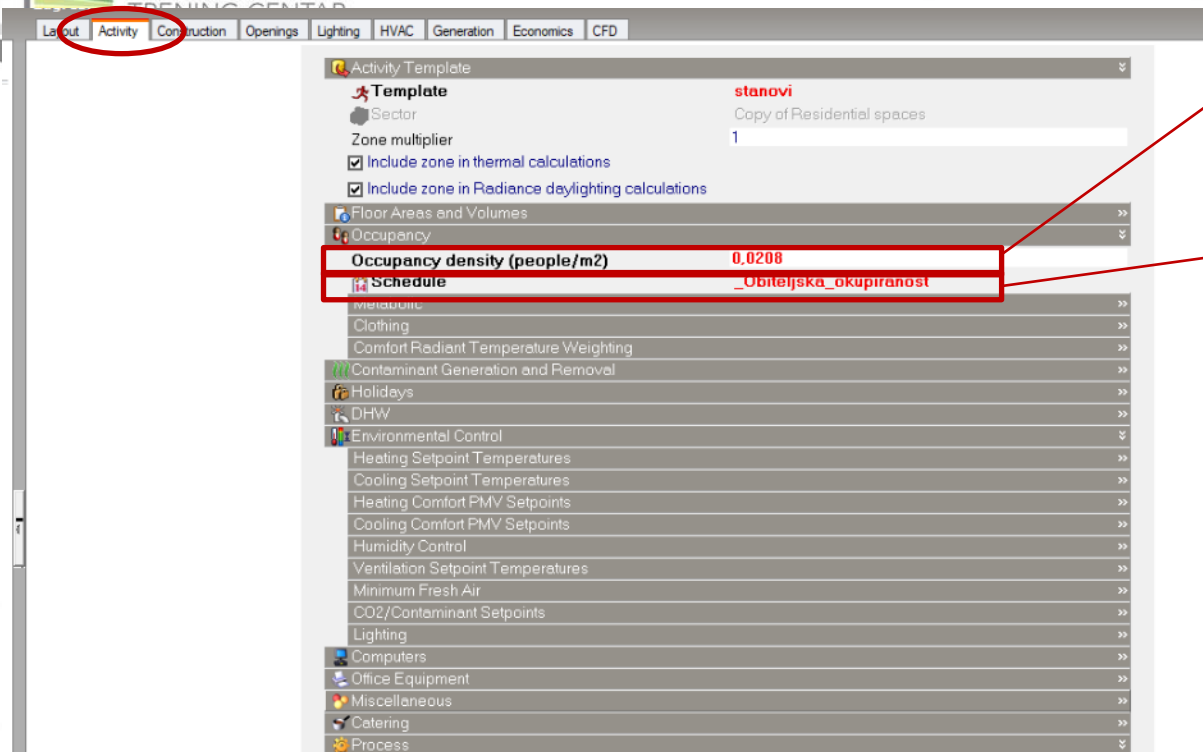
On at 7:00

Off at 19:00

Schedules >>

Schedule Office_OpenOff_Light

Okupiranost



Gustoća
okupiranosti zgrade
= 4 osobe / 192 m²

Okupiranost zgrade
– metabolički dobici

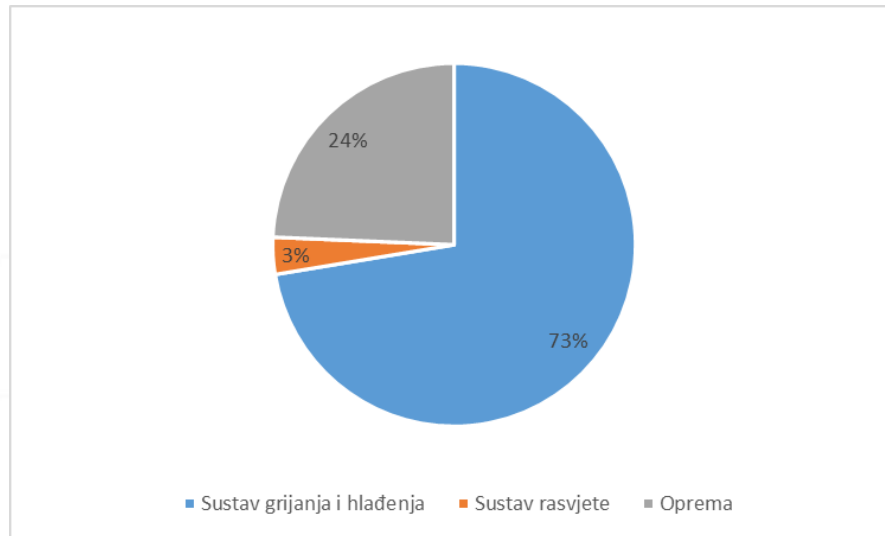
```
Schedule:Compact
_Obiteljska_okupiranost
Fraction,
Through: 31 Dec,
For: Weekdays,
Until: 06:00, 0.94,
Until: 07:00, 0.88,
Until: 08:00, 0.68,
Until: 16:00, 0.53,
Until: 18:00, 0.65,
Until: 23:00, 0.83,
Until: 24:00, 0.94,
For: Weekends,
Until: 06:00, 0.94,
Until: 23:00, 0.88,
Until: 24:00, 0.94,
For: Holidays,
Until: 24:00, 0.53,
For: AllOtherDays,
Until: 24:00, 0;
```

Kalibracija modela

- 3 mogućnosti kalibriranja:
 - Godišnji model
 - Mjesečni model
 - Satni model
- Ovisi o dostupnosti podataka

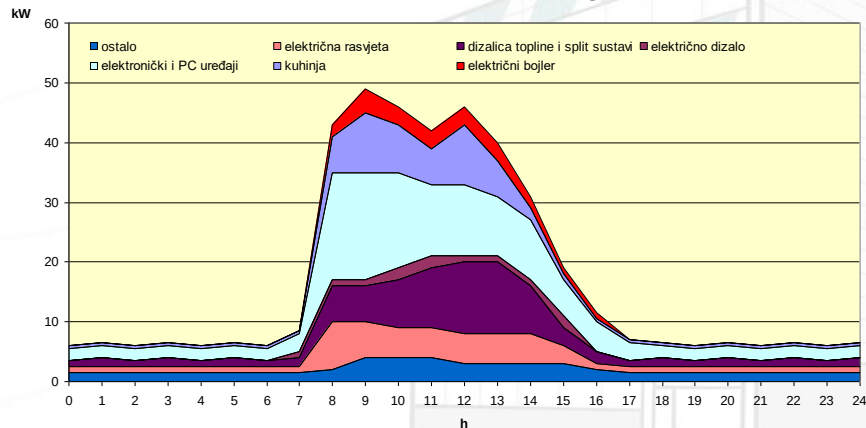
Kalibracija modela

- Prema podacima iz energetskeg pregleda (računi + bilanca potrošnje energije) – godišnji model
- Potrošnja električne energije – cca 10.000
- Prilagodba rasporeda
- Prilagodba temperatura



Kalibracija modela

- Poznata ciljana godišnja potrošnja
- Prosječna dnevna potrošnja (dijeljenje sa 365)
- Iz računa poznat odnos potrošnje u višem i nižem tarifnom razdoblju – raspodjela prosječne dnevne potrošnje na noćno i dnevno opterećenje
- Satna podjela prema strukturi potrošača- i načinu korištenja dobivenom od strane korisnika



Fotonapon

- 2 ključna parametra:
 - Slobodna površina krova sa orijentacijama – predstavlja tehničko ograničenje
 - Potrošnja električne energije – predstavlja legislativno ograničenje (želja da se sva proizvedena električna energija utroši na lokaciji)
- Zgrada nema fotonapon, ali moguća je ugradnja
 - Cca 40 m² (5 kW) i 10.000 kWh (8 kW)

Hvala na pažnji!

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